PHYTOGEOGRAPHY AND VEGETATION ECOLOGY OF CUBA

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BY

A. BORHIDI

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To the memory of my unforgettable master

Julian Acuña Gale

expert of Cuban botany and agriculture,
the model of a great man and scientist

INTRODUCTION

My studies on the flora and vegetation of Cuba began in 1965 and were initially based entirely on published work. The literature on the Caribbean region was fairly poor, therefore, I extended the literature survey to the general features of tropical vegetation, with emphasis on the geobotanical methods applied or potentially applicable to the tropics.

In this respect, my study-tour to Paris in 1967 was most worthwhile for I had the opportunity to attend a course on tropical botany at the University of Paris and to consult with some of the most distinguished representatives of tropical vegetation research and mapping (Professors M. Mangenot, A. Aubréville, Dr. J. Vidal and Dr. Mme S. Jovet Ast). I am most grateful to them for their advice, patience and tolerance. I was deeply impressed by Professor H. Gaussen whose personal letters, publication series on bioclimatology and mapping provided me with a thorough systematic and methodological concept of the modern bioclimatological principles.

My first study trip to Cuba took place from July 1969 to September 1970, with the task to organize and instruct a geobotanical mapping group, and to draw a vegetation map of Cuba at the scale of 1:1,000,000. This work received a modest financial and a considerable moral support by the Hungarian Academy of Sciences, primarily by István Láng Secretary General for which I should like to express my gratitude. I should like to stress the scientific advice and professional support received from J. Balogh, Member of the Hungarian Academy of Sciences, Professor of Zoology at the Eötvös Loránd University, Budapest, the most recognized Hungarian expert of tropical soil biology; and from T. Pócs, head of department of the Institute of Ecology and Botany of the Hungarian Academy of Sciences, who has extensive experience in tropical bryology and bryogeography.

The fact that it was possible to complete the mapping project within the 14 months of my first Cuban stay and to obtain important results in geobotany, phytogeography and taxonomy was due to the Cuban Academy of Sciences and the inexhaustible help of Cuban colleagues, co-workers and professionals. Primarily, I should mention my master, J. Acuña Gale, the great personality of Cuban botany and agriculture who regretfully passed away in 1973 but who still lives in my grateful memory. By revising 14 000 herbarium sheets of our collection, with his unselfish and devoted teaching of his taxonomic knowledge and extensive field experience he was an outstanding example of both botanical expertise and human greatness. In a

few months he introduced me to the flora of six and a half thousand vascular species of Cuba thus making me able to carry on a successful vegetation study.

I am grateful to O. Muñiz, former Director of the Botanical Institute of the Cuban Academy of Sciences, who could ensure favourable working conditions for me even in the difficult phase of the organization of the institute. He took the lion's share in organizing our expeditions and actively participating in the field trips thereby contributing to their success. Besides this, he was my devoted collaborator in the preparation of the maps of the phytogeographical regions and vegetation of Cuba. Thanks are due to the numerous members of the staff of the institute. I am grateful especially to Dr. Antonia Garcia Gavilán for her long and painstaking work in collecting meteorological data and in helping me with the literature survey, to Isabel Elias for performing calculations in the life-form and flora analyses and expert management of the collected plant material, to Sergio Vazquez for his exceptional and enthusiastic field work, to Nazario Gonzales for his multilateral help, and to A. Izquierdo, Director of the Water Management Research Institute, for providing me with unpublished data of measurements of the institute. Without their understanding and help, our investigations aimed at determining the potential vegetation and creating a bioclimatological survey of Cuba could not have been possible.

During my second Cuban visit of 29 months (1974—1976), together with E. del Risco and R. Capote, we worked out the long-term plan of the Geobotanical Department which had meanwhile been set up in the Botanical Institute of the Cuban Academy of Sciences.

Research was commenced in two topics:

1. Ecological studies of a tropical evergreen forest in the MAB — station in the Sierra del Rosario.

2. The preparation of the Vegetation map of Cuba at the scale of 1:250 000. In the framework of an earlier project, together with E. del Risco, we completed the vegetation map of the Zapata Peninsula at the scale of 1:100 000. In the course of our work an opportunity arose to continue our research on the ecology and geobotany of Cuba with the help of gifted young Cuban geobotanists. E. del Risco deserves appreciation since, after a year of collaboration, he is compiling the geobotanic monograph of Zapata Peninsula. I received valuable help from my young collaborators. R. Capote, in the course of mapping the vegetation of Pinar del Rio province at a scale of 1:250 000, became proficient in the application of modern geobotanic mapping methods. J. Urbino gained experience in the geobotanical interpretation of aerial photographs, and helped me in mapping the plant communities. We worked out an analytic key for the geobotanical interpretation of aerial photographs. Ramona Oviedo participated in the taxonomic identification of the collected material and, during our collecting trips, became a reliable expert of the dicotyledonous flora of Cuba.

Althougth I use only partial results from our joint research in this book, the colleagues deserve acknowledgement for their diligence and enthusiastic collaboration. Thanks are due to O. Muñiz, for his support and deep understanding without which our project could not have been finished with success.

Data processing and evaluation required a further three years of intensive work.

I am indebted to dr. Zoltán Szőcs, my colleague, for his valuable help in the computer processing of the huge mass of phytosociological data. For scrutinizing the literature on plate tectonics and providing guidelines, thanks are due to Dr. Károly Brezsnyánszky. I am grateful to Mrs. H. Muhoray for preparing the drawings, and to Mrs. F. Zotter and Mrs. S. Baksza for their help in compiling the manuscript.

I should like to express my thanks to Prof. Imre Máthé and Pál Jakucs, Members of the Academy, to Prof. Tamás Pócs to László Kádár, Professor of Geography of the University of Debrecen, and to Dr. Edmund Tanner, Lecturer of the Botany School of Cambridge University, for the critical reading of this text thereby eliminating mistakes and misinterpretations.

In some taxonomic and botanical historic questions, Prof. Richard A. Howard, former Director of the Arnold Arboretum of Harvard University, and Prof. William T. Stearn, former Director of the Botanical Department of the British Museum oriented me very kindly. I am very thankful for their help.

The English text was translated by Mrs. I. Kecskés and Dr. J. Podani and the critical reading of the translation was made by Dr. J. Podani, Prof. L. Mihályi and Dr. E. Tanner. For their helpful and important remarks I wish to express my gratitude.

Last but not least, I am extremely grateful to my wife, Zsuzsanna B. Thury, and to her kind parents for their understanding, endurance and capacity for sacrifice without which this book could hardly have been written. I have to thank my wife especially for her valuable work in revising the Herbarium of the Academy of Sciences of Cuba (HAC) for carrying out leaf-size measurements of Cuban trees and shrubs, and for her help in the compilation of the literature.

Scientific preliminaries and objectives

The scientific preliminaries in Cuba, just as in most tropical countries, are closely correlated with the history of the country, political situation and economic conditions. Cuba was a Spanish colony until the end of the last century a half colonized republic under the sway of American monopoly, until 1959. So the scientific life was similar to that of the colonized countries. The plant kingdom of Cuba was studied and discovered mostly by foreigners, mainly American, Scandinavian, German and French researchers. The respectable figures of Cuban botany, such as Blain, Sauvalle, Roig and Acuña, were physicians, pharmacists, agricultural engineers who struggled as amateurs to attain the highest ranks in the knowledge and study of the Cuban flora. However, they had neither time nor financial support necessary to compete with the professional foreign researchers supported by considerable funds. Nevertheless, they did not want the botanical values of their country to be discovered without their participation and they (especially Roig and Acuña) — took a major share in flora research and in the establishment of the national collection.

After the revolution, the situation of science changed basically. The Cuban Academy of Sciences was formed with numerous research sites and institutions. In

these institutes there are many foreign experts, especially from the East-European countries who work under the guidance and control of home institutions with the organization of Cuban research workers, according to a more or less well-developed long-term research plan.

Exploration and study of the Flora

Two hundred years of Cuban botanical research are almost entirely associated with flora research. Its history was compiled up to the turn of the century by Urban (1898), till 1945 by León (1946) and until 1957 by Alvarez Condé (1958).

The history of flora research in Cuba can be divided into three stages. The first is from the discovery of Cuba till 1850; this period is characterized by sporadic collecting extended over small areas. More important explorers of this period were Kunth, Linden, La Ossa, Valenzuela, La Sagra, etc., whose collections were later named and revised in the early volumes of De Candolle's Prodromus and later by A. Richard in volumes X and XI of the great Cuban Encyclopaedia of La Sagra (1845, 1850). The feature best reflecting the second period is a comprehensive work encompassing large areas; it lasts from 1850 to the turn of the century. A most prominent figure is C. Wright who travelled all over Cuba with the exception of the highest mountains and tripled the number of the phanerogamous plant species known from this territory in 10 years.

His collections were identified by Grisebach, an outstanding expert in both taxonomy and plant geography 1857, 1860, 1862, 1864, 1866. To Grisebach's work Wright contributed additions (in Sauvalle 1868—71, 1873). Apart from him, dozens of specialists (Sullivan, Eaton, Berkeley, Muller, Underwood, Mueller von Argau, De Candolle, Schlechter, Urban) dealt with Wright's material which, even today, reveals points of interest to botanists.

The third phase of flora research stretches from the turn of the century till 1960. A feature of this period is the striving for a flora synthesis that summarizes the intensive collecting work of many researchers. The goals of this period are the establishment of large collections (New York, Stockholm, Berlin, Santiago de las Vegas, Havanna), the elimination of the "white spots", the reconstruction of Wright's itinerary and the identification of his type localities. Among the many excellent collectors (Combs, Curtiss, Baker, Britton, P. Wilson, León, Roig, Jack, Marie-Victorin, Acuña, Howard, Killip, Alain), J. A. Shafer's and, above all, E. L. Ekman's activity emerges in importance and achievement. Ekman was the first to explore the highest peaks of Sierra Maestra and Sierra del Cristal which were considered to be unconquerable. He alone collected more taxa than all the botanists together before him. The elaboration of the collections made in this wonderful period is being carried out by three exceptionally talented taxonomists (Urban, Britton and Marie-Victorin) as well as numerous excellent specialists (for example Hitchcock, Chase, R. E. Fries, Moldenke, O. C. Schmidt, Loesener, Kükenthal, Cogniaux, Schlechter, Maxon, Morton, Standley, Mc Vaugh, etc.). In consequence of their work, the vascular flora of Cuba surpassed 6300 known species. After numerous attempts at synthesizing (Gómez de la Maza and Roig 1914, Roig 1928,

Britton, Wilson and León 1914, 1932 ined.), the first comprehensive work appeared in five volumes by León (1946). León and Alain (1951—1957), Alain (1962), and in a supplement (Alain 1969). Although this work is an important milestone in the Cuban flora research, it cannot be regarded as a final one.

In the 10 years since its publication, eight new phanerogamous genera and almost 500 new species and subspecies enriched the Cuban flora as a consequence of research partly by Alain Liogier further by Bisse, Lippold, Areces, Mészáros, and partly by Borhidi, Borhidi, Acuña and Muñiz, Borhidi and M. Fernandez, Borhidi and Muñiz, M. Fernandez and Borhidi, Muñiz and Borhidi, Klotz, Lepper, Manitz, Köhler, Meyer, Dietrich, Leyva, Alvarez, Diaz, J. Fernandez etc.

At present, the fourth phase of flora research is taking place whose goal is the preparation of a detailed critical flora work. A characteristic of this phase is that whereas only selected localities were explored previously, now the aim is the thorough study of whole geographic regions and the increase of knowledge on the natural variability of taxa. Such work demands collecting from many areas and an extensive critical approach. This kind of work has been started from 1975 within the framework of the "New Flora of Cuba Project" organized by the National Botanical Garden of Cuba in collaboration with the Botanical Department of the University of Jena (GDR) with the participation of about 50 specialists of Cuba, GDR, USSR, Hungary, Poland, The Netherlands, Belgium etc. A large number of preliminary studies and genus-monographs have been published as products of this project in the reviews "Revista del Jardin Botánico National", "Ciencias Biológicas", "Acta Botanica Cubana", "Acta Botanica Hungarica", "Feddes Repertorium", "Wiss. Zeitschrift der Universität Jena" etc.

Plant geographical studies

The so-called "ecological" research (or more precisely, geobotanical, chorographical and plant geographical) was extremely restricted till 1960. Ekman (in Urban 1923, 1924) first provided a short description of some characteristic Cuban plant formations. In the course of flora explorations about one hundred floristic and geographic publications appeared mainly due to León and Alain, Acuña and Roig. The first trip with a geobotanic approach was due to Seifriz, who distinguished ten plant formations and thereby provided a survey of the most important vegetation types of the island (1943). The most intriguing is the magnificent three-volume diary of the expedition of Marie-Victorin and León (1942, 1944, 1956), which is virtually a storehouse of original observations. Many original chorological data, plant distribution maps and numerous valuable comments are contained in it with respect to the structure and distribution of certain vegetation types, and to their more interesting plant species. Carabia's (1945a) study on the vegetation of Sierra de Nipe, Lötschert's (1958) work on the conic karst vegetation of Sierra de los Organos, and P. Ponce-León's (1952, 1953, 1954) zonation studies on the vegetation of the sandy and rocky littoral belts and the lowland semi-deciduous forests are worth mentioning. These are simply qualitative surveys of vegetation without structural and quantitative analyses. The first

quantitative analysis was carried out by Howard and Briggs (1953) on the microphyllous shrubforests, in the limestone "dog-tooth" area of the south coast of Las Villas. E. Smith's work, "The Forests of Cuba", provides a survey on the tree species of Cuban forests valuable from a forestry point of view and gives a practical classification of forests. Its qualitative lists and sample plot analyses contain many valuable data but are incomplete from a phytosociological viewpoint. As the lists were compiled primarily for the assessment of valuable timber species, they give the impression that the composition of tree species of Cuban forests is everywhere almost identical, this is not the case, of course.

Geobotanical research

The geobotanical, phytosociological and ecological research, understood in the strictest sense, began following the revolution in the sixties mainly with the collaboration of Czechoslovakian, German and Hungarian botanists. V. Samek's work should be particularly emphasized. He investigated the pine-woodlands and forests of Isla de Pinos, Cajalbana and Sierra de Nipe, and the water vegetation of sandy lagoons of the Guanahacabibes Peninsula (Samek and Moncada 1970) with the phytosociological methods of the Zürich–Montpellier school (1967, 1973 a,b). Furthermore, he mapped the vegetation of Isla de Pinos (1967, 1969). Hadač and Hádačová (1969, 1971), studied some plant communities in the sandy regions of Pinar del Rio, and carried out autoecological investigations on several Cuban plant species. Schubert and Danert (1969, 1971) studied two nature conservation areas (El Veral and Cupeyal) with respect to their plant communities and microclimate. Gantcheff (1968) attempted to write a phytosociological monograph on the vegetation of the latter area.

With respect to the ecological effect of serpentine rocks on the tropical vegetation, Berazain (1979, 1981), Borhidi (1975, 1980), Borhidi and Pócs (1985) reported new results. On the origin and distribution of Cuban savannas Borhidi and R. Herrera (1977) have presented a detailed account. The first systematic review of the Cuban plant communities appeared in 1979 (published by Borhidi, Muñiz and Del-Risco). Since that time an intensive exploration of the plant communities has been made by Borhidi, R. Capote, Balátová-Tuláčková and their collaborators (see: Acta Bot. Hung., Folia Geobot. et Phytotax., and Acta Botanica Cubana).

Phytogeographic division

The first short summary of the phytogeographic relationships of Cuba appeared in the first volume of the Flora of Cuba (1946:45—63) by León who distinguished 3 phytogeographic regions and 9 districts. The more recent, so-called "geobotanic map" of Voronov is only a little more detailed (Atlas Nacional de Cuba 1970:59). Samek's (1973 c) work is a valuable phytogeographical study, which is primarily based on the distribution patterns of endemic species. A different view was pointed out by Bisse (1975) about the phytogeographic regions of Cuba. He proposed to

distinguish 4 floristic sectors. This opinion was not followed by Klotz (1978). The work of R. A. Howard (1974) on the vegetation of the Antilles is worth mentioning. It presents interesting tables on the patterns of plant distribution in the Antilles. Numerous smaller articles appeared on the characteristics of plant area types, especially on the richness of endemic species (León 1926, Carabia 1945, Alain 1953). The most outstanding works are the excellent review of Alain (1958) and Muñiz's map on the ecological requirements and geographic distribution of the endemics (Atlas Nacional de Cuba 1970:60). All these works and the field experiences served as bases for the authors to work out a new phytogeographic survey of Cuba related to the recent results of the Global Tectonics (Borhidi 1985, Borhidi and Muñiz 1986).

Vegetation maps

Five vegetation maps of Cuba have been made. The first appeared in the inside face of the cover of the first volume of Flora of Cuba (León 1946), at the scale of 1:5 million. This illustrated the natural vegetation, distinguishing among 8 vegetation units altogether.

The second map appeared in the Atlas Nacional (1970:58—59) after our work had begun. It was prepared in the scale of 1:1.5 million by A. Alonso and Voronov with the collaboration of Cuban geographers. This map is based on 3 months of field work and depicts the actual vegetation of Cuba. However, large areas are indicated as being agricultural lands, the map does not distinguish among the different polydominant forest types (there are at least 6 types). Its units cannot be identified with the generally accepted types shown by tropical vegetation maps. A potential vegetation map at the scale of 1:3 750 000 is available (Borhidi 1974). It contains 21 vegetation units and is the simplified version of map (1:1000 000) published by Borhidi and Muñiz in 1980 and 1984 distinguishing 34 vegetation units, and several derived thematical maps. Another important map was published on the actual vegetation of Cuba by A. Areces in the Atlas de Cuba (1978:38—39) in a scale of 1:1.750 000.

Bioclimatic studies

Bioclimatic research started only in the recent past. Only one publication has appeared. Samek and Travieso's work on Cuban climatic regions (1968) is based exclusively on data from lowland meteorological stations and so it is biased. Since the authors were not aware of either Gaussen's or Walter's or Meher-Homji's climatic divisions, their climatic types are of local importance.

As a summary of a comprehensive bioclimatological study, the first correct bioclimatological map and a complex bioclimatological and vegetation transect was published in Borhidi's book (1974) and later in Borhidi and Muñiz (1980, 1984).

After the critical examination of the preliminaries outlined above, I set as my goal the following procedure and order of realization.

Map of the potential vegetation

My main task was the modern reconstruction of the natural potential vegetation in a map at a scale of 1:1 million. The following partial tasks had to be solved to achieve this goal.

Typification of vegetation

Establishing the vegetation units to be mapped and their structural analysis at the formation level are involved in typification. In connection with this, the meaning of the different local vegetation names are to be revealed.

Vegetation analysis

The analysis of structure and composition of the different units of vegetation and their ecological investigation are objectives of plant sociological and ecological basic research.

Bioclimatological research

Bioclimatological basic research of the actual vegetation is indispensable for the theoretical reconstruction and mapping of the natural potential vegetation. Considering that three quarters of the area of Cuba are covered by secondary and semi-anthropic formations, the preparation of a bioclimatological map of Cuba has become necessary. It was also important to provide an as comprehensive bioclimatic synthesis of the whole country and its most varied regions as possible.

Life-forms and phytogeographic elements

As the structural investigation of the vegetation types to be mapped is based on the life from types, it was our aim to know the life-form types and the distribution types (geoelements) of the vascular flora of Cuba (almost 6600 species). On this basis it was possible to prepare the first ecological spectrum and plant geographic analysis of the Cuban flora (Borhidi 1982).

Phytogeographical regionalization

In connection with the vegetation mapping, the extension of the programme of the expedition made it possible to explore the inner and outer phytogeographical relationships of the flora, so our aim was to prepare a new phytogeographic regionalization of Cuba. Its first version was elaborated by Borhidi and Muñiz in 1970 in manuscript later published by Borhidi (1973, 1976) in Hungarian. A Spanish

version of this phytogeographic subdivision has been published in the second volume of Acevedo's Geography of Cuba (1986) and an English version by Borhidi (1985) and Borhidi and Muñiz (1986).

Geobotanic monograph

For the realization of the above goals it was finally possible to link all these in a geobotanic synthesis, the topic of this section. What the author had in mind was such a uniform comprehensive phytogeographic-geobotanic work which has been prepared in most countries of Europe but which is available only in a few tropical countries.

I have to stress that with respect to botanical investigations, in spite of what was mentioned above Cuba may only be considered to be behind compared to the European countries. As to the tropical countries, it is a relatively well-studied country. For laying the fundamentals of a synthesis, however, multilateral studies had to be carried out. In Europe, such a synthesis arises almost by itself from the meticulous measuring and data collecting activities of numerous research institutes and several dozen researchers over a few decades. In contrast with this, in Cuba a similar information and methodological basis of geobotanic research to be laid down at an accelerated rate, concentrating exclusively on the goals on which the subsequent more detailed research could be built.

This work, as a basic geobotanic synthesis, wished to serve two goals: a) by revealing the actual and potential situation of the natural resources of the vegetation, it attempted to give a scientific basis for a more rational land use and regional management and for developing an environmental protection system; b) laying the geobotanic basis on which Cuban botany could undertake scientific tasks related to terrestrial ecosystems in the framework of MAB or other biological research programmes.

Material and methods

Expeditions

For the realization of the mapping task, a 140-day field research expedition programme was developed. In the course of this, we travelled in Cuba from Cabo San Antonio to Punta Maisi and Isla de Pinos (Isla de la Juventud) around 10 000 km with trailer and landrover. Our field studies and observations were checked on several flights and complemented by aerial photographs. In many cases, we started out from the data of the geological and pedological maps. We established in the course of our field excursions that there were 36 types of zonal, extrazonal and azonal vegetation types to be mapped.

Vegetation belt profiles

First of all, the localization of the vegetation belts of the different mountain regions was clarified. We prepared profiles about altitudinal distribution of the climatic and vegetation belts, schemes of succession series and catenas of the contact and complex formations and communities.

Phytosociological sampling of plant communities

In the course of phytosociological sampling, we studied primarily the natural plant communities and, within these, the Lignosa type noda, the polydominant tropical forests, shrub forests (matorrales) and thickets nobody had previously dealt with. Altogether, over 500 phytosociological samples, more than 20 transects and a further 20 vegetational profiles have been prepared.

Methodological problems of sampling

Sampling created several methodological problems. We attempted with my collaborators to find the most appropriate method for solving the task. Therefore, the same vegetation object was very often studied with different methods.

Sampling of monodominant and oligodominant vegetation

We established that for the sampling of communities composed of few strata and the monodominant and oligodominant communities (meadows, water vegetation pine woodland, oak forests) the method of the Zürich–Montpellier school was perfectly suitable. This method was adapted in most cases; the abundance-dominance and sociability values of the Braun-Blanquet scale were estimated. The 11 valued Domin scale was also made (see Kershaw 1968, Hadač and Hadačová 1971) since the values obtained in this way are more suitable for data analysis according to Bannister (1966). Our experience suggested that the advantages of the Domin scale in data analysis technique diminish because of the sampling errors. It is difficult to estimate certain values of the Domin scale in the field.

Sampling of polydominant tropical forests

The sampling of polydominant tropical forests was carried out using two kinds of methods, which were often combined. On the one hand we prepared a vegetation transect of an area of 5 × 30 to 5 × 150 m (cf. Lindeman 1953, Webb 1959), according to Richards' method in Richards, Tansley and Watt (1940), depending on the vertical structure of each community. On the other hand, square plots were taken using the method of the Zürich–Montpellier school. The minimal areas were

different in the community levels. In the canopy it varied between 500—5000 m², in the shrub layer it was 300—1000 m², and in the herb layer the minimum area was 50—200 m². In the epiphytic layers, the number of individuals was recorded or estimated for an average tree and the occurrence within a square was also recorded (according to Tixier 1966). In the other levels, dominance and sociability were determined on the scale mentioned above.

Method of transforming a Richards' transect into a Braun-Blanquet's square plot

The study of a tropical polydominant forest with the Zürich–Montpellier school method is a tedious hard work. Nevertheless, we found it necessary to use such a method for sampling as we could get more detailed data, thus a more objective comparison of the floristic composition of tropical polydominant forests became possible. That we could express a profile of the Richards' type for the canopy in the AD scale meant a considerable saving of time and costs. The essence of the method is that for each species we calculated the average canopy diameter by measuring that of each individual. From it the percentage cover of every species could be directly calculated.

Sampling plots in scrub forests

The most difficult sampling was that of the closed scrub forests if we consider that the high density was accompanied by high diversity. In these communities, 2 × 20 m transects were cut and 5 such transects were taken as one sample.

Classification of vegetation units by computer techniques

In the classification of the sociological units studied, the obviously different water plant communities, swamp meadows coastal grasslands and mangroves were separated from the other communities.

Forty forest and scrub communities — containing 2042 species in 267 samples were classified using several computer methods. The floristic diversity of noda was studied by Z. Szőcs, using principal component analysis (PCA, Lawley and Maxwell 1963 and Harman 1967) with 5 factors taken into account.

The classification of noda was examined according to their structural characteristics, flora element composition and life-form structure in the studied communities. The agglomerative clustering procedure of Orlóci (Orlóci 1967, Goldstein and Grigal 1972) was used. The calculations were carried out by a CDC 3300 computer.

The reconstruction of the original vegetation

We paid particular attention to revealing and establishing the original vegetation types of the cultivated areas and to the study of the origin of actual anthropic and semi-anthropic formations. On the basis of 5 years of observations of the new 3000-station precipitation network of the Water Management Institute, we drew up a new precipitation map of Cuba and a map of the climatic water balance (precipitation—evaporation). To characterize the climates ecologically, we analyzed published data from 400 stations and processed unpublished rough data of a further 600 stations. On the basis of 217 climatic diagrams selected from these analyses, according to Gaussen's bioclimatological classification, we established the climatic types of Cuba and their distribution, and prepared the bioclimatological map of Cuba. Eleven complex bioclimatological and vegetation transects were made at the characteristic points of the island for studying the correlation between climate and vegetation. These investigations permitted us to reconstruct by extrapolation the potential natural vegetation of the anthropically modified waste territories, and to draw up the vegetation map of the country.

From the bioclimatological research we prepared an ecological map of Cuba according to Holdridge's life-zone system. We found some inaccuracies in the parameters of the Holdridge's life-zone pyramide and proposed a new quick method for PE estimation. The method was checked by linear regression analysis.

Life-form and phytogeographic analysis

We determined the life-form and chorological distribution pattern types of 6350 phanerogamic and 500 vascular cryptogamic plant species of Cuba. On this basis the first life-form and chorological analysis of the Cuban flora was prepared. A leaf-size analysis of the trees and shrubs (about 3000 species) was also performed.

Phytogeographical division

In order to clear up the phytogeographical position of Cuba the phytogeographical subdivision of the Caribbean floristic region has been revised and a new phytogeographic map and regionalization of Cuba as well as the phytogeographical geobotanical characterization of phytogeographic regional units (phytogeographic region, province, sector, district) have been prepared. To illustrate the characteristic distribution patterns and evolution of Cuban flora, original chorological maps were prepared. Further conclusions were drawn as to the origin, probable evolution centres and migration routes of some characteristic ecological groups.

Taxonomic work

In addition to mapping, 20 000 plant specimens were collected and identified with the help of Acuña. From this material 5 new genera, more than 350 species, subspecies and varieties have been described. In some cases, we carried out special

taxonomic studies on phytogeographically significant species (e.g., *Amyris stromatophylla, Maytenus buxifolia, Calycogonium rosmarinifolium, Anemia coriacea)* and genera (e.g. *Schmidtottia Machaonia, Scolosanthus, Moacroton, Leucocroton,* etc).

Documentation of results

This book will be concerned only with floristic-geobotanic results and will not deal with taxonomic research, although these results, e.g., distribution maps, formed the starting point for the conclusions so they are implicitly present. Reference will be made to these wherever appropriate.

Figures

We attempted to illustrate the topic of this book with appropriate figures and photographs, with an aim to emphasize more essential aspects from the mass of data supplied by the text and tables. Apart from the most important formations and vegetation types, the photographs will show several dominant and characteristic species and indicator plants.

The logic of the discussion

The logic of the discussion, in accordance with the demands of the synthesis does not follow the deductive train of thought from the phenomenon towards the cause. By discussing the vegetation as a result of environmental and evolution processes, it wishes to approach the topic inductively and to comprehend the development, structure, various properties and distribution of the vegetation. Accordingly, starting out from the climate-soil-vegetation trilateral-system, the book will treat first the climatic conditions and mainly the special bioclimatical aspects of climate-vegetation interrelations (Part I), some general and more important questions of the soil-vegetation relationships (Part II).

Then, it will deal with the origin, migration, chorological and ecological aspects of the flora (Part III) and then the phytogeographic regions of Cuba will be presented (Part IV). The mapped vegetation units, their structure, composition and general ecological properties will be given, also treating the problems of classifying tropical vegetation (Part V). Finally, an attempt will be made to give a systematic survey of Cuban plant communities (Part VI).

From the synthetic aspect of the book it was unavoidable to write some general chapters about the geography, climatic, geological, and soil conditions of Cuba, in which we did not carry out original research but which contain necessary basic information whose knowledge promotes the understanding of the parts on bioclimatology, ecology, phytogeography and geobotany.

PART I

BIOCLIMATOLOGICAL FUNDAMENTALS

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1 Physico-geographical survey

1.1 Geographical location and characteristics of Cuba

Cuba belongs to the West Indies and within these to the Greater Antilles as its largest and economically most important country. It lies in the middle of the Caribbean Sea, south from the Tropic of Cancer between the 74°8 and 84°58 western longitude and the northern latitude of 19°50 and 23°17. To the north a 180 km wide straight separates it from Florida and to the west a 210 km wide straight from the Mexican Yucatan peninsula. In the south the closest island is Jamaica 140 km distant and in the east it is altogether 77 km from Hispaniola (Fig. 1).

The island of Cuba itself is an elongated narrow land extending in the north-west, south-eastern direction. The aerial distance from Cabo San Antonio to Punta Maisi is 1250 km, the narrowest width between Mariel and Majana by air is 32 km. The length of the coast is about 5746 km. The area of the Republic of Cuba — including the Isle of Pines and the reefs encompassing Cuba from north and south and the smaller islands is 110 922 km^2. Of this, the island of Cuba accounts for 105 007 km^2 the Isle of Pines 2200 km^2 and the other islands and reefs altogether 3715 km^2.

1.1.1 Administrative distribution

This region falls into 6 administrative units — provinces — (Fig. 2) which are the following in the west-east direction: Pinar del Rio 13 200 km^2, La Habana including the Isle of Pines which belongs to it 7 952 km^2, Matanzas 11 340 km^2, Las Villas 18 004 km^2, Camagüey 25 335 km^2 and Oriente 35 102 km^2.

From the first of January 1977 a new administrative order has been enforced. The number of the provinces has increased to 14 (Fig. 2). Havanna the capital has become a city of provincial rank, Las Villas is distributed into three provinces (Villa Clara, Cienfuegos, Sancti Spiritus), Camagüey over two provinces (Ciego and Camagüey), Oriente over five provinces (Tunas, Holguin, Granma, Santiago, Guantanamo-Baracoa). Since our results were published according to the earlier administrative units all the topographic data reported in the book have been given according to these earlier distributions.



Fig. 1 Map of the West Indies



Fig. 2 Political map of Cuba Administrative provinces A: until 1976, B: starting from 1976

1.2 Orography of Cuba

The orography of Cuba is rather varied (Fig. 3). Along the whole length of the island we may find several isolated mountains of different height. The most important are the following:

1.2.1 Mountain ranges of Pinar del Rio province

The most significant mountain of western Cuba is the Guaniguanico Massif stretching lengthwise over the whole province of Pinar del Rio. It falls into two ranges of distinct geological ages and composition. The most ancient is the Sierra de los Organos consisting of Jurassic limestone deposited on slaty sandstone in the west; its highest peak is Pan de Azúcar of 591 m height. To its east lies the younger Sierra del Rosario highly varied in geological structure with the limestone peak Pan de Guajaibón of 692 m.

1.2.2 Hilly ranges of the Havanna and Matanzas provinces

In the province of Havanna and Matanzas two parallel low ranges stretch in the north the Havanna-Matanzas range with Pan de Matanzas of 389 m height, a little to the south with the Bejucal-Madruga-Coliseo range with Loma de Grillo (321 m).

1.2.3 Mountains of the Las Villas province

In the middle of the island in Las Villas province, several mountain regions can be found. Parallel to the north coast stretch the north Las Villas ranges comprising several low contours, the Mogotes of Caguaguas, Sierra de Purio and Sierra de Jatibonico rising to 410 m height. South of these in the middle of the province the hill region of Santa Clara does not even reach the 300 m height. Above the southern coast rises the Guamuhaya Massif or Sierra de Escambray range which is divided into two mountain regions: the western Trinidad mountains whose highest peak is Pico San Juan (1156 m) and the eastern Sancti Spiritus mountains with its summit —Loma de Banao—of 843 m height.

1.2.4 Mountain ranges of the Camagüey Province

There are altogether three low hill ranges in Camagüey Province. In the north-west la Cunagua hill or Sierra de Judas (338 m), in the northern part, the ancient denuded karstic range of Sierra de Cubitas can be found with its highest point, the Loma Tuabaquey (335 m), while in the south the disintegrated hills of Sierra de Najasa with the Cerro de Chorillo (301 m).



Fig. 3 The mountain ranges of Cuba

1.2.5 Mountain ranges of the Oriente Province

Oriente Province is the richest province of the Cuban mountains. The inselbergs of the Maniabon group with its varied landscape rising north from the Cauto lowland, do not even reach 300 m. The southern and north-eastern part comprises continuous montane areas: the ranges of Sierra Maestra and Sagua-Baracoa (Fig. 3).

a) Sierra Maestra is a 250 km long and 30 km wide mountain chain and the highest range of Cuba. Its western wing, the Cordillera del Turquino which stretches from Cabo Cruz to Santiago Bay — both in extent and in height — surpasses the wing extending from Santiago de Cuba to the Guanatanamo basin. In the former we find the high ridge of the Maestra range with the Turquino group (Pico Cuba 1872 m, Pico Real 1974 m and Pico Suecia of 1734 m) whose main middle peak is the highest summit of Cuba (Fig. 4), furthermore Pico Bayamesa (1730 m), Pico Marti (1722 m) and numerous peaks rising above 1500—1600 m. From here the mountain region abruptly drops towards the west and east and only at Sierra de Cobre does it rise above 1000 m. The eastern wing comprises two ridges of the Cordillera de la Gran Piedra: the Sierra de Gran Piedra range rising to 1226 m and the central range of Sierra de Santa Maria de Loreto stretching northward and rising to 500 m a.s.l.

b) The most complex mountain system is the Sagua-Baracoa Massif. The northern part consists of several serpentine block mountains separated by deep river-valleys. The most isolated is the westernmost member of the range: the Sierra de Nipe highland with the summit of La Mensura of 995 m. East of this rises Sierra de Cristal whose peak of 1231 m is the highest elevation of the range. The other three members of this mountain range Sierra de Moa with its peak El Toldo of 1139 m, Cuchillas de Toa with the 1011 m high summit of Pico Galan and Cuchillas de Baracoa produce a very complex intervowen relief system. The southern part of the mountain range comprises mainly plateau-like limestone mountains: Meseta de Guaso with its group constituted by Monte Libano, Monte Verde and Monte Cristo rising altogether 911 m above Guantanamo. South of it, lies the lower Sierra de Maquey (868 m). The most significant mountain ranges of the group are Sierra de Purial and Sierra de Imias with the summit El Gato of 1181 m and finally Meseta de Maisi with the Vista Alegre peak of 641 m.

1.2.6 Mountains of Isla de Pinos

Numerous little block hills can be found in Isla de Pinos. The oldest geologically, are the limestone ones of Sierra de Casas and Sierra de Caballos rising above Nueva Gerona. The highest is Sierra de la Canãda composed of slate and stretching over a north-west and south-east direction (310 m).



Fig. 4 The highest summit of Cuba, the Turquino-group in the Sierra Maestra (left: Pico Cuba 1862 m, middle: Pico Real 1974 m, right: Pico Suecia 1734 m; photo: A. Borhidi)

1.3 Hydrography of Cuba

The hydrography of Cuba is characterized by a large number of rivers which are short and periodically lacking water. The island has around 200 smaller or larger rivers and creeks. Of the latter they are only temporarily filled with water, during the dry winter period they dry up completely. The number of the rivers longer than 100 km is altogether 13, the longest is Rio Cauto (370 km). The most abundantly supplied with water is the river Toa in the Sagua-Baracoa range of Oriente, which with its over 77 km long stretch collects the waters of 71 tributaries and over almost the whole catchment area there is an evenly distributed precipitation of more than 2000 mm annually (Fig 5).

1.3.1 The allochthonous character of Cuban rivers

Numerous Cuban rivers are allochthonous: originating from a different geologic formation than that on which they later progress over. The Cuyaguateje originates on acidic slate and continues its route over limestone mountains. Many rivers of Oriente originate on serpentine then pass over limestone areas (Rio Nipe, Rio Naranjo, Rio del Medio, Rio Yumuri, Rio Piloto, Rio Miguel) in other cases (Rio Moa, Rio Duaba) they continue on serpentine originating from limestone.

1.3.2 Cuban still waters

The number of Cuban still waters is small. The larger ones are ocean saltwater lagunes, such as Laguna de Leche (67 km^2) and Laguna Barbacoas (19 km^2). The lakes are generally small, the largest are Ariguanabo and Laguna del Tesoro (of 9 km^2 water surface each). Of the mentioned peat bottomed lakes those of sandy and clay bottoms are more frequent. These account for the largest lake region in the Guanhacabibes peninsula in the southwest part of the Pinar del Rio Province, where more than one hundred smaller lakes are to be found. There are a large number of karst lakes of rock bottom being no more than several hundred m^2 in size which are widespread in the lowland limestone "dog-tooth" areas of the Guanhacabibes peninsula, on the southern part of Isla de Pinos and on the Zapata peninsula. Among these may be found the deepest lake of Cuba which is about 100 m in diameter and 25 m deep, Laguna San Juan.

2 General characteristics of the Cuban climate

The nature of the climate of Cuba is determined by the general atmospheric movements on the one hand and by the warm sea currents on the other. One of the branches of the warm, north-equatorial current, the so-called Cuban re-current almost entirely encircles the shores of the island its effect being reinforced by the southern equatorial current which encroaches the Caribbean Sea from the southern



Fig. 5 The watercourses of Cuba

direction. The result of these is that the climate of Cuba is much warmer and balanced — more tropical — than that of larger land masses lying in the same latitude — along the tropic. This is proved by the fact that in the areas regarded to be identical with Cuban climate — isoclimatic areas — on the continents of Asia, Africa and South America may be found between the latitudes of 8—15°.

2.1 Atmospheric currents of Cuba

The atmospheric movements of Cuba are controlled by the combined effect of the cyclone system moving the low pressured equatorial atmospheric masses and by the activity of the high-pressured air masses of different anti-cyclones. The main cyclonal activity falls to the summer rainy period more exactly from July to November. Its effects and phytogeographic significance will be discussed at length later.

2.2 Anti-cyclonal activity

The sunny dry weather is a consequence of the activity of two anti-cyclonic activities. The North Atlantic anti-cyclone developing north-east of the island makes itself felt leading to a drop in mid-summer precipitation and double peaks. It may be attributed to this that apart from the generally widespread winter dry season a summer dry period may be detected starting from the middle of the island and progressing along the northern coast eastwards which on the coasts of north Oriente may even reach 2—3 months.

2.3 Characteristics of the dry winter season

In the dry winter season—which lasts mainly from December until the end of April—the cool dry high pressured air masses developing above the North American continent stream towards Cuba creating sunny weather. If however, the activity of the air masses of the Arctic intensify, the frontal zone situated to the north, may spread above Cuba too and on the effect of the warm southern winds arising in the southern part of the Caribbean may be repressed northwards. This alternation of the cold and warm fronts occurs every 2—3 days but in contrast with the summer storms these cause showers. These sporadic winter rains therefore indicate that deviating from the typical monsoon climates (e.g. India) the dry season in Cuba is not entirely dry. The phytogeographic and ecologic significance of this climatic feature will be discussed in detail later.

3 Distribution of the temperature

3.1 Temperature maps

The temperature conditions of Cuba have not been clarified to this day. The temperature map of the yearbook of the National Observatory published in 1965—obviously due to a lack of appropriate data—completely ignores the orography isotherms virtually, as if the whole island were a plain. A major breakthrough has been provided by the temperature map published in the Atlas Nacional de Cuba (1970) which already differentiates the temperature zones according to the altitudinal belts. The temperature map presented in Fig. 6 is taken from the Atlas of Cuba (1978).

3.1.1 Distribution of annual mean temperature

The annual mean temperatures—in accordance with the moderating effect of the sea—are higher along the coasts than in the interior of the island. In this respect the island is quite even throughout. On the lowlands of West Cuba the values vary between 24 °C and 25 °C, and drop below 25 °C in the vicinity of Havanna and the valleys of Sierra de los Organos and Sierra del Rosario and the whole island of Isla de Pinos belong to this temperature range. The 25 °C isotherm is surpassed in the middle of Las Villas province in the line of Caibarien–Sancti Spiritus–Trinidad. In the east Cuban lowlands, the annual mean temperature remains between 25—26 °C with the exception of the central part of Camagüey Province between Ciego de Avila and Camagüey where in consequence of the continental effect causing greater daily fluctuation, the annual mean drops below 25 °C. The temperature rises above 26 °C only in one part of the northern coastline of Oriente (Gibara) as well as the hottest part of the island, the southern coastal region of Oriente from Manzanillo to the tip of the island at Maisi. The hottest point of Cuba lies in this part too, in the Guantanamo Bay and its environs where the annual mean reaches 27 °C.

3.1.2 Extreme values of temperature

With respect to extreme values, the situation is the reverse. As a consequence of the continental effect—even if it is only slight—the extreme values can be found along the axis of the island. With respect to the absolute maximum values the most striking are Placetas with 40 °C, Sancti Spiritus, Banes and Guantanamo (Central Baltony) with 39 °C tops, while absolute maxima of 36—37 °C are generally widespread.

The centre of the cold point of the island falls north-northeast of Sierra de Escambray and to West Cuba. The lowest values are most often found here. The absolute minimum in relation to lowlands is 3 °C (Paso Real and Zaza del Medio), 5 °C was measured in Candelaria, Santiago de las Vegas and Placetas. Frost or snow

was never detected in Cuba not even on the almost 2000 m high Pico Turquino. The minimum winter temperature of Turquino was estimated at around 1 °C. In the course of my own measurements in December on the 5th, 6th and 7th 1969, I found minima of 1.5—2 °C.

3.1.3 Temperature fluctuation

Two kinds of tendencies can be detected. The temperature values grow on the one hand, from the coast towards the interior of the island, on the other hand, lengthwise along the island in a south-east direction.

As exemplified in Table 1, the tropical character of the climate in Oriente is more accentuated by the greater uniformity of higher mean temperature.

While the annual fluctuation of the monthly mean temperature was 6.4 °C in Pinar del Rio province (11 stations), in Oriente it was only 5.2 °C (14 stations). There is a tendency of uniformity in the mean temperature distribution of the mountain regions. In contrast with the tropical lowlands — where there is a slight daily temperature fluctuation that of the mountain regions is high. According to my measurements on Pico Cuba at 1750 m height the daily maximum may attain 25—30 °C on winter days too. These daily fluctuations during the course of the year appear rather uniformly and their extreme values alternate between such small intervals that the mean temperature in the annual distribution fluctuates only between 4.5—5.5 °C. The daily temperature fluctuation increasing with the height

Table 1 Comparison of the annual mean temperature and fluctuation of monthly means in Oriente and Pinar del Rio provinces

City	Annual mean temperature (°C)	Annual fluctuation of monthly means (°C)
Oriente Province		
Guantanamo	28.0	5.0
Maisi	27.8	4.8
Santiago de Cuba	27.6	5.1
Manzanillo	26.9	5.1
Cabo Cruz	26.8	4.7
Victoria de las Tunas	26.5	4.7
Pinar del Rio Province		
Pinar del Rio	24.7	6.8
Minas de Mathambre	24.9	6.6
Paso Real	24.9	6.4
Artemisa	25.4	6.5
San Juan y Martinez	25.5	6.5
Guane	25.8	6.3



Fig. 6 The mean annual temperature in Cuba

a.s.l. and the seasonal temperature difference decreasing parallely with it is a feature observable in tropical mountain regions as Walter's (1962) measurements proved in Kilimanjaro too.

3.1.4 Physiological effect of temperature

We can hardly assess the effect of temperature on living organisms—and on the vegetation—without considering the relative moisture content. Living organisms sense and tolerate heat conditions not in terms of temperature degrees but as positive or negative thermal effects to be neutralized or physiologically to be balanced out. Depending on the relative moisture content of the air even of the same temperature, its heat generating or heat depriving activity may be quite different, and this difference could well surpass the tolerance threshold level of numerous organisms. It is a well known fact that vegetation has a much greater tolerance to dry cold weather than to wet cold one (note the polar timber line). In humid hot climate the energy loss of the vegetation by transpiration/guttation and dissimilation may be several times more that of what it has to tolerate under the same temperature but with lower humidity.

3.2 Relative atmospheric humidity

It was not possible to draw conclusions from the 3—4 observations annually carried out by sixty stations, as to the relative atmospheric humidity changes, especially not with respect to the spread, variance and extremes of the values. Several general conclusions may be drawn nevertheless.

The annual mean values of relative humidity content ranges mainly between 74—80%. Values lower than these can be experienced on the southern coastline in Sierra Maestra and Baracoa. The minimum was measured in Guantanamo on the edge of the semi-desert belt with an annual mean of 68%.

3.2.1 Vertical distribution of relative humidity

The vertical distribution of relative humidity shows a decided rise in the lower limit of the montane rainforest belt (Topes de Collantes), at 700 m the annual average was 85%, in the middle of the zone (Gran Piedra) of 1120 m the annual average was 88—90% which is above the declining point of filmy ferns characteristic of rainforests *(Hymenophyllum)*.

The vertical gradient of relative humidity appears at 100 m intervals as 1.8% probably not in even distributions.

3.2.2 Annual distribution of relative humidity

The annual distribution of atmospheric humidity on the whole, resembles that of precipitation. Its minimum in the whole area of Cuba falls to the end of the dry season to March—April while in the rainy season a double peak may be found. In western and central Cuba there is a first peak in June and a second one in October. In East Cuba however, a weaker second peak in June is followed by a vigorous main peak in October—November towards the end of the rainy season. Atmospheric humidity and the annual distribution of precipitation show a very similar variation in south-east Africa, in Tanzania, Zambia and Mozambique similar to the distribution of temperature values (Griffiths 1962, Pócs 1976, personal communication). In the North Oriente montane region on the influence of the North-Atlantic anti-cylone the maximum atmospheric humidity falls to November, December, January, the minimum to April—May. Numerous vertical gradients—obviously due to the forceful mixing effect of North Atlantic winds — up to about 600 m height cannot be demonstrated. The fact that the annual distribution pattern of atmospheric humidity significantly differs from that of the temperature, and that their minimum and maximum values fall to different seasons all contribute to a balanced thermal economy of the climate. This has an important effect on the quality of the vegetation cover which will be elaborated in detail later.

3.3 Vertical distribution of the temperature

So as to be able to construct a hypothetical sketch of the original vegetation of a cultivated land to delineate the vertical belts and within these to establish the zonal types of the soil and vegetation we had to become acquainted with the bioclimatic conditions of Cuba and to draw up its climate diagrams. The basis for this was to prepare a map reflecting the real temperature for which the vertical gradients of the temperature had to be calculated for the different montane regions.

3.3.1 Vertical temperature gradient

The vertical temperature gradient in the temperate zone is usually taken as 0.5 °C/100 m which generally agrees with the empiric values. Such calculations have not been carried out in Cuba. The gradients which can be read only with approximate exactness and estimated from it in the Atlas Nacional de Cuba (1970:35) vary unexpectedly in the different montane regions. In Sierra Maestra it is 0.65 °C, Sierra de Nipe 0.85, Sierra de Escambray 1.2 °C/100 m. Obviously these values were derived from some misprint. If they were real then the same vegetation belt should be developed in the Sierra de Escambray at a 4—500 m lower altitude than in the Sierra Maestra. In contrast with this, the vegetation belts of the two montane regions would occupy the same altitude a.s.l. which contradicts the difference in gradients.

Our investigations were carried out based on the data of the following stations: In

Table 2 Temperature gradients for three montane regions

	Sierra Maestra	Sierra de Escambray	Sierra de Nipe
J	0.9	0.9	0.6
F	0.8	0.8	0.6
M	0.8	0.8	0.6
A	0.8	0.8	0.6
M	0.8	0.8	0.6
J	0.8	0.8	0.6
J	0.8	0.8	0.7
A	0.8	0.8	0.7
S	0.8	0.8	0.8
O	0.8	0.8	0.8
N	0.8	0.8	0.7
D	0.9	0.9	0.6
annual	0.8	0.8	0.66

Sierra Maestra vertical gradients were calculated between Santiago de Cuba University (44 m) and the Gran Piedra Meteorological Station (1120 m); in Sierra de Escambray between Trinidad (35 m) and Topes de Collantes (760 m) based on 25 and 10-year registration periods and we found them completely identical. This result coincides with the parallelism of the phytogeographic zones mentioned in 5.31 in the two montane regions. With respect to Sierra de Nipe for the registration of the temperature difference between stations at Mayari (40 m) and Pinares de Mayari (650 m) only data of 10 and 5 years were available. According to our investigations the temperature gradients for the monthly and annual values in the mentioned three montane regions are to be seen in Table 2.

Due to the unfortunately small number of montane meteorological stations we could not draw graphs of the vertical gradients. Obviously the gradients are not even and they depend to a large extent on the humidity of the climate (Pócs 1974). Probably the gradient rises evenly in the Cuban montane regions to about 800 m a.s.l. while in the condensation belt (800—1600 m) it drops significantly and above this it suddenly rises again.

4 Distribution of precipitation

4.1 Derivation of data

In Cuba there are more than one hundred precipitation measuring stations with data from over 20—60 years of observations and a further 450 stations with more than 10 years of measurements. These measuring sites with a few exceptions operated in lowland coastal region in cultivation areas — largely in sugar refining centres.

With respect to montane precipitation we had no information until recently. This has changed considerably due to the fact that in 1964—65 the Instituto de los

Recursos Hidraulicos built a precipitation network station consisting of close to 3000 stations extending the observations to montane regions. The data were published in Boletin de Lluvia but not for each station but by averaging the data of several stations for four quarters of map sheets to a scale of 1:50 000. Our calculations were based partly on this published material and partly on the almost 1000 selected individual stations so as to get as far as possible, a complete and reliable picture of the precipitation pattern of Cuba.

4.1.1 Precipitation maps and their evaluation

It follows from this that although several attempts were made to construct a genuine precipitation map, only recently has this been achieved on account of the missing data. With respect to the annual precipitation amount O.L. Fassig (in Tropical Plant. Res. Foundation) prepared a map in the thirties which has been quoted by many (see Seifriz 1943; Nuñez 1959). According to this map the mean annual precipitation ranged between 750—1800 mm and the most humid part of Cuba is the western montane region of the Sierra de los Organos. The precipitation map published by Observatorio Nacional in 1965 is rather similar which lists the montane ranges of North Oriente — which have the most rainfall in Cuba — under the driest areas. A considerable advance was made in this respect with Trusov's map (1967) which indicates categories between 800—2200 mm with 100 mm isohyetes. This is the first map which has approximated correctly the regions with the most precipitation in Cuba (Sierra Maestra, Sierra de Escambray, Sagua-Baracoa) although their ranking is still not correct and the isohyetes of the Sagua-Baracoa mountain follow the orography excessively whereas in this area the valleys and the moderate slopes have the most precipitation and the tops are relatively dry.

4.2 Regional distribution of precipitation

The precipitation map drawn up by us (Fig. 7) distinguishes 8 classes between 300—3000 mm. The region with the most precipitation is the Moa-Toa-Baracoa mountain complex which is the only lowland rainforest belt. The precipitation conditions of the semi-desert cactus-scrub belt of South Oriente is reflected correctly by this map. Generally, the data of this map coincide with the borders of the different vegetation types and place numerous vegetation-ecologic questions in the right perspective. It should be noted that on account of the scaling of the map we could not indicate the density of the isohyetes according to reality. In Sierra Maestra and Sagua-Baracoa essentially higher precipitation means occur than those indicated. These have been depicted under climate diagrams on bioclimatic profiles and bioclimate maps.

It may be concluded from the geographical distribution of the annual total precipitation that:

- Precipitation increases over the whole island from the coast towards the interior of the island.

- The western Cuban lowland has a balanced 1400—1600 mm precipitation pattern, in prominent montane region 1800 mm, in fact, in places even 2000 mm.
- The annual precipitation amount along East Cuba lowland remains below that of the western part and tends to decline towards the east to 1300—700 mm.
- With a rise in altitude there is a rise in annual precipitation amount.
- In the southern rain shadow belt of the mountains, extremely dry zones develop and extremes of precipitation rise eastward. Thus in East Oriente over a 30—50 km stretch, the annual mean precipitation total ranges between 400 mm and 3000—5000 mm.

This phenomenon under similar general atmospheric conditions and orographic situations can be observed in East Jamaica and western Hispaniola (Asprey and Robbins 1953, Ciferri 1936).

4.3 Annual distribution of precipitation

For the determination of the characteristics of the climate and the quality of the vegetation it is essential to know the temporal distribution of the annual precipitation.

4.3.1 Arid and wet seasons

Cuba belongs to the belt of the zenital rains where it is characteristic for the annual distribution of precipitation that there is one summer rainy season which lasts from May to October and a dry period from November to April. This rainfall type resembles that of the monsoon climate which is typical for southern India, a large of Brazil and subequatorial regions of Africa. However, in Cuba this precipitation distribution is not caused by the monsoon winds but by the passat wind-system. The north-east coastline of Cuba falls into another rainfall distribution type where two dry and two wet periods alternate. In north East Oriente there is a transition to an opposite precipitation distribution in which the period with more rainfall lasts from September to February and there is a certain affinity to the Mediterranean precipitation distributions. Lacking suitable data, Trusov was not aware that in the montane regions of Oriente there is a third type of precipitation distribution from which a steady abundant rainfall throughout the year is characteristic. This will be elaborated when discussing the bioclimatic types of Cuba.

4.3.2 Precipitation distribution types of Trusov

According to Trusov there are eight annual precipitation distribution types in Cuba based on the position and quantity of maxima and minima. From the eight types of occurrences he established eight precipitation zones. The criteria for these zones were determined partly from agricultural practices (e.g. sugar cane harvesting regional organization) partly irrigation and erosion and flood protection aspects for which they are suited. However, there is a flaw in this classification, in that Trusov

has ignored the rainfall amounts whereas this is not negligible from water management aspects either. To understand the climatic demands of terrestrial ecosystems from the point of view of the connection between climate and vegetation types and their spread Trusov's regionalization does not provide really worthwhile information.

4.4 Ecological significance of rainfall distribution

Just on account of those viewpoints mentioned, it is necessary to make some generalizations on the ecological-phytogeographical significance of the temporal precipitation distribution.

4.4.1 Amount and distribution

In determining the quality of the structural types of vegetation and terrestrial ecosystems the annual precipitation amount below a certain level is more important than the annual distribution. Above a certain threshold however, the annual distribution is decisive in contrast with the total amount. The actual threshold values are divergent in the different temperature zones and within one temperature zone they vary depending on the soil type (Walter 1951, Borhidi 1969). These aspects will be explained at length in *9.4.2–9.4.3.*

4.4.2 Extent of the rainy season

From the quality aspects of vegetation types the duration and intensity of the rainy season are essential, furthermore at this latitude whether it falls to the long-day (summer) or the short-day period. However, it is indifferent within this, what the number of rainfall maxima are or whether they fall close or distant to each other and in which month of the season they fall.

4.4.3 The length of the dry season

The duration of the dry season and the intensity of the dryness with respect to the vegetation is essential. The average precipitation amount and the minimum actually falling is the dry season in of decisive importance but as to which month these occur is irrelevant.

4.4.4 Summer or winter dryness

Which season the dry period falls in is of distinct significance for phytogeography. The short-day (winter) dryness leads to the development of quite another adaptation form than the long-day (summer) dryness. This will be discussed at length in points *9.3.2–10.3.3.*

4.4.5 More dry periods

With two dry periods the ecological effects of each period differ from quantitative and qualitative points of view, and to these the vegetation reacts in different forms of acclimatization and the ecosystems by forming nutrient chains and patterns.

4.5 Fluctuation of annual precipitation

Apart from studying the averaged amounts of precipitation it is necessary to mention the variation and extreme values of the precipitation. According to Trusov (1967) the coefficient of variance of the annual amount based on 30 years' means fell between 0.19—0.30. In areas with annual means ranging from 1400 mm to 1600 mm the precipitation amounts for certain years may vary from 600—800 mm to 2200—2500 mm. Often the "semi-desert type" of years and "rainforest type" series alternate which do not alter the basic structure of the ecosystem but it may influence the intensity and rhythm of the metabolic cycle e.g. the extent of the litter fall and the decomposition-rate of the litter and humus. In contrast with this the variability of precipitation greatly affects the functioning of the short cycle ecosystems and above all, the agricultural chances (Kool 1953, Knapp 1973).

4.6 Extreme values of precipitation

When discussing the effect of climatic elements on biologic objects it is often customary to stress the importance of extreme values and their limiting effect. The extreme values are of special significance to agricultural cultivations especially to one-year-old monocultures. Therefore certain authors consider the estimation of probability values to provide the most information on effectiveness of precipitation (Glover et al. 1954). This is even more the case since according to our observations, the extreme values of temperature or dryness or humidity are of constraining nature only in the case of "sufficiently frequent repetitions" and have a more vigorous effect on the populations of a genetic-adaptive "unit" than on polytypical systems or complex ecosystems. An outstanding extreme value may cause transient disturbance in the ecosystem which just on account of its systems nature, by means of its self-regulating mechanism, compensates during a longer or shorter time or is eliminated by regeneration. The more complex the structure of the ecosystem, the more tolerant it is to more drastic extreme values. The tropical rainforest ecosystems belong to the most complex types. The lasting disturbances of such systems may be caused by such climatic extreme event which at the same time cause the entire or partial destruction of the basic conditions of the natural ecosystem (landslides, erosion). Such climatic extremes causing long-lasting changes are the tropical cyclones and hurricanes.

5 Cyclones and their phytogeographic role

5.1 Cyclonic activity

Cyclonic activity includes western Cuba to the greatest extent. In the period ranging between 1800—1966 Havanna province had 35 hurricanes, Pinar del Rio 32, Matanzas, Las Villas, Oriente 25 each, Camagüey 20. The formation of cyclones is caused by a typical anomaly in the tropical atmosphere which is called barometric wave.

5.1.1 North Atlantic cyclones

Cyclones reaching the Caribbean region form in the southern part of the Passat belt in the northern region of the Atlantic Ocean and entering the Caribbean region following a parabola course leave in a north or north-eastern direction. The North Atlantic cyclones are most active in July, August and September. A large part of these progress along the exterior line of the Antilles or Bahamas and do not reach Cuba or once in the Caribbean region cutting it through a western direction leaves the region south from Cuba.

5.1.2 Caribbean cyclones

The other cyclones form in the southern part of the Caribbean Sea, north of Panama and Venezuela shores. The activity of these Caribbean cyclones falls to June, October and November and their trajectory in most cases reaches Cuba.

5.2 Factors causing hurricanes

Two essential elements in extremes and effects of hurricanes are wind and water. The speed of advancement of cyclones may exceed 200 km/h and may cause extraordinary strong cloud burst rains lasting for 2—3 days during which so much rain falls in the course of a day as in an average month of the rainy season (150—300 mm). In fact in the case of an extremely strong hurricane more than this. The maximum rainfall for one day was measured in 1963, in Santiago de Cuba at the time of the hurricane Flora—735 mm—which is equivalent to the total annual precipitation for an average year. During the three days of the Flora hurricane 1435 mm of precipitation was registered, more than that of many years registered at the station.

5.3 The role of hurricanes in the migration of plants

Analyzing the phytogeographic effect of hurricanes we must attribute an important role to them as migration factors in the spread of plant species, in flora migrations especially in such an isolated region as the West Indies where the

connections with the continent had ceased over millions of years. The cyclones obviously had a major role in spreading the epiphytic small flowering plants *(Orchids, Bromelias)* but apart from this the translocation of very many species of the woody families with flying seeds *(Meliceae, Bignoniaceae)* to the archipelago. Hurricanes of great intensity are capable of taking complete huge trees, not only seeds, loaded by thousands of epiphytes into the atmosphere to great distances carrying out the introduction and transplantation literally.

5.3.1 Chorological types created by hurricanes

Apart from the mentioned widespread Neotropical plant species there are two chorological types (the Cuba—Antilles—South American and the Cuba–South American elements) altogether 170 species whose spread largely from the South American continent to certain parts of the West Indies or only just to Cuba may be attributed to the activity of cyclones in fact, in numerous cases they cannot be satisfactorily explained otherwise.

5.3.2 Effect of hurricanes on the vegetation

The effects of cyclones on the vegetation generally are detrimental, for the winds break up the forest along steeper slopes destroying them and the rains cause landslides and by erosion destroy the habitat for the denuded rocks thereby eliminating the ecosystem. In Cuba, the mentioned hurricane Flora, caused such destruction in several points of Sierra Maestra. I myself observed and studied its effect on the southern and western slopes of Pico Cuba.

5.3.3 The potential effect of hurricanes on succession and evolution of the flora

The surfaces derived in this way are at the same time suitable for re-settlement of pioneer vegetation for survival of species having low competitiveness, relics, in fact for the formation of new taxa within the genera having appropriate genetic and adaptive reserves. On the basic rocks which erode more readily, the landslides caused by downpours are more frequent. On these habitats mostly characteristic successional processes develop, e.g. dense pinebreak of the endemic *Pinus maestrensis* developed as first pioneer stage in the Sierra Maestra.

6 The concept and significance of bioclimatology

Bioclimatology is an interdisciplinary science derived from the coincidence of ecology and meteorology or rather climatology. Its observation material is derived on the one hand, from ecology and other field biological disciplines (phyto and

zoo geography, phyto and zoo sociology) on the other, from areas of meteorology. At the same time the points in question are basically of an ecological nature with a view to solving ecological problems.

The starting point for bioclimatology is provided by the dual recognition:

a) the basis of biospheric operation is formed by the interaction and coordination of a natural trial system of climate—soil—vegetation whose prime connection is the ecological relationship of climate and vegetation,

b) the climate is a continuous and rhythmically changing system in space and time of the meteorological elements which through vectorical correlations of the different elements finally affects the biosphere through its residual, and the producing vegetation.

6.1 Goals and perspectives of bioclimatology

The goal of bioclimatology is to analyze this complex effect. It is obvious that not all meteorological elements and not all to the same extent, are responsible for their effect on the biosphere. It would be the same mistake to suppose that the structure, metabolism or productivity of systems adapted and compensated in so many directions such as a plant association or rather an ecosystem, would depend on the changes of one single factor of a climatic complex. The task of bioclimatology is to select that small complex the "functional climate" or "ecoclimate" which is significant biologically (structure *vs.* function showing a tight positive or negative correlation). Further, to work out such a model which would reflect the trend, extent, and preciseness of these small complex elements comprised of generally no more than 2—4 factors from the large complexity of numerous meteorological elements of the "holo" climate. Meher-Homji concisely refers to this as the "Bioclimate c'est le climat en fonction de la vie" (1963).

Perspective tasks of bioclimatology entail the definition of biologically important complex climatic concepts and their modelling such as humidity and aridity, oceanity, continentality or the working out of the bioclimatic model of the global vegetation types. Studies of this kind have become of increasing interest in relation to the recently started International Geosphere Biosphere Programme.

Bioclimatology in a biological sense—in biological effects and results—is concerned with recognizing the analogous climatic types (isoclimates according to Walter) and their characteristics and from this to work out a climatic system significant from a biological aspect. Classifying climatic elements purely from physical, morphological or other practical aspects often does not contain the minimal biological information as Gaussen (1954 abc) and Meher-Homji (1963) have referred to with numerous examples. I refer to this in points *4.4.1—4.4.5* in the same sense.

6.2 Bioclimatology and ecosystem research

It may be deduced from what has been said that bioclimatology is an ecological science which to this stage has been concerned with the relationship of "large-scale problems" of large systems (vegetation types, formations, large ecosystems) and its scope and importance may extend significantly in other directions.

The causal climatological investigation of primary production of ecosystems opens the area of biosystems having a smaller dimension for bioclimatology of which, Précsényi's (1972) research may be ranked among the first in the world. This present work on account of the methodological difficulties, studied the significance of certain meteorological elements. In my opinion investigation of the effect of functional element complexes of the climate may mean further progress.

6.2.1 Bioclimate and microclimate

It should be noted that the term bioclimatology is misused. Some authors use it as the synonym for microclimatology and by bioclimate they mean microclimate. Undoubtedly, in setting up microclimate areas, vegetation usually has an important role but this is not necessarily so (e.g. desert or urban microclimate). Microclimate always means climate close to the surface while bioclimatology primarily the large-scale interrelations of climate and vegetation, so mainly the ecological effect of macro- and meso-climates. Their methods and problems clearly diverge; they form strictly borderline, but well delineated areas of ecology.

6.3 Bioclimate and phytogeography

The basic concept of bioclimatology coincided with phytogeography when Humboldt observed that the plants adapt with typical adaptive so-called basic forms to the different climates which determine the general aspects or so-called formations of the vegetation.

Bioclimatology inspite of this, has been latent for almost one and a half centuries. Classification of climates and the distribution of climatic types has primarily been the job of geographers and meteorologists. The investigation of climates from a biological approach came increasingly to the foreground in the course of the nineteen forties. Mapping of vegetation and especially the demands of tropical vegetation mapping emerged at the beginning of the fifties. Since in the reconstruction of cultivated regions denuded of their degraded and original vegetation, bioclimatology has a basic task. The importance of reconstruction of vegetation has increased in connection with the tropical projects of the "Man and Biosphere Programme". In my opinion the perspectives and tasks of bioclimatology will expand in biosphere research not only in understanding the operation and productivity of ecosystems but perhaps in other spheres (e.g. ethology, human hygiene etc.) too.

7 Bioclimatologic formulae, diagrams, systems

7.1 Mathematical expression of climatic features

The complexity of the climate has made it necessary and at the same time crucial, to assess the characteristics of the climate and to recognize their analogies. Numerous investigations have been carried out to establish the characters of the climate, comparing the climate of the different regions to be able to work out such numerical formulae or graphic methods which appeared to be suitable for a comparison of the climates of different regions. Experiments aimed at determining the climatic features especially the humid and arid aspects were carried out to distinguish the climatic criteria of forest steppes and deserts since in the description of certain climates the vegetation in the regions had a rather important role. In half a century the trend of research and unfortunately its demands have been reversed. Previously, vegetation had been an indicator of climate, today we make inferences from the climate on the original quality of the already destroyed natural vegetation.

7.2 Bioclimatological formulae

To express the climatic characters mathematically, numerous empirical equations have been suggested. As examples we could mention those of Transeau (1905), Penck (1910), Lang (1915), Köppen (1918), Meyer (1926), De Martonne (1926), Emberger (1930), Perrin (1931), Thornthwaite (1931), Rosenkrantz (1936), Gorczynski (1943), Selyaninov (1948), Thornthwaite (1948), Mangenot (1951), Capot-Rey (1951), Gaussen and Bagnouls (1952), Hiernaux (1955). The majority of the formulae and indices created by the authors listed here are critically discussed by Meher-Homji (1963).

Of these the most widely known and used in America are the humidity and aridity indices and the general moisture index of Thornthwaite developed on the basis of his potential evapotranspiration concept. These indices, however, have been criticised by many tropical ecologists (Bagnouls and Gaussen 1957, Gentilli 1953, Barucha and Shanbag 1957, Aubréville 1965b, Chen-Chiang Chen 1957). The xerothermic index of Gaussen and Bagnouls (1952) should be mentioned from which the rather widely used ombrothermic diagram (Bagnouls and Gaussen 1952) and the Walter's climatic diagram (1955) were developed.

7.3 Graphic methods for description of the climatic features

Graphic description of the climatic character apart from being a means of comparison was meant to be illustrative. Taylor's (1915) hysterograph is widely used, e.g. by Richards *et al.* (1940), Vidal (1961), Aubréville (1966b) etc. Chaptal's (1933) polygonal star diagram and Szántó's (1940, 1949) indices of oceanity,

continentality and climatic bonity worked out on graphical bases, have not been extensively used. Azzi's (1954) thermopluviometric diagram created wider interest which is used in agricultural evaluation effectivity of agricultural land use.

7.4 Climate diagram of Gaussen and Walter

Bagnouls and Gaussen's (1953) ombrothermic diagram was derived from the illustration of the monthly values of the xerothermic index where the months are depicted on the horizontal axis and the temperature and precipitation values on the vertical one in the ratio of 1:2. In this coordinate system by plotting the monthly mean temperature and precipitation values we get a temperature and precipitation curve which reflects the kind of climate, its warm, cold, humid and arid seasons, their length and intensity.

The ombrothermic diagram was improved by Walter (1955) on the basis of the T:P = 1:3 relation of Selyaninov's hydrothermic index incorporating in the diagram the sub-arid province already distinguished by Gaussen ($2T < P < T$) further the winter, frosty and frost-free periods with several ingenious graphic solutions and with the numerical depiction of the different extreme and mean values — a universal most illustrative climatic diagram was developed which can be used all over the world.

7.4.1 Advantages of the Gaussen–Walter's diagram

The advantages of this type of climate diagram over all the earlier and later formulae or diagrams are the following:

- Maximal information efficacy with minimal information (the lowest number and most readily available climatic elements) provides maximal bioclimate information.
- It shows the whole annual course of temperature and precipitation and beyond that it gives a most illustrative picture of the kind of climate.
- Its universal applicability is not constrained to certain climate zones or continents.
- As a consequence of this it serves as an objective source of comparison for estimating analogous climates or isoclimates.
- It provides an opportunity for working out a general climate system or climate classification with a biological approach.
- It may be a basis for further refinement of graphic or numerical methods for solving special spatial problems (Borhidi 1961, 1969).

7.5 Thornthwaite and Mather's climate diagram

Thornthwaite and Mather's (1955) graphic illustration experiment is worth mentioning which aims to express the arid season more exactly in that, instead of the T curve of the ombrothermic diagram it uses real (AE) and potential

evapotranspiration (PE) values. In this case the area between PE and AE curves indicates the arid period, the phase between precipitation curves and AE curve the water utilization by the soil.

This rather logically conceived diagram which was further developed according to ecological viewpoints by Major (1963) — is wrought with numerous uncertainties. Such as:

a) The lack of an equation by which it would be possible, from the little data of PE, to estimate the whole global surface;

b) Uncertainty in the estimation of soil water capacity. At first Thornthwaite calculated that the soils generally are able to store 100 mm of precipitation, then later estimated the average storing capacity of soils at 300 mm. According to Major the water capacity of soils cannot be estimated over 100 mm, Russel and Hurlbut claim that in the USA it can be an average of 90 mm but it strongly depends on the quality of the soil;

c) The number of those registering stations is small which have all the measuring data necessary for estimation of AE and PE and this fact restricts the spread of this method.

7.6 Classification of the bioclimates

To establish and express the characteristics of climate as well as to compare objectively the climatic types it is aimed to set up a uniformly conceived climate classification.

7.6.1 Climate system of Köppen

The most well known to this day is the Köppen's climate system which was first published in 1918 and which appeared in a more detailed edition (Köppen and Geiger 1936) too. This climate classification is based on the annual and monthly mean values of temperature and precipitation and it considers the native vegetation to be the most exact expression of climatic effect. It recognizes that the efficiency of precipitation depends on the temperature. Its advantage is, namely, that it is flexible and that certain provinces are marked by letters and certain climatic types by letter formulae. This makes the climatic classification readily available for scrutiny and most manageable. It is a pity that the majority of ecologists apply the Köppen climate types automatically and only few have striven to further develop it from a bioclimatologic approach as Zólyomi (1958) did.

7.6.2 The Köppen–Trewartha climatic system

The Köppen system was updated by Trewartha (1954) with several alterations and in this version it has spread rapidly throughout America — as Trewartha says — on account of its didactive advantages. It appears however, that the Trewartha type of alteration — which proved to be useful with respect to North American climate classification — has been employed less in Europe than the original classification.

7.6.3 Thornthwaite's climate systems

Two climate classifications were created by Thornthwaite. The first (1931) is based on thermal efficiency and on the complex registering numbers of precipitation efficiency and it sets as its criterion of climate elements—that is criteria for limiting climatic areas—the plants and quality of the vegetation.

The second Thornthwaite's system of climate introduced the potential evapotranspiration (PE) concept. The climatic limits were drawn on the basis of the relation of potential evapotranspiration to precipitation, both data were derived from meteorological measurements. So in this system the vegetation is considered as the main diagnostic feature of the climatic types, but their limits were drawn exclusively on the basis of climatic data.

7.6.4 Ecological gaps in climate systems

Looking at it from the ecologist's viewpoint the main flaw in the mentioned climate systems is that the natural vegetation is considered as the criterion of climate—but without adequate knowledge of the vegetation types. All the mentioned categories of the climate system are somewhat over-generalized at least compared to the demands of plant ecologists and phytogeographers and this lack becomes more obvious as our knowledge of vegetation increases. It is generally known now, that in Köppen's–Thornthwaite's and Trewartha's savannah climate the zonal vegetation is tropical deciduous or dry forest, whereas the savannas are in reality edaphic or anthropic in this climate belt. On the other hand, if the climatologist tries to isolate the system from the vegetation as a phenetic starting point its categories easily become virtual. In the climate as a continuous accumulation of phenomena we may only draw limits of practical value if those are connected with some objectives segregated into phenetically different kinds of qualities.

The most suitable objective of this kind is the series of large zonal ecosystems in energy balance with the climate or the zonal vegetation representing them phenetically. The climate systems of practical adaptation have to incorporate this principle even if the climatic categories and zonal vegetation types do not coincide, their relationship sometimes is complex and apparently inconsistent. We will return to a discussion of the latter.

7.6.5 Importance of the bioclimatic system

It follows from the criticism of the mentioned climate systems that the demands of the ecologist could best be met by the climatic classification of a bioclimatological conception. Naturally the ombrothermic diagrams demand this too. It is unfortunate that in the othervise outstanding "Klimadiagram-Weltatlas" of Walter and Lieth (1964—68) the climate diagrams have been classified according to the Köppen system of categories, thereby, disregarding the conclusions of an ecological concept in the diagrams. According to our experience from the vegetation research

aspects and demands of vegetation mapping, the most suitable climatic classification — at least in the tropical and subtropical belt — is the Gaussen bioclimatic system which has been published with Borhidi's original supplementation.

7.6.6 Gaussen's bioclimatic system

I Warm and moderately warm climates. The temperature curve throughout the year is above the horizontal axis.

1 Thermo-heremic or warm desert climatic belts: the number of dry months is 12. It is subdivided into the following regions:

1 *a* There is no rain all the year: real hot desert (e.g. Central Sahara, deserts of Egypt, South African deserts, Atacama desert).

1 *b* Rainy days in the "winter" short day period, transition to the Mediterranean climate (e.g. North Sahara, Arabian deserts).

1 *c* Rainy days in the summer, long daylight period; transition towards the monsoon and passat climates (South Sahara, Indian deserts, Mexican deserts)

1 *d* Rainy days with irregular distribution (e.g. Californian and Australian deserts).

2 Thermo-hemieremic or warm semi-desert climatic belt: the number of dry months is 9–11. The subregions are the following:

2 *a* The long daytime, summer period is dry: it occurs in the semi-desert belts bordering on the Mediterranean climatic areas (e.g. North Africa, Middle-East, California and South Australia.

2 *b* The short daytime "winter" season is dry: semi-desert in contact with tropical regions (e.g. South Sahara, South African, Indian, Mexican, North Australian semi-deserts)

2 *c* The dry period is not bound to a certain season or several dry seasons exist. They are mainly conditioned mesoclimatically in rain shadow belts or coastal semi-deserts (e.g. the Greater Antilles, Ethiopia).

3 Xerotheric warm climatic belt. The summer is dry, the temperature of the coldest month is above 0 °C. It may be distributed into two groups:

3 *M* Xerotheric Mediterranean or dry summer Mediterranean climates. The mean temperature of the coldest month ranges between 0–15 °C. It is widespread in southern Europe, North and South Africa, South and West Australia furthermore in California and certain parts of South America (Argentine, Chile). Its subtypes:

3 *a M* Long dry Mediterranean climate with 7–8 dry months

3 *b M* Dry Mediterranean climate with 5–6 dry months

3 *c M* Moderately dry Mediterranean climate with 3–4 dry months

3 *d M* Submediterranean climate with 1–2 dry months

3 *T* Xerotherotropical or summer dry tropical climates. The mean temperature of the coldest month is above 15 °C. The climatic types previously not discussed; for further explanation see point *I. 7.6.7.* Its subtypes:

3 *a T* Long summer dry tropical climate with 7–8 dry months.
3 *b T* Summer dry tropical climate with 3–4 dry months.
3 *c T* Moderately dry summer dry tropical climate with 3–4 dry months.
3 *d T* Subhumid summer dry tropical climate with 1–2 dry months.

4 Xerochimenic or winter dry tropical and subtropical belts. The climate is divided into a longer or shorter winter dry season and a rainy summer. It is a rather distributed tropical climate type. It is dominant on the latitudes 5–25° forming a more or less wide belt over all continents. It divides into two subgroups and several subtypes:

4 *Th* Thermoxerochimenic or winter dry hot climate: The mean temperature of the coldest month is above 15 °C. The subtypes according to the length of the dry period:

4 *a Th* Long dry subtype: the number of dry months is 7–8,
4 *b Th* Dry subtype: the number of dry months 5–6.
4 *c Th* Moderately dry subtype: the number of dry months 3–4.
4 *d Th* Subhumid subtype: number of dry months 1–2: transition towards the hot humid rainforest climate of the equatorial belt.

4 *Mes* Mesoxerochimenic or winter dry, moderately warm tropical and subtropical climates. The mean temperature of the coldest month is below 15 °C. It is widespread on the intermediate zone between the tropical and subtropical belts and in the central middle ranges and highlands lying inside the tropical continents (e.g. India, central and south China, Paraguay, north Argentine, Mexico).

The subtypes are similar to the previous ones:

4 *a Mes* long dry subtype; the number of dry months is 7–8;
4 *b Mes* dry subtype; number of dry months is 5–6;
4 *c Mes* moderately dry subtype; the number of dry months is 3—4;
4 *d Mes* subhumid subtype; the number of dry months is 1–2; transition towards the subtropical humid rainforest climate or to the tropical montane rainforest climate.

5 Bixeric or tropical climates with two dry periods: the year falls into four seasons, one winter and one summer dry period and two transitional rainy seasons. Usually the winter dry period is longer. It is a climate much less extensive compared to 4 and of importance forming in the coastal regions and montane rain shadow areas within the monsoon and passat climate belts. This occurs in north and east Mexico, east Africa, southern slopes of the Himalayas and in east Australia. Its subgroups and subtypes:

5 *Th* Thermobixeric or two dry seasonal tropical climates; the mean temperature of the coldest month is above 15 °C

5 *a Th* Long dry subtype, the number of months of the two dry periods is 7–8; transition towards the semi-desert climate (2 *c*);
5 *b Th* Dry subtype; the number of dry months is altogether 5–6;
5 *c Th* Moderately dry subtype; the number of dry months is 3–4;
5 *d Th* Subhumid subtype; with 1–2 dry months is a transition towards the tropical moist rain climate.

5 ***Mes*** Mesobixeric or subtropical climates with two dry seasons. The mean temperature of the coldest month is below 1 °C.

5 ***a Mes*** Very dry subtype; the number of dry months is altogether 7–8.

5 ***b Mes*** Dry subtype; with 5–6 dry months;

5 ***c Mes*** Moderately dry subtype with 3–4 dry months;

5 ***d Mes*** Subhumid subtype; with altogether 1–2 months of dry weather, transition to subtropical rainforests and humid moderate climates (7).

6 Thermaxeric or hot humid equatorial climatic belt. The number of dry months is zero. Climatic belt forming mainly in the basins and low montane regions in the vicinity of the equator; on the effect of warm sea currents it may develop further from the equator too (e.g. Central America, West Indies, Madagascar, North Vietnam, South-East Africa). Its subtypes:

6 ***a*** Euthermaxeric or hot humid lowland climate. The mean temperature of the coldest month is above 20 °C (valleys of the rivers Amazonas and Congo, Indonesia, Central America). Belt of tropical lowland rainforests.

6 ***b*** Hypothermaxeric or montane tropical rainforest climate. The coldest month ranges between 15–20 °C. Climate of tropical ranges and highlands between 1000–2500 m.

7 Mesaxeric or wet subtropical and humid moderate climatic belt: the number of dry months is zero. In contrast with the previous climatic belt the mean temperature of the coldest month is below 15 °C. Mainly warm temperate lowlands, subtropical montane regions and the high montane belts of the tropical ranges belong to this climate (e.g. South-east China and south Japan, New Zealand, south-east Australia, western Europe, the Pacific coasts of North America, Uruguay, East Argentina, south Chile, the southern slopes of the Himalayas, a large part of the Andes. Its subtypes:

7 ***a*** Eumesaxeric or subtropical humid climatic belt: the coldest month ranges between 10–15 °C. In subtropic and oceanic warm moderate lowlands, low and middle ranges and/or in the montane rainforest belt of tropical mountains, between 2000–3000 m.

7 ***b*** Hypomesaxeric or humid temperate and wet subtropical montane climate. The mean temperature of the coldest month ranges between 0–10 °C. In the tropical highlands this is the climate of the subalpine belt.

II Cold and moderately cold climates. The temperature curve assumed negative values in certain periods of the year.

8 Psychroeremic or cold desert climatic belt: the number of dry months 11–12. The highland deserts of Central Asia belong here (Tibet, Gobi). Its sub regions are the following:

8 ***a*** Precipitation may not occur for years

8 ***b*** There is no snow accumulation

8 ***c*** Small amount of snow

9 Psychrohemieremic or cold semi-desert climatic belt: The number of dry months is 9–10. Its occurrence in the temperate highlands and in their continental basins in rain shadow areas (Central Asian highlands and the Aralo-Caspian region, South Andes and the semi-deserts of the North American Great Basin).

10 Xerotheric cold or steppe climate belt: number of dry months 1–8. The subtypes are the following: Generally it is widespread in the internal part of the temperate continents, and in the higher montane belts of the Mediterranean and subtropic ranges. Its sub division is as follows:

10 ***a*** Long dry subtype 7–8 dry months, salt desert belt: thorny puna vegetation in the Andes, in the Atlas, the belt of sphaerical thorn bushes.

10 ***b*** Dry subtype with 5–6 dry months; dwarf shrub deserts, belt of *Artemisia* grasslands; in the Andes the belt of dry punas;

10 ***c*** Moderately dry subtype with 3–4 dry months, belt of dwarf grass steppes; in the Andes the belt of wet punas and alpine pastures;

10 ***d*** Slightly dry subtype with 1–2 dry months; subcontinental climate often with a submediterranean character. Belt of tall grass steppes and prairies; in the Andes, climate of the paramo belt.

11 Psychroaxeric or wet cold climatic belt: number of dry months: 0. The most widespread climatic belt which includes the Eurasian pine forests and tundras and the upper regions of the temperate highlands. Only the Andes and the alpine belt of the New Zealand mountains of the southern hemisphere belong here. According to the extent of the frosty period and the intensity of temperature fluctuation the following subdivisions may be discerned:

11 ***a*** Strongly cold subtype with more than 8 frosty months.

11 ***b*** Cold subtype with 7–8 frosty months. Further variations: oceanic (Oc) continental (Ct) hypercontinental (Hct) montane (Mt). Vegetation: subarctic needle-leaved forest belt.

11 ***c*** Moderately cold subtype with 4–6 frosty months. Vegetation: taiga belt. Variations similar to the previous: Oc, Ct, Hct and Mt.

11 ***d*** Slightly cold subtype with less than 4 frosty months. Continental broad-leaved forests and pine broad-leaved mixed forests.

III Ice climate — the tempereature curve throughout the year is negative.

12 Cryomeric or frost climate belt: the number of frosty months: 12. No plant life.

7.6.7 New classification of xerotheric climates

It became necessary to have a new classification of xerotheric climates because on the border of the north-east montane region of Cuba, at the northern margin and in the coastal region of Moa and Baracoa mountains we registered a climatic type which could not be identified in the Gaussen's bioclimatic system, in fact in other climatic systems either. This climatic type which I referred to previously, indicates a

Mediterranean—summer dry—feature in its precipitation while its temperature conditions unequivocally indicate a tropical climate. Accordingly we distinguish it as a xerotheric tropical or summer dry tropical climate type. Very similar climatic types are known in south India and the eastern coastal regions and the surrounding mountain slopes of Sri Lanka (Ceylon) (Meher-Homji 1963); furthermore in east Africa, Mauritius and Sao Thome, eastern slopes of the mountain regions of central Vietnam (Pócs, personal communication) but it is expected that this climatic type will be registered along the eastern coastline of Australia, in the mountains of East Mexico and other West Indian islands. It is more likely to occur where the bixeric climate comes in contact with montane wet tropical climate but as a consequence of the effect opposing the monsoon and/or passat wind system, the winter dry period disappears, while the dry summer period remains in a transitional area between the two climates. The formation of similar conditions can be expected mainly in the lower montane regions along the eastern tropical coastline of the continents and islands.

7.6.8 Bioclimatic map of the world

The phytogeographic geobotanical aspects of Gaussen's bioclimatic classification are discussed in detail by Meher-Homji (1963). In the same work a world bioclimate map of Bagnouls and Meher-Homiji is published in the scale of 1:50 million. Although this map contains some striking inaccuracies, of the climatological maps which have appeared so far, it fits the zonal vegetation type distribution best.

8 Cuban bioclimatology

The Cuban bioclimatic types were analyzed on 217 representative ombrothermic climate diagrams which had been selected from those of more than 1000 stations. From these we established the bioclimatic types of Cuba and their distribution (Borhidi 1974) which was illustrated on a map (See: Fig. 23). Further 11 bioclimate and vegetation profiles were prepared on the most characteristic regions of Cuba from geomorphological and geobotanical points of view demonstrating the relationship of the relief to the bioclimate and vegetation over the whole length of the island.

We should note that the registering station names are repeated in some cases on the diagrams. The cause for this is, that the individual meteorological stations are indicated with the settlement name of the mapsheet of 1:50 000 scale and a serial number after it. So for example between Moa 756 and Moa 1290 there is a distance of 40 km, a 1000 m high ridge, and a difference of 400 m in altitude and consequently their bioclimates are entirely different.

Furthermore numerous stations—mainly in the montane regions—have only a precipitation data series; the corresponding temperature values were estimated from the data under point *3.3.1* with the help of appropriate temperature gradients. We should stress that the character and variability of the Cuban climate and the distribution of its types can be found correctly for the first time in this work. On

Köppen's climate map the whole island belongs to the savannah climate. According to Bagnouls and Meher-Homji's map it uniformly belongs to the thermaxeric tropical rainforest climate. Trewartha's map is less erroneous, because it lists West Cuba under the savannah climate, central and east Cuba under the tropical arid steppe belt. The least inaccuracy is contained in the Walter's "Klimadiagram Weltatlas" based on data from not more than 4 or 5 Cuban station.

8.1 Cuban bioclimate types

Taking the Gaussen's type of bioclimatic system discussed in the previous chapter as the basis, we can distinguish the following bioclimatic types:

8.1.1 Semi-desert climate

Thermohemieremic hot semi-desert climate without a characteristic rainfall distribution (**2 *c subtype***). It is the climate which prevails along the southern coastline of Oriente Province from Guantanamo basin to Punta Caleta which forms in the rain shadow of Sierra del Purial, Sierra de Imias and Cuchillas de Baracoa (Fig. 8.). The annual average temperature is 27—28 °C, the mean annual precipitation varies between 350—500 mm in a rather sporadic distribution. It is striking, that not a single month is completely free from precipitation, at the same time, a peak in May and October-November can be observed from which it follows that in the west the autumn peak may fall out and in the east the spring one. The prevailing vegetation on the sandy soils is a cactus scrub, in the rocky karstic surfaces it is a loose thorny thicket or a shrub forest. An analogous climate to this can be found in Africa, Somalia and in Asia, likewise in the rain shadow of the south Indian Tamil desert.

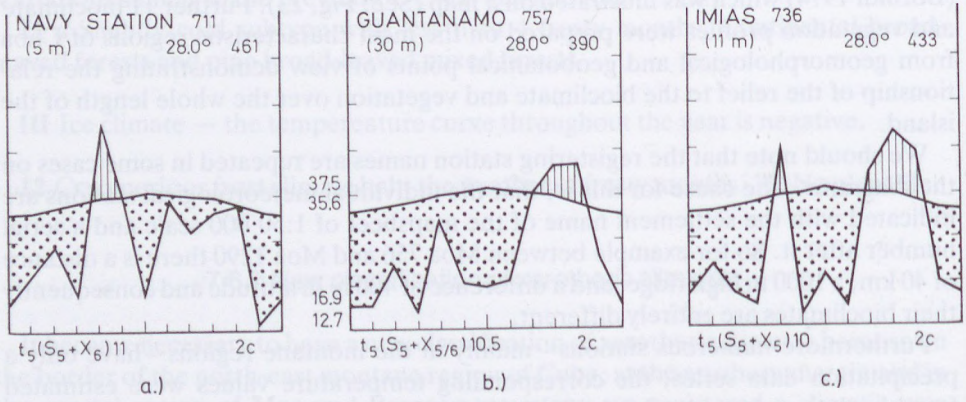

Fig. 8 Diagrams of the semi-desert climate (2c) in South-east-Oriente: a) Navy Station of Guantanamo 711: b) Guantanamo 757 and c) Imias 736

8.1.2 Xerotherotropic or summer dry tropical climate

This appears in the north eastern part of Oriente province, the climate type occurring in the northern margin and coastal belt of the Moa and Baracoa ranges. The dry season generally lasts from April to the end of August which in certain areas and in certain years has been cut into two by a slight rain peak in May. Not in frequently there is a slight February dry period. The annual precipitation ranges between 950—1500 mm. In these areas in Cuba on limestone evergreen shrub woodlands evergreen microphyllous or semi-deciduous forests, on the latosols pine forests prevail while in east Africa or South-East Asia dry evergreen forests and semi-deciduous forests can be found.

Subtypes

3 *b T* Summer dry tropical climate with 5—6 dry months. Medium subtype (Fig. 9). In the north-east coastline of Oriente and eastern peak cover smaller areas, the climate type has annual precipitation of 900—1000 mm and is intensively arid over

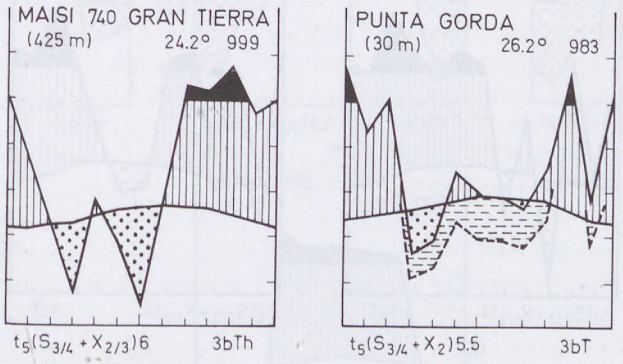

Fig. 9 Diagrams of the xerotherotropical climate, medium subtype (3bT) with 5—6 dry months, in north-east-Oriente: a) Gran Tierra—Maisi 740 and b) Punta Gorda

longer period. The zonal vegetation comprises serpentine evergreen shrub woodlands, latosol pine forests, limestone semi-deciduous forests, perhaps deciduous dry forest.

3 *c T* Summer dry tropical climate with 3—4 dry months. Moderate subtype (Fig. 10). It is to be found between Baracoa and Maisi over a small region of the Yumuri delta. The annual precipitation ranges between 1100 and 1300 mm. Zonal vegetation is a semi-deciduous forest.

3 *d T* Summer dry tropical climate with 1—2 dry months. Subhumid subtype (Fig. 11). It occurs in small patches alternating with the previous types. The zonal vegetation is seasonal evergreen forest.

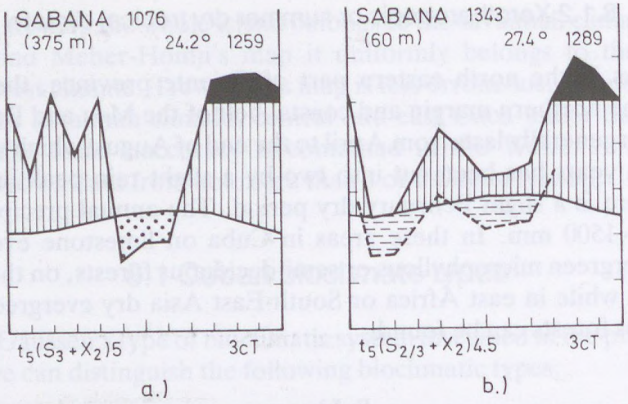

Fig. 10 Diagrams of the xerotherotropical climate, moderate subtype (3cT) with 3—4 dry months, in north-east-Oriente: a) Sabana 1076 and b) Sabana 1343

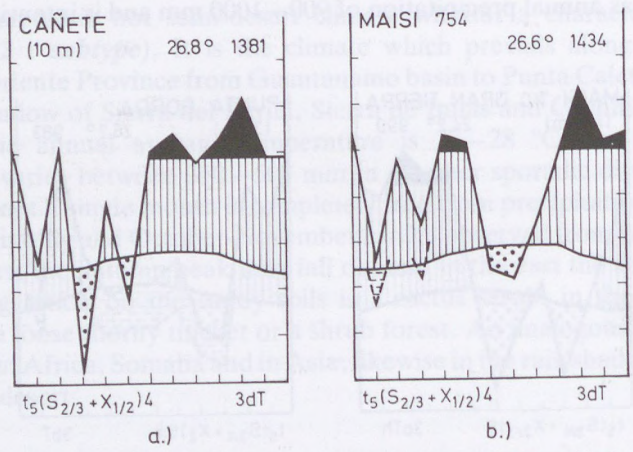

Fig. 11 Diagrams of xerotherotropical climate, subhumid subtype (3dT), with 1—2 dry months, in North-east-Oriente: a) Cañete and b) Maisi 754

8.1.3 Xerochimenic winter dry tropical climate

It is the most common climate in Cuba; it prevails for the most part from West and Central Cuba from Cabo San Antonio to the Cauto lowland as well as Isla de Pinos, in fact, within the montane regions of Oriente, in Sierra Maestra, Sierra de Nipe, and Sierra de Cristal for the most part with the exception of higher belts. The annual mean temperature varied between 20—27 °C, the annual mean precipitation is between 800—1800 mm, it may rise exceptionally to 2200 mm. A characteristic feature of precipitation distribution in Cuba is that due to the effect of the sea, the dry season is also moderately rainy similar to other areas of the Caribbean region (Mexico, Venezuela) and is not extremely arid as in the classical regions of

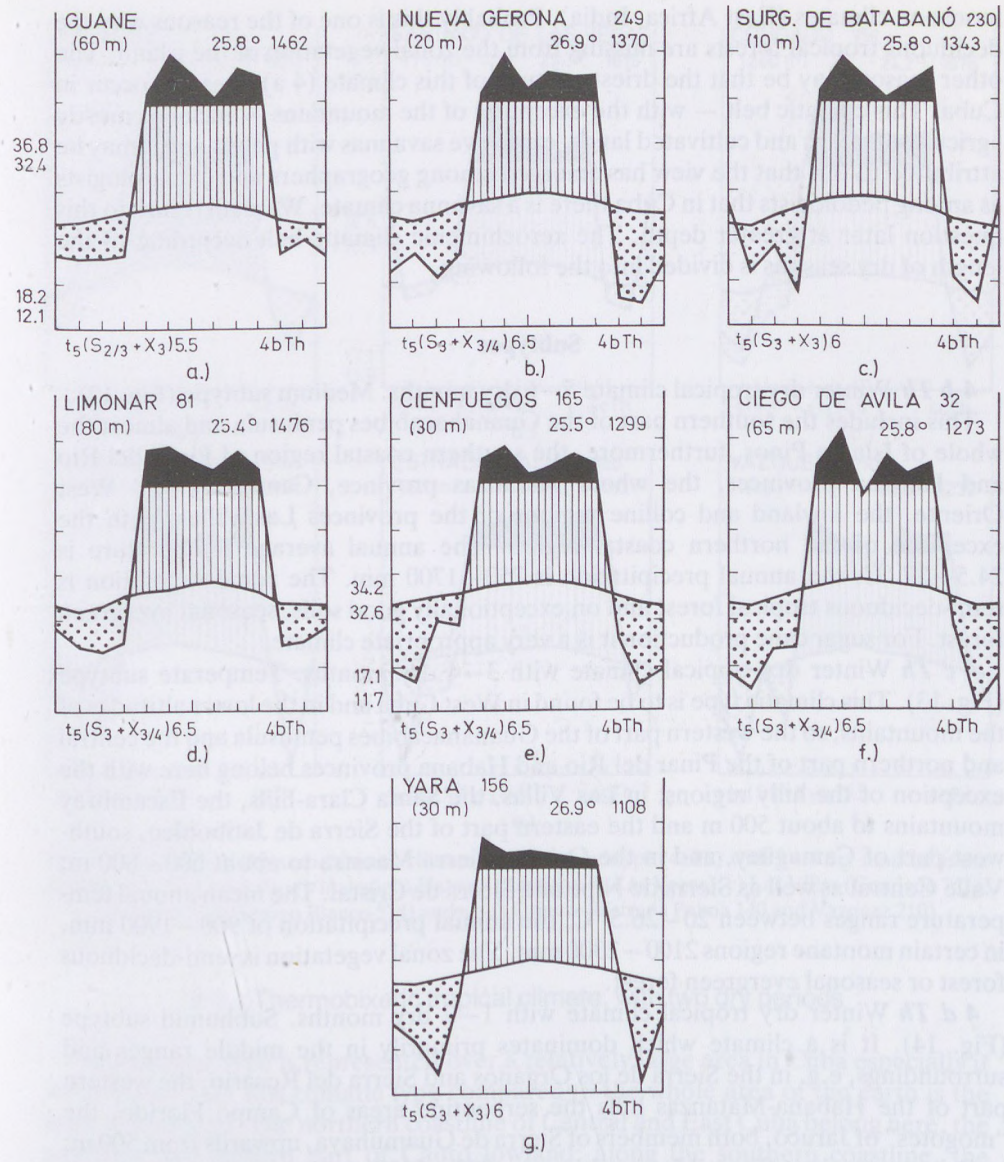

Fig. 12 Diagrams of the xerochimenic tropical climate, medium subtype (4bTh) with 5—6 dry months in the provinces: a) Pinar del Rio (Guane); b) Isle of Pines (Nueva Gerona 249); c) Habana (Surgidero de Batabanó 230); d) Matanzas (Limonar 81); e) Las Villas (Cienfuegos 165); f) Camagüey (Ciego de Avila 32) and g) Oriente (Yara 156)

monsoon climates (East Africa, India). Probably this is one of the reasons why the deciduous tropical forests are missing from the zonal vegetation of the island. The other reason may be that the driest subtype of this climate (4 a) does not occur in Cuba. This climatic belt — with the exception of the mountains — includes mostly agricultural areas and cultivated lands, extensive savannas with palms and it may be attributed to this that the view has emerged among geographers and climatologists as among pedologists that in Cuba there is a savanna climate. We shall return to this question later at greater depth. The xerochimenic climatic belt according to the length of dry seasons is divided into the following.

Subtypes

4 *b Th* Winter dry tropical climate 5—6 dry months. Medium subtype (Fig. 12). This includes the southern part of the Guanahacabibes peninsula and almost the whole of Isla de Pinos, furthermore, the southern coastal region of Pinar del Rio and Habana provinces, the whole Matanzas province, Camagüey and West Oriente, the lowland and colline regions of the provinces Las Villas, with the exception of the northern coastal region. The annual average temperature is 24.5—27 °C, the annual precipitation is 750—1700 mm. The zonal vegetation is semi-deciduous tropical forest and on exceptionally good soils, seasonal evergreen forest. For sugar cane production it is a very appropriate climate.

4 *c Th* Winter dry tropical climate with 3—4 dry months. Temperate subtype (Fig. 13). This climatic type is to be found in West Cuba and in the lower altitudes of the mountains, so the western part of the Guanahacabibes peninsula and the central and northern part of the Pinar del Rio and Habana provinces belong here with the exception of the hilly regions; in Las Villas, the Santa Clara-hills, the Escambray mountains to about 500 m and the eastern part of the Sierra de Jatibonico, south-west part of Camagüey, and in the Oriente Sierra Maestra to about 600—800 m; Valle Central as well as Sierra de Nipe and Sierra de Cristal. The mean annual temperature ranges between 20—26.5 °C, the annual precipitation of 900—1900 mm, in certain montane regions 2100—2300 mm. The zonal vegetation is semi-deciduous forest or seasonal evergreen forest.

4 *d Th* Winter dry tropical climate with 1—2 dry months. Subhumid subtype (Fig. 14). It is a climate which dominates primarily in the middle ranges and surroundings, e.g. in the Sierra de los Organos and Sierra del Rosario, the western part of the Habana-Matanzas hills the serpentine areas of Campo Florido, the "mogotes" of Jaruco, both members of Sierra de Guamuhaya, upwards from 500 m; in Oriente province Sierra Maestra between 800—1400 m (such as the Turquino—Bayamesa group, the Loma del Gato in the Sierra del Cobre and the Gran Piedra) as well as Sierra de Nipe and Sierra de Cristal to 600—700 m. The annual mean temperature is 18—25 (to 26) °C the annual rainfall is 1100—2400 mm. The zonal vegetation types are seasonal evergreen forests, dry submontane and montane rainforests, wet montane rainforests.

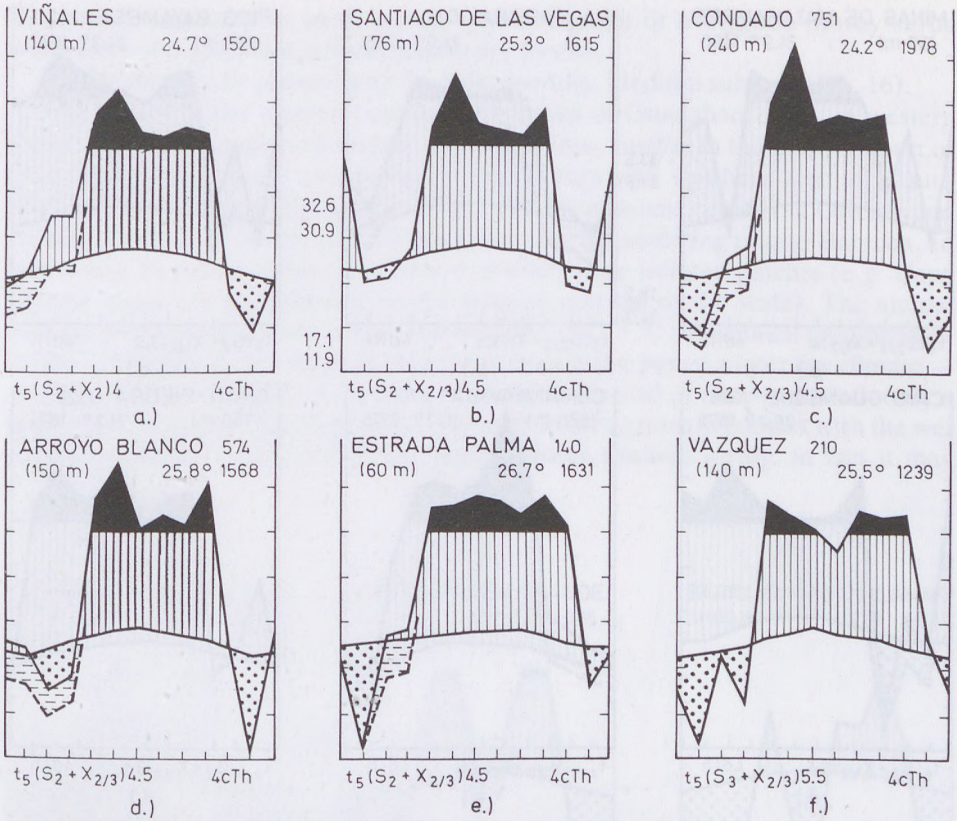

Fig. 13 Diagrams of the xerochimenic climate, moderate subtype (4cTh) with 3—4 dry months in the provinces: a) Pinar del Rio (Viñales); b) Habana (Santiago de Las Vegas); c) Las Villas (Condado 751); d) Camagüey (Arroyo Blanco 574) and e—f) Oriente (Estrada Palma 140 and Vazquez 210)

8.1.4 Thermobixeric tropical climate, with two dry periods

This climatic type is represented over a relatively large area in Cuba especially if we consider that this climatic type compared to the whole area of the earth is the least widespread. The northern coastline of Central and East Cuba belong here, the northern and eastern part of Cauto lowland; along the southern coastline, the eastern part of the isthmus of Guanahacabibes with the south-western part of Isla de Pinos, furthermore the foothill regions of the Sierra de Escambray and of the Oriente mountain ranges. This climate along the northern coastlines comes about macroclimatically as a consequence of the intensified activity of the west Atlantic anti-cyclone in summer, while on the southern coasts it forms mesoclimatically in the rain shadow of the mountains. The vegetation adapts to the two dry periods in different ways in many respects more than to the winter dry monsoon and passat climates. Besides this, the time span of the arid period has to be evaluated differently than in the case of one dry season climate. Both aspects are discussed in

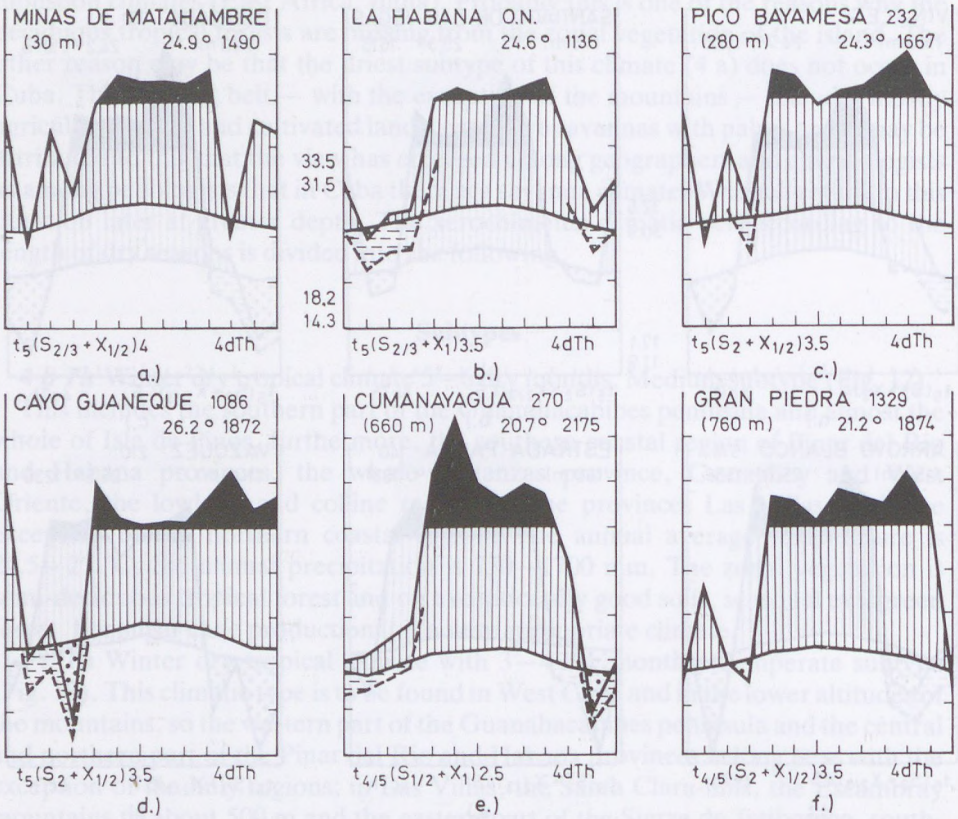

Fig. 14 Diagrams of the xerochimenic climate, subhumid subtype (4dTh) with 1—2 dry months in the lowland—colline belt of the provinces: a) Pinar del Rio (Minas de Matahambre); b) Habana (National Observatory of Habana) and c—d) Oriente (Pico Bayamesa 232 and Cayo Guaneque 1086) and in the submontane belt of e) Las Villas (Cumanayagua 270) and f) Oriente (Gran Piedra 1329)

depth in *9. 1.* The annual mean temperature ranges between 24.5—27.5 °C, the annual precipitation varies on an average between 550—1800 mm. On the basis of the total length of dry periods the following can be distinguished:

Subtypes

5 a Th Extremely dry bixeric climate with 7—8 dry months. Accentuated subtype (Fig. 15).

It formed on the south coastal region of Las Villas province in the rain shadow of Escambray mountains, on the north Camagüey islands, further on, the southern slopes of Sierra Maestra and in the Guanatanamo basin and east of it on the southern promontories of Sierra de Puriales. The latter two areas are in transition towards the semi-desert belt. In these areas the annual mean temperature is between 25.5—28.0 °C, the annual precipitation average is between 550—750 mm.

The zonal vegetation is small-leaved semi-evergreen or evergreen thorny shrub woodlands and succulent rich deciduous dry forests.

5 b Th Dry bixeric climate with 5—6 dry months. Medium subtype (Fig. 16).

This occurs in the eastern part of the isthmus of Guanahacabibes, in western Cuba, and in the south western part of Isla de Pinos, further in the northern part of Camagüey and Oriente provinces, in the eastern and southern part of Cauto lowland progressing on the southern slopes of the montane regions of Oriente and turning northwards on the plain of Maisi forming a connecting ring to Baracoa. In fact it may be found further to the west in many little isolated patches (e.g. Cayo Mambi, these are not depicted on the map on account of the scale). The annual average mean temperature ranges between 24.5—27.5 °C, the annual precipitation is 740—1150 mm. In the zones in transition towards the passat winter dry climate — mainly in West and Central Cuba — in summer, instead of the dry period, only a semi-arid one occurs. In other cases especially in the regions in contact with the wet montane climate — the winter dry period passes towards spring, in fact it may

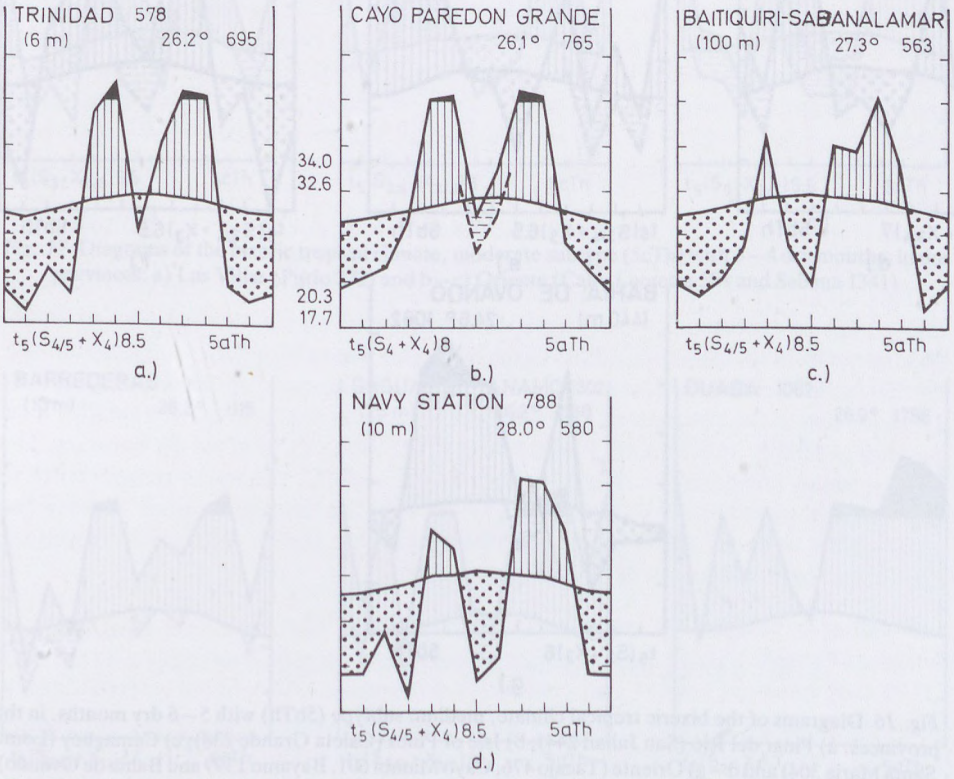

Fig. 15 Diagrams of the bixeric tropical climate, extreme subtype (5aTh) with 7—8 dry months, in the provinces: a) Las Villas (Trinidad 578); b) Camagüey (Cayo Paredon Grande) and c—d) South-east-Oriente (Baitiquiri-Sabanalamar and Navy Station of Guantanamo 788)

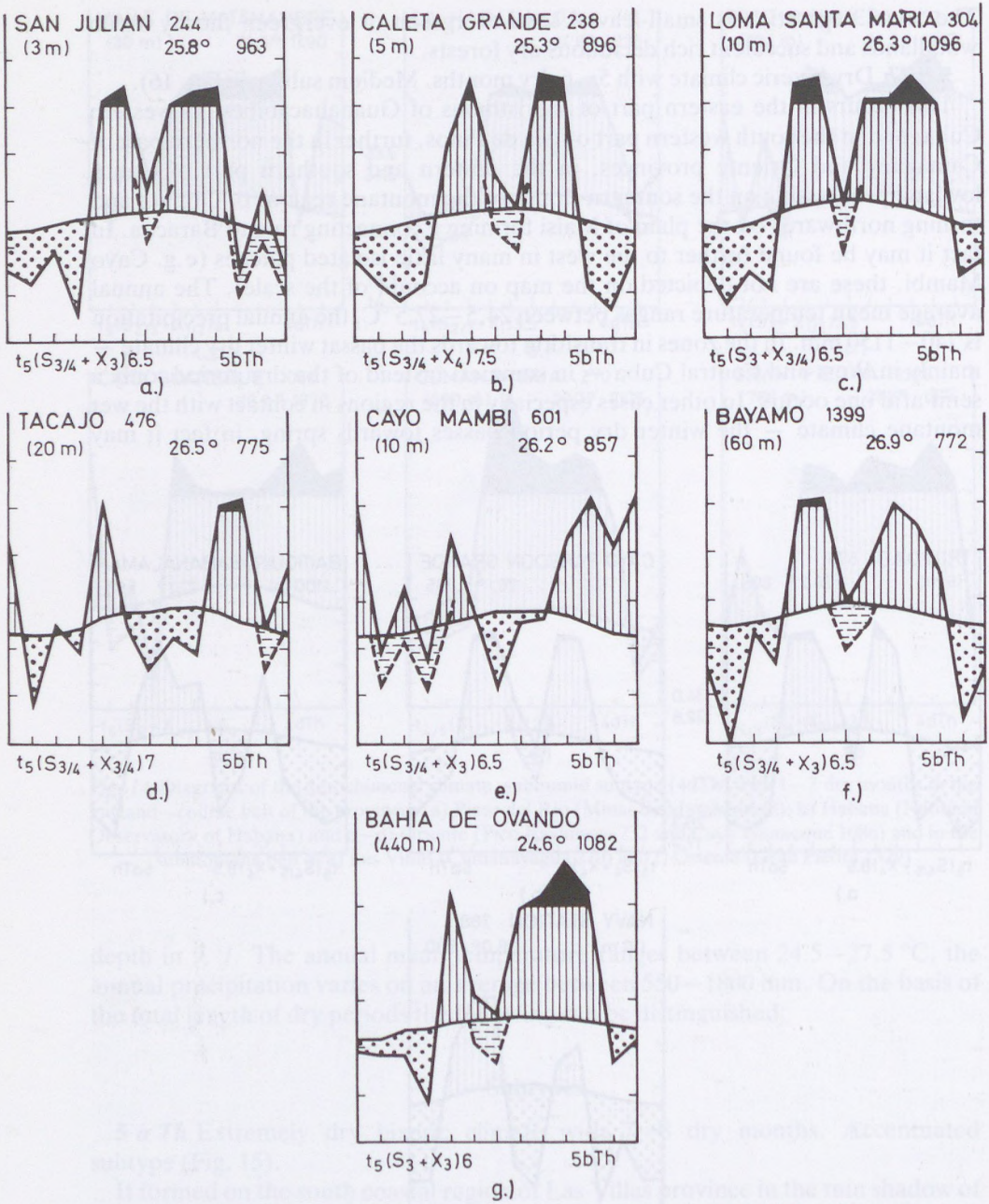

Fig. 16 Diagrams of the bixeric tropical climate, medium subtype (5bTh) with 5—6 dry months, in the provinces: a) Pinar del Rio (San Julian 244); b) Isle of Pines (Caleta Grande 238); c) Camagüey (Loma Santa Maria 304) and d—g) Oriente (Tacajo 476, Cayo Mambi 601, Bayamo 1399 and Bahia de Ovando)

merge with the summer one as a consequence of which a precipitation distribution similar to that of the Mediterranean climate is formed. Zonal vegetation types: small-leaved dry evergreen shrub woodland or forest, microphyllous semi-deciduous forest.

5 *c Th* Moderately dry bixeric climate with 3—4 dry months. Moderate subtype (Fig. 17).

This occurs in Las Villas province and the northern shores of West Camagüey, in Oriente, in the eastern part of the Mariabon group, further in Sierra de Nipe and in the northern promontory of Sierra de Cristal, in fact, in smaller patches in the northern and southern ridges of the montane regions of Moa and Baracoa. In the

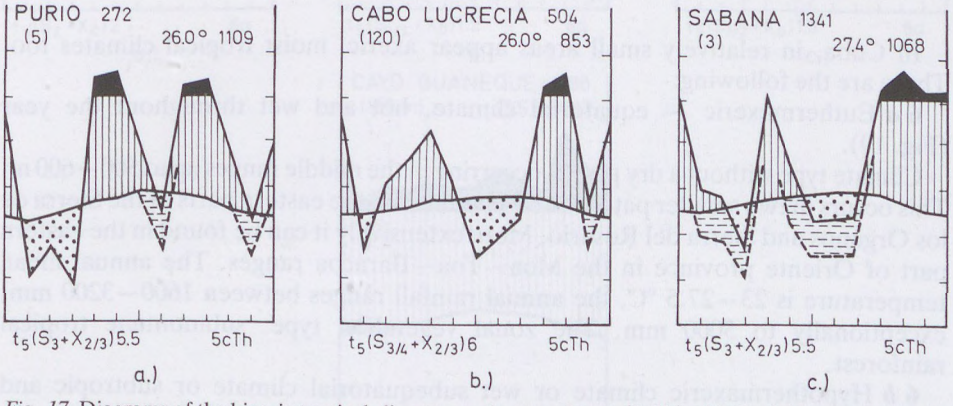

Fig. 17 Diagrams of the bixeric tropical climate, moderate subtype (5cTh) with 3—4 dry months, in the provinces: a) Las Villas (Purio 272) and b—c) Oriente (Cabo Lucrecia 504 and Sabana 1341)

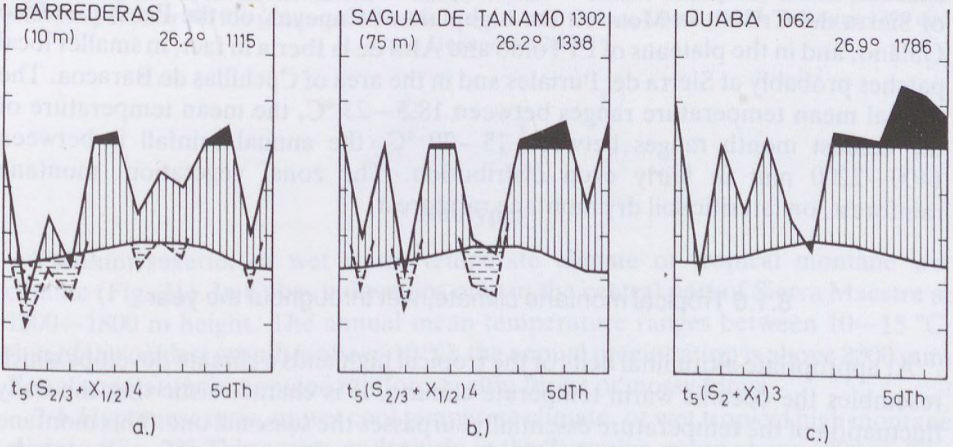

Fig. 18 Diagrams of the bixeric tropical climate, subhumid subtype (5dTh) with 1—2 dry months in Oriente (a), Barrederas b), Sagua de Tánamo 1302 and c), Duaba 1062)

latter sites it occurs as a version in transition towards the xerotherotropic climate **(3 *bT*, 3 *cT*)** (Fig. 49). The annual mean temperature ranges between 23—27.5 °C, the annual precipitation is 850—1350 mm. The zonal vegetation is semi-deciduous forest, seasonal evergreen tropical forest and dry evergreen forest.

5 *d Th* Subhumid bixeric climate with 1—2 dry months. Subhumid subtype (Fig. 18).

This occurs exclusively in the north-east coastal region of Oriente at the border of the Moa—Toa—Baracoa ranges. Annual average temperature varies between 23—27 °C, annual precipitation average is between 110—1800 mm. Zonal vegetation: semi-evergreen forest, seasonal evergreen forest, submontane rainforest.

8.1.5 Axeric, tropical climates wet throughout the year

In Cuba, in relatively small areas appear axeric, moist tropical climates too. These are the following:

6 *a* Euthermaxeric — equatorial climate, hot and wet throughout the year (Fig. 19).

Climate type without a dry period occurring in the middle ranges up to 500—600 m. This occurs in two smaller patches in West Cuba on the eastern parts of the Sierra de los Organos and Sierra del Rosario. More extensively it can be found in the eastern part of Oriente province in the Moa—Toa—Baracoa ranges. The annual mean temperature is 23—27.5 °C, the annual rainfall ranges between 1600—3200 mm, exceptionally to 5000 mm. The zonal vegetation type: submontane tropical rainforest.

6 *b* Hypothermaxeric climate or wet subequatorial climate or subtropic and tropical submontane climate without dry season (Fig. 20).

This climate type in Cuba occurs only in the montane belt generally between 600—1400 m altitude, e.g. in Sierra de Escambray, in the central part of Sierra Maestra and in the plateaus of Sierra de Nipe and Loma Mensura on the main ridge of Sierra del Cristal, in Moa, on the highplain of Cupeyal, on the Palenque, Pico Galáno, and in the plateaus of El Toldo and Alto de la Iberia in fact, in smaller local patches probably at Sierra del Puriales and in the area of Cuchillas de Baracoa. The annual mean temperature ranges between 18.5—23 °C, the mean temperature of the coldest month ranges between 15—20 °C, the annual rainfall is between 1400—2200 mm in fairly even distribution. The zonal vegetation: montane rainforest, on lateritic soil dry montane rainforest.

8.1.6 Tropical montane climate, wet throughout the year

At appropriate altitudinal belts of the tropical highlands a climate develops which resembles the oceanic warm temperate climate. It is characteristic that the daily fluctuation of the temperature essentially surpasses the seasonal one. This montane belt is appropriately coined in the highlands of Latin American, 'Tierra templada' that is temperate belt. In Cuba its two climatic subtypes can be found:

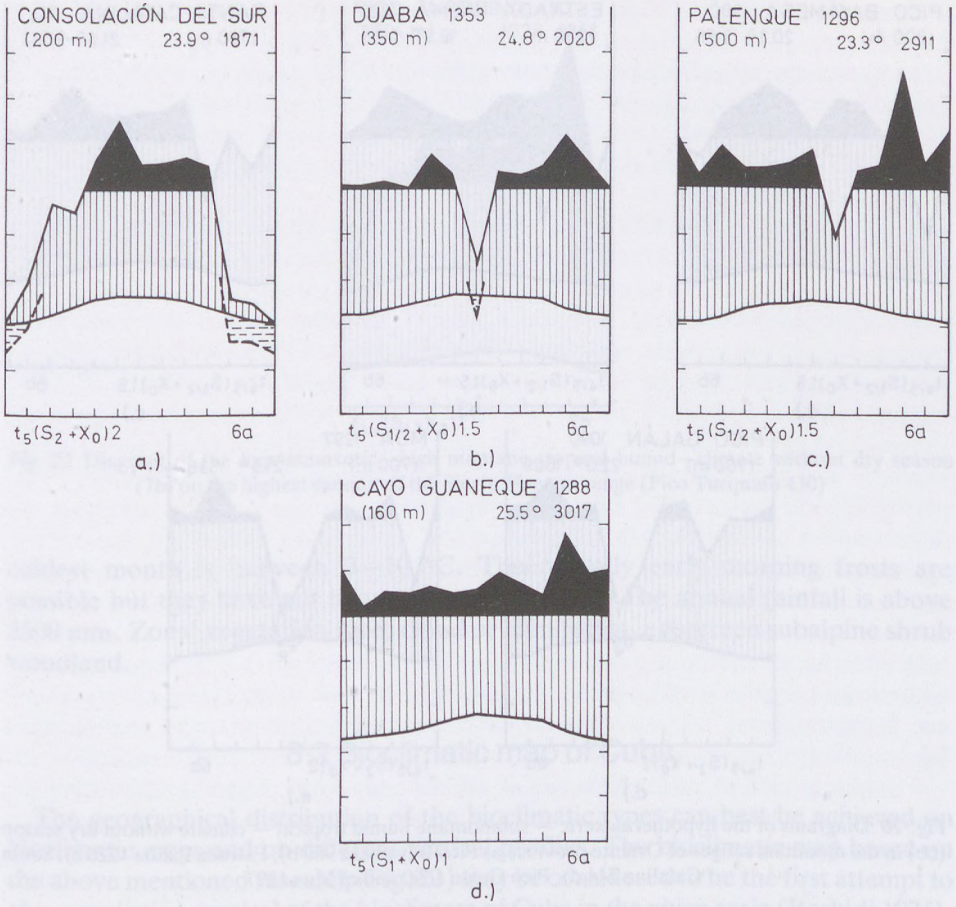

Fig. 19 Diagrams of the euthermaxeric — humid tropical — climate without dry season (6a) in the provinces: a) Pinar del Rio (Consolación del Sur) and b—d), Oriente (Duaba 1353, Palenque 1296 and Cayo Guaneque 1288)

Subtypes

7 *a* Eumesaxeric, or wet warm temperate climate or tropical montane wet climate (Fig. 21). In Cuba, it develops only in the central part of Sierra Maestra at 1200—1800 m height. The annual mean temperature ranges between 10—15 °C, that of the coldest month is above 10 °C; the annual precipitation is above 2000 mm. Zonal vegetation is montane rainforest, elfin forest or mossy forest.

7 *b* Hypomesaxeric, or wet cool temperate climate, or wet tropical high montane climate (Fig. 22) This occurs exclusively in the Turquino group above 1800 m. The annual mean temperature is between 10—12 °C, the mean temperature of the

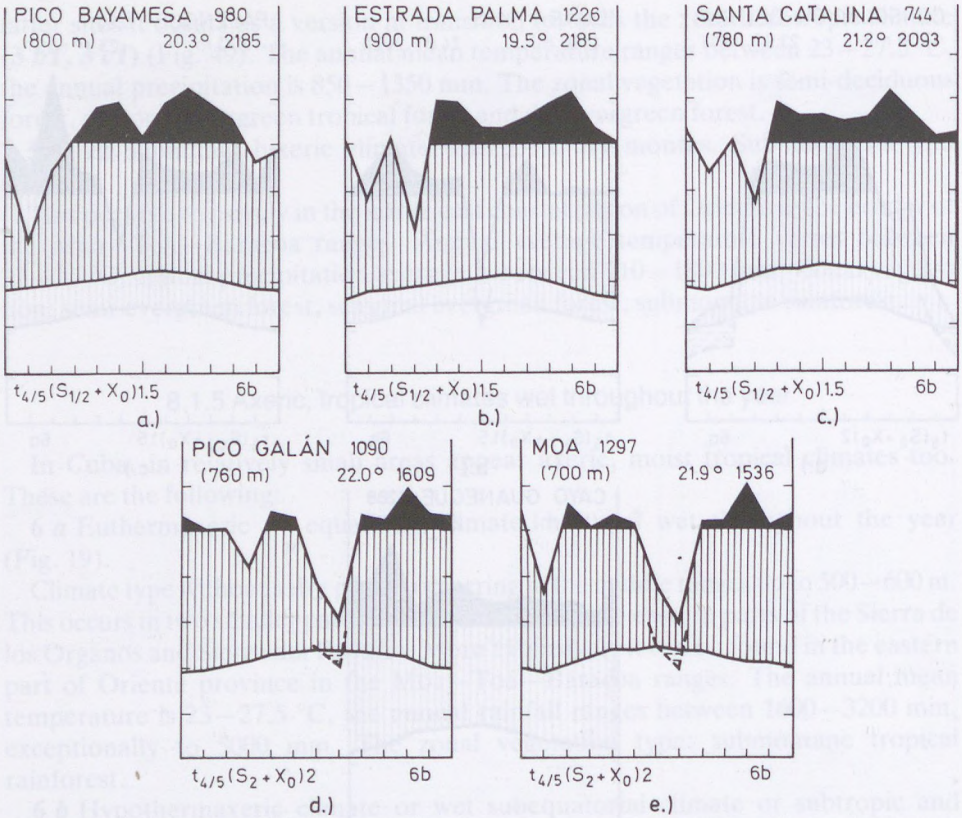

Fig. 20 Diagrams of the hypothermaxeric — submontane humid tropical — climate without dry season (6b) in the mountain ranges of Oriente province a) Pico Bayamesa 980 b), Estrada Palma 1226 c), Santa Catalina 744 d), Pico Galán 1090 and e) Moa 1297

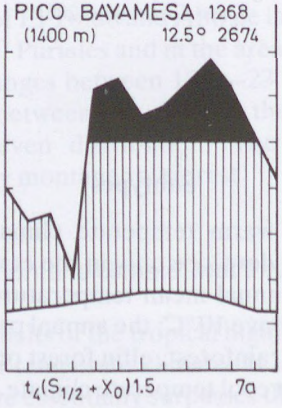

Fig. 21 Diagram of the eumesaxeric — montane humid tropical — climate without dry season (7a) on the summits of the Sierra Maestra range (Pico Bayamesa 1268)

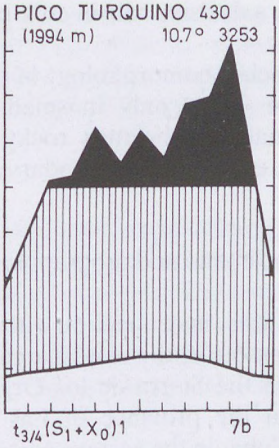

Fig. 22 Diagram of the hypomesaxeric—high montane tropical humid—climate without dry season (7b) on the highest summit of the Sierra Maestra range (Pico Turquino 430)

coldest month is between 0—10 °C. Theoretically early morning frosts are possible but they have not been observed in Cuba. The annual rainfall is above 2500 mm. Zonal vegetation type; cloud or elfin forest, evergreen subalpine shrub woodland.

8.2 Bioclimatic map of Cuba

The geographical distribution of the bioclimatic types can best be achieved on bioclimatic maps and on different vertical profiles. The bioclimatic map based on the above mentioned research (Fig. 23) may be considered to be the first attempt to give a realistic appraisal of the bioclimate of Cuba in the given scale (Borhidi 1974).

8.2.1 Bioclimatic types based on a geographical approach

It may be clearly discerned from the bioclimatic map of Cuba that in this country — including Isla de Pinos — there is largely a winter dry passat climate represented with dry and moderately dry subtypes **4** ***b Th*** and **4** ***c Th*** which is mostly characteristic of the lowlands of Matanzas and Camagüey provinces. The most uniform is the climate of the Matanzas province where only one of 13 climatic types of Cuba occur. Two factors create a variability already described in this climatic uniformity:

a) The anti-cyclone effect of the west Atlantic, which creates the bixeric climate of the northern shores, in fact it is responsible for the xerotheric climate of the Moa-Baracoa shores.

b) The mountains which on account of their height cause tropical rainforest climates **6** ***a,*** **6** ***b*** and wet montane temperate climates **7** ***a,*** **7** ***b*** on the other hand by

their shading effect they have a decisive role in creating the extremely dry climates **2 *c*, 5 *a***.

As a consequence of the special geomorphology of the region and the varied soils, the zonal vegetation can be found only in small patches and in their place edaphically determined azonal or subclimax rocky forest and paraclimax pine woodlands prevail, as well as, edaphic and secondary savannas.

8.2.2 Bioclimatic and orographic diversity

The climatic variability of Cuba, in connection with the conditions of the relief, is best shown by three fairly remote and isolated areas: (1) western Cuba and the province of Pinar del Rio (in the Sierra de los Organos and Sierra del Rosario region), (2) central Cuba in the province of Las Villas (along the Sierra de Escambray) and (3) eastern Cuba, in the eastern part of Oriente (the areas of Sierra Maestra and the Sagua-Baracoa Massif). In addition to the geohistorical and petrographical factors, this climatic variability is also significant in affecting the development of high floristic abundance and diverse vegetation. Of these three regions, the Sagua-Baracoa Massif has the most varied climate; 13 climatic types of the 15 in Cuba occur here. Within the 56 km distance between Imias and Cañete, seven climatic types are found (see bioclimatic profile Fig. 34) and the semi-desert belt and the submontane rainforests are only 15 km apart. It is noted that this climatic and vegetational diversity is not unique in the Antilles. Similar phenomena are reported from eastern Jamaica (Asprey and Robbins 1953) and western Hispaniola (Ciferri 1936) under similar atmospheric and orographic conditions.

The dry period of passat climates is absent only from the mountainous areas, showing the particular mesoclimatic significance of the mountains. Consequently there is no tropical rainforest climate in the plains of Cuba, and rainforests occur as

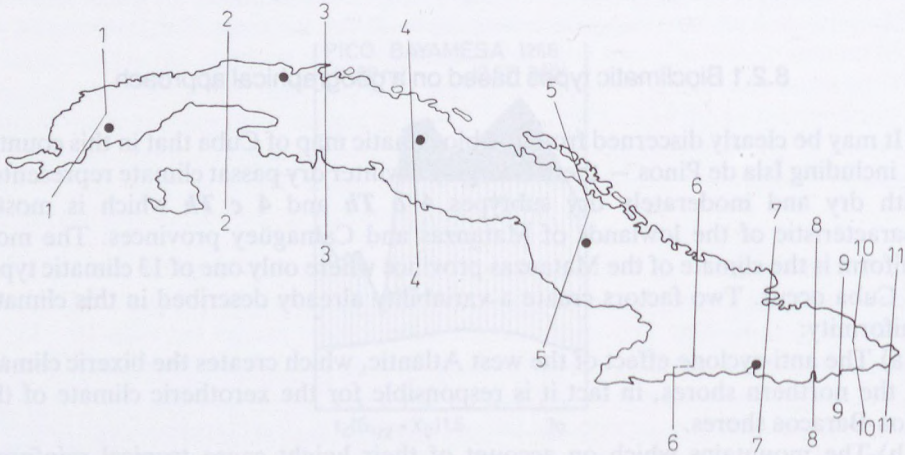

Fig. 24 Geographic localization of the complex bioclimate and vegetation transects in Cuba

zonal vegetation types of the submontane, montane and cloudy regions at various elevations above-sea-level. Upon the influence of mountains, too, the dry period of seasonal climates is longer in the southern slopes and extremely dry mesoclimatic zones develop, resulting in sclerophyllous and thorn shrubwoods and semi-desert vegetation with cacti.

8.3 The bioclimatic and vegetation profiles of Cuba

These profiles provide a good illustration of the spatial alterations of bioclimate and their relationships with relief and vegetation types. 11 bioclimatic and vegetation profiles have been prepared for Cuba. These are selected to represent all the regions of Cuba which have characteristic relief and vegetation (Fig. 24).

8.3.1 Bioclimatic and vegetation transect through the province of Pinar del Rio

The transect gives the climate and vegetation of Pinar del Rio, from Sierra de los Organos towards the Guanahacabibes Peninsula in the southwest. It is typical that due to the cold winter fronts the dry winter season is shortened, or divided into two short and weak periods by the more rainy January. This is in effect, up to the middle of the island, and disappears only in the southern plain. It is seen that the rainy winds getting over the northern range of Sierra de los Organos do not lose all the precipitation, and the southern range behind the drier central valley and the slatey outcrops in its foreground get more rain. In the alternating 5 climatic types the occurrence of 4 vegetation types may be expected: **4 *b Th*—5 *b Th:*** dry evergreen forests, **4 *b Th*—4 *c Th:*** semi-deciduous forests, **4 *d Th:*** seasonal evergreen rainforests, and **6 *a:*** true tropical rainforests.

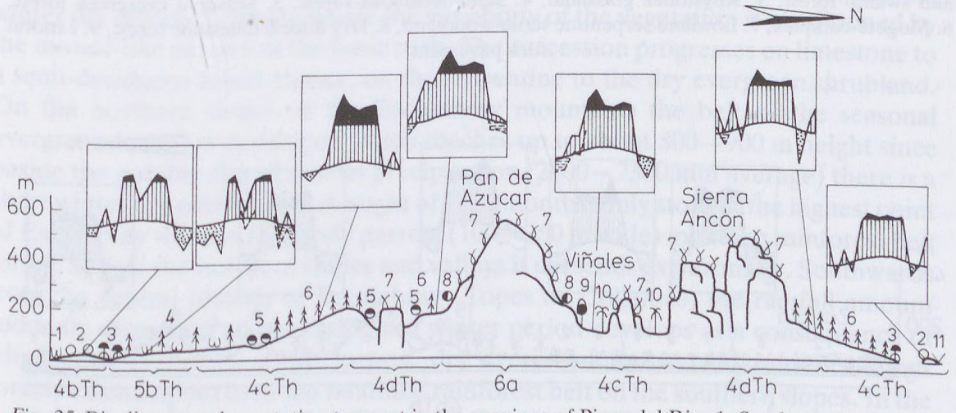

Fig. 25 Bioclimate and vegetation transect in the province of Pinar del Rio. 1. Sandy seashore, 2. Dry littoral forest, 3. Mangrove forest, 4. Pinewoodland on sand, 5. Evergreen oak-forest, 6. Pine forest on slatey sandstone, 7. Mogote-complex, 8. Semi-deciduous forest, 9. Seasonal evergreen forest, 10. Roystonea-grassland, 11. Littoral rock pavement

8.3.2 Bioclimatic and vegetation transects in the lowlands of Central Cuba

In the province of Havanna (Fig. 26) due to the slight relief, the climatic variability drops further, which is accompanied here by an even more geologic and pedologic uniformity. This climatic and edaphic conformity reaches its peak in Matanzas Province where an only climatic type dominates over the whole breadth of the island (Fig. 27). In both profiles it can be observed that there is a more even distribution of precipitation along the northern coastal region and a minimal rise in precipitation. According to what has been said about Camagüey Province (Fig. 28) the east Cuban lowland climate does not differ essentially from that of the west Cuban lowland. The only deviation from this is provided by the bixeric climatic types developing along the northern coastline which by the disappearing of the summer dry period, pass to a dry winter seasonal climate. The climax vegetation of these lowlands is rather uniform; semi-deciduous tropical forests are predominant

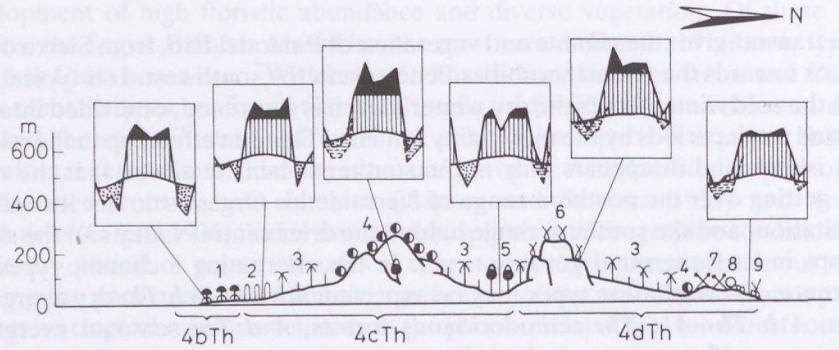

Fig. 26 Bioclimate and vegetation transect in the province of Havanna. 1. Mangrove forest, 2. Alluvial and swamp forest, 3. Roystonea grassland, 4. Semi-deciduous forest, 5. Seasonal evergreen forest, 6. Mogote-complex, 7. Lowland serpentine scrub-woodland, 8. Dry littoral limestone forest, 9. Littoral rock pavement

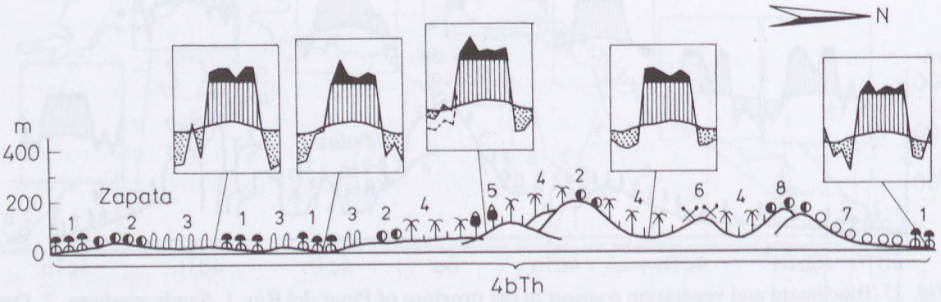

Fig. 27 Bioclimate and vegetation transect in the province of Matanzas. 1. Mangrove forest, 2. Semi-deciduous forest, 3. Swamp forest, 4. Roystonea grassland, 5. Seasonal evergreen forest, 6. Lowland serpentine scrubwoodland, 7. Dry littoral limestone forest

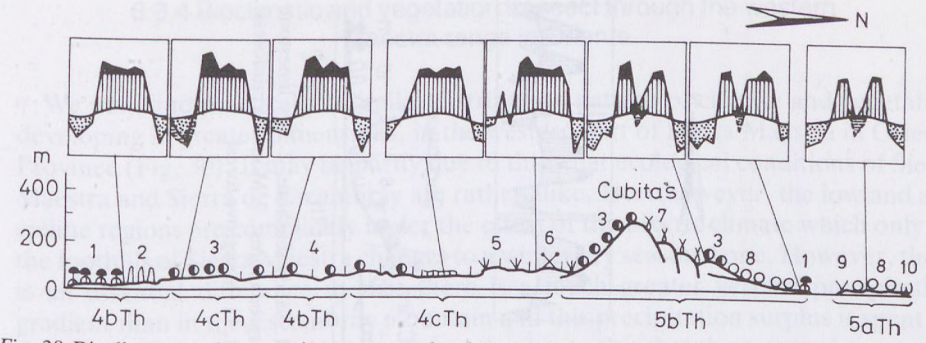

Fig. 28 Bioclimate and vegetation transect in the province of Camagüey. 1. Mangrove forest, 2. Alluvial forest, 3. Semi-deciduous forest, 4. Broad-leaved wooded grassland, 5. Low palm grassland, 6. Lowland serpentine scrub-woodland, 7. Mogote-complex, 8. Dry littoral limestone forest, 9. Littoral rock pavement, 10. Sandy seashore

which on more fertile soils (e.g. Matanzas clay) are substituted by seasonal evergreen rainforests. In the bixeric climatic belts dry evergreen forests and shrub forests are dominant.

8.3.3 Bioclimatic and vegetation transect through the Escambray mountains in the central provinces

The most varied region of western and central Cuba from orographic and climatic points of view is to be found in the central provinces (former Las Villas province, Fig. 29). On the northern coastal region in a narrow band, the bixeric climate has a relatively smaller effect on the vegetation in the wide mangrove belt and the flat swamp areas. The northern ranges of Villa Clara, the serpentine hills of Santa Clara and the northern forehills of Sierra de Escambray are under the influence of the winter dry seasonal climate where the variability of the vegetation is conditioned by the mosaic-like pattern of the basic rock. The succession progresses on limestone to a semi-deciduous forest climax, on the serpentine to the dry evergreen shrubland. On the northern slopes of the Escambray mountains the belt of the seasonal evergreen forests is developed which reaches up to about 800—900 m height since beside the notable rise of annual precipitation (2000—2300 mm average) there is a short winter dry period. This drought of 1—2 months, only stops at the highest point of Escambray where a relatively narrow (100—250 m wide) montane rainforest belt forms, and on the northern slopes and valleys it descends extrazonally. Southwards from the central plateau of Escambray (Topes de Collantes) the rainfall amount suddenly drops and an increasing dry winter period develops as a consequence of which, the evergreen shrub forests, dry evergreen forests and semi-deciduous forests extend upwards to the montane rainforest belt on the southern slopes. In the southern lowland of the mountain, a bixeric zone with 8—9 dry months is formed which favours the formation of sclerophyllous and thorny evergreen thickets.

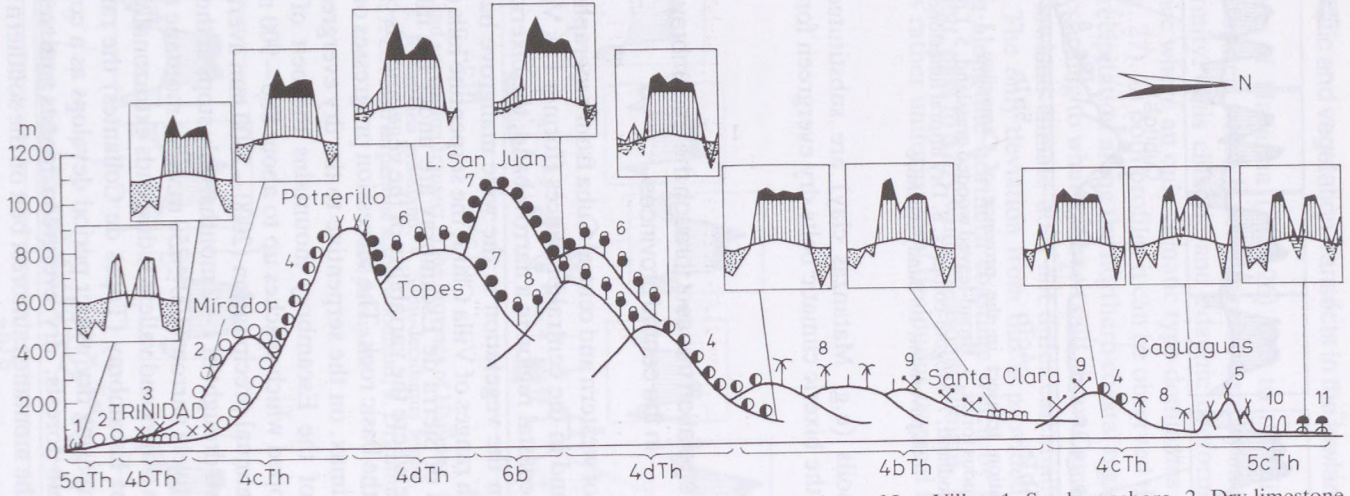

Fig. 29 Bioclimate and vegetation transect through the Escambray range in the province of Las Villas. 1. Sandy seashore, 2. Dry limestone forest, 3. Limestone thorn scrub-woodland, 4. Semi-deciduous forest, 5. Mogote formation, 6. Seasonal evergreen forest, 7. Montane rainforest, 8. Roystonea grassland, 9. Lowland serpentine scrub-woodland, 10. Alluvial or swamp forest, 11. Mangrove forest

8.3.4 Bioclimatic and vegetation transect through the western Maestra range in Oriente

We may find practically a similar distribution pattern of climate and vegetation developing in greater dimensions, in the western part of Sierra Maestra in Oriente Province (Fig. 30). It may be partly due to this, that ecological conditions of Sierra Maestra and Sierra de Escambray are rather alike. Here however, the lowland and colline regions are completely under the effect of the bixeric climate which only on the foothills of Sierra Maestra changes to a winter dry seasonal one. However, there is an essential difference in that there is a much greater vertical precipitation gradient than in the Escambray mountain and this precipitation surplus is spent on the elimination of the dry season. It may be due to this that the seasonal evergreen rainforests cover also the foothill belt of the mountain and the montane rainforest belt extends downwards more. Along the ridge of the mountain from 1400 m altitude upwards, above the montane rainforest belt, a milder form of wet temperate climate develops, and from 1800 m a cooler type corresponding as above 1600 m, a cloud forest or mossy forest or elfin forest belt appears (in Cuban terminology monte fresco) and above 1800 m the elfin thicket belt occurs.

8.3.5 Bioclimatic and vegetation transect through the eastern Maestra range and the Nipe mountains

The climatic variability of the eastern ridge of Sierra Maestra and of Sierra de Nipe is demonstrated in Fig. 31. The bixeric climate prevailing along the coasts in the mountains suddenly passes to axeric rainforest climate, the efficiency of the precipitation surplus here likewise surpasses the values experienced in western and central Cuba but rainforest climate still only forms in the montane belt. Seasonal climate, with one dry period develops in the intermontane central valley and its bordering colline areas.

8.3.6 Bioclimatic and vegetation transects through the Sagua-Baracoa mountains

Three bioclimatic and two vegetation profiles of East Oriente, the most varied part of Cuba climatically speaking, will be shown (Figs 32—34) of which each demonstrates the variations of the 7 bioclimatic types from the semi-desert to tropical rainforests. A common feature of all three profiles is that the **2** ***c*** semi-desert type in all cases passes first through bixeric then through monoxeric climatic type, into axeric rainforest climate. Likewise another common aspect is that the summer dry seasonal climatic type appearing on the northern coastlines over a rather short phase goes over to wet tropical climate. In Fig. 32 it may be seen that the climatic type changes are fairly simple. The summer dry seasonal climate on the northern slopes of Sierra de Cristal suddenly goes over to a wet montane climate type. The rainforest climate however, similar to Sierra Maestra and Sierra de Nipe only develops in the montane regions. On the southern side of the mountain we find first

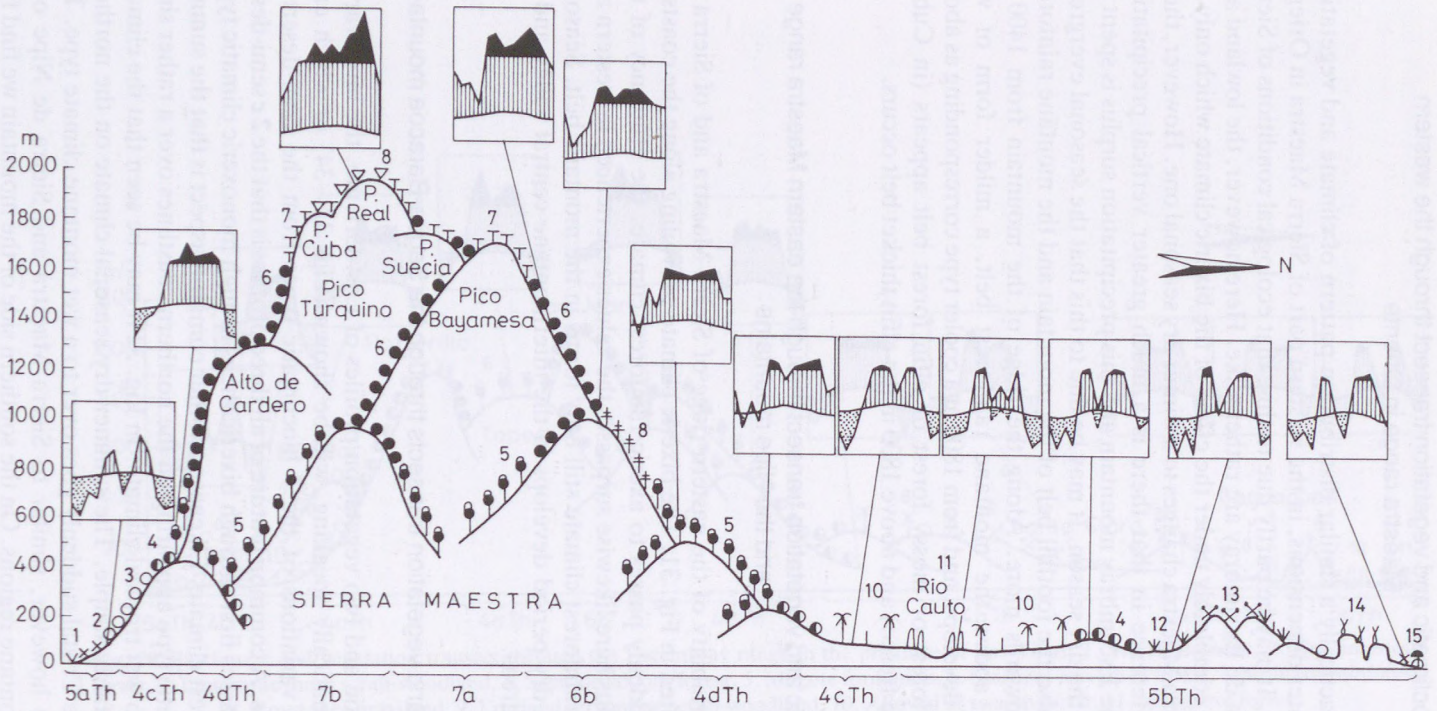

Fig. 30 Bioclimate and vegetation transect through the western Sierra Maestra range in the province of Oriente. 1. Littoral rock-pavement, 2. Littoral thorn-scrub, 3. Dry limestone forest, 4. Semi-deciduous forest, 5. Seasonal evergreen forest, 6. Montane rain forest, 7. Elfin mossy forest, 8. Elfin woodland and thicket, 9. Montane pine forest, 10. Roystonea grassland, 11. Alluvial forest, 12. Low palm serpentine grassland, 13. Lowland serpentine scrub-woodland, 14. Mogote-complex, 15. Mangrove forest

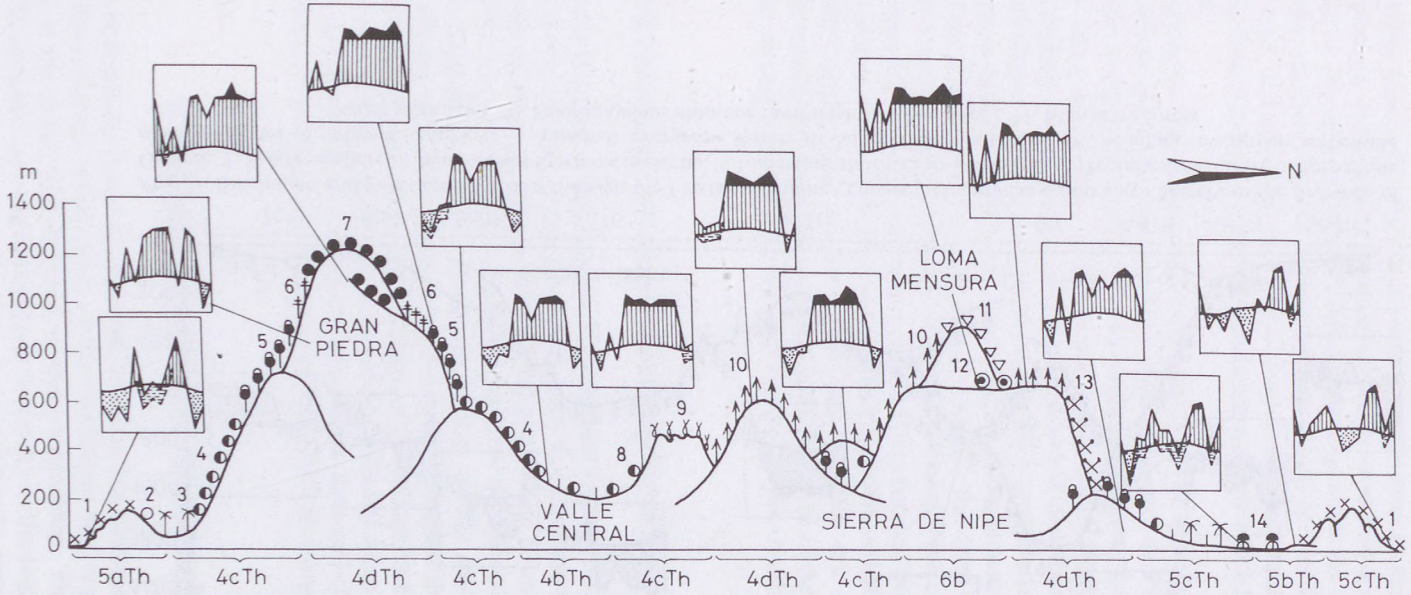

Fig. 31 Bioclimate and vegetation transect through the eastern Sierra Maestra range and the Nipe Mountains in the province of Oriente. 1. Thorn limestone scrub-woodland, 2. Dry limestone forest, 3. Roystonea grassland, 4. Semi-deciduous forest, 5. Seasonal evergreen forest, 6. Montane pine forest, 7. Montane rainforest, 8. Grassland with broad-leaved trees, 9. Mogote-complex, 10. Serpentine pine woodland, 11. Montane evergreen serpentine scrub-woodland, 12. Sclerophyllous montane rainforest (on serpentine), 13. Dry serpentine scrub-woodland. 14. Mangrove forest

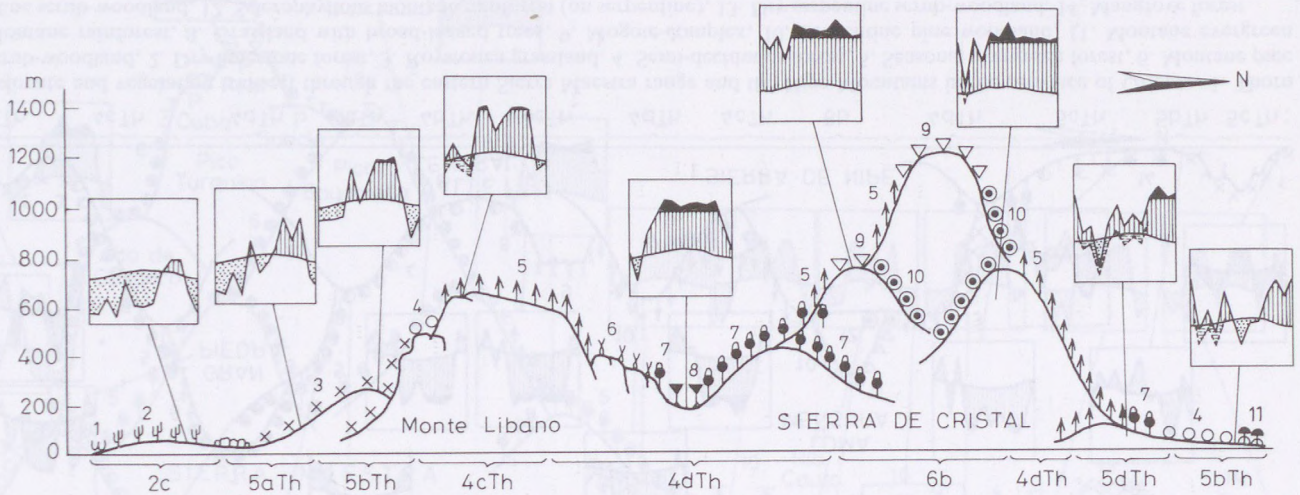

Fig. 32 Bioclimate and vegetation transect through the Cristal Mountains between Guantánamo and Cayo Mambi in the province of Oriente. 1. Sandy seashore, 2. Semi-desert thorn-cactus scrub, 3. Limestone thorn scrub-woodland, 4. Dry limestone forest, 5. Serpentine pine woodland, 6. Mogote-complex, 7. Seasonal evergreen forest, 8. Submontane rainforest, 9. Montane evergreen serpentine scrub-woodland, 10. Sclerophyllous montane rainforest (on serpentine), 11. Mangrove forest

a heavy rainy winter dry climatic zone which soon loses its moisture along the Monte Libano plateau and reaching its southern edge turns into a very dry bixeric climate type. Due to the drying effect of the descending winds on the southern slopes the bixeric dry climate and the sclerophyllous shrub forests here reach the highest altitude a.s.l. in Cuba (700 m). The climate in the Guantanamo basin further dries and south from the city, we reach the semi-desert belt which forms here over a width of 20 km.

A much more differentiated picture is given by the spacing of the climate (Figs 33 and 34) where the triple range of Moa, Toa and Sierra de Puriales mountains meet with wetter oceanic air masses and the triple obstructing system to a larger extent 'exploits' the precipitation. The plateaus and northern slopes of the Sierra de Moa are only slightly wet but with a favourable balanced distribution. As a consequence of the turbulence of air masses reaching the Moa and Iberian plateau, most of the precipitation falls to the internal lower ridges of the mountain — on the northern slopes of the Toa and Sierra de Puriales — namely the deep valleys of Toa, Jaguani and Duaba on an average annually of 2000—3000 mm. As a consequence of this, the only submontane tropical rainforest belt in Cuba formed here. The climate on the southern slopes of Sierra de Puriales and Sierra de Imias rapidly becomes drier with the parallel appearance of the winter and summer dry seasons, the montane rainforest climate almost without a transition passes to a bixeric climate and further along the coastal sandy lowlands and on the karstic foothills into a semi-desert climate.

8.3.7 Bioclimatic and geomorphological transect of the Maisi-region

A climate diagram of the famous Maisi terrace regions on the eastern tip of Cuba is shown in Fig. 35. The registering stations are not frequent enough for us to follow the climatic analogy of changes of the vegetation belt from terrace to terrace (cf. Seifriz 1940, León 1942). The climatic types show the following variations:

a) The transition of the semi-desert climate of the southern side to the wet tropical climate within the Baracoa mountain lying behind the terraces.

b) A climatic change along the coastline of the island from a semi-desert climate through several bixeric types to a summer dry seasonal climate.

c) The development of a tropical summer dry seasonal climate on the north — north-eastwards directed on the upper terraces and its transition to a wet tropical climate.

9 Climate-vegetation relationships

Going beyond the basic relationship that the big climatic belts and vegetation more or less coincide, researchers on the bioclimate and vegetation are interested primarily in the depth and tightness of this relationship. The question is, at what level of the climatic and vegetation type hierarchy is the regular relationship to be expected and with what probability. It is extremely important for a botanist

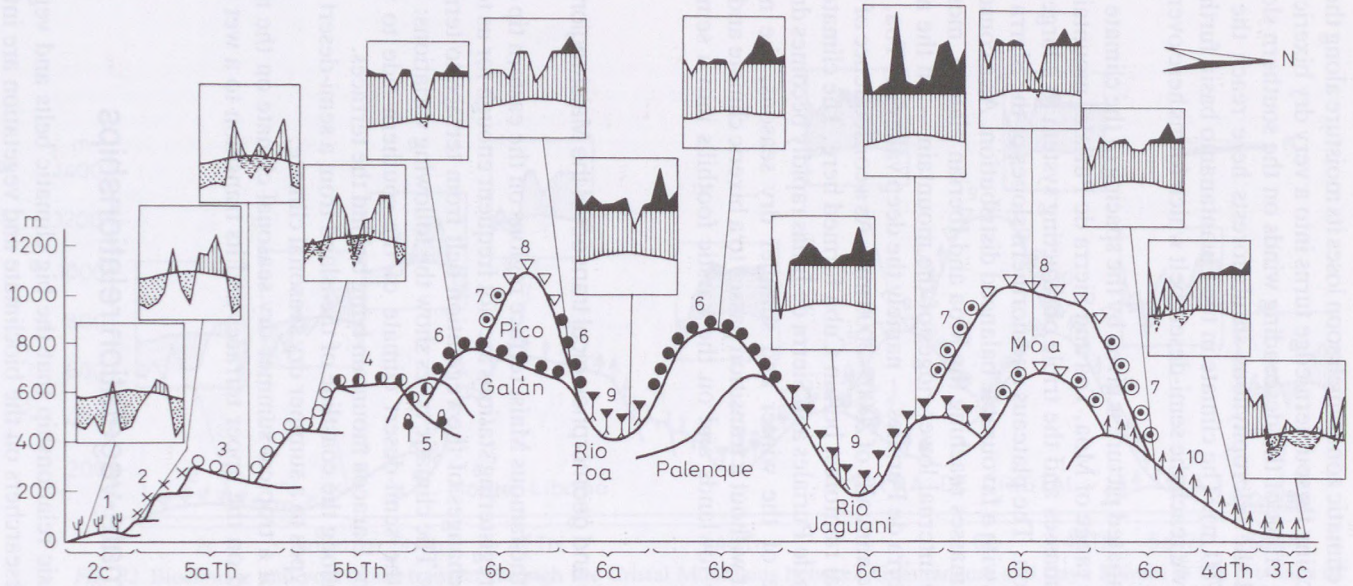

Fig. 33 Climate and vegetation transect through the Moa-Toa ranges between Baitiquiri and Punta Gorda in the province of Oriente (Borhidi 1974, modified). 1. Semi-desert thorn-cactus scrub. 2. Limestone thorn scrub-woodland, 3. Dry limestone forest, 4. Semi-deciduous forest, 5. Seasonal evergreen forest, 6. Montane rainforest, 7. Sclerophyllous (serpentine) rainforest, 8. Montane evergreen scrub, 9. Submontane rainforest, 10. Serpentine pine woodland

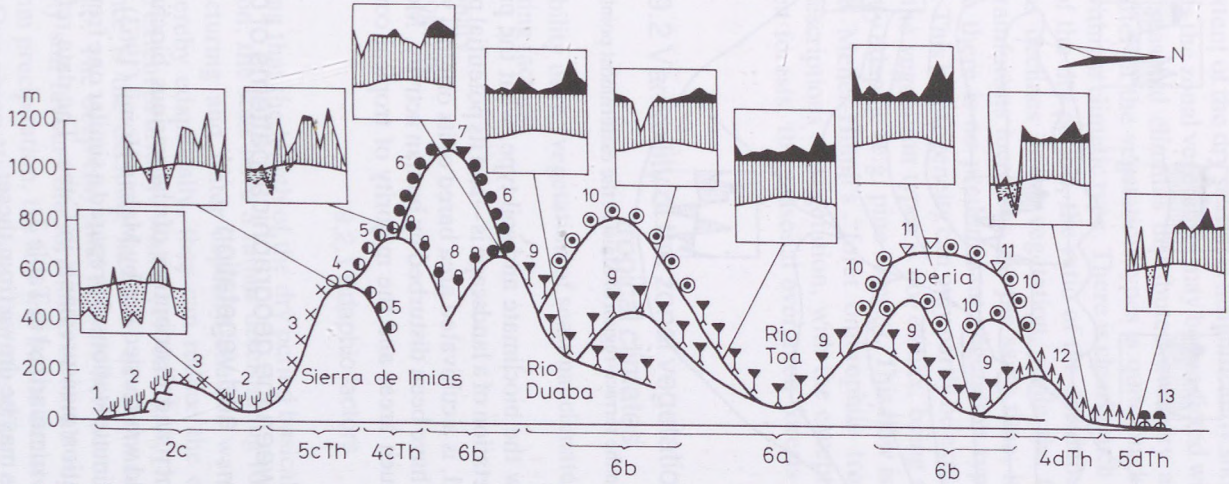

Fig. 34 Bioclimate and vegetation transect through the Imias and Iberia ranges between Imias and Cañete in the province of Oriente. 1. Littoral rock pavement, 2.Semi-desert thorn-cactus scrub, 3. Limestone thorn scrub-woodland, 4. Dry limestone forest, 5. Semi-deciduous forest, 6. Montane rainforest, 7. Montane evergreen scrub-woodland, 8. Seasonal evergreen forest, 9. Submontane rainforest, 10. Sclerophyllous (serpentine) montane rainforest, 11. Montane evergreen serpentine scrub, 12. Serpentine pine woodland, 13. Mangrove forest

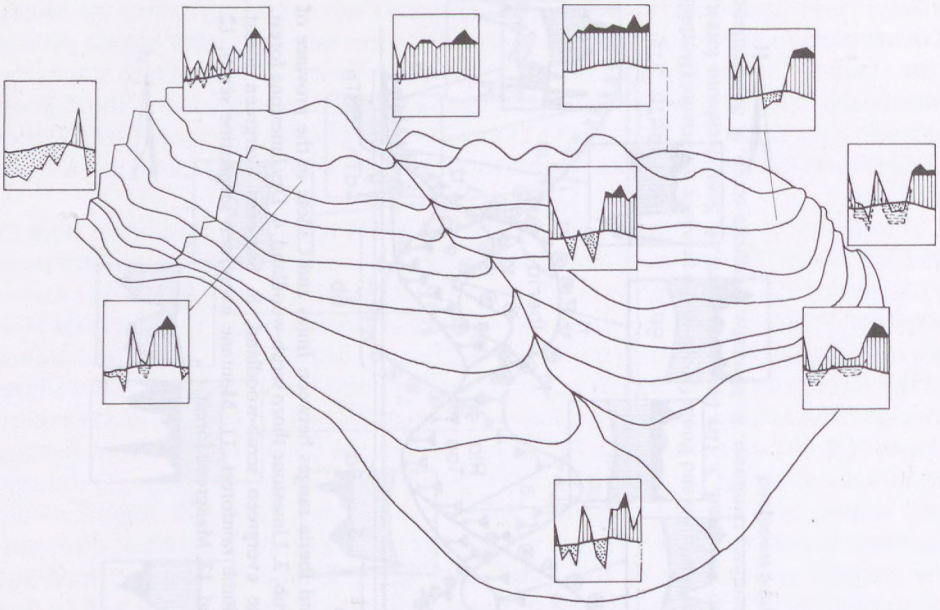

Fig. 35 Bioclimate transect in the terrace-region of Maisi at the easternmost point of Cuba

mapping vegetation to know the bioclimate and soil type, what the probability of estimating the potential vegetation of a landscape is—and its potential production—especially if what is involved, is a cultivated area bared of its original vegetation or the mapping of areas which have been disturbed by human activity. Most countries of the world have mainly such areas and the majority of tropical countries is no exception, as Cuba.

9.1 Correlation between the geographical patterns of climate and vegetation

A survey on the frequency and distribution of the various bioclimates of the vegetation types of the world was carried out by Meher-Homji (1963) based on the zonal vegetation and 1100 climate stations. I prepared a similar one from 250 data of my own climate and vegetation measurements in Cuba. The data referring to the bioclimatic types have been summarized in Table 3.

The following conclusions may be drawn from these:

a) Zonal vegetation is the most uniformly developed in climates dry all the year **1** and in climatic types which are wet throughout the year **6, 7**. Obviously the effect of other important non-climatic factors in forming the vegetation (rock, soil type) because the constant drought becomes of secondary importance or on the effect of constant wetness in some — e.g. by uniform soil development — is compensated or tapers out. Similarly in those seasonal climates, this is the case

where the extent of the dry season is insignificantly short **4** ***d*****, 5** ***d***. In the mentioned climatic types the zonal vegetation may be predicted with high probability.

b) In the seasonal climates distributed over dry and wet periods **2, 4, 5** the variation scatter of the vegetation types is quite marked, their number may even reach 7—9 within a climatic type. There is clearly such a tendency, for this with the shortening of the dry period, the ratio of the deciduous or semi-deciduous forests and savannas declines in the vegetation, while the frequency of the evergreen forests and rainforests increases. At the same time, it can be seen, that within a climatic type there is no predominant vegetation type, but 2—4 occur in equal proportions. This heterogeneity can only partly be explained by a slight flaw, in that one part of the vegetation types is not climax, being secondary (e.g. savanna) or predominantly edaphic (e.g. pine forests). This flaw is compensated for partly, by the fact that Meher-Homji's "forêt ombrophile tropicale" on account of the inaccurate descriptions of vegetation, with the exception of rainforests embraces the evergreen forests, the seasonal evergreen forests and a part of the montane rainforests.

9.2 Variability of the zonal vegetation in seasonal tropical climates

The variability of the vegetation of seasonal climates may be attributed to three main regulating factors:

- edaphic
- evolutionary
- anthropogenic

9.2.1 Edaphic factors

Considering that the length of the dry period basically determines the quality of the vegetation, the soils have a rather determining role due to the fact that their diverse structuring and water capacity enables water to be stored to varying degrees. Thereby edaphically, they can reduce the extent of the dry season or decrease the extent of aridity. Walter (1970a: 71, 80) has stressed several times that soil difference is the deciding factor in development of climatic savannas and climatic scrub. The deep clay sand favours herbaceous plants and grasslands, the looser pebbly soil favours the formation of shrub vegetation. According to him, below 500 mm precipitation, the soil will be the decisive factor in the quality of the vegetation. Our observations reveal that the effect of the soil does not diminish entirely even in the hyper-humid climate – above 2000 mm annual precipitation – for example in Cuba the montane rainforests and the semi-dry rainforests differ only in their edaphic conditions not in climates.

Table 3 Correlation between the occurrence of climate and vegetation types in percentage of territory occupied by vegetation types in each climate

Climate types:	1a	1b	1c	1d	2a	2b	2c	4a	4b	4c	4d	5a	5b	5c	5d	6a	6b	7a	7b
Vegetation types of the Earth according to Meher-Homji (1963)																			
Desert	100	82	93	94	28	9	8	—	—	—	—	—	—	—	—	—	—	—	—
Semi-desert	—	9	7	6	36	13	15	—	—	—	—	—	—	—	—	—	—	—	—
Scrub	—	9	—	—	25	21	39	4	2	—	—	34	11	—	—	—	—	—	—
Tropical grasslands	—	—	—	—	7	—	8	3	—	—	—	—	—	—	—	—	—	—	—
Dry subtropical forest	—	—	—	—	4	5	15	—	2	3	2	—	—	—	—	—	—	—	—
Thorn forest	—	—	—	—	—	35	15	23	1	—	—	—	—	—	—	—	—	—	—
Savanna	—	—	—	—	—	17	—	23	20	5	2	33	22	9	—	—	—	14	—
Dry tropical deciduous forest	—	—	—	—	—	4	—	42	16	1	—	33	22	—	—	—	—	—	—
Tropical semi-deciduous forest	—	—	—	—	—	—	—	1	19	10	—	—	—	—	—	—	—	—	—
Tropical evergreen forest	—	—	—	—	—	—	—	1	3	10	4	—	—	—	—	—	—	—	—
Tropical rainforest	—	—	—	—	—	—	—	3	20	52	90	—	34	82	100	100	70	9	—
Monsoon forest	—	—	—	—	—	—	—	—	17	19	2	—	11	9	—	—	6	18	—
Montane and subtropical rain-forest	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	18	68	9
Montane shrublands	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	6	—	—
High montane shrubs, — paramos	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	7

High montane coniferous forest	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3
Temperate evergreen forest	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	42
Temperate deciduous forest	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	39
Vegetation types of Cuba according to Borhidi (1973)																			
Semi-desert with cacti	—	—	—	—	—	—	57	—	—	—	—	—	—	—	—	—	—	—	—
Scrub	—	—	—	—	—	—	33	—	2	—	—	25	6	—	—	—	—	—	—
Thorn forest	—	—	—	—	—	—	10	—	2	—	—	15	11	—	—	—	—	—	—
Dry evergreen shrub-forest	—	—	—	—	—	—	—	—	16	7	4	50	41	30	10	—	—	—	—
Tropical coniferous forest	—	—	—	—	—	—	—	—	4	2	23	—	4	10	10	—	—	—	—
Dwarf palm savanna	—	—	—	—	—	—	—	—	—	7	—	10	17	—	—	—	—	—	—
Tall palm savanna	—	—	—	—	—	—	—	—	44	33	11	—	13	—	—	—	—	—	—
Tropical semi-deciduous forest	—	—	—	—	—	—	—	—	30	35	7	—	8	40	10	—	—	—	—
Tropical seasonal evergreen forest	—	—	—	—	—	—	—	—	2	16	51	—	—	20	50	12	—	—	—
Tropical submontane rain-forest	—	—	—	—	—	—	—	—	—	—	—	—	—	—	10	88	—	—	—
Montane rainforest	—	—	—	—	—	—	—	—	—	—	4	—	—	—	10	—	64	—	—
Semi-dry (serpentine) rain-forest	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	30	—	—
Elfin forest	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	6	100	—
Elfin thicket	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	100

9.2.2 Evolution of the vegetation as a factor group

The variability of the vegetation in seasonal climates may also be attributed to evolutionary reasons. Plants have adapted to aridity in many ways. As a consequence of this, the flora of different regions in accordance with their propensity for adapting, could develop vegetation types of different structures under similar climates. For example in the rainforest climate of Australia and in the Mediterranean belt, the forests consist of evergreen hard-leaved trees (c.f. Walter 1970a: 72) since the paleotropic rainforest flora could only transgress to New Guinea and Australia well after the development of tropical climate in the same area and until then the native hard-leaved flora occupied the major part of the tropical rainforest belt.

9.2.3 Historical factors

We consider the evolutionary aspects in the formation of the vegetation types to be made up of four kinds:

a) ecological background
b) adaptive capacity
c) migration possibility
d) colonization possibility

a) Obviously, even after rather diverse palaeoclimatological prior events two regions similar in climate can be in the same climatic belt. The consequence of this is, that just those elements of the flora become lost which have remained in the other.

b) As a consequence of this, the adaptive capacity of the flora becomes further restricted; namely those limits of its adaptability which are given by the anatomic-physiologic structure of the taxa and by their genetic plasticity. The major difference in these factors could only mark the different paths of adaptation for two floras. As an example we could mention that we found an analogous climate to that of Cuba in south-east India and south-east Africa. While in the latter two, seasonal deciduous forests prevail in Cuba there are no tropical deciduous forests at all but instead dry sclerophyllous evergreen forests.

c) Generally the already adapted migrating flora spreading with the climatic changes has an advantage in colonizing over the native flora which has not adapted. With island flora however, the opposite may be valid too. In the case of appropriate quick adaptation, the native flora may retain its stand in contrast with that of the migrating one.

d) Penetration of an outer vegetation type conditioned climate changes into an island flora may only be successful under favourable migration conditions (tides, prevailing wind) if as a consequence of some geological change e.g. raising up by tectonic elevation or by sedimentation of such surfaces which are suitable for colonization or the native flora tolerance drop — caused by climatic changes — provides an opening for new elements to penetrate into the ecosystem.

9.2.4 Anthropic influences

The heterogeneity of vegetation occurring under one climatic type may be largely increased by the anthropogenic effects. These thrived the best under the seasonal tropical climates especially in the semi-deciduous forest belt. The eradication and burning of these during the dry season provided better ploughing fields and pastures with higher yields than in the forest belts. This is how the high palm tall grasslands or so-called wet savannas creating the impression of original vegetation and the dwarf palm short grasslands or dry savannas originated many centuries ago. Only in **2** ***b*** climate growing savannas can be accepted from Meher-Homji's table, as climatically conditioned ones, the others in the 8 climate types are in all certainty secondary. The two savanna types mentioned under Cuban vegetation types are merely for comparison since of these neither is climatic. The high palm savannas are residues of semi-deciduous and seasonal green forests, the dwarf palm savannas are the secondary semi-anthropic type derived from dry evergreen shrub forests and scrub vegetation.

9.2.5 Conclusions

It may be concluded from what we have discussed that:

a) The zonal vegetation type in extremely dry and wet climates **1, 6, 7** types may be listed here) may be estimated with a high degree of probability on the basis of the climatic information.

b) In seasonal climates **2, 4, 5** in relation to larger areas (the world *or* continents) prediction to similar degree of exactness is not possible.

c) In relation to continents, knowing the evolution of the flora, the ecological background of development and the predisposition for adaptation of the flora, as well as knowledge of the zonal soil vegetation relationships make possible a further more precise approach.

d) Knowledge of edaphic and cultural history conditions within smaller areas of flora having uniform development can provide an approximately exact estimation. But as our survey of Cuban vegetation shows the number of the possible zonal types in an area of this scale is too big.

e) Generally speaking we can say that the zonal vegetation of tropical seasonal climate types cannot be predicted with the accuracy needed.

So as to be able to do this the vegetation types have to be plotted in such a climatic coordinate function where the individual function phases versus space segments clearly define the zonal vegetation type of the given climate. Two such examples will be demonstrated, however, we have to clarify a point at this stage.

9.3 Ecological differences between monoxeric and bixeric tropical climates

From Table 3 it cannot be ascertained whether there is any essential difference between the vegetation of the winter dry **4** ***Th*** climates and the bixeric **5** ***Th*** ones. Meher-Homji could not draw any definite conclusions from this which is under-

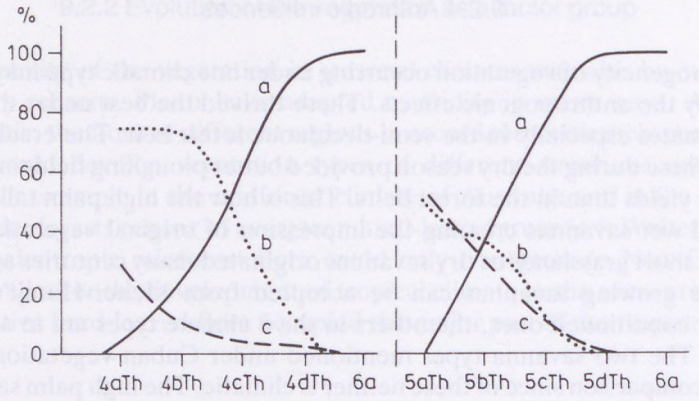

Fig. 36 Relative frequency of tropical forest types of the world in different seasonal climates. a) rainforest, b) deciduous forests, c) sclerophyllous dry evergreen forest and scrubs

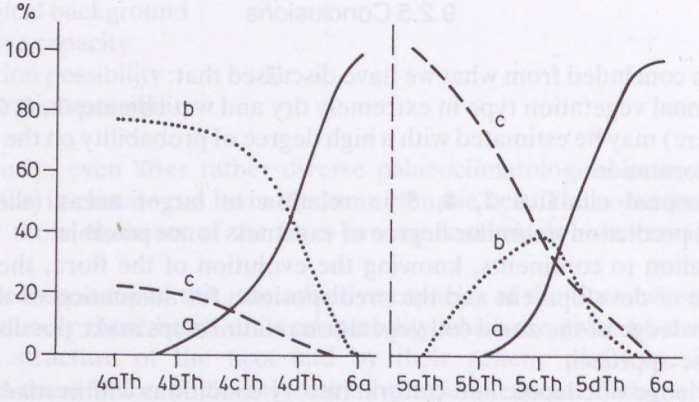

Fig. 37 Relative frequency of tropical forest types of Cuba in different seasonal climates: a) rainforests, b) deciduous forests, c) sclerophyllous dry evergreen forests and scrubs

standable since he had vegetation data for altogether 33 bixeric stations and not all of these were reliable too. In Cuba we examined 53 bixeric climatic stations with respect to their zonal vegetation and found that apart from the common tendency of the two climates (both are a transition from the semi-desert and rainforest climates) there is a decided difference in the vegetation. These differences become obvious if we carry out some combinations in Table 3. The vegetation types were grouped into:

- rainforests
- deciduous forest and shrublands
- sclerophyllous evergreen forests and shrublands and the savannas are classed into the forest group from which they derived. This distribution of the three groups may be seen in Figs 36 and 37.

9.3.1 Favourable water utilization of bixeric climates

Two important correlations may be detected from the figure with respect to the effect of the **4** ***Th*** and **5** ***Th*** climates. The one is concerned with the effect of the length of dry period which may be seen on the rain forest frequency curve. It may be seen well that the rainforests reach the same frequency in **5** ***Th*** climates by half a class earlier than in **4** ***Th***.

This means that the distribution of aridity into two periods spares the humidity of one wet month and has exactly the same effect as a winter dry tropical climate whose dry period is shorter by a month. In other words 4 dry months of a bixeric climate is equivalent to a 3-month dry xero-chimenic climate and a 3-month dry bixeric climate is equivalent to a 2-dry month xero-chimenic climate — from the point of view of the effect of the dry season.

9.3.2 Deciduous and sclerophyllous vegetation as two adaptive links

Another striking correlation is that the winter dry climate favours vegetation which has adapted to the deciduous life rhythm. In this climate the deciduous or semi-deciduous vegetation types prevail. In contrast with this, to avoid the two dry periods, different forms of sclerophylly e.g. coriaceous leaf, microphylly, thorny leaves, proved to be the successful ways of adaptation. In vegetation, the dry evergreen forests prevail composed of sclerophyllous elements as thorn evergreen forests and scrub formations. The bixeric climate therefore favours the sclerophyllous evergreen vegetation. This tendency can be observed already in the semi-desert climate belt — where the scrub and thorny forests are strikingly more frequent in the types **2** ***b*** and **2** ***c*** than in the winter dry **2** ***a*** type — and it can be obviously demonstrated in the bixeric climates.

Probably, this effect of the bixeric climate is not simply the resultant of the two dry periods but to a large extent, it is attributable to the fact that one dry season occurs in summer. In frost-free climates, the summer aridity itself favours the hard-leaved evergreen vegetation. This also justifies that the rare summer dry tropical climates should not be listed under the xero-chimenic climates but under the tropical version of the Mediterranean climate or it should be regarded as the extreme case of the bixeric climate.

9.3.3 The high frequency of the sclerophyllous vegetation in Cuba

The fact that the frequency of the sclerophyllous evergreen vegetation type in Cuba (Fig. 37) well surpasses the average in the world can be attributed to three other local factors. One of these is the high relative humidity ensured by the proximity of the sea which considerably reduces leaf-fall and favours the higher frequency of evergreens, at the same time the marine winds contribute to the development of adaptive features serving reduction of transpiration (microphylls with thick cuticle). The other factor is represented by the oligotrophic soil types

(white sands, acidic soils on slate and serpentine latosols) which over millions of years came to form a hard-leaved, evergreen flora. And finally, the evolution of a particular insular flora, the primordial native evergreen small-leaved trees and shrubs had a much greater role in that the deciduous elements migrated in mostly later.

9.4 Methods for predicting probable zonal vegetation in seasonal tropical climates

As we saw earlier, certain bioclimatic types and vegetation types often do not coincide especially in the different seasonal tropical climates. Therefore the actual climatic requirements, climatic limits of the zonal vegetation have to be outlined more accurately in a coordinate system comprising climatic elements determining the quality of the vegetation in the form of such phase functions or spatial range province from which the zonal occurrence of the given vegetation type can be anticipated with a fairly high probability.

9.4.1 Coordinate method of Walter

Walter (1962: 136, 1970: 71) suggested such a coordinate system whose Y axis represented annual precipitation amount and the X axis, the duration of the arid period or the number of dry months. With the aid of such a coordinate system it was possible to delineate the 6 zonal vegetation types of India — in my version 8 climax vegetation types (Fig. 38). Samek and Travieso (1968) supposed that the limits of zonal vegetation types of Cuba were located just where those of South India were, and they delegated climatic diagrams of Cuba into Walter's diagram. Although their supposition proved to be wrong Samek (1969) came to the conclusion that there are no climazonal savannas in Cuba. I myself applied this method successfully to delineate five zonal vegetation types of Cuba (Fig. 39). The method has the flaw that not having a temperature coordinate it is only suitable for distinguishing vegetation types of a single climatic belt. Distinguishing the vegetation types of vertical zones from those of lowland areas cannot be done using this method. In Fig. 39 the squares with a vertical line indicate the montane seasonal evergreen forests and the montane rainforests which obviously coincide with the appropriate lowland types on the same spatial range of the coordinate system.

9.4.2 Amount vs distribution of precipitation as a determining factor

The problem arises whether of the two coordinates the quantity of precipitation or the length of aridity is the more determining structure of the forest. Walter (1962a) rightly concludes that in the moist vegetation types it is the length of the dry period which is the more important factor whereas in the dry types the amount of precipitation. Later referring to his diagram he established that both factors were important, neither can be disregarded. He considered from the lines indicating the

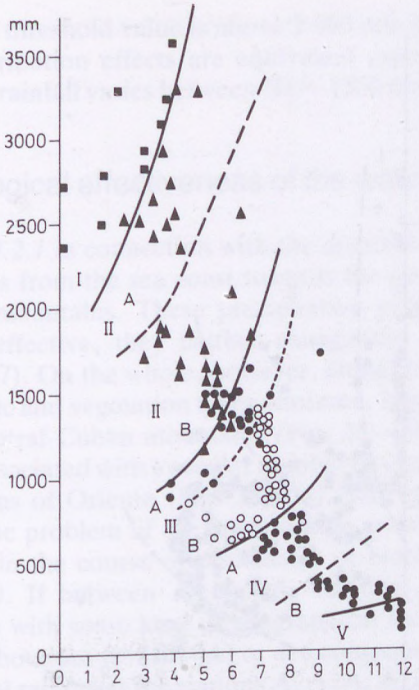

Fig. 38 Climatic delimitation of vegetation types of India in relation to annual precipitation average and the number of the dry months (Walter 1962, modified). I. Rainforests, II. A. Seasonal evergreen forests, II. B. Semi-deciduous forests, III. Deciduous monsoon forests, A: humid type; B: arid type, IV. A thorn scrub forests, IV. B. Savanna or semi-desert, V. Desert

limits of vegetation that the precipitation amount is more decisive for the wet forest types whereas for the dry types the length of the dry period.

However, this latter correction of the interpretation was probably a clumsy way of expressing it. The dividing line of the vegetation types by itself is not informative, only if we compare it with the curve describing mass of points. It can readily be seen that these points are distributed roughly along a hyperbolic curve the upper phase of which fits into the Y axis and the lower phase approaches parallelly to the X axis. But the same tendency characterizes the limit values of vegetation types. Namely the limiting curve of wet forest types above a certain amount of precipitation run parallelly to the Y axis. This means that above certain Y values the vegetation limit can only be transgressed in the direction of the X axis. The opposite is true for dry types where the distribution of the vegetation points and the limit lines flatten to a curve approaching and running parallelly to the X axis.

In this range however, the transgression of the vegetation limit is shorter in the direction of the Y axis, i.e. for the qualitative change in the vegetation the precipitation amount is more important.

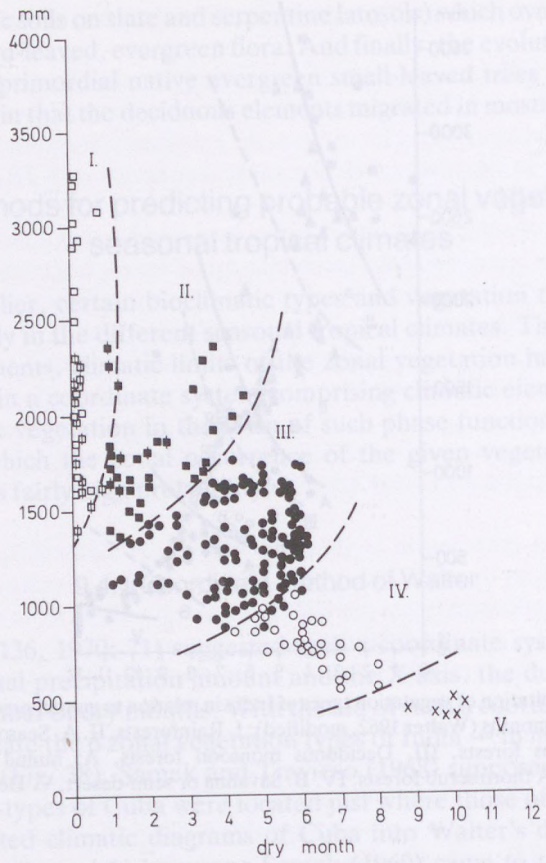

Fig. 39 Climatic delimitation of Cuban vegetation types related to annual average precipitation and to the number of the dry months. I. Rainforests, II. Seasonal evergreen forests, III. Semi-deciduous forests, IV. Dry evergreen and thorn forests, V. Semi-desert scrubs

9.4.3 Conclusions

Our findings in point *4.4.1* may be considered to be proved concerning the geobotanical importance of the amount and distribution of precipitation. Below a certain threshold level when determining the vegetation structural type or a terrestrial ecosystem, the total amount of precipitation is more important than the annual distribution, however, the annual distribution is vital above a certain threshold level in contrast with the annual total. This tendency is valid not only for the extreme values of the series but with certain vegetation types in the middle range. The concrete threshold values diverge in the different temperature zones; within a temperature zone they vary depending on the relative humidity and the soil.

In Cuba, the upper threshold value derived from Fig. 39 is about 1700 mm and the lower one about 500 mm. In India however, probably due to the lower atmospheric

moisture — the higher threshold value is above 2 000 mm the lower is at 500 mm. The quantity and distribution effects are equivalent especially in those regions where the total annual rainfall varies between 500—1500 mm.

9.5 Ecological effectiveness of the water surplus

As we discussed in *4.2.1* in connection with the distribution of precipitation, in Cuba, rainfall increases from the sea coast towards the interior of the island and intensifies above the mountains. These precipitation gradients in certain areas remain completely ineffective, they neither change the climatic type nor the vegetation type (Fig. 27). On the whole, however, along the vertical precipitation gradient several climatic and vegetation types alternate. It is striking however, that in the western and central Cuban mountains (Figs 25—29) the same number of bioclimatic types are associated with a smaller number of vegetation type changes as in the mountain regions of Oriente (Figs 30—34). This raises another question which may be called the problem of the precipitation growth (P_i) efficiency (EP_i) which we touched on in the course of discussions of bioclimate transects in the former chapter *(8.2.1)*. If between A_1 and A_k stations, precipitation gradient develops in connection with some kind of geographical factor, changing continuously (e.g. increasing above sea-level height or as a consequence of distancing from the coast) so that annual rainfall at the stations A_1 A_2 A_3 A_k are:

$P_1, P_2, P_3 \ldots P_k$ than compared to P_1 each station will have ($i_1, i_2, i_3 \ldots i_k$) amount of precipitation surplus. This is called precipitation rise (P_i) whose value between P_1 and P_k could even be 2000—3000 mm. It depends on the efficacy of P_i (EP_i) as to what kind of changes are brought about by concrete values of P_i in the zonal vegetation.

It may be read from Figs 38—39 that there could even be 1000 mm difference between two stations in the precipitation without it affecting the number of dry months and the quality of vegetation. This means that the $i_1, i_2, i_3, \ldots i_k$ surplus increases mostly the precipitation amount of the wet season — at a time when precipitation is overabundant and most of it flows off the surface, — in other words, P_i is practically ineffective. If however, a major part of $i_1, i_2, i_3 \ldots i_k$ results in the shortening or elimination of the dry season then P_i is effective and those cases $P_i = 200—300$ mm may be followed by the change in zonal vegetation type.

9.5.1 EP_i evaluation

Evaluation of EP_i may be carried out in several ways. The most appropriate for EP_i analysis is to introduce the concept of (Qpx) dry season precipitation participation:

$$Qpx = \frac{\bar{P}100}{P}$$ where $\bar{P}$ = total precipitation of dry season divided by the number of dry months

P = total annual precipitation divided by 12.

9.5.2 Efficiency of precipitation gradient

P_i is efficient when $P_1 \langle P_2 \langle P_3 \langle \ldots \langle P_k$ and simultaneously also $Q_{px1} \langle Q_{px2} \langle Q_{px3} \langle \ldots \langle Q_{pxk}$ and $Q_{pxk} \rangle 50$.

This means that increased precipitation is the more effective, the more the average precipitation amount of the dry months approaches that of the annual average months, or the more the difference disappears between the dry and wet months. In such cases, it is highly probable, that along the precipitation gradient one, two or perhaps more zonal vegetation types alternate. If however $P_1 \langle P_2 \langle P_3 \langle \ldots \langle P_k$, and simultaneously $Q_{px1} \rangle Q_{px2} \rangle \ldots \rangle Q_{pxk}$; and $Q_{pxk} \langle 50$ then the P_i between the stations A_1 and A_k is ineffective and at the most one zonal vegetation type limit is expected with little probability. However, we should like to note that the number of dry months and that which one must be considered as dry is defined by the starting station of every series (A_1). Therefore if Q_{px2}, Q_{px3} and Q_{pxk} are to be counted from the same months as Q_{px1} even if in the case of A_2 A_3 and A_k stations, the referred months are not at all dry. The change can only be measured objectively in this form.

9.5.3 EP_i description

We attempted to demonstrate the EP_i value with the aid of a coordinate system consisting of two vertical and one horizontal axis. The left vertical axis represents the annual precipitation amounts, the right the Q_{px} values, on ($A_i \ldots A_k$) situated on the precipitation gradient. In the middle the $Q_{px} = 50\%$ value implying the efficiency level. Below it the complex aridity index of Meher-Homji has been depicted related to certain stations.

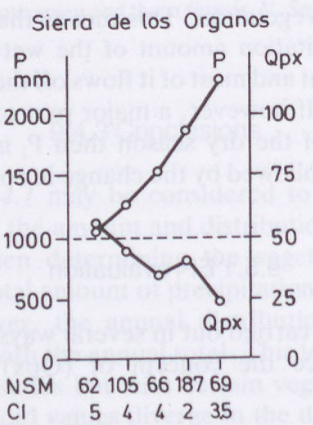

Fig. 40 The efficiency diagram of the precipitation surplus in the Organos-range of West Cuba. P=annual average precipitation, Q_{px}=precipitation-rate of the dry season, according to the text, NMS=number of the meteorological station, CI=complex index S+x+g of Meher Homji (1963)

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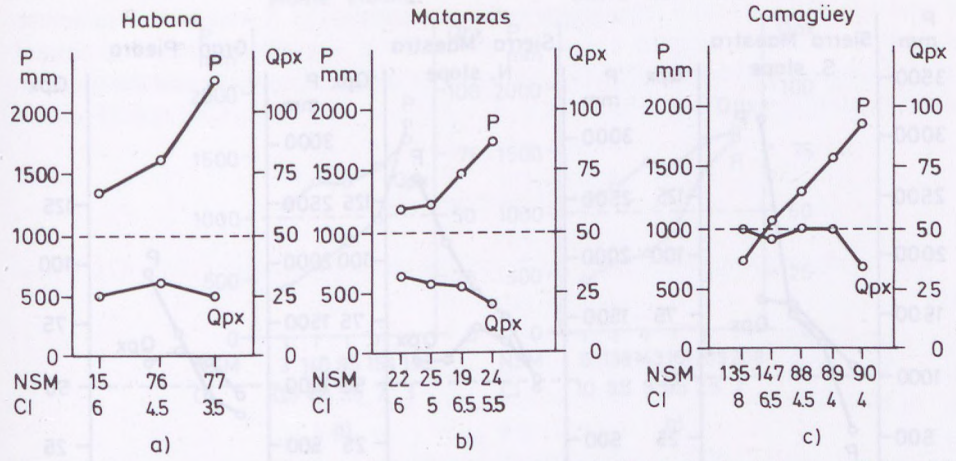


Fig. 41 The efficiency diagrams of the precipitation surplus in the Cuban lowland areas. a) Habana b) Matanzas; c) Camagüey. For symbols see Fig. 40

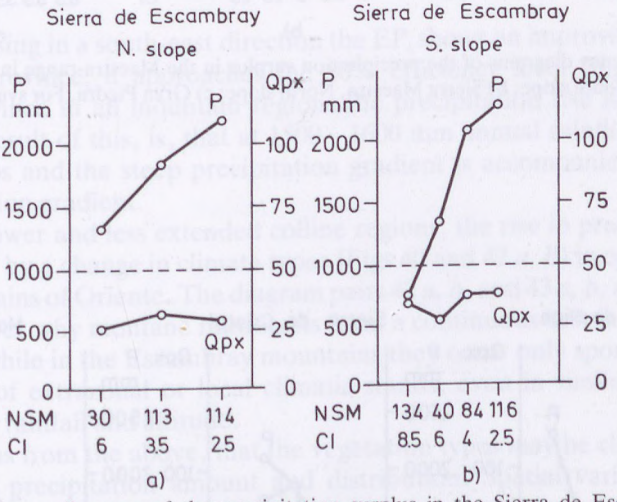


Fig. 42 The efficiency diagrams of the precipitation surplus in the Sierra de Escambray range in Central Cuba. a) North slope; b) South slope. For symbols see Fig. 40

9.5.4 Formation of EP_i in Cuban precipitation gradients

Of the Cuban bioclimatic profiles, we studied 14 characteristic precipitation gradients from the point of view of EP_i which are shown in Fig. 40. From these it can be established that:

a) The efficiency of precipitation gradients of West and Central Cuba is rather low (Figs 40—42), obviously in the lowland and mountain belt even with 2000 mm annual precipitation a climax rainforest cannot develop.

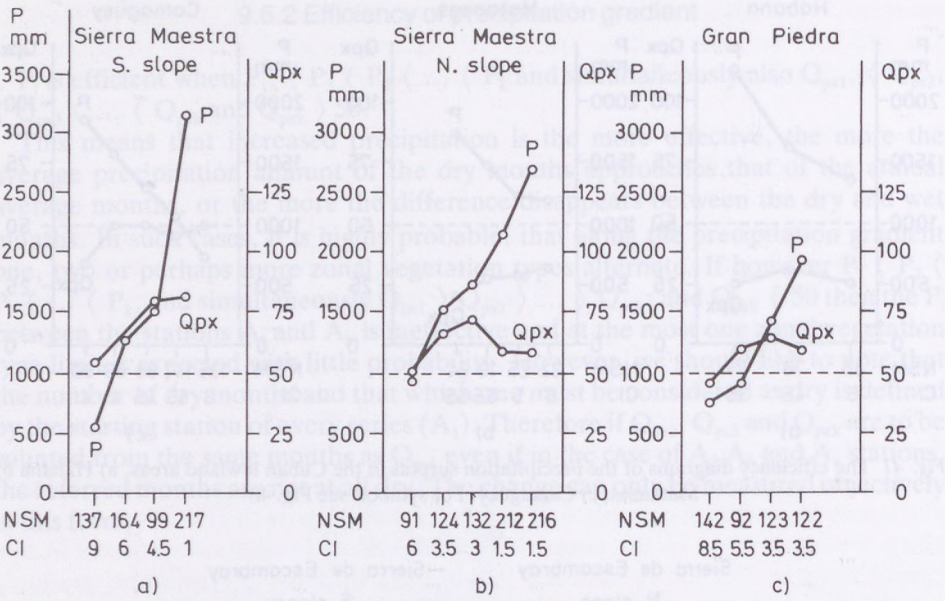


Fig. 43 The efficiency diagrams of the precipitation surplus in the Maestra-range in eastern Cuba. a) Sierra Maestra, South slope; b) Sierra Maestra, North slope; c) Gran Piedra. For symbols see Fig. 40

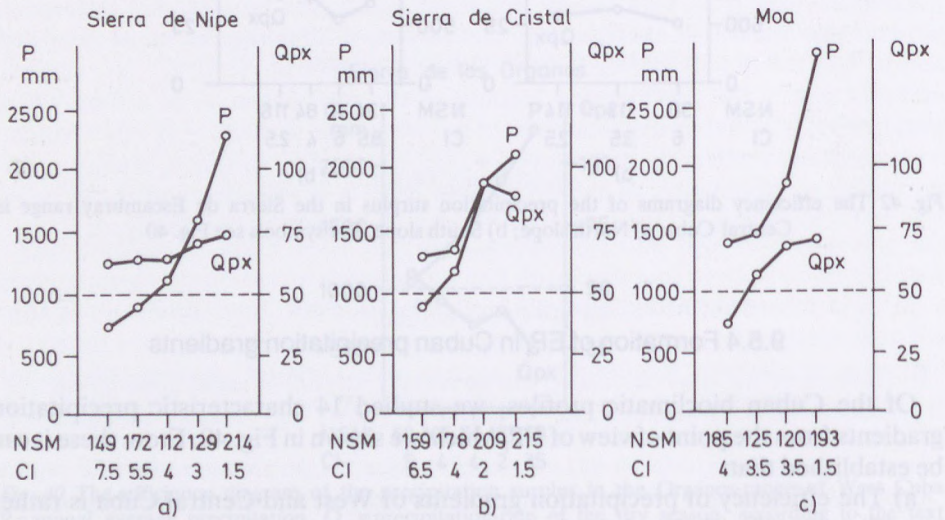


Fig. 44 The efficiency diagrams of the precipitation surplus in the northern Sagua-Baracoa range in eastern Cuba. a) Sierra de Nipe; b) Sierra de Cristal; c) Moa. For symbols see Fig. 40

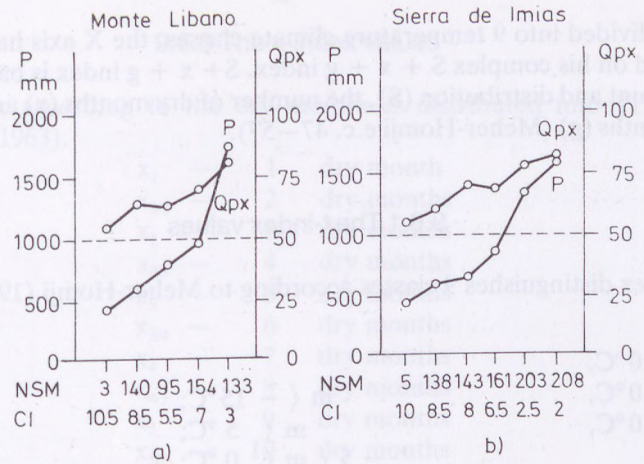


Fig. 45 The efficiency diagrams of the precipitation surplus in the southern Sagua-Baracoa range in eastern Cuba. a) Monte Libano; b) Sierra de Imias. For symbols see Fig. 40

b) Progressing in a south-east direction the EP_i shows an improving tendency. In Camagüey Province, it approaches the 50% efficiency level (Fig. 41 *c*) and in Oriente Province in all mountain regions the precipitation rise is effective (Figs 43—45). A result of this, is, that at 1500—1600 mm annual rainfall the rainforest zone develops and the steep precipitation gradient is accompanied by a likewise steep vegetation gradient.

c) In the lower and less extended colline regions, the rise in precipitation is not accompanied by a change in climate types (Figs 40 and 42 *a, b*) in contrast with the larger mountains of Oriente. The diagram pairs 42 *a, b*, and 43 *a, b*, at the same time serve to answer why montane rainforests form a continuous belt in Sierra Maestra (Q_{pxk} 50%) while in the Escambray mountains they occur only sporadically mainly in the form of extrazonal or local climatic stands, even in similar conditions of temperature, rainfall and altitude.

It is obvious from the above, that the vegetation types may be classified roughly according to precipitation amount and distribution. Spatial variations of these factor pairs may be refined — as above — with more sophisticated methods.

9.6 Universal bioclimatic classification of zonal vegetation using the S + x + g index of Meher-Homji

As we have already referred to it in point *9.4.1*, the vegetation types only of a single climatic belt can be distinguished on the basis of precipitation distribution and amount where temperature does not have a role in their separation. The universal classification of the zonal vegetation however, is only possible in such a coordinate system where one axis is the temperature, the other is moisture in some index form. Meher-Homji (1963: 117, 118) prepared such a coordinate on which the

Y axis was divided into 9 temperature climate classes, the X axis had 12 moisture classes based on his complex S + x + g index. S+ x + g index is based on annual rainfall amount and distribution (S), the number of dry months (x) and the number of frosty months (g) (Meher-Homji e.c. 47—57).

9.6.1 The t-index values

The t-index distinguishes 9 classes according to Meher-Homji (1963: 47). These are:

t_1 – M $\langle$ 10 °C,	m $\langle$ – 15 °C;	
$t_{1/2}$ – M $\rangle$ 10 °C,	m $\langle$ 5 °C;	
t_2 – M $\rangle$ 10 °C,	– 5 $\langle$ m $\langle$ 0 °C;	
t_3 –	0 $\langle$ m $\langle$ 10 °C;	
$t_{3/4}$ –	10 $\langle$ m $\langle$ 15 °C;	
t_4 –	15 $\langle$ m $\langle$ 20 °C;	
$t_{4/5}$ –	m 20 °C;	annual mean $\langle$ 30 °C;
t_5 –		annual mean $\rangle$ 30 °C;
t_6 –		

where M — is the mean temperature of the warmest month
m – is the mean temperature of the coldest month.

9.6.2 S-index values

The S-index expresses the wetness and aridity of the climate according to Meher-Homji (1963: 49) and slightly modified by me distinguishing altogether 11 categories:

Annual precipitation in mm

S_1 –	P $\rangle$ 3000	
$S_{1/2}$ –	3000 $\rangle$ P $\rangle$ 2000	
S_2 –	2000 $\rangle$ P $\rangle$ 1500	
$S_{2/3}$ –	1500 $\rangle$ P $\rangle$ 1000	with 1—2 dry months
S_3 –	1500 $\rangle$ P $\rangle$ 1300	with 3—5 dry months
S_3 – or	1500 $\rangle$ P $\rangle$ 750	with 0 dry months

and with negative temperatures at certain periods of the year

$S_{3/4}$ –	1000 $\rangle$ P $\rangle$ 750	with 1—6 dry months
S_4 –	1000 $\rangle$ P $\rangle$ 750	with 7—8 dry months
$S_{4/5}$ –	750 $\rangle$ P $\rangle$ 500	
S_5 –	500 $\rangle$ P $\rangle$ 250	
$S_{5/6}$ –	250 $\rangle$ P $\rangle$ 100	
S_6 –	P $\langle$ 100	

9.6.3 The x-index values

The x=index according to the dry months is distributed into 11 categories (Meher-Homji 1963).

x_1	—	1	dry month
$x_{1/2}$	—	2	dry months
x_2	—	3	dry months
$x_{2/3}$	—	4	dry months
x_3	—	5	dry months
$x_{3/4}$	—	6	dry months
x_4	—	7	dry months
$x_{4/5}$	—	8	dry months
x_5	—	9	dry months
$x_{5/6}$	—	10	dry months
x_6	—	11—12	dry months

9.6.4 The g-index values

The g-index values can be divided according to the number of frosty i.e. "physiologically" dry months into 11 classes (Meher-Homji 1963: 56). Frosty month is considered to have a mean temperature below −2 °C. The values of the g-index are the following:

g_1	—	one	frosty month
$g_{1/2}$	—	2	frosty months
g_2	—	3	frosty months
$g_{2/3}$	—	4	frosty months
g_3	—	5	frosty months
$g_{3/4}$	—	6	frosty months
g_4	—	7	frosty months
$g_{4/5}$	—	8	frosty months
g_5	—	9	frosty months
$g_{5/6}$	—	10	frosty months
g_6	—	11—12	frosty months

The g-index in Cuba has no role in the development of the complex s + x + g index.

9.6.5 The Meher-Homji coordinate system

This coordinate system proved to be suitable for ordering the zonal vegetation types of India and the world according to their climatic demands and for their partition according to certain statistical frequencies (Meher-Homji, see 132—133). On the Cuban diagrams — left below the X axis — we also demonstrated the s + x + g and t-values of the diagrams and arranged them according to geographic areas and the s + x + g index values. Further we attempted to show the Cuban vegetation types in the above coordinate system.

9.7 Cuban vegetation belts

We found that the method was very useful for selecting and characterizing the zonal vegetation types in Cuba. We distinguished the following 8 zonal vegetation belts (Fig. 46):

- Semi-desert scrubs
- Evergreen shrub-forests
- Deciduous forests or small-leaved, semi-deciduous forests
- Semi-deciduous forests
- Submontane rainforests
- Montane rainforests
- Mossy cloud forests or elfin forests
- Elfin woodland

9.8 Examining special problems with Meher-Homji diagram

We found this diagram, apart from distinguishing vegetation types, and climatic classification suitable for studying questions of zonality and ecology.

9.8.1 Distinguishing zonal, edaphic and paraclimax vegetation types

The Meher-Homji diagram is suitable furthermore, for clarifying the zonality of certain edaphic associations and to demonstrate their intrazonal, paraclimax or edaphic climax character. Thus, it could be shown of the pine forests of Cuba that each type of them actually belong to one determined vegetation belt (Fig. 47). As

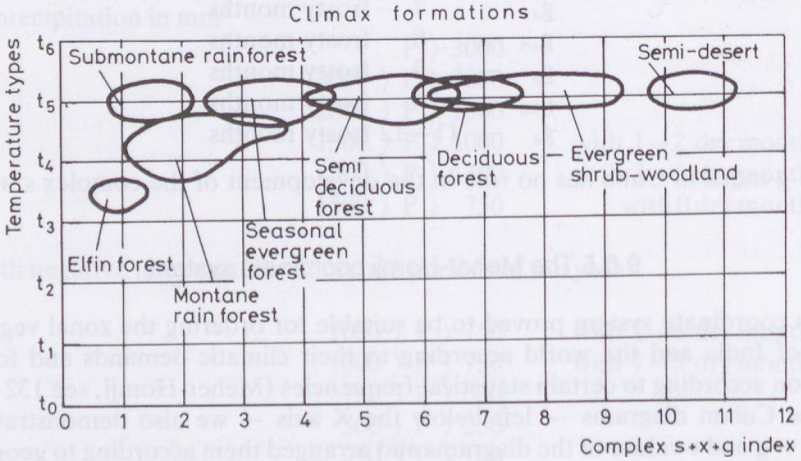


Fig. 46 Distribution of the Cuban zonal vegetation types in the "ecological coordinate system" of Meher-Homji

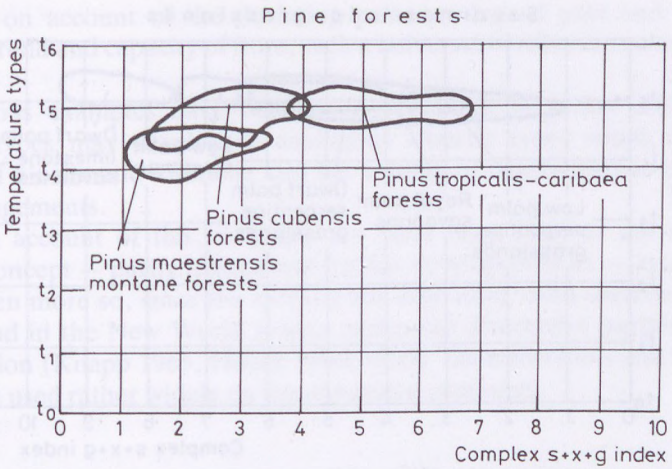


Fig. 47 Distribution of the Cuban pine forests and pine woodlands in the ecological coordinate system of Meher-Homji

such, they may be regarded as intrazonal edaphic climax communities on latosols. The *Pinus tropicalis* and *P. caribaea* forests belong to the semi-deciduous forest belt. The distribution of *Pinus maestrensis* forests coincides completely with the montane rain forests while the *Pinus cubensis* forests can be considered as the paraclimax communities of the seasonal evergreen forest belt but, as we shall see later, for historical reasons they overlap to the lower part of montane rainforest belt as well.

9.8.2 Investigation of anthropic and semi-anthropic vegetation types

The great merit of the diagram is that by means of it, the different anthropic formations and derivation types can be traced to their origins, that is, it is useful for the reconstruction of the vegetation of cultivated landscapes. It can be clearly demonstrated for the Cuban savannas (Fig. 48) that they all fall without exceptions to any of the forest formation climax belts. The royal palm mesophilous savannas are derivatives to a small extent, of the seasonal evergreen forests and for the most part the semi-deciduous forests. The low palm *(Copernicia, Sabal)* savannas originated from the deciduous forests or from the small-leaved, semi-deciduous forests, and the dwarf palm savannas *(Copernicia, Coccothrinax)* are derivatives of the evergreen shrubforests and scrubs.

9.8.3 Analysis of the zonality of savannas

Our investigations confirmed the statement of Samek (1969) in that climatic savannas do not exist in Cuba. Savanna climate only occurs southward from Guantanamo over a small area but there the soil conditions favour the formation of

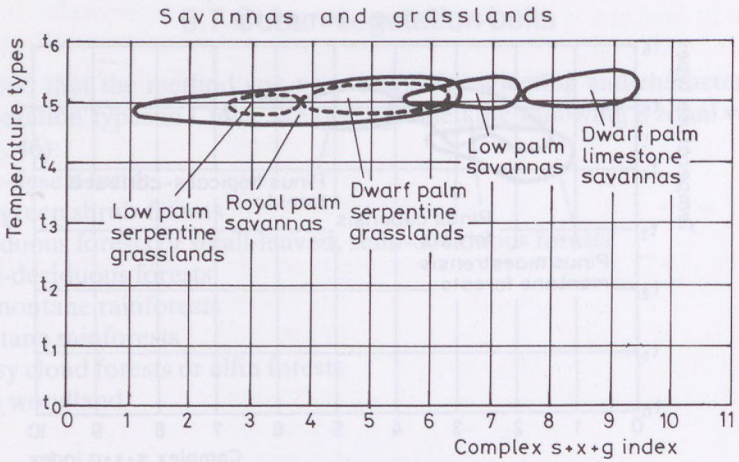


Fig. 48 Distribution of the Cuban savannas and grasslands in the ecological coordinate system of Meher-Homji

a semi-desert cactus scrub. Discounting this small area the climate over the whole area of Cuba is suitable for forest vegetation. The large savanna regions of west and central Cuba are natural, edaphic savannas in a small area (in greater detail in the chapter of plant soil relationships) the majority of the region is made up of anthropo -zoogenic secondary savannas.

9.8.4 Analysis of ecological equivalences

By comparing formation of similar structures conditioned by different soils it may be ascertained from the diagram, to what extent the physiological effect of any basic rocks or soil types may be equivalent to the kind of climatic difference. From this it can be seen, that on the effect of latosols of the serpentine rocks, such vegetation types develop as on limestone with 500 mm less annual precipitation or with a 3—4 months longer dry period. That is, the effect of the serpentine rocks is ecologically equivalent to the mentioned difference.

10 Potential evapotranspiration and the possibilities of utilizing the life-zone system in the classification of plant formations

These two bioclimatological concepts and methods need to be reviewed because;

- So far no such universal bioclimatic method has been worked out for classifying vegetation types which could completely meet the requirements of vegetation research in each climatic belt and preferred dimensions. Of course, it is not at all

likely, that on account of the deviating palaeoecological past and the diverse adaptation trend and capacity of flora, such a universal bioclimatic method will ever be found.

- Numerous examples have confirmed (see point *9.1*) that different zonal vegetation types may develop in analogous climatic types which restricts the suitability of bioclimatic formulae and the validity of conclusions to be drawn on spatial arrangements.
- Just on account of this, it would not have been right to use *a priori* the Gaussen's concept — partly refined and further developed by us — as optimal.
- The even more so, since the method has until now, been used only in Africa and Asia and in the New World tropics rather for illustrative purposes than for documentation (Knapp 1965, Hueck 1966) while Thornthwaite's and Holdridge's concepts are used rather widely on the American continent.

10.1 Criticism of the PE concept

Thornthwaite's theory and method based on PE was most popular in America not only among geographers but agriculturalists and forestry experts, even biologists. The sharp criticism by botanists of the old world (apart from an overview in point *7.2:* Aubréville 1965 *c*: 297—300) went unheeded by the American experts. From this, it may be concluded that Thornthwaite's concept has produced satisfactory results at least for classifying American vegetation.

10.2 Climatic water balance of Cuba

Not having the necessary data for calculating PE, we estimated the basic parameter of the general moisture, the precipitation surplus (S = P − E) or annual values of the climatic water balance and drew them in a map (Fig. 49).

10.2.1 Climatic water balance

The climatic water balance map is similar to the precipitation map. It is striking that a clearly humid climate according to this map, is only to be found in rainforest areas. Even the dry season of 1—2 months, gives a deficit in water balance which geobotanically can be objected to, because such a short dry period generally allows the formation of rainforests but in the worst case it enables the development of zonal seasonal evergreen forests which is likewise of a humid vegetation type and in no way can be regarded as water deficient in an ecological sense.

It can be established that the climatic water balance values even over such a small area as Cuba do not correlate closely with the limits of the vegetation belts. In the mountains of Pinar del Rio and Las Villas the P− E = 0 line only runs along the limits of the seasonal forests. In the montane regions of Oriente it coincides with the lower limits of the montane rainforests but in numerous places (Sierra del Cristal,

Sierra del Purial) in areas of even 400—600 mm precipitation deficit there are wet montane rainforests. On the other hand, the south-east coast of Oriente and the middle of the Cauto basin are depicted on the map as equally deficient areas although the wetness and vegetation of the two regions are quite different.

10.2.2 Conclusions

We can conclude from all this, that precipitation surplus (S) precipitation deficit (d) and the PE terms in Thornthwaite's interpretation are primarily theoretical which do not or only minimally take into consideration the ability of the vegetation to economize with climatic and edaphic water resources by different means and ways. Thus it is not surprising that there is only a vague correlation between the vegetation types and Thornthwaite's formulae. Therefore his terms lack a bio-climatological and synecological concept. These terms can only be regarded ecological in relation to plant cultures where we are faced with an artificially simplified synbiological situation, namely the population of a single species and the only water utilization parameter being the useful yield.

10.2.3 New attempts at a rational climatic explanation

Thornthwaite's method was used by Blackie (1965) in the high montane regions of East Africa, while in West Africa Davies (1965) used it but he did not find the results to be satisfactory. More recently, Penman's PE formula (1948, 1956) has been judged to be more successful. Davies and Robinson's (1969) potential water loss, R_R formula is partly a further development of this. The spatial pattern of certain values of the water balance formula of these authors ($P-E_R$ i.e. precipitation — potential water loss) corresponds to the distribution of certain vegetation types in Nigeria.

10.3 The life-zone theory of Holdridge

In connection with the PE and vegetation mapping relationships, mention should be made of Holdridge's so-called ecological vegetation maps which mainly reflect Thornthwaite's influence.

Holdridge (1962) studying the relationship in atmospheric water cycles carried out an ingenious universal classification scheme of the world plant formation as "natural life-zones" (1967). The classification diagram devised by him rests on three factors:

- Annual total precipitation (P)
- Quotient of potential evapotranspiration (PE/P)
- Annual mean biotemperature (t°) where

$$t^\circ = \frac{\Sigma\, t\, 0^\circ}{12}$$

All three factors are projected in logarithmically graded scales; the first two reflected in a 60° angle to each other giving a tirangle of equal sides. This is divided along the presumed bioclimatic limit values P = 125, 250, 500, 1000, 2000, 4000, 8000 mm and PE (P = 0.25, 0.5, 1.2, 4, 8, 16, 32) parallel lines (t° = 1.5, 3, 6, 12, 24) are divided into hexagonal areas of equal sides of which each, represents a zonal formation and its ecological space.

10.3.1 The PE constant of Holdridge

The diagram is supplemented by a fourth coordinate axis which is parallel to the vertical axis t°. This represents the annual PE total which according to Holdridge is directly proportional to biotemperatures as in the equation below:

$$PE = t° \times 58.93$$

In Holdridge's system, all plant formation bioclimatic limits are determined by the upper and lower limits of three factors P, PE/P and t°. In fact, going further, as PE is proportional to t°, the number of determining factors is two: the annual precipitation and annual biotemperature.

10.3.2 Critical remarks on Holdridge's formulae

Although Hämet-Ahti *et al* (1974) established that the bioclimatic vegetation sector worked out by them, in basic principles agrees with Holdridge's life-zones, the biotemperature index is not considered to be informative enough.

As for the Holdridge's PE constant, Borhidi (1973, 1976) demonstrated that it is valid only for tropical lowland climates which are wet all the year. Extending this to the whole life-zone is not right and it only serves to aggravate the uncertainty arising from the methodological flaws of Thornthwaite's PE. Borhidi furthermore proved that different empirical constants have to be worked out for all such areas where the distributions of temperature and atmospheric moisture do not change parallelly. In, for example, the montane regions, a special altitude correction factor has to be included whose value grows progressively, proportionally to the altitude.

10.3.3 Ecological maps of the life-zone system

With his graphical method, Holdridge established a school among forest experts in Latin America and in extratropical America too (Sawyer and Lindsay 1964, Steila 1966, Thompson 1966). Ecological maps have been prepared in Holdridge's system for all countries of Central America (1953—1962) furthermore, for Peru (Tosi 1960), Columbia (Espinal and Montenegro 1963), Equador and Venezuela too. The simplicity of the method provides a rather tempting opportunity to draw up an ecological vegetation map knowing the relief map and P and T values of the

meteorological network of any country without even having seen the country, its vegetation and ecological conditions.

This possibility should be contemplated even if we have no reason for doubting whether the authors of those maps did visit the country they mapped. At the same time it is striking that, inspite of the often digressing or contradictory results of the vegetation plot analyses and the structural profiles diagrams made by them, they still rigidly adhere to the theoretical limits of the graphical system. In any case, the Holdridge's life-zone maps create the impression that very often there is no real correlation between the theoretical structure and the real distribution patterns of the vegetation. This seems to be confirmed by Holdridge *et al.* (1971) imposing huge book on the forest ecosystems of Costa Rica where within a life-zone the most diversely structured and composed forests are discussed by the authors.

10.3.4 A few critical observations

Holdridge's classification system can be rightly criticized for its theory. Only the more important flaws are listed:

- The annual 24° isotherm can hardly be regarded as the limit of the tropical and subtropical belt everywhere.
- A general flaw of the classification is that Holdridge's terms such as rather dry forest, dry forest humid forest, moist forest, wet forest etc. are very uncertain categories whose concrete physiognomic properties — at least for a time — have not been clarified and this makes for rather subjective interpretation.
- The formation frameworks given by way of the Holdridge system in certain intervals — for example between P = 500—2000 m – is grossly exaggerated, since in this province only two formations are distinguished:

a) tropical rather dry forest and
b) tropical dry forest

whereas — not to mention the impossible terminology; in reality 3—5 zonal formations may alternate under appropriate seasonal precipitation distribution (c.f. Figs 37, 38 and Walter's and Borhidi's diagram). At the same time, in other intervals e.g. P = 2000—8000 mm — the number of possible plant formations is much too high. There is no real, well-defined structural difference between Holdridge's tropical humid, moist, wet rainforests.

It is a mistaken presumption that with an annual precipitation throughout the year of 8000—10 000 mm, the quality and production of the forests improves continuously. In reality, above an evenly distributed annual precipitation of 3000 mm the quality of the forests does not improve, in fact, above 4000 mm it definitely deteriorates as for example in Africa and the Amazonas basin (c.f. Aubréville 1965:305) probably in consequence of the accelerated latosolization and soil deterioration due to soil erosion.

10.3.5 The ecological map of Cuba and its critical appraisal

In judging the merit of a method it is often worth more to try it in practice. So I made an ecological map of Cuba (Fig. 50) according to Holdridge's method and compared it to my field experiences. The findings which I concluded are the following:

a) The Holdridge system of ecological maps gives 10 climazonal formations instead of, in reality, 8 vegetation belts.

b) The "tropical thorn forest" in its distribution corresponds to that of the cactus scrub vegetation of semi-desert shrubs.

c) Instead of the "tropical very dry forest" or savanna, there are xerophilous evergreen shrub forests in Cuba, their distribution however, differs considerably from the area on the ecological map because in reality they occur in the north and southern coastal areas of West and Central Cuba but are missing in the Cauto basin.

d) The "tropical dry forest" belt roughly corresponds to the semi-deciduous forest zones, but in reality within this belt there are a further 3 climazonal vegetation types to be found depending on the seasonal precipitation distribution and the rock formation or quality of the soil (seasonal evergreen forests, small-leaved, semi-deciduous and evergreen shrub forests).

e) The tropical wet forest is exactly equivalent to the submontane rainforest belt.

f) The "subtropical dry forest" formation only exists on the map, in reality it does not differ from the semi-deciduous forests.

g) The equivalent of the "subtropical wet forest" in reality is the seasonal evergreen forest which is not subtropical at all and is not confined to the montane regions as is supposed to be according to the ecological map. Holdridge considers that this formation type in Cuba should be widespread in the mountains up to 1000 m. Instead, in reality, the seasonal evergreen forest belt is to be found in Sierra Maestra up to 800 m and in the Sagua Baracoa mountains not higher than up to 400 m.

h) Holdridge's "subtropical very wet forest" in Cuba does not differ from the "rather wet montane forests," in reality, both are montane rainforests whose distribution actually is much larger than on the map.

i) Between the "montane very wet forest" and the "high montane very wet forests" there is no difference — at least in Cuba. Both are mossy forests.

10.3.6 Conclusions on the life-zone system

We are of the opinion that the Holdridge's ecological model is to be praised for its originality. It would deserve to be scrutinized and by extensive comparison and critical appraisal be rid of its theoretical flaws and its rigid application by which this model has mostly been used. I agree totally with Holdridge in his attempts to model the world vegetation types according to bioclimatologic parameters (see point *6.2.1*). The key problem of success in vegetation mapping is to be able to determine the closeness of the correlation between bioclimate and vegetation types. This task was attempted by me using several methods and for smaller areas relating to Cuba.

There is no question of the need for such a large-scale and valid ecological model, and it is not unlikely that the Holdridge's life-zone system may be the starting point for such a model. For this, however, several things would be needed:

- Much parallel bioclimatic and vegetation research,
- Critical and reciprocal checking of the results of theoretical and field research
- Dynamic approach. The vegetation type should not match the theoretical compartment but the theoretical aspect should be determined on the basis of the real distribution patterns of the vegetation.
- Development of a nomenclature approaching the modern physiognomic classification of vegetation types.

10.3.7 Life-zone system and biotypes of tropical trees

I should like to point out several ecological fields where the Holdridge model in its present form is extremely suitable. Such is, for example, the study of the ecological amplitude of tree species and in connection with this the biotype research of trees. Holdridge in his excellent book (Holdridge *et al.* 1971) described the ecological pattern of numerous tree species in a very instructive way in the life-zone system. In my experience, numerous neotropical tree species could be observed with various ecological patterns of behaviour in the Antilles (e.g. in Cuba) as the diagrams prepared in Costa Rica show. Such surveys on the whole area of distribution of tree species could greatly promote knowledge on the biotypes of tropical tree species.

PART II

RELATIONSHIPS BETWEEN THE SOIL AND VEGETATION IN CUBA

11 A brief survey of Cuban soils

11.1 Geological background

The richness of the flora and the variability of the vegetation in Cuba are explained by the varied edaphic conditions. The diversity of soils is attributable to the wide variability of rocks on the island (limestones of various age, serpentine, dolomite, basalt, granite, diorite, gabbro, sandstone and slate) on which, as a consequence of the varied geological past, soil developing processes of different duration proceeded. Certain land masses have elevated (Sierra de los Organos) since the Cretaceous, others (Sierra de Nipe, Moa) from the beginning of the Oligocene, whereas the lowlands and coastal regions of considerable areas are of Quaternary origin. It is understandable that the many kinds of bedrock, under rather varied climatic conditions, produced soil development processes of strongly different duration. An extremely wide range of soil types developed, as well reflected by the soil classifications based on various approaches.

11.2 Soil classification of Bennet and Allison

Five different comprehensive classifications have appeared on the soils of Cuba. The first is of Bennett and Allison (1928) supplemented by a map to a scale of 1:1 million prepared by Bennett (1932). It is based mainly on morphological features (colour, structure, consistency, more important chemical properties, the presence of ironpan or gley horizon, drainage, bedrock) of the soils.

Only the soils of agricultural regions are studied and discussed, the majority of forest areas are excluded. The soil types are classified into series and these are grouped into families. Bennet's soil system comprises 15 families and 108 series which bear the name of those localities (e.g., families Matanzas, Nipe, Truffin, Bayamo, Esmeralda, Habana, Norfolk, etc.) where the soil types were originally described. The map depicts, with certain simplifications, the distribution of 79 types.

11.3 The genetic concept of Zonn

Zonn (1968), Zonn, Vazquez and Cabrer-Mestre (1966), apart from their own analyses, primarily used the results of Hungarian researchers (Klimes-Szmik and Szabédi unpubl.). Their genetic soil system is based on the origin and the

developmental stage of soils. This, above all, can be expressed by the characteristic molecular ratios of the soils and in their clay fractions as SiO_2/R_2O_3, SiO_2/Al_2O_3, SiO_2/Fe_2O_3 and Al_2O_3/Fe_2O_3. Zonn's system distinguishes 6 soil types and 17 subtypes as follows:

I. Red ferrallitic soils
1. Limestone red ferrallitic soils
2. Acid red ferrallitic soils

II. Quartz allitic soils
3. Humic quartz-allitic soils
4. Yellow lessivated quartz allitic soils
5. Yellow pseudogleyic quartz allitic soils
6. Pseudopodsolic laterites
7. Yellow pseudopodsolic quartz allitic ferrallitic soils

III. Soils formed on serpentines
8. Ferritic soils
9. Allitic-ferritic soils
10. Humic magnesio-siallitic pseudopodsolic soils

IV. Humus carbonate siallitic soils
11. Humus carbonate soils
12. Iron carbonate soils

V. Cinnamonic siallitic soils
13. Cinnamonic carbonate soils
14. Cinnamonic carbonate-free soils

VI. Alluvial soils
15. Dark carbonate-sulphate alluvial soil
16. Black, leached alluvial soils
17. Humic gley alluvial soils

No distribution map has been drawn yet of the mentioned soil types.

11.4 The first genetic soil classification by Cuban pedologists

Cuban researchers, O. Ascanio (1968) and his team (Jimenez, Hernandez), worked out a detailed system of the genetic soil types of Cuba. This, in principle, is similar to the earlier one but relies to a greater extent on the morphological properties and the origin of the soil (quality of the bedrock). This system consists of 17 main types divided into 100 genetic types according to the origin of the type and the quality of the bedrock. These are the following (the number of genetic types in each main type is in brackets).

1. Latosols or ferritic soils (4)
2. Latosolic or ferrallitic soils (20)
3. Weakly gleyized grey sands (1)
4. Tropical black soils (13)
5. Tropical brown soils (18)
6. Brown and red carbonate soils (9)

7. Humus carbonate soils (8)
8. Tropical meadow soils (17)
9. Alluvial soils (1)
10. Mocarrero or hardpan or cuirasses (4)
11. Yellow-red montane soils (7)
12. Yellow montane soils (2)
13. Peat (1)
14. Swamp soil (1)
15. Coastal swamp (1)
16. Salty soils (1)
17. Lowland karsts (Piedra hueca, dogtooth on hard limestone).

Two maps were drawn on the distribution of the types in 1968 to the scales of 1:250 000 and 1:1 000 000.

11.5 Correspondence between soil classifications

The soil classification categories of the three approaches are partly the same, their agreement is illustrated by Table 4 with several examples of corresponding soil types.

Table 4 Soil classification

Bennett	*Zonn*	*Ascanio*
Matanzas	acidic red ferrallitic soil	red latosolic or ferrallitic
Nipe	ferritic soils	latosols or ferritic soils
Bayamo	humus carbonate siallitic	tropical black soil
Guantanamo	cinnamonic carbonate	brown carbonate
Mocarrero	pseudopodsolic laterites	mocarrero or hardpan
Guane	yellow alluvial quartz allitic	yellow latosolic

11.6 Two new classifications of the soils of Cuba

At the first symposium of the Soil Science Institute of the Cuban Academy of Sciences (1975), two new soil classifications were introduced by G. Tatevosian, A. Hernandez and others. One of them is the second genetic soil classification of Cuba with a more updated approach and has more detailed descriptions than the earlier versions. This is advanced especially in the classification of primitive soils, alluvial and swamp soils, vertisols and tropical brown soils. The other is Ascanio's classification and primarily serves purposes of agricultural practice, starting from diagnostic aspects and providing a soil classification key. This instructive soil classification fully combines the theoretical achievements of the genetic concept with practical aspects and greatly facilitates the rapid recognition of the more important soil types in the field for both farmers and ecologists.

11.7 Remarks on soil classifications in Cuba from ecological viewpoint

The soil systems mentioned are based on very detailed investigations and exceptional expertise. They give, however, the impression for ecologists that the majority of the described soil types are based on incomplete profiles which must have been decapitated and modified by the century-old anthropic influences. This is especially striking if we compare the soil profiles prepared in natural ecosystems to those described by Bennett, Zonn, Ascanio and Hernandez. The latter can only rarely be found under natural vegetation. Tatevosian (Conferencia del Instituto de Suelos AC 1975) expressed that Cuban soils are generally aged soils for which a slow water infiltration and small degree of permeability are characteristic as well as a high accumulation, accompanied by slow mineral cycling and a reduced micro-biological activity. These phenomena are interpreted by pedologists and ecologists in different ways. In our view the main reason of the mentioned soil features is the intensive erosion and not the age of the soil. The whole of Cuba was originally covered with forest soils of developed A-level, more or less rich in humus. As a consequence of logging and burning of the forests the upper layer of the soils was partly decomposed and its major part was lost due to erosion. The upper layer of the B-horizon reaching up to the surface in this way became reactivated by the effect of the secondary grass cover developed in the course of succession and turned into a secondary thinner A-layer poor in humus. Its physical and chemical properties are worse, the permeability, fertility and biological activity are of course lower than those of the original forest soil, partly due to the lower biomass production of the grass cover, partly due to the harmful pedozoological and soil-microbiological effects of burning. According to our view, the lowland soils of Cuba are spoiled or modified rather than old or aged, and in fact we know very little about the soils of the natural vegetation.

12 The main relationships between soil and vegetation types

Comparing the genetic soil map and the vegetation map of Cuba (Inset), numerous differences and agreements can be found. The first difference is that the number of soil types is much higher than the vegetation types so the quality of the soil is not always a decisive factor in the development of vegetation. Climax vegetation types are sensitive to only drastic soil differences, the smaller edaphic differences are tolerated by the climax vegetation.

12.1 Serpentines and soil types

It is quite obvious that the serpentine rocks within every soil type produce other vegetation than the similar soils developed on other bedrocks. The effect of serpentines is felt on all genetic soil types perhaps the least on tropical brown soils.

It is striking that in the latosolic soils quite different climax vegetation may develop while certain vegetation types, e.g., semi-deciduous forests and pine-forests, may occur on completely different soil types. The soil-vegetation correlations, summarized in the next paragraph do not always exist but are expected with a rather high probability.

12.2 Soil-vegetation type relationship

It can be established that pine-forests and semi-dry, sclerophyllous montane rainforests may occur with high probability on latosols while pine woodlands on quartz-allitic soils and poor white sands. Furthermore, evergreen dry shrub forests live on siallitic or allitic-ferritic serpentine soils while on limestone a similar vegetation can be found on cinnamonic humus carbonate soils. On tropical black soils the original vegetation is alluvial forests similar to the tropical meadow soils originally also covered by forests.

The distribution of the tropical brown soils coincides quite well with the semi-deciduous forest belt while the original vegetation of the ferrallitic red soils signified the seasonal evergreen lowland forests and partly the semi-deciduous forests. We find the submontane tropical rainforests on yellowish red soils while the wet montane rainforest and the cloud forest belt coincides with the area of the tropical yellow soils. In spite of the intensive annual water table fluctuation, the mocarreros are not savanna soils as Bennett and Allison (1928) suggested. The autochthonous vegetation of these areas was a deciduous or semi-deciduous thorny scrub forest which, as a consequence of burning off, quickly transforms to grassland and is reforested slowly. Accordingly, mainly semi-anthropic *Sabal* and *Copernicia* grasslands or secondary *Dichrostachys* thickets can be found on their sites. In the limestone haystack hill regions special deciduous or semi-deciduous small-leaved forests, the so-called "mogote forests", prevail: the lowland dogtooth karsts are covered by dry evergreen forests and semi-deciduous forest mosaics. As expected, the coastal regions comprise sandy and rocky vegetation whereas the muddy swamp coasts are covered by mangroves. The vegetation of flat and undrained basins comprises swamps and marshes. In the salty coastal zone behind the mangroves a halophytic vegetation of extremely salt-tolerant subshrubs predominates.

Table 5 shows the main correlations between vegetation and soil types, according to the three different classifications of Cuban soils.

13 The effect of serpentines on the flora and vegetation

The effect of serpentine rocks on the flora has been studied in all climatic belts with the main conclusion that the serpentine zones have particular flora and include special territories of speciation and species conservation. Kitamura (1950), Rune (1953) and Whittaker (1954) consider the richness of serpentine flora to be due to the size of the serpentine area and the abundance of the flora in the surrounding area.

Table 5 Correlation between vegetation and soil types of Cuba (after Borhidi 1973, Borhidi and Muñiz 1980, 1984, Capote et Berazain 1984)

Vegetation Physiognomic units	Soil types according to the soil classifications of Cuban authors made in 1973	1975	1979
A. Woody formations			
I. Closed forests			
I.1. Tropical ombrophilous forests			
I.1.1. Submontane rainforests	latosolic yellow tropical	red ferrallitic and yellow ferrallitic	red ferrallitic and yellow ferrallitic
I.1.2. Montane rainforests			
I.1.2.1. Wet montane rainforests	latosolic yellow tropical	red ferrallitic and leached yellow ferrallitic	red ferrallitic and leached yellow ferrallitic
I.1.2.2. Semi-dry sclerophyllous rainforests on serpentine	latosols	ferritic purple and ferrallitic yellow	ferritic purple and ferrallitic yellow
I.1.3. Elfin forests	yellow tropical	leached yellow ferrallitic	leached yellow ferrallitic
I.2. Tropical evergreen seasonal forest			
I.2.1. Broad-leaved evergreen forests			
I.2.1.1. Lowland type	latosolic and yellow tropical and pardo tropical	red ferrallitic and reddish-brown fersiallitic and tropical brown	red ferrallitic and reddish-brown fersiallitic, yellowish-red fersiallitic, not carbonate brown soil
I.2.2.2. Submontane type	humic limestone	red rendzina and black rendzina	red and black rendzinas
I.2.2. Needle-leaved evergreen forests			
I.2.2.1. Lowland type	yellow tropical latosol brown tropical	ferritic purple quarzitic ferrallitic skeletal	purple red and quarzitic sandy soil, yellow quarzitic ferrallitic, skeletal
I.2.2.2. Montane type	latosol montane yellow	purple ferritic montane yellowish-red ferrallitici or allit-ferritic	purple ferritic montane yellowish-red allit-ferritic
I.3. Edaphically humid evergreen or deciduous forests			
I.3.1. Alluvial or riverain forests	alluvial	alluvial	alluvial
I.3.2. Mangrove forests	gley tropical	peat and mud	peat and mud
I.3.3. Tropical swamp forests	gley tropical	peat	peat
I.4. Tropical semi-deciduous forests			
I.4.1. Mesophyllous	humic carbonate brown tropical	rendzina red and black carbonated brown soil	red and black rendzinas carbonated brown soil
I.4.2. Microphyllous	skeletal on dog-tooth limestone	skeletal	black protorendzina brown protorendzina and skeletal
I.5. Tropical deciduous forests	skeletal on dog-tooth limestone	skeletal	black protorendzina skeletal
II. Shrublands and thickets			

II.1. Evergreen broad-leaved thickets			
II.1.1. Montane serpentine	latosol, gravelly	purple ferritic	purple ferritic
II.1.2. Elfin thicket	montane reddish-yellow	not specified	not specified
II.2. Semi-deciduous broad-leaved thickets			
II.2.1. Littoral limestone thicket	skeletal on dog-tooth limestone, brown soil	skeletal and red rendzina, black rendzina carbonated brown	skeletal, rendzina red and black, carbonated brown
II.2.2. Submontane serpentine	latosol, latosolic red	purple ferritic red ferrallitic	purple ferritic red ferrallitic
II.2.3. Lowland with fluctuated water table	mocarrero	gravelly reddish yellow pseudogley	gravelly reddish and yellow pseudogley
II.3. Extremely xeromorphic (thorny) thicket			
II.3.1. On serpentine	latosol, latosolic	purple ferritic red latosolic	purple ferritic red latosolic
II.3.2. In the subdesert belt		red fersiallitic	reddish-brown fersiallitic
B. Herbaceous formations			
III. Savannas and parklands			
III.1. Tall grass savannas			
III.1.1. with tall palms	latosolic brown tropical black tropical	red ferrallitic brownish-red fersiallitic dark plastic gleyized	red ferrallitic brownish-red fersiallitic dark plastic gleyized
III.1.2. with evergreen trees	black tropical alluvial	dark plastic gleyized alluvial	dark plastic gleyized alluvial
III.1.3. with deciduous trees	mocarrero brown tropical yellow tropical	reddish-yellow pseudogley reddish-brown fersiallitic	reddish-yellow pseudogley reddish-brown fersiallitic
III.2. Short grass savannas			
III.2.1. with low palms	dog-tooth limestone, skeletal, quarzitic sand, latosolic, mocarrero	skeletal, red rendzina, quarzitic ferrallitic, red ferrallitic, reddish-brown fersiallitic	skeletal, red rendzina, quarzitic ferrallitic, red ferrallitic, reddish-brown fersiallitic
III.2.2. with xeromorphic trees	mocarrero, black tropical	reddish-brown fersiallitic dark plastic gleyized	reddish-brown fersiallitic dark plastic gleyized
III.3. Swamps and marshes			
III.3.1. Sedge swamps and marshes	gley tropical, alluvial	peaty gleyized, dark plastic gleyized, alluvial	peaty gleyized, dark plastic gleyized, alluvial
III.3.2. Wet lowland savannas	black tropical	dark plastic gleyized, dark plastic not gleyized	dark plastic gleyized, neoautomorphic dark plastic, greyish-brown soil
III.4. Herbaceous and half-woody salt swamps			
III.4.1. Half-woody salt marsh	saline soils	solonetz and solontshak	solonetz and solontshak
III.4.2. Salt meadows	saline soils, black tropical	solonetz, solontshak, dark gleyized soil	solonetz, solontshak dark gleyized,

13.1 The serpentines and endemism

Rune (1953) demonstrated that the rocks with high Ca and Mg contents (serpentine, magnesite, dolomite, limestone, gypsum, gabro) favour the formation and conservation of palaeoendemics and relic species while on heavy metal soils primarily neoendemic taxa develop. The serpentines combine both chemical properties, thus they are rich both in palaeoendemics and neoendemics.

13.2 Serpentines as an ecological factor group

Studying the mechanism of action of serpentines, most researchers concede [cf. Krause's review (1958 *a*)], that the serpentines are effective as several other equally important limiting factors combined in a so-called "serpentine combination". Of these factors the following were studied:

a) Ca/Mg ratio: Blackshaw (1920), Novák (1928), Beckett (1965), Proctor (1971 *a,b*). Lyon *et al.* (1971) consider the low Ca/Mg ratio of serpentine soils to be decisive since it influences the stability or inhibits the development of the Ca/Mg balance of living organisms.

In the young serpentine soils of Cuba, the Ca/Mg ratio varies between 0.01—0.5 and even on the most mature latosols it does not reach one. This factor seems to be rather important and it shows why the serpentines are unsuitable for other Mg plants (dolomite and gypsum plants). At the same time it could be established that neither the high Mg-content nor Mg-excess are constant properties of serpentine soils. Bennett and Allison (1928), as well as Robinson *et al.* (1935), demonstrated for latosols and latosolic serpentine soils that they were completely free of Mg. Without doubt, due to the instability of Ca-balance, the ultrabasic character of young serpentine soils with relatively low SiO_2 content may change quickly and this could make the serpentines ecologically ambiguous: relatively basic and relatively acid at the same time.

b) Nutrient deficiency: Gordon and Lipman (1926) emphasized the role of the high pH values accompanying low N and P content. Robinson *et al.* (op. cit.) pointed out the connection between the decline of Si in the course of soil development, the poor Al storage of clay minerals and the reduction in adsorption capacity due to Ca deficiency. Bennett and Allison (op. cit.) demonstrated that the clay of Cuban serpentine ferritic soils was suitable for ten times less adsorptive capacity than the clay fraction of a sandy mud soil. Lipman (1926) pointed out the exceptionally weak microflora of these soils.

c) Ca deficiency: Kruckeberg (1954) and Walker (1954) later considered the role of Ca deficiency to be important and that of Mg to be secondary, whereas in the case of the serpentines the effect of both cannot entirely be separated.

d) Mg toxicity: Proctor pointed out in his excellent study series (1970, 1971*b*) that Mg is extremely toxic. He proved with water culture experiments that this toxic effect is decisive in the low Ca/Mg ratio. The strongest toxicity was produced by Mg with total lack of Ca and upon the slightest addition of Ca the toxic effect was

reduced. In this way Proctor reinforced Kruckeberg (1954) and Walker's (1954) views with respect to the importance of the lack of Ca. From another aspect Berazain's investigations in Cuba show that the vegetation of the serpentines strive to balance the low Ca/Mg ratio of the soil with a vigorous adsorptive control. She proved by studying six species living in serpentines that in spite of the 0.09—0.17 Ca/Mg ratio in the soil, all investigated plant leaves had a Ca/Mg ratio of about 1.0 or more. Of the studied species the most serpentine-tolerant was *Leucocroton havanensis* Borhidi (*L. flavicans* auct. cub. non Muell. Arg.) which approached the optimal physiological value of the Ca/Mg ratio in the leaves (Table 6).

Table 6 Element content of leaves in plants of serpentine soils: Loma de Galindo, Prov. Matanzas, Cuba (after Berazain 1981b) in % of dry matter

	Ni	Co	Mg	Fe	Ca	Cu	Zn	Ca/Mg
Serpentine latosolic soil,								
Horizon A.:	1.58	0.03	5.81	12.1	1.04	0.00	0.00	0.17
Horizon B + C	1.29	0.02	11.61	9.9	1.04	0.00	0.00	0.09
Serpentine-tolerant plants								
Leucocroton havanensis	11.45	0.05	7.13	0.18	26.58	0.02	0.05	3.72
Buxus flaviramea	6.34	0.02	13.75	0.26	18.36	0.02	0.04	1.26
Myrtus matanzasia	0.89	0.03	12.50	0.50	11.60	0.04	0.03	0.92
Neobracea valenzuelana	0.12	0.01	14.50	0.38	20.78	0.03	0.04	1.43
Ternstroemia peduncularis ssp. *obovalis*	0.02	0.01	6.25	0.13	13.34	0.02	0.03	2.13
Coccothrinax miraguama ssp. *roseocarpa*	0.05	0.01	2.50	0.18	3.38	0.02	0.06	1.35

e) Mo deficiency: It has been proved that the serpentine soils were poor in physiologically important trace elements, especially in Mo, as it was pointed out by Johnson, Pearson and Stout (1952).

f) High Fe content: Sarasin (1917), Göhlert (1928) and Minguzzi and Vergnano (1953) showed that high iron concentrations had a major role in dwarfing plants. It is without doubt that one of the most striking features of plants living on serpentines is the dwarf growth, moreover, the Fe_2O_3 content in serpentine soils may be as high as 80%. Of the six species studied by Berazain, all appear to be major Fe accumulators. Nevertheless, if compared to the related species, none of them showed signs of nanism. Dwarfing in plants, according to my observations, develops in Cuba only in ancient serpentine areas on mature latosols where the Fe_2O_3 content of the soil exceeds 50% and on extremely poor acid white sand.

g) Ni toxicity: the high toxicity of Ni has been studied by numerous researchers. Hunter and Vergnano (1952), Crooke and Inkson (1955), Crooke (1956), Soane and Sauder (1959), Proctor (1971 *a, b*), Proctor and Woodell (1971), Brooks, Lee and Jaffré (1974), Wiltshire (1974) and Berazain (1981) studied Ni tolerance on

materials derived from Scandinavia, Britain, Italy, Rhodesia, Cuba, New Zealand and New Caledonia. All agree that the toxic effect is significant, the plants accumulate Ni in large quantities and the Ni uptake increases in acid soils. Hunter and Vergnano suppose that in the plants which had adapted to Ni (e.g., *Alyssum bertoloni*), Ni has a positive physiological role, perhaps the plant makes up for lacking Ca by Ni. This supposition has not yet been confirmed. Wiltshire proved that Ni tolerance did not depend on the amount of Ni uptake, but on the site of accumulation in the plant. Populations with higher Ni tolerance take up the same amount of Ni as the less tolerant ones, but the Ni level decreases from the root to the stem. Berazain's investigation, however, shows that the narrower the area of a serpentine endemic species the greater the activity of the nickel ion accumulation. At the same time it is striking that heavy metals are hardly accumulated in the leaves of palms. Gregory and Bradshaw (1965), Proctor (1971*b*) and Wiltshire (1974) established that Ni tolerance is less specific than copper tolerance and that chromium and copper have a greater effect on the mechanism of speciation, as it has been shown by Duvigneaud (1959), Duvigneaud and Plancke (1959), Duvigneaud and Timperman (1959) in Katanga, by Jacobsen (1967, 1968), Wild (1968, 1970) and Wiltshire (1974) in Rhodesia and by Drew and Reilly (1972) in Zambia.

h) Dysgeogenic effect: The slow dysgeogenic decomposition of serpentines creates typical geomorphological forms of extreme micro-climate and habitats with reduced competitivity. This is similar to the dolomite phenomenon (Gams 1930, Zólyomi 1942) and to the effect of other dysgeogenic rocks (e.g. quartzite, sandstone, quick sand).

i) Physical properties: Numerous researchers (Novák and Pelišek 1940, Benett and Allison 1928, Robinson *et al.* 1935, Rune 1953, Lam 1927) have stressed the characteristic physical properties of serpentine soils, the hot dry feature of the shallow serpentine rendzina, the flexibility, the lack of rocks, the water-retaining capacity, etc. of the serpentine laterite. It can be established, however, that these physical properties do not explain the low fertility of the serpentines; in the evolution of serpentine soils the physical properties considerably change without changing their effect on the flora.

j) Role of reduced competition: according to Kruckeberg (op. cit.) this is an important feature in the evolution of endemics on serpentines. The non-serpentine populations of species occurring both on serpentine and non-serpentine soils as a consequence of competition become exhausted earlier and extinct, while those living on serpentines are faced with reduced competition and survive as isolated populations. He supposes that many serpentine endemics come about as a consequence of such biotype exhaustion. The populations adapted to serpentines are not able usually to return to other rocks because they are not able to tolerate the stronger competition prevailing on other soils anymore. It is largely a consequence of this that the serpentines can be regarded as edaphic islands which have their own endemic flora (Cain 1944, Mason 1946).

13.2.1 Conclusion

Based on observations carried out so far, we cannot make general conclusions on the mechanism of serpentine effect. Observations confined to various areas and factors cannot yet be assessed although research in recent years has primarily stressed Mg and heavy metal toxicity. According to Krause (1958a), so much is certain that it is not the omnipotence of a single factor but basically the combination of different serpentine factors that have to be taken as the starting point and each case must be analyzed individually in accordance with the circumstances.

From our observations we may state that, of the serpentine factors, the really acting, limiting ones can be different in dependence of time and place. From the point of view of place the composition of the serpentine rock (the peridotite/augite ratio), as the initial material of soil formation, and the climate, as a factor determining the direction and stages of soil development processes, are important. Time is important because soil evolution proceeds in time, and in different phases of soil development different serpentine factors become decisive in limiting and adaptation mechanisms. The only factor group which remains more or less unchanged irrespective of place and time is nutrient deficiency. Undoubtedly, this factor group has a great effect in that the metabolism of serpentine plants is essentially slower compared to plants living on other rocks. This is an irreversible adaptive property of plants (see *13.3.5*). It may be attributed to nutrient deficiency that in spite of the different acting serpentine factors the physiognomy of serpentine vegetation is rather uniform. However, we cannot accept it as a single factor because other nutrient deficient rocks may produce similar physiognomic vegetation but the gene pool similar to serpentines cannot. Nutrient deficiency cannot be disregarded, it is rather important because in different phases of soil evolution processes it reinforces certain soil factor effects since the plant has been forced to take up and tolerate large amounts of toxic material.

13.3 A concept of serpentine effects on tropical flora and vegetation

We shall try to assess how and to what extent the different serpentine factors have a role in developing the flora and vegetation of serpentine areas of various age, size and climate under tropical conditions.

13.3.1 Serpentine areas of Cuba

Cuba is an especially suitable region for studying the origin and adaptation of serpentine floras because it has three large serpentine ranges and nine smaller or larger separate lowland colline serpentine territories of 7500 km^2 area altogether. These areas largely differ from one another with respect to age, evolution, orography, soil conditions and climate and are appropriate for multilateral observation.

13.3.2 Endemic serpentine genera in Cuba

The serpentine areas in Cuba have proved to be the most intensive and successful 'workshops' of plant speciation and diversification. This is proved by the fact that one-third of the endemic flora of Cuba (920 species, 31.2%) has developed on serpentine areas covering not more than 7% of the whole country. 14.6% of the total flora is endemic exclusively, to serpentine. Of the 72 endemic phanerogamous genera 24, i.e., 33.3%, live in serpentine areas. Examples are *Ekmanochloa Sauvallella. Moacroton, Kodalyodendron, Adenoa,* (Fig. 51) *Tetralix, Phidiasia,*



Fig. 51 Adenoa, a monotypic endemic genus of Turneraceae living in the serpentine mountains of the northern Oriente (Photo: A. Borhidi)

Sapphoa, Dasytropis, Acunaeanthus, Ceuthocarpus, Neomazaea, Phyllomelia, Schmidtottia, Ariadne, (Fig. 52) *Shaferocharis, Eosanthe, Koehneola, Lescaillea, Harnackia, Shafera, Ciceronia* and *Feddea,* 75% of the endemic *Acanthaceae* genera (3 genera), 67% of the endemic *Rubiaceae* genera (8 genera) and 50% of the endemic *Compositae* genera (6 genera) are exclusively serpentinecolous. Apart from the listed genera, some supraspecific taxa should be mentioned whose species are also exclusively serpentine endemic, such as *Phyllanthus* sect. *Orbicularia, Leucocroton* sect. *Leucocroton* and *Spathelia* sect. *Splendentes* (see Table 6).



Fig. 52 Ariadne (Rubiaceae) an endemic genus of the serpentine shrubwoods in the Sagua-Baracoa range (Oriente) (Photo: A. Borhidi)

13.3.3 Causes of taxon-richness of serpentine floras

The richness of serpentine floras *(12.1.1)*, according to our observations, depends on the following factors in order of importance:

- Age of serpentine region
- Size of serpentine region
- Number of climatic changes
- Specialization of surrounding flora
- Richness of surrounding flora

a) The richness of serpentine flora depends above all on the age of the region (not the age of the rock), or more exactly, on the time available for the flora evolution. Of the twelve serpentine regions of Cuba, four are rather old surfaces, the west Cuban Cajalbana collines, the Nipe, Cristal and Moa ranges of Oriente. On these areas as a result of several million years of soil development processes the latosolization is in an advanced state, according to many soil scientists it is predominated by old fossil soils. According to Finko, Korin and Formell (1967), the estimated age of latosols in Moa is about 30 million years. The other eight serpentine territories of Cuba can be found in central Cuban lowlands and collines which are around 1 million years of age or younger. Their soils are young humus magnesium siallitic or allitic ferritic soils of moderate development. The old

Table 7 Comparison of old and young serpentine areas with respect to the flora

Type of regions	Area		Endemic genus		Endemic species	
	km²	%	No.	%	No.	%
Old serpentine areas	4800	64	22	91.7	750	81
Young serpentine areas	2700	36	0	0	128	14
Common	0	0	2	8.3	42	5
Total	7500	100	24	100	920	100

serpentine areas cover a 4,800 km² area (64% of the total serpentine surfaces) whereas the young serpentine areas correspond to 2700 km² (36%). Comparing the flora of the two regions (Table 7) it is striking that of the 24 endemic serpentinecolous genera mentioned in *13.3.2*, 22 are exclusive to the old serpentines. Only the *Acunaeanthus* and *Moacroton* are common, for both old and young serpentine regions. The young serpentines have no endemic genus. Of the 920 endemic serpentine species 792, i.e. 86%, are found in the old serpentines. Of these 750, (81%) are exclusive to this area while 42 species (5%) — e.g. *Neobracea valenzuelana* (Fig. 53) — are common in the younger regions. In contrast with this the endemic species of the younger serpentines account for 14%.

b) The extent of the serpentine area from the point of view of flora richness is only important in certain extreme cases, namely when it is so small that it becomes



Fig. 53 Neobracea valenzuelana (A. Rich.) Britt. a Pan-Cuban serpentinophilous shrub occurring in all serpentine areas of Cuba. (Photo: A. Borhidi)

a barrier to isolation of newly evolved populations. In serpentine areas of the same age and larger than 500 km², the differences noticeable in orographic variety, habitat of climate may have a much greater effect on the floristic richness than the extent of the region. The size of the region is effective if it is combined with orographic variability, abundance of different meso- and microclimatic habitats. Table 7 can also be interpreted in such a way that in addition to the age of the areas, their extent can also have a major role in the development of floristic richness. In reality, as compared to the age, the importance of the extent of the area is minimal. Our findings are supported by the data of Table 8 where it is seen that in an area of 70 km² colline serpentine block of Cajalbana Hill there are twice as many endemic species as in the Camagüey serpentine zone which is younger and ten times larger in area. Moreover, the former has three endemic genera and a number of isolated palaeoendemics while in the latter area, almost without exception, vicarious neoendemics occur only.

Table 8 Comparison the serpentine areas of Cajalbana and Camagüey with respect to local endemics

	Area	Local endemic genus	Local endemic species
Old serpentine area			
Cajalbana	70 km²	3	32
Young serpentine area			
Camagüey	800 km²	0	16

c) The climatic changes have a rather important role in the evolution of flora, especially the frequent changes of longer wet and dry periods. The floras of the Moa and Nipe ranges of about the same age of old regions are good examples. From the latosols and extrazonal rain forests we may justly conclude that this montane region previously had moist tropical climate; in fact in the latosols of the Nipe several hardpan layers can be found as products of alternating dry and wet climatic periods of the Quaternary or upper Tertiary ages. It may be due to this that the relatively lower flora richness approaches that of Moa as seen in Table 9.

Table 9 Comparison of the flora of the Moa and Nipe ranges, with respect to endemic species

Region	Area	Annual mean precipitation	No. of endemic genera	No. of endemic species
Nipe Mts.	500 km²	1617 mm	4	151
Moa Mts.	2500 km²	2314 mm	4	190
Common	—	—	6	263

We have to note that drought in Cuba is a rather stimulating evolutionary ecological factor which is not surprising since the main trend in the evolution of the plant kingdom is its tolerence to drought. Figure 54 demonstrates this effect of dryness well, from which it turns out that 68% of the microphyllous trees and shrubs are endemic, 78% of the nanophyllous trees and shrubs and 75% of the leptophyllous trees and shrubs. On serpentine areas this evolutionary effect is even

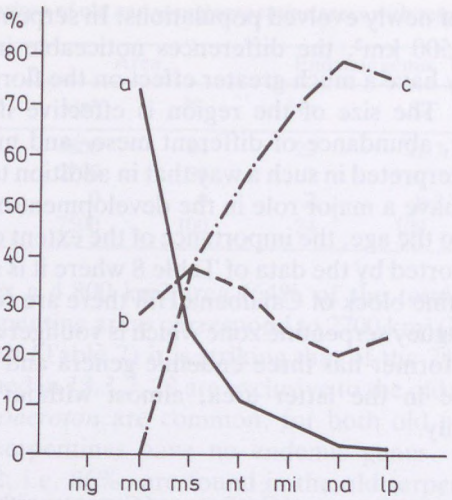


Fig. 54 The leaf size class pattern of the Cuban trees and shrubs. mg: megaphyll; ma: macrophyll; ms: mesophyll; nt: notophyll; mi: microphyll; na: nanophyll; lp: leptophyll, — a) tropical species, b) Caribbean species, c) Cuban endemic species

more explicit since the physiological drought of serpentine soils, as will be shown later in several examples markedly increases the ecological effect of the climatic aridity.

d) Naturally, the serpentine areas reaching the surface by denudation develop their own flora from the surrounding 'basic' flora, so it is important how rich the basic flora is. A more important factor than species richness is the degree of basic flora specialization. A species-poor basic flora, which has adaptable and genetically flexible taxa, can develop into a serpentine flora of greater variability than a species rich one which has become highly specialized. There are examples of these in Cuba: the Cajalbana hills are surrounded by the conic karst areas of Sierra de los Organos and Sierra del Rosario on which—being in one stretch from the Cretaceous age already by the middle of the Miocene—a probable time for the emergence of Cajalbana serpentines—a very rich but strongly specialized chasmophytic limestone flora developed whose members were mostly unsuitable for colonizing the serpentine region. So Cajalbana obtained its florula not from here but from the species-poor Cayetano sandstone regions. From that developed a highly specialized serpentine flora whose richness is comparable with the older relic flora of Sierra de los Organos.

13.3.4 Importance of Mg and Ca level

With respect to the ecological factors inducing the evolution of serpentine flora and development of special "serpentinomorphoses", we agree with Proctor (1971a, b) in finding low Ca/Mg ratio and heavy metal, especially Ni, toxicity. It should be emphasized that the two factors rarely act combined or simultaneously as the same

plant population does not tolerate Mg and Ni generally to the same extent (Proctor 1971b: 839). Kruckeberg (1954) and Walker (1954) consider the Ca deficiency to be the determining ecological effect of serpentines, as well as low nutrient level and finally Mg content and the reduced competition. There are several questions which are difficult to answer:

Why is it that we find the most serpentine endemics in the pioneer shrub vegetation of primary serpentine rendzinas which are not yet poor in Ca?

Why did the flora of serpentine areas remain isolated even when a Ca-free rock area surrounds it, e.g., granite, diorite or sandstone?

Obviously, it is due to the high Mg level. According to our experiences under tropical conditions, Ca deficiency, besides appropriate augite content, appears on mature ferrallitic and ferritic serpentine soils and not in the early phases of soil evolution whereas the decisive moment of the development of endemic serpentine flora takes place just on these young, Ca-rich (CaO content ranges between 3—10%) and Mg-rich soils. Thus, the importance of Ca deficiency has to be considered as a secondary or tertiary factor however spectacular the mature serpentine soils are from the point of view of flora development. Undoubtedly, the plant species which have adapted to Ca deficiency are most suitable to settle in serpentine areas, often without changes in the biotype (e.g., conifers, grasses, *Ericaceae*), but the acidophilous species which have adapted to serpentines in the form of a new biotype are rarely able to return to the original bedrock although the Ca deficiency would not mean a barrier.

13.3.5 Irreversible adaptation to serpentines and effects of fertilization

The specialization of trees and shrubs of Cuba to serpentine rocks results in metabolic changes and is a largely irreversible process. The serpentine species are not able to survive on soils other than serpentine merely on account of the intensified competition. Acuña (personal communication) and my own observations proved that in the Botanical Garden of Santiago de las Vegas, on limestone latosolic ferrallitic soils, the serpentine endemics introduced there disappeared after one or two years without having any competitors. It is also proved by K, N and P fertilization experiments which aimed at greater productivity and growth of serpentine flora and vegetation by reducing nutrient deficiency on serpentine soils. Fertilization accelerated the metabolism of plants which caused growth discrepancies, leaf fall and dieback of serpentine trees and shrubs. Fertilization experiments carried out with grasses proved that raising the low nutrient level does not entail significant yield growth, in fact, it rather spoils the tolerance to toxic materials. The most effective proved to be Ca fertilization (Walker 1954, Proctor 1971b) but in the tropics this could only produce results on young shallow soils still rich in Mg. Crooke (1956) proved that low pH increased heavy metal toxicity and Crooke and Inkson (1955) pointed out that the toxicity of nickel was greater in the presence of high phosphorus and low Ca and K levels. N-fertilization was found to be ineffective on Mg soils (Wiltshire 1974) because the N source had no effect on the Ca/Mg ratio. Negative results of N fertilization were likewise found on Ni soils because

ammonium as an N source intensified the acidity of the soil and, together with this, the heavy metal uptake and toxicity (Antonovics *et al.* 1971, Gigon and Rorison 1972). Nitrate addition, however, stimulates the uptake of iron and aluminium even up to a toxic level. It has to be remarked that these plant responses were experienced on grasses of great adaptivity and not on less tolerant tree and shrub species which account for 75% of the serpentine flora of Cuba.

13.4 Stages of serpentine flora development and the controlling factors

Studying the old and richest serpentine flora of East Cuba we consider the following stages of the flora evolution to be the most probable, if we take as an example a simple case where the tropical climate has evenly distributed precipitation and it does not change in the course of soil evolution.

a) The low Ca/Mg ratio and Mg toxic effect The CaO content of primary serpentine rendzina soils may range between 3—8%, the MgO content 10—40% and the Ca/Mg ratio may vary between 0.01 and 0.5. Since these soils are rather poor in nutrients, mainly in phosphorus and the habitat warms up to some extent due to the open vegetation and strong insolation, the plants have to transfer large amounts of water, which makes the uptake of Mg salts unavoidable, in order to take up sufficient nutrients and water for transpiration. As Mg is a poison detrimentally influencing the metabolism of the cell, and the environment does not have sufficient Ca reserves to counteract this, the serpentine plants have to develop an internal mechanism to neutralize Mg, to eliminate it from the metabolism and to accumulate it. The plants colonizing primary serpentine soils are actually shocked by this over-abundant Mg, to which they cannot get adapted, and are either killed or forced to change the biotype. In the development of serpentine flora this has to be regarded as the decisive factor since the number and frequency of endemic elements are the highest in these pioneer evergreen shrubs (see Table 10). It should be noted that the ubiquitous, edaphically indifferent plants are rarely able to survive on pioneer serpentine habitats. For these plants the secondary pioneer habitats resulting from degradation are suitable sites for colonizing as seen in Cuba, in the case of *Dichrostachys cinerea, Rhynchelytrum roseum* etc.

b) In the further development of serpentine soils — siallitization then latosolization — Ca and Mg gradually become leached from the upper levels, the SiO_2 content drops steeply and the soil turns acid. The montmorillonite type of clay minerals is exchanged by kaolinite type and in the adsorption complex Al_2O_3 becomes predominant. Instead of the Mg toxicity, Al toxicity becomes the most dangerous. It is easy to realize that the siallitic, ferrallitic and allitic-ferritic soils formed in this way have completely different ecological features than those to which the serpentine flora was adapted in the first stage of speciation. Soil development therefore necessarily induces newer flora development in the form of a slow differentiation. Largely, the pioneer serpentine flora developed earlier provides the genetic basis, but the plants of neighbouring acid areas (quartz-allitic soils,

yellow montane soils) may also be important. For these leaching process of the surfaces went into effect faster than the adaptation of the serpentine flora. The semi-dry sclerophyllous rainforest flora prevailing on such areas is relatively poor in endemic species compared to pioneer shrubs but it is enriched in fresh genetic material which may serve as a newer starting point of flora development for the next phase of soil evolution, e.g. *Talauma minor* ssp. *minor* → ssp. *oblongifolia, Cyrilla racemiflora* → *C. cubensis,* → *C. nipensis* and *Ilex macfadyenii* → *I. moana,* etc.

c) Effect of heavy metals In the last phase or latosolization, as a consequence of vigorous leaching of SiO_2 and Al_2O_3, ferritic latosols form which accumulate considerable amounts of Fe_2O_3, Ni, Mn and Cr oxides, reaching as much as 60—70% Fe_2O_3 and 1.1—1.6% Ni content. Undoubtedly, the enrichment of latosols with heavy metals has an added ecological shocking effect on the plants even if the concentration change is not as sudden and intensive as in the primary serpentine soils. Since the latosols are extremely poor in exchangeable bases (in the Nipe clay 1.1%, Bennett and Allison 1928) the uptake, accumulation and neutralization of heavy metal ions in the course of water and nutrient uptake are unavoidable, thus another wave of adaptation is invoked. This process may be well assessed by the fact that the frequency of endemic species in the pine forests prevailing on latosols shows a rising tendency compared to the vegetation type of the previous stage. (Table 10).

Table 10 Frequency values of the endemic species in different stages of a successional series old serpentine area

Serpentine endemisms	Pioneer thickets (4 noda)	Semi-dry rainforests (3 noda)	Pine forests (6 noda)	Degraded pine woodland (3 noda)
Fr %	71.65%	58.29%	63.28%	46.67%

Since the latosols are several million years old they may be just as suitable for the evolution of paleoendemics and the survival of relicts (e.g. *Shafera, Koehneola, Feddea, Dracaena cubensis*) as the pioneer habitats rich in Mg. In this sense Rune's (1953) findings on holarctic heavy metal soils were right in that heavy metal soils primarily induce the formation of neoendemics. However, paleoendemisms could arise in large numbers in the tropical belt if there is a much longer process of flora development on heavy metal soils, which was not possible in the north temperate belt due to the glacials.

13.4.1 Serpentines and competition

Studying competition conditions it appears that competition is the least intensive on ferritic latosols. The different anthropic effects influencing the pine forests lead to invasion by weeds and a drop in the number of endemic taxa.

13.4.2 Genetic drift in the evolution of serpentine floras

It should be pointed out that in the development of the serpentine flora, at least under tropical conditions, the exhaustion of biotype is only the first step to the isolation of serpentine endemics. In the further evolution of flora, genetic drift plays an essentially greater role in developing species richness by diversification of the isolated endemics. Since most species are represented by small and strongly dispersed populations pollinated by insects, there is a great chance that the newly derived characteristics become dispersed and isolated. This is indicated also by the fact that in the Nipe mountains every valley has its own florula with different local endemics of the genera *Tabebuia, Gochnatia* and *Leucocroton.* In Moa the different highplains and peaks have their own florula with a number of vicarious *Cordia, Ilex, Buxus* and *Phyllanthus* species.

13.5 Serpentines and vegetation

Whittaker (1954) compared the effects of serpentine rocks on vegetation with those of diorite under similar climatic conditions. He found the following.

13.5.1 Characteristic features of serpentine vegetation

Xeromorphism or pseudoxeromorphism. This means that the serpentine vegetation physiognomically represents in each case a dryer degree than a vegetation type on another soil. In his opinion this is not merely the consequence of physical properties of serpentine soils, which may often be identical with those of other soils. Serpentine vegetation stands are usually open, which permits the increase of the extreme values of temperature, transpiration, and insolation. Therefore, under identical temperature conditions water loss is greater than on diorite.

Reduced productivity. The height and closure of serpentine vegetation and as a concomitant of this, its production is smaller than in the non-serpentine plant communities living under similar climatic conditions.

Reduced structure. The diminishing of the vegetation layers results in the transfer of the active surface to lower layers.

Predisposition to certain growth forms (Kruckeberg 1954). Grasses have an advantage over forbs, pines over deciduous trees, sclerophyllous evergreen shrubs over deciduous shrubs. Generally, the serpentines favour the vegetation types consisting of pines, evergreen shrubs and grasses.

13.5.2 Serpentines and succession

Serpentine rocks basically influence succession. It can be established that:

- Serpentines have their own succession series and climax which in all respects differ from the non-serpentine, climatic climax.

• The terminal stage of serpentine succession, let us take it as subclimax or edaphic climax vegetation, will never be equivalent to the vegetation of the surrounding, economically more valuable areas.

13.6 Serpentine effects on tropical vegetation

Serpentine rocks have their own succession series and edaphic climax which differ from the series developing on other bedrocks and the climatic climax in identical climates. However, there are series and noda developed on other rocks in drier climates which correspond to a given series or is a nodum of the serpentines regarding structure, physiognomy and production. This means that serpentine communities always represent a dryer degree than a community living on another rock, e.g. on limestone or diorite and in a dryer climate on a non-serpentine rock a community of a similar structural physiognomy and production can be found. In Cuba, from the point of view of physiognomy and production, a serpentine series is equivalent to a limestone series living in a dryer climate of less than 400—500 mm annual rainfall or in a bixeric climate with 2—3 months longer dry period (Fig. 84 and *9.8.4*).

The series of acid rocks poor in nutrients are closer to those of the serpentines. The series developing on slate, sandstone or white sand, which have more precipitation, is equivalent to a series of serpentines with more than 100—200 mm precipitation or a one month shorter arid period.

13.6.1 Xeromorphy of serpentines and its climatic equivalence

The xeromorphy of serpentine vegetation or the degree of physiological aridity of serpentine soils can be described exactly by the deficit in precipitation or the length of the dry period.

We have to stress that, the mentioned precipitation amount does not merely express, in a theoretical sense the difference between the habitats mentioned but in reality this amount is able to compensate for the physiological dryness of serpentine habitats. This has been proved by the semi-dry sclerophyllous montane rainforests developing extrazonally in the dryer pine forest belt of the Nipe and Moa mountain regions and the wet montane rainforests occurring in the local climatic humid habitats in the semi-arid sclerophyllous rainforest belt.

With respect to the climatic equivalence and the compensating effect of the edaphic xeromorphy of serpentine plants we investigated the structure, characteristic LAI-s and the ratio of thorny plants in the plant communities of serpentine and limestone areas occurring in different climatic types. In Fig. 84 and from *17.4.2.* the climatic differences existing between serpentine and limestone formations of identical structure and biomass can be seen. Studying the leaf size class frequencies expressing the xeromorphism of vegetation we found that the xeromorphism of serpentine vegetation compared to the limestone vegetation under given temperature conditions (24—27 C° annual average) is equivalent to a 500—600 mm annual

precipitation deficit. The increased xeromorphism of serpentine vegetation is evident from the frequency of thorny plants which is more greatly intensified by the drying of the climate here than in the limestone vegetation.

13.6.2 Utilization of space by the serpentine vegetation

It is generally characteristic of the serpentine vegetation that space is not fully used both vertically and horizontally. Whittaker's (1954) findings on tropical vegetation cited in *13.5.1c* are supplemented by the following:

a) Compared to the climatic climax the serpentine climax vegetation is;
— 5—10 m lower,
— the number of tree layers is less by one,
— the canopy is always open,
— the active closed layer is the second one, most frequently, the shrub layer.

b) In the rainforest belt the so-called semi-dry, sclerophyllous types develop. These are called semi-dry because their climate and habitat are wet; only the physiognomy of the vegetation is xeromorphic. The characteristics of semi-dry forests are that their canopy is open and, as a consequence of this, certain layers are missing e.g., the sciophilous, shade-tolerant epiphytic layer is lacking or poor in epiphytic orchids, tree ferns; the epiphytic and epiphyllous liverworts are almost missing and the mossy ground layer is poor; both are replaced by lichens. In contrast with this, the small-leaved shrub layer composed of low trees and shrubs is rather well-developed.

13.6.3 Edaphic extrazonality of serpentine vegetation types

As an important conclusion we may say that because of the loose structure, xeromorphism and the reduced production of the serpentine vegetation it is an extrazonal imitation of not only a dryer but, in reality, a cooler climatic and vegetation belt. Certain types of tropical serpentine vegetation, primarily the sclerophyllous scrub forest and the hard-leaved evergreen undergrowth pine woodlands, are very closely related physiognomically to the Mediterranean macchia, chaparral and scrub formations and the Mediterranean pine woodlands.

13.6.4 Descending vegetation zones in serpentine mountains

The extrazonal character of serpentine vegetation is manifested more explicitly in the vertical vegetation belt arrangement. Lam (1927) and Bauman-Bodenheim (1955) found that the alpine and montane plant species are prone to settle on the lower belts in the serpentine mountains. Our observations in Cuba proved that it was not merely certain highland elements but entire vegetation belts which descended. In the serpentine highlands certain vegetation belts (in the form of their dryer variants) develop at considerably lower altitude, in Cuba at half that altitude,

than in the non-serpentine mountains. Certain extremely humid vegetation zones, such as the cloud or mossy forest belt, are completely missing from the serpentine ranges. This correlation has been supported by the vertical distribution of some life-forms and growth forms as well (Fig. 130). In Table 11 the vertical distribution of the vegetation belts in two east Cuban mountain regions is shown (Fig. 55).

Table 11 Vertical distribution of the vegetation belts in two mountain regions of Cuba

Vegetation belts	Sierra Maestra andesite, limestone, sandstone	Moa serpentine, gabbro
Lowland-submontane belt	seasonal evergreen forest 100—800 m	submontane rainforest 100—400 m
Lower montane belt	humid montane rainforest 800—1600 m	semi-dry, sclerophyllous montane rainforest 400—900 m
Higher montane belt	elfin forest 1600—1900 m	— — — — — — — —
Subalpine belt	elfin thicket 1900— m	semi-dry montane thicket 900—1100 m

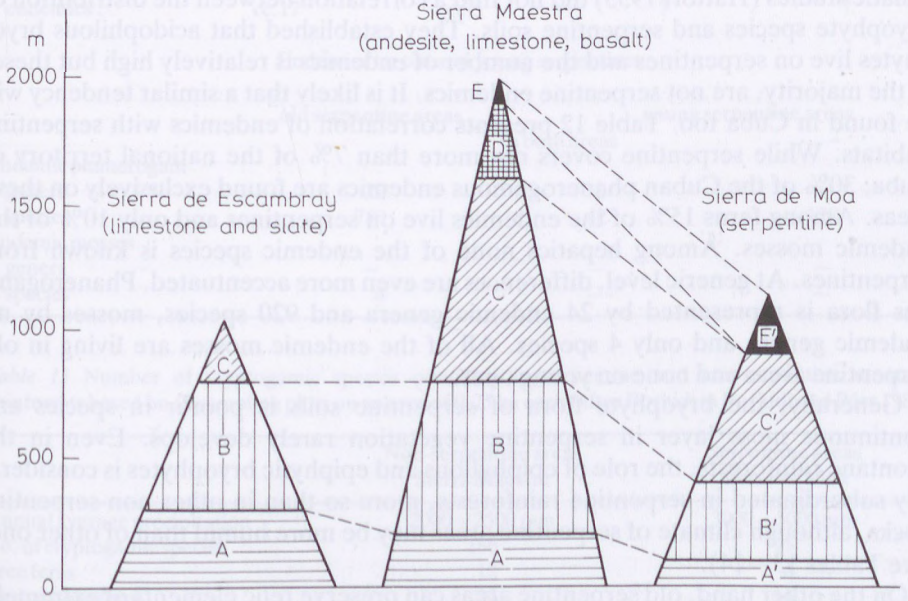


Fig. 55 The serpentine effect on the vertical pattern of the vegetation zones in Cuba. A: Semi-deciduous forest; A': Pine woodland; B: Submontane seasonal evergreen forest; B': Submontane rainforest; C: Montane rainforest; C': Sclerophyllous montane rainforest; D: Mossy elfin forest; E: Elfin woodland; E': Elfin thicket

13.6.5 Serpentine preference of higher plants

Numerous authors have found that serpentine soils favour xero-photophilous oligotrophic elements, such as the genera *Pinus, Vaccinium, Genista, Cytisus* and many species of the *Myrtaceae, Gramineae, Cyperaceae and Caryophyllaceae* families. According to our observations, the serpentinophilous taxa, apart from those mentioned and listed in Table 6 are the following (the brackets indicate the number of taxa and percentage proportions of serpentine plants in Cuba): *Podocarpus* (4 species, 80%), *Harpalyce* (16 species, 94%), *Leucocroton* (26 species, 96%), *Buxus* (26 species, 79%), *Cyrillaceae* (12 species, 86%), *Spathelia* (8 species, 80%), *Ossaea* (27 species, 60%), *Calycogonium* (13 species, 68%), *Ilex* (16 species, 57%).

13.6.6 Serpentine effect on cryptogamic flora

Serpentines have a much less effect on the differentiation of the cryptogamic flora than on that of the phanerogamic flora. In the fern flora the proportion of endemics is considerably smaller, although 30% of them are serpentine plants. Certain fern genera have a greater role in serpentine vegetation, such as *Anemia, Lindsaya, Pteridium, Odontosaria* and mainly hard-leaved and climber ferns. In contrast, the role of hygrophilous ferns is definitely subordinated in serpentine vegetation, for example, the epiphytic and filmy ferns are less represented.

At this stage we know little about the effect of serpentine soils on mosses in Cuba. Asiatic studies (Hattori 1955) did not find a correlation between the distribution of bryophyte species and serpentine soils. They established that acidophilous bryophytes live on serpentines and the number of endemics is relatively high but these, in the majority, are not serpentine endemics. It is likely that a similar tendency will be found in Cuba too. Table 12 presents correlation of endemics with serpentine habitats. While serpentine covers not more than 7% of the national territory of Cuba, 30% of the Cuban phanerogamous endemics are found exclusively on these areas. Among ferns 15% of the endemics live on serpentines and only 10% of the endemic mosses. Among hepatics none of the endemic species is known from serpentines. At generic level, differences are even more accentuated. Phanerogamous flora is represented by 24 endemic genera and 920 species, mosses by no endemic genera and only 4 species. All of the endemic mosses are living in old serpentine areas and none on young ones.

Generally, the bryophyte flora of serpentine soils is poorer in species and continuous moss layer in serpentine vegetation rarely develops. Even in the montane rainforests, the role of epiphyllous and epiphytic bryophytes is considerably subordinated in serpentine rainforests, more so than in other non-serpentine rocks, although climate of serpentine areas may be more humid than of other ones (see Tables 13—14).

On the other hand, old serpentine areas can preserve relic elements of extremely disjunct distribution pattern from very early geologic ages. In Cuba, we consider the following serpentine liverworts as relicts: *Calypogeia venezuelana, Plagiochila steyermarkii* and *Syrrhopodon elongatus* (Reyes 1982).

In section *13.6.4* an important phytogeographic particularity of the serpentine is discussed, namely the descendence of the montane vegetation belts and montane-subalpine species to lower altitudinal levels. This phenomenon is clearly manifested by the distribution of a number of mosses. Table 14 shows the altitudinal range of some moss species in non-serpentine and serpentine mountains. Eleven selected moss species are listed occurring on serpentines at about half the altitude where they are found on other bedrocks. Pócs explains (Borhidi and Pócs 1985) this by the fact that on serpentines real humid rainforests developed only in the deep valleys while slopes and ridges were covered by more open sclerophyllous evergreen

Table 12 Correlation between endemic taxa and serpentine areas in different plant systematic levels (after Borhidi and Pócs 1985)

	National territory of Cuba		Serpentine areas	
Surface	110 922 km²		7 500 km²	7%
Flora	No. of species	Flora in %	No. of species	Endemics in %
Phanerogams	6 350	100		
endemics	3 153	50	920	30
Ferns	500			
endemics	53	11	8	15
Bryophytes	723			
Mosses	386			
endemics	39	10	4	10
Hepatics	337			
endemics	cc.17	cc.5	?	?

Endemics on old and young serpentines

	old serpentine areas	in both areas	young serpentine areas
Endemic phanerogam			
genera	22	2	—
species	750	42	128
Endemic mosses			
genera	—	—	—
species	4	—	—

Table 13 Number of cryptogamic species occurring in serpentine and non-serpentine montane rainforests based on 10 sampling plots on an area of 0.25 ha each (after Borhidi in Borhidi and Pócs 1985)

	Non-serpentine areas Sierra Maestra	Serpentine areas Sierra de Moa
Annual average precipitation	2000—2500 mm	3000—5000 mm
No. of cryptogamic species	186	95
Tree ferns	12	6
Herbaceous ferns	26	16
Epiphyte ferns	28	18
Mosses	75	34
Hepatics	45	21

Table 14 Altitudinal range of some mosses in Cuban serpentine and non-serpentine mountains

	Non-serpentine Sierra Maestra	Serpentine Sierra de Moa
Acroporium pungens	1000—1900 (m)	300—470 (m)
Campylopus porphyriodietion	1800—1950 (m)	600—800 (m)
C. saxatilis	1500—1800 (m)	200—470 (m)
Isopterygium micans	1500—1800 (m)	500—800 (m)
Leucobryum giganteum	1000—1800 (m)	600—900 (m)
L. polakowskyi	1100—1950 (m)	600—800 (m)
Mettenothamnium reptans	1200—1950 (m)	700—800 (m)
Philonotis sphaericarpa	1600—1900 (m)	600—800 (m)
Pogonatum tortile	1000—1200 (m)	400—600 (m)
Schlotheimia torquata	1500—1800 (m)	200—800 (m)
Syrrhopodon tenuifolius	1700—1950 (m)	500—700 (m)

forests or shrub forests conditioned by nutrient-poor and drier serpentine soils. In these communities real hygrophylous rainforest species rarely occur, they are replaced mostly by xero-tolerant elements. Many of them are elements of the elfin forests and thickets of subparamo-character originating from the higher belts, and have been preserved as relics in the lower altitudes. Table 15 contains some species occurring in the Andes and on other Antillean islands between 2000—3000 m, while in Cuba they live as isolated relics at much lower altitudes and only on serpentine bedrock.

Table 15 Altitudinal distribution of some moss species in Latin America (after Pócs in Borhidi and Pócs 1985)

	Antilles + Andes	Cuba only on serpentine
Leskeodon andicola	2000 m →	400— 500 m
Plagiochila stayermarkii	2200 m	1000—1100 m
Drepanolejeunea suchaeta	1000—2500 m	900—1100 m
Leptoscyphus cuneifolius	~ 3000 m	800—1100 m
Calypogeia venezuelana	~ 2000 m	400—1000 m

13.6.7 Serpentine and sclerophyllous vegetation

It is to be stressed that the serpentine rock in tropical climate primarily favours sclerophyllous shrubs and small trees. It can largely be explained by the serpentine effect that 46% of the endemic flora of Cuba is made up of these two life-forms. The role of grasses and sedges is much smaller in the tropical serpentine areas than in the temperate belt. They are commonly abundant mainly in the herb layer of the pine forests and in secondary pine woodlands and dwarf palm savannas. Generally, the extremes of seasonal tropical climates and the compactness of ferritic soils favour their spread. Under tropical conditions they may become dominant only as a consequence of human effects.

13.7 Xeromorphy as a general adaptive syndrome of vegetation

On the basis of the above observations and the large number of contradictory findings on xeromorphism we came to the conclusion that although xeromorphism may be attributed to extremely heterogeneous ecological and physiological factors, it may be interpreted only in one way. Xeromorphism can be conceived as a general response of plants to different environmental stresses. It is a general adaptation syndrome, a sort of stress mechanism, which results from an adaptation to different deficiency shocks of the habitat and becomes fixed genetically and morphologically in the plants, and then appears after a long time as a uniform feature in the physiognomy of vegetation.

Vales expressed that in the serpentine plants outer morphological features of xeromorphy are not fully accompanied by inner anatomical characteristics provoked by dry habitat. In many cases (e.g. *Myrica shaferi, Bucida ophiticola, Neomazaea phialanthoides*) tissue structure and elements of the vasoductor system show a combination of xeromorphic and mesomorphic anatomical features. Therefore he named this special adaptation form of the serpentine plants as "pseudoxeromorphism" (Vales *et al.* 1982, Carreras and Vales 1986). In some cases the xeromorphic character of serpentine vegetation does not reflect the really existing drought of the habitat but the deficiency of soil in nutrients and indispensable micro-elements, etc. For this reason, xeromorphy of serpentine vegetation can be considered also as "peinomorphy", i.e., a general plant response to the hunger-stress of the habitat at a vegetation level.

14 Relation of soil and vegetation development

As indicated earlier, the processes of soil evolution may vary considerably depending on the quality of rocks, the duration of the process and its speed. Eiten (1972) distinguished 9 different soil development series in the Cerrado zone of Brazil, just on the basis of the initial and final phase under identical relief and climatic conditions. In Cuba, we have to count on at least 6 different pedological large series. Of these, we studied the most widespread and studied limestone series and the succession of its vegetation. For the correct interpretation of soil genetic processes we followed Zonn (1958), Zonn *et al.* (1966) and Maul (1973). For characterizing the different soil types the works of Bennett and Allison (1928), Klimes-Szmik in Zonn (1975), Klimes-Szmik *et al.* (1980) and Ascanio *et al.* (1968) were used in addition. The observations on the succession of vegetation types and vegetation-soil relationships during their co-evolution came from the author's field studies. The biomass values of vegetation types were estimated based on structural data according to Basilevich *et al.* (1969).

14.1 Climatic pattern

The relationships between soil and vegetation during their coevolution are shown by the simplified scheme in Fig. 56. Here, the complex succession of a lowland limestone region is depicted in the case when the annual mean temperature of the climate is 25 °C and the evenly distributed annual precipitation is 1400—1800 mm with short, moderately dry periods of 1—2 months and in the course of succession it does not change.

14.2 Soil succession

A total of five stages of siallitization and latosolization, which are the main phases of soil evolution, are shown in the diagram. Each of these stages represents a large soil type group: the primary rendzina-like humus carbonate soils, typical tropical carbonate soils, siallitic soils, ferrallitic soils and ferritic soils. The transitional ferritic-allitic and allitic-ferritic soil types formed during the latosolization are disregarded due to the small number of data.

14.2.1 Change of soil features during succession

The two diagrams at the bottom of Fig. 56 illustrate the changes in the adsorption complex in the course of soil succcession.

It can be seen that the maturation process of tropical soils is a kind of podsolization whose essence is the leaching of the initially dominant SiO_2 and a simultaneous decline in the SiO_2/R_2O_3 ratio. The limit between siallitization and latosolization processes is set by about 50% of SiO_2 content and where the ratio SiO_2/R_2O_3 is about 2. Simultaneously with the above process, in the course of siallitization the relative amount of Al_2O_3 and the Al_2O_3/Fe_2O_3 molecular equivalent ratio gradually increase and reach their maximum in the ferrallitic soils. During the ferritization process, which is the second phase of latosolization, Al_2O_3 becomes washed out from the soil together with SiO_2 and its amount decreases rapidly. Parallel with this, the relative Fe_2O_3 amount grows continuously; first rather slowly in the phase of siallitization, while in the second phase of latosolization it suddenly rises and thus Fe_2O_3 becomes predominant in the ferritic soils. Its increase results in a decline of the adsorption capacity, thereby implying the re-mineralization of the soil, the regression to rock form.

14.3 Change of vegetation types during succession

In the upper section of the diagram of Fig. 56 the structure profile of each vegetation type is shown. The curves below it show the height of the upper layer and the average biomass values, obtained by extrapolation, for the different vegetation noda.

a) On the rendzina-like humus carbonate soils an evergreen shrub vegetation of 5—6 m height develops in a mosaic-like pattern of scattered individuals of small

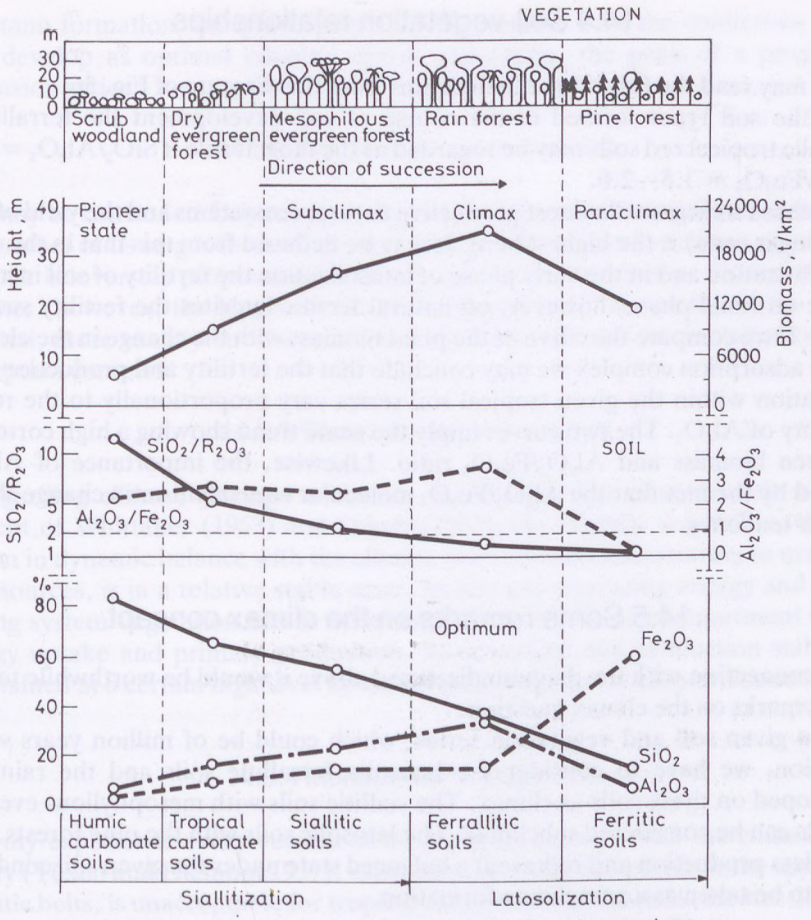


Fig. 56 Scheme of the succcession of the tropical soils and vegetation types

trees and small grassy patches (scrub woodland). Its biomass could be around 2000—5000 t/km².

b) On the typical carbonate soils small-leaved evergreen shrub forests grow with a 12—18 m high canopy. Its biomass is estimated to be about 6000—12 000 t/km².

c) On siallitic soils, under given climatic conditions, mesophilous evergreen forests or seasonal rainforests may develop with a canopy of 20—28 m height with emerging giant trees; the biomass may surpass 16 000 t/km².

d) On ferrallitic or latosolic soils we can find the most developed vegetation type of the highest production, the real lowland-submontane rainforests whose height in Cuba varies between 30—40 m. Their biomass is probably more than 20 000 t/km².

e) On ferritic soils we may find vegetation types of much less organized structure and lower production: 15—25 m high pine forests and pine woodlands whose biomass is 9000—15 000 t/km² at most.

14.4 Soil-vegetation relationships

We may read the following relationships from the diagram of Fig. 56.

Of the soil types formed in the course of soil development the ferrallitic or latosolic tropical red soils may be regarded as the most fertile if $SiO_2/Al_2O_3 = 1$ and $Al_2O_3/Fe_2O_3 = 1.5-2.0$.

On these soils grow the most productive natural ecosystems and the yield of crops (e.g. sugar cane) is the highest here. It may be deduced from this that in the course of siallitization and in the early phase of latosolization the fertility of soil increases. In the terminal phase, however, on natural ferritic laterites the fertility suddenly drops. If we compare the curve of the plant biomass with the change in the elements of the adsorption complex we may conclude that the fertility and production of the vegetation within the given tropical soil series vary proportionally to the relative quantity of Al_2O_3. The two curves imply the same trend showing a high correlation between biomass and Al_2O_3/Fe_2O_3 ratio. Likewise, the importance of Al_2O_3 is proved by the fact that the Al_2O_3/Fe_2O_3 molecular equivalent ratio change shows a similar tendency.

14.5 Some remarks on the climax concept

In connection with the diagram discussed above it would be worthwhile to give a few remarks on the climax question.

In a given soil and vegetation series, which could be of million years scale in duration, we have to consider the latosolic ferrallitic soils and the rainforests developed on these soils as climax. The siallitic soils with mesophyllous evergreen forests can be considered subclimax. The latosolic soils with the pine forests, which have less production and represent a balanced state under the given soil conditions, have to be taken as a paraclimax formation.

14.5.1 Pine woodlands as paraclimax

We have to stress that the role and situation of the soil and vegetation types during succession may be quite different under other climates and, with certain minor modifications, any stage may be even a climax. Under identical temperature conditions with 600—800 mm annual precipitation and 8—9 months of aridity the rendzina-like humic carbonate soils turn into cinnamonic humus carbonate climax soils and the scrub woodland formed on them is the terminal phase of the successional series. Likewise, in the case of 800—1100 mm annual precipitation and with 6—7 dry months the typical humus carbonate soils and microphyllous evergreen forests represent the climax; the siallitic soils and the mesic evergreen forests with 1200—1600 mm precipitation in the case of 3—5 dry months may likewise become stabilized as climax. The latosols and the pine forests developed on latosols cannot in any way be regarded as climax, only as paraclimax or edaphic climax of the post-climatic phase of succession. On other soils depleted of nutrients on account of the nature of bedrock e.g., on the slate-sandstone of the San

Cayetano formation, on quartz-allitic yellow latosolic soils the coniferous forests may develop as optimal edaphic climax vegetation, the peak of a progressive succession series.

14.5.2 Dry season and succession

It may be concluded from all these that the length of the successional series, i.e., the number of its stages from the pioneer stage to the climax formation on identical bedrock is inversely proportional to the length of the dry season. Under identical climates, however, the length of the series depends on the quality of the parent material, more exactly on, the nutrient content of soils and on the capacity of the adsorption complex.

14.5.3 Climax ecosystem concept

Regarding climax, it seems necessary to mention that in agreement with the concept of Whittaker (1953) and Odum (1962), the climatic vegetation, that is a system in dynamic balance with the climate and soil and endeavouring to maximize its resources, is in a relative stable state. In this self-regulating energy and matter cycling system vegetation has to be considered as the basic compartment for the energy uptake and primary production. Its structural and production stability is maintained at a certain high level by the dynamic balance of the populations.

14.5.4 Monoclimax or polyclimax

In my experience every version of monoclimax theory, even the climax-group theory (Tüxen and Diemont 1937), which appears to be acceptable in the temperate climatic belts, is unacceptable for tropical conditions. In identical climates different successional series develop conditioned by different bedrocks. The convergence of these series however, even at formation level, does not lead to the climax of identical structure and production. Therefore, several edaphic climaxes of different structure and composition may develop under the same climate in the areas of different geological substrate (limestone, serpentine, slate, sandstone, granite, diorite, quartz sand, etc.) which all have the characteristics of the climax ecosystem on their sites. Among these edaphically modified climaxes there is a climax of highly organized structure and maximal production which, using Clement's term (1936), can be considered as an optimal or climatic climax. In most cases, as in Cuba also, this climatic climax corresponds to the climax developing on limestone.

14.5.5 Non-seral factors

I consider all vegetation types to be excluded from the climax concept whose existence is conditioned by edaphic factors of non-bedrock character and by other environmental limiting effects (high water table, shallow hardpan, salt spray,

erosion, human influences, etc.) which are able to stabilize the early stages of succession. In this sense I do not accept the concept of the "natural edaphic savanna climax" (Beard 1943) which will be discussed at length in the following.

15 Nature and origin of savannas in Cuba

15.1 Short historical survey

The literature on the origin of the ecological causes for the existence of savannas comprises divergent and contradictory views. The contradictions can be deduced partly from the inconsistent nomenclature, namely from the term savanna which has been interpreted in various ways. Geographers, pedologists, botanists and ecologists interpret this term in different and sometimes incorrect ways, as the numerous examples by Beard (1953), Walter (1962, 1970a) and others have shown. Furthermore, contradictions stem from the fact that studies discussing the ecological causes of the origin of savannas on the whole disregard the obvious possibility that the xero-mesophyllous tropical tree- and treeless grasslands, called savannas, originate from different vegetation types and are influenced by ecological causes in different ways. Thus, researchers consider the climate, others the bedrock, still others the different soil properties and many consider the fire, grazing and other human interventions to be responsible for the formation of savannas.

15.1.1 Climatic grassland concept

Special soil conditions and seasonally dry climate are attributed to the formation of savannas in Warming's (1892) opinion. This kind of climate is suitable for forest formation, too. However, he rejects the theory as "completely unpermittable" which claims that savannas are caused by cutting and burning of forest areas. Schimper (1898), however, considered savannas to be climatic formations. He qualified the climate of the Venezuelan "llanos" as antiforestal and entirely rainless because of the 5 dry months. Later, under his influence, Warming (1909) thought that the cause for savannas was to be found in dry seasons and did not mention the soil. Schimper's opinion was criticized by Troll (1935). Later, Walter (1962: 254—255) demonstrated that there are zonal savannas in dry regions with less than 500 mm annual rainfall on fine textured alluvial soils and not rocky or gravelly soils. Warming and Graebner (1918) referred to savannas as tropical grassland regions of rainy summers and dry winters which could have been treeless partly for geological, partly for climatic reasons. Hayek (1926) approached the question also from a climatic aspect. He considered the savannas to have developed on dry tropical regions where the rainy season coincides with the vegetative period of grasses.

15.1.2 Low nutrient level concept

The main cause of savanna formation was considered by Pulle (1906, 1936), Lanjouw (1936) and Hardy (1945) to be in the leaching of soils. On such nutrient deficient soils only low loosely structured forests can occur which are prone to catching fire in the dry season and turn into a savanna. Ijzerman (1931) exposes that savannas must have been created by pedological factors because the climate of savannas does not differ in any way from that of surrounding forest areas. Jones (1930) and Waibel (1948) found that on certain geological formations particularly poor soils develop on which only savanna vegetation can survive; namely that the existence of the savannas is to be deduced purely from geological reasons. Jones found a definite correlation between sandstone and savannas as well as volcanic rocks and forests. This correlation was reinforced by Walter (1970: 84) in connection with the savannas of the Guyana plateau and the Brazilian sandstone sheath. He stressed the importance of white sand which is a primary product of sandstone decomposition and is extremely nutrient-deficient and is mainly lacking in phosphorus and trace elements.

15.1.3 Drainage concept

On the basis of their soil investigations in Cuba, Bennett and Allison refuted (1928) the concept stating the geological origin of savannas. They established at first that savannas were conditioned by unfavourable drainage which generally is associated with an unpenetrable ironpan layer (mocarrero) close to the surface. As a consequence of this, the habitat in the wet season becomes swamp and in the dry season dries out like a desert, thereby making the otherwise shallow fertile layer unsuitable for forest vegetation. Likewise the "bowal", the tropical grasslands of the African forest belt has developed by reaching to the surface of the lateritic hardpan layer (Schnell 1970, 1971). The same factor was considered by Charter (1941) to be the essential cause of natural savannas in Honduras, by Hills (1969) in South America and by Beard (1944, 1953) in entire tropical America (see Hills and Randall 1968). More recently, Walter (1970: 81—83) reinforced this opinion based on his investigations carried out on the "Ilanos" of the Orinoco valley. In East-Africa, Vesey-FitzGerald (1963a, 1970) came to a similar conclusion, he considered valley grasslands only to be natural grass vegetation. Fanshave (1969) is of the same opinion with respect to the south-east African savannas.

15.1.4 The fire concept

Extensive literature is available on the effect of fire on vegetation. In Africa, Busse (1908), Gradman (1916) and Obst (1923) pointed out that a large part of open grasslands appearing as climax vegetation must have been formed through fire. Bews (1929) in his great work found that the tropical tall grass savannas were derivates of burnt forests while the short grass savannas develop mainly in areas

with climate unsuitable for the survival of closed forests. Bouiellenne (1930) and Myers (1936) represent ambiguous standpoints. They regard the savannas of the Guyana highland to be caused by climatic drought and maintained by fire. Thus, the term fire climax was coined by Myers for savannas. Later this concept became widespread and numerous African ecologists regard a major part of the African savannas as fire climax. Although it has been shown that in certain regions, e.g., Africa, the atmospheric electric activity is especially high, Komarek Snr. (1971) excellent article indicates that this factor should not be overestimated. According to Penzhorn (in Komarek Snr. 1971), between 1957 and 1970 there were 29 fires each year caused by lightning. However, this is only 11% of all fire caused during the same period. Besides, it should be remembered that fires caused by lightning rarely occur repeatedly at the same area during the same period. Therefore, it appears that the role of fires caused by lightning is only decisive in critical situations, for example, in the struggle zone of the grassland-forest ecotone. In this way we can speak of real fire climax only for relatively small areas.

15.1.5 Fire ecology

With respect to clarifying the ecological role of fire, Phillips' works (1930, 1931, 1938, 1965) are outstanding. He demonstrated that fire is the basic cause for creating African grasslands and for destroying the original forest vegetation. He pointed out the economic advantages of applying fire control and the terrible destruction caused by irresponsible burning. On his initiative a scientific network was devised which endeavours to determine by experimentation the scientific ecological bases of the economic use of fire. Of these, Charter and Keay's (1960) comparative investigations are regarded as pioneering with respect to early burning, late burning and protected grassland sites. Several researchers in their works have been reporting the effect of many kinds of treatments in similar experiments (Trapnell 1958, West 1965, 1971, Glover 1968, Innes 1971, Rensburg 1971, Kennan 1971, van Wyk 1971, Scott 1971). They found that the so-called early burning carried out at the beginning of the dry season does less damage to the ecosystem, protects the trees more, including the fire-sensitive species and the zooedaphon, too. This relatively "cool" fire applied regularly leads to the development of savanna woodlands or parklands. In contrast with this, the so-called late burning at the end of the dry season results in hot and intensive fires and regular application of these promotes treeless grasslands with sparsely scattered tree groups. All this is true only for areas where burning is not accompanied by intensive grazing.

15.1.6 Holocenotic concept

Lately, other authors (Cole 1960, Eden 1964, Hills 1965, 1969, Goodland 1970, Monasterio 1971, Monasterio and Sarmiento 1971, Eiten 1972) refer to the interaction and concurrence of several factors in the origin and maintenance of

savanna ecosystems. Some may be simply conditioning or predisposing factors, others may be necessary but not sufficient determinants while others may be important in the genesis of the ecosystem but not in its maintenance. Since this concept includes a set of simultaneous and/or successive agents, it is called holocenotic by Sarmiento and Monasterio.

15.1.7 Anthropic grassland concept

We saw above that ecologists consider fire to be the fundamental cause for the occurrence of grassland also for their maintenance. It would be an illusion to say that savannas are brought about by climatic fires. Christoffel (in Aguerrevere *et al.* 1939) showed that in the Guyana highland the Indian aborigines destroyed forests by burning as early as 8—10 000 years ago. Clark (1959), on the basis of the radiocarbon dating, found that man used fire more than 53 000 years earlier in Zambia and Tanzania. Bantu tribes keeping cattle in the first century used fires to gain areas for grazing, for cultivating crops, for supplying fresh grass and for charcoal burning which they used for melting iron. Fire thus became a vegetation modifying means in man's hands and the formation of large grassland areas is above all a result of human activity of combining fire and grazing. While in the neotropics the destruction of forests became extensive especially after the discovery of America, but in Africa, which looks back at a much longer cultural history (Richards 1973), anthropic savannization or desertification (Aubréville 1949) is in a much more advanced state than in the tropics of other continents. In the last decades more studies dealing with the anthropogenic origin of savannas have appeared (Johannenssen 1963, Taylor 1963, Puig 1972). The anthropogenic origin of savannas for Africa was demonstrated by Phillips (1930), Scott (1934), Burtt (1942), Thomas (1946), Aubréville (1947, 1949), Welch (1960), Cole (1963), Hopkins (1965*a, b*), Trapnell and Langdale-Brown (1971), Lind and Morrison (1974), for Laos by Vidal (1960), for Vietnam by Jeanplong (1968) and Pócs (personal communication). Central and South American savannas were likewise qualified as anthropic ones (Budowski 1956a, b, Aubréville 1965a). Of the latter, Blydenstein (1962, 1963), Vareschi (1960, 1962) and Tamayo (1961, 1962) proved their anthropic origin. The south Brazilian savannas of the Cerrado zone were also considered by Rawitscher (1948) and Cole (1960) as of anthropic origin.

15.2 Cuban grasslands. Bennett's concept

In Cuba, ecological research on savannas was commenced by Bennett and Allison (1928) and their findings are reported in *15.1.3.* These, in theory, were basically correct and the cited authors strove to use the vegetation as an indicator and to maintain that the savanna should not be determined simply from pedological or geographical aspects but in correlation with the vegetation. So, those soils in which there was a compact water locking layer at 25—35 cm and where grasses and

herbaceous plants prevailed, the Esmeralda, Estrella and Mocarrero soils (altogether 15 soil types) were classified as natural savanna soils. This would have meant that almost one third of the area of Cuba was covered by natural savannas.

15.2.1 The influence of Bennett's concept

Bennett and Allison were outstanding soil scientists but they did not have the necessary botanical and ecological experience to be able to recognize the often hardly conspicuous difference between the natural and secondary savannas. Their authority and the thoroughness of their pedological study influenced greatly the view of the botanists, based on their suggestions León (1946), León and Marie-Victorin (1942, 1944), Seifriz (1943), Carabia (1945*b*) and later Beard (1953) and Knapp (1965) considered the grassland areas with scattered palms and pines in Cuba as original natural savannas. Carabia (1945) even considered the secondary grassland formed on the site of the cut and burnt pine forests of the Nipe highland as original montane savannas, and Beard adapted this erroneous assumption (1953).

15.2.2 Seifriz's interpretation

Seifriz's study should be particularly mentioned as it is regarded in the literature as the only comprehensive work on Cuban vegetation using an "ecological approach" and which most authors take as the basic source. Seifriz's study has really a geographical view and not an ecological one. During his brief stay in Cuba he could only have got an impression of the vegetation and he probably did not have a comprehensive knowledge of the flora. Thus, his observations are superficial and often faulty. His finding that the most important feature of the Cuban landscape was that it is a savanna, gives the impressions of a traveller. However, his statement is erroneous from an ecological point of view. He mentions, however, that the royal palm savannas probably came about anthropically from some kind of forest vegetation, but the grasslands growing on sandstone and serpentine were definitely considered by him as original savannas. He lists more than twenty-five palm species characteristic for savannas whereas more than half of these does not occur in grassland areas at all but are species of scrubs and shrub forests. The savannas are discussed by him according to the administrative provinces disregarding their ecology, physiognomy, floristic composition and origin. So, Seifriz's savannas are rather heterogeneous even at formation level and in his species lists the most divergently occurring species are listed together.

15.2.3 Anthropogenic savanna concept in Cuba

The anthropogenic origin of Cuban savannas has hardly been mentioned until recently. Muñiz (1959) reports the tremendous destruction of lowland forests but he regards 25% of the country to consist of natural savannas.

Numerous Cuban botanists are of the opinion (Acuña, Muñiz, pers. comm.) that Cuba originally was a forest region but special studies on this have not been carried out. Waibel (1943) tried to reconstruct the original vegetation on the basis of the names of Cuban localities but he was not successful because the word savanna in Cuba is used in rather varied interpretations (Samek and Duek 1967). For example, the Sabana village in the Baracoa region is still surrounded by original seasonal rainforests.

15.3 The savanna concept of Beard

Beard's (1953) comprehensive study summarized the characteristics of savannas as follows:

a) Savanna is a more or less xeromorphic grassland vegetation conditioned by the unfavourable water economy of the natural soil developed in the old eroded land forms. Its life pattern is controlled by regular alternation of flooded and dry periods.

b) Savannas occur in extremely different climates ranging from a 500 mm of annual precipitation and 7—8 dry months to 2500 mm of annual precipitation and negligibly short dry period.

c) The lowland climates of tropical America are suitable everywhere for growing some kind of forest vegetation. Savanna climate does not exist.

d) All savanna types may be regularly damaged by fire and vegetation is adapted to it. Grassland vegetation however, is not maintained by fire but by the soil and habitat as an edaphic climax.

Beard's basically correct findings need a few comments and modifications.

a) It may be debated that natural savannas would be restricted to edaphic, poorly drained though climazonal savannas also exist (Walter 1962).

b) It is not particularly appropriate to consider drainage savannas as edaphic climax. Only Walter's climax savanna can be regarded as edaphic climax because it is conditioned climatically on certain fine grained sedimentary soil types. There it is replaced equivalently by the semi-desert shrub or shrub forest vegetation in other rocks. The drainage savanna can only perhaps be regarded as a paraclimax where it has attained a senescent stage of soil development occurring in over-mature soils. On the whole, however, the natural savannas are edaphically stabilized pre- or subclimax associations and cannot be considered as climax vegetation.

c) Generally, it can be accepted that soils with impermeable layer formed near the surface favour the development of savanna vegetation, but two important aspects were not noticed by Beard. The mocarrero or hardpan soils are not a necessary condition for the formation of savannas. For example, on the latosols of Oriente highlands we can find numerous ironpan outcrops covered by scrub, shrub forest or semi-dry rainforest vegetation or even closed pine forests and only the anthropogenic effects may turn them into savannas. Guerra (1953) studied original lowland rainforests growing in the Amazons on 10 inch (25.4 cm) deep soil with a 1 m thick laterite hardpan layer underneath. Eiten (1972) studied the effect of laterite ironpans on the vegetation of the cerrado zone and found scrub woodland vegetation on them in 90% of the cases.

d) Beard failed to take into account that cutting and burning of vegetation effectuate radical changes not only in the vegetation but in the soil, too. In fact these operations promote the formation of impermeable layers and their thickening and the erosion and thinning of the permeable layer. Samek (1969), in the course of vegetation mapping in the Isle of Pines, came to the conclusion that a major part of the actual natural-like drainage savanna areas was covered originally by mesophyllous tropical forests which are able to balance the water table fluctuation of dry and wet seasons by their own water utilization, by shading of the soil, reducing the transpiration of the soil, and regulating the trend of soil moisture changes. After destroying the forests the fluctuation of ground water table extremely increases in the wet season due to the insufficient utilization of water surplus and in the dry season on account of the extreme evaporation loss, these movements could considerably accelerate the process of ironpan formation. Soil degradation can be intensified by wind erosion of the unprotected upper soil level that desiccates in the dry season. This process eventually leads to the loss of the permeable soil layer. In this way not only the secondary savannas are anthropogenic but often the habitats of natural-like savannas are also products of anthropic influences.

e) It can be misleading to over-estimate the soil conditions with respect to the nature of savannas as well as the inaccurate interpretation of vegetation and certain life-forms. Many authors call shrub forests and scrub vegetation as savannas just because the patchy herbaceous layer is also present. León's (1946) serpentine savanna, for example, in reality is a scrub or shrubwoodland (Grudzinskaya 1975).

f) It is an unfortunate misbelief of Beard that palms rarely exist together with broad-leaved trees and that the fan palms are mainly typical savanna elements. All of the nearly 100 palm species in Cuba live also in closed forests or shrub vegetation and, in fact, half of the species do not occur in open grasslands (Borhidi *et al.* 1979). Palms are esteemed useful plants that are carefully preserved when forest and scrubs are cut. Most palms tolerate fire well and the early burning used widely in Cuba favours their spread. So, they can easily adapt to grassland conditions. However, this does not mean that savannas can be regarded as natural or original just because of the presence of palms.

15.3.1 Vesey-FitzGerald's grassland classification

Vesey-FitzGerald (1963, 1971), in the course of studying east African grasslands, distinguished three main categories:

1. Natural grasslands are under edaphic or climatic control. They occur prevalently where the drainage or under soil drainage is impeded or seasonal. Swamps, bogs, river valleys, flood plains and other sites in the lower part of the catena are characteristic of their distribution (Vesey-FitzGerald 1970). Seasonally arid flat plains with shallow soils also support natural grasslands. The component species and associations are relatively few and often exhibit a zonal or mosaic form of distribution. The composition and state of natural grasslands may be modified by fire, but fire exclusion will not cause the grassland formation to be replaced by a woody formation.

2. Secondary grasslands are seral. The majority are induced and maintained by fire. In the place where fire is eliminated the course of succession proceeds to a woody sere. A large variety of species occurs, and they tend to have a random distribution. However, in certain circumstances, where a degree of stability is established, a few species may occur as dominants or co-dominants.

3. Derived grasslands are a special type of secondary grasslands. They more or less permanently replace a previously existing type of vegetation as a result of attendant changes occurring in the environment at the time when the original vegetation was replaced. They may conform to the catena, because the original vegetation did so. They may also alternate with relict stands of the preexisting vegetation. Examples are the upland and montane grasslands. Derived grasslands are frequently maintained by grazing if there is an animal community available to occupy them.

15.4 Physiognomic types and genesis of Cuban grasslands

One of the main objectives of our vegetation mapping project was to distinguish between natural and secondary savannas and to theoretically reconstruct the latter. The potential productivity of cultivated lands can only be estimated objectively based on the original climax vegetation. For land use plans it is extremely important to know whether a savanna of 4000 t/km^2 biomass, or a forest of 15 000 t/km^2 should be considered, i.e., the distinction between the actual and the potential is essential. In addition to the "landscape surveys" and the "soil studies" carried out by the mentioned authors cited above, our interest was focused on the exploration of intact forest and shrubwood patches and on a comparative phytosociological and floristic analysis of lignosa communities and savannas.

The bioclimatic map of Cuba (Borhidi 1974, Borhidi and Muñiz 1980, 1984) clearly shows that on the lowlands and hilly regions of Cuba a seasonal tropical climate prevails along the whole island which is considered as savanna climate. Although actually only 8% of the national territory of Cuba is covered by natural forests, most of the authors considered (Bennett and Allison 1928, Seifriz 1943, Marie-Victorin and León 1942, 1944, Carabia 1945, León 1946, Beard 1953, Knapp 1965) that originally 25—50% of Cuba was covered by natural grasslands. But when we mapped the natural vegetation and studied its correlation to the climatic and soil types we found that the country must have been fundamentally a natural forest land and not more than 5—8% of the Cuban territory would have been covered by natural grasslands (Borhidi 1973, 1976, Borhidi and Herrera 1977, Borhidi and Muñiz 1980, 1984).

Almost all the actually existing grasslands of Cuba have developed under a long-term human impact of combined logging/cutting—burning—grazing patterns, (Figs 57—59).



Fig. 57 Recently logged plot of a seasonal evergreen forest stand (in the background) with remaining royal palms

15.4.1 The physiognomic types of Cuban savannas

A classification of the Cuban savannas based on physiognomic criteria was developed by Borhidi and Herrera (1977). The following units of savanna vegetation were distinguished:

A) Tall grasslands with tall palms
   a) Royal palm—cotton tree savannas
   b) Royal palm savannas
   c) *Copernicia* savannas
   d) *Sabal* savannas
B) Short grass savannas
   a) Dwarf palm savannas on serpentine with *Coccothrinax* and low *Copernicia* palms
   b) Savannas with pines and *Colpothrinax* palms
C) Sedge-savannas
   a) Humid savannas with *Sabal* and *Acoelorrhaphe* palms
   b) Seasonally flooded savannas with broad-leaved trees
D) Treeless grasslands

15.4.2 Genesis and savannization processes of Cuban grasslands

The Royal-palm savannas are without exception secondary savannas derived from different forest vegetation types.

Roystonea—Ceiba—Samanea savannas are derivatives of seasonal tropical evergreen forests living on fertile red ferrallitic soils (Fig. 57). All stages of their evolution processes have been studied by us in the Guanahacabibes Peninsula where the forest was cut with bulldozers in 1954—1955 and where the royal palms and cotton trees were left only. Then, the area was burnt several times and grazed. In this way the characteristic *Roystonea–Ceiba* savanna of the Cuban landscape developed in a few years (Figs 58—59). As of 1959, however, after the revolution and the redistribution of lands, burning and grazing stopped on one part of the area and the return of shrubs and forest trees began from the forest edge where every stage of a spontaneous reforestation process from the appearance of the first shrubs to the closure of the shrub layer can be observed, the scattered appearance of pioneer low trees, later their collective penetration, to the formation of forest clumps around the tall left trees could be observed on a 3—5 km wide strip.

Cases of savannization processes were studied in seven different habitats.

a) Royal-palm savannas

In the seasonal evergreen lowland forest belt on fertile deep ferrallitic red soils (Matanzas clay), after having logged the valuable timber trees—as *Swietenia, Cedrela, Hibiscus elatus, Calophyllum*—a *Roystonea–Ceiba* woodland develops which is converted into a *Roystonea–Ceiba* tall grassland by repeated burning and into a pasture by an intensive grazing combined with burning (Fig. 60).



Fig. 58 Royal palm savanna on deep fertile red latosolic soil after cutting, burning and grazing of the area at the foot of the Cubitas range, north of Camagüey (Photo: A. Borhidi)



Fig. 59 Giant *Ceiba* tree a remainder of the original seasonal evergreen lowland forests of Cuba at Perico, Matanzas province. The lower branch indicates the general height of the first canopy (Photo: A. Borhidi)

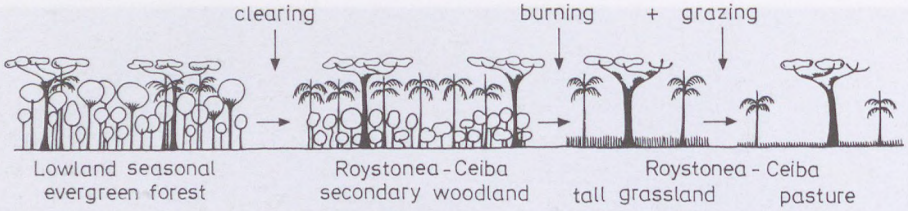


Fig. 60 Scheme of the evolutionary process of the *Roystonea–Ceiba* grassland in Cuba

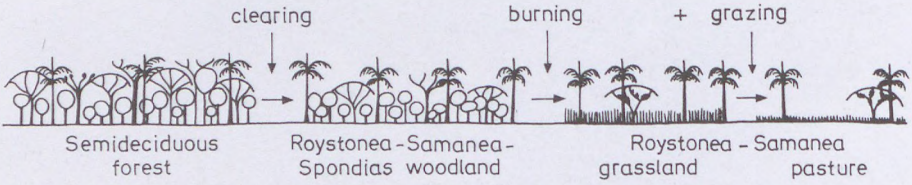


Fig. 61 Scheme of the evolutionary process of the *Roystonea–Samanea* grassland in Cuba

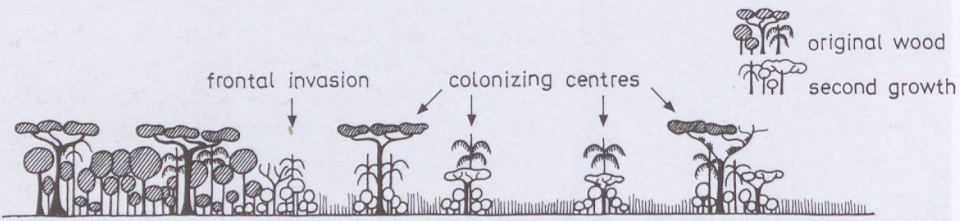


Fig. 62 Redevelopment of a lowland seasonal evergreen forest from tall grass savannas

In the belt of the semi-deciduous forests a similar process went on passing through the stages of a *Roystonea–Samanea–Spondias* woodland and a *Roystonea-Samanea* tall grassland ending in a pasture with scattered *Roystonea* palms (Fig. 61).

Redevelopment patterns of the mentioned forest types were also studied. The process is going on by a frontal invasion of the colonizing species starting from the edge of the still existing forest patches and also by scattered colonizing centres developing around the left palms and trees. In the invasion of the colonizing plants N-fixing shrubs as *Cassia, Myrica, Caesalpinia, Belairia, Behaimia* and *Brya* species, further fast-growing deciduous soft-wood trees, like *Bursera, Zuelania, Casearia, Trema,* in the hilly regions *Muntingia* and *Cecropia* play a dominant role. (Fig. 62)

In the colonizing centres evergreen shrubs and deciduous trees distributed by birds, like Myrtaceae (*Eugenia*), Borraginaceae *(Cordia, Bourreria), Spondias*-species, palms, and by wind-like Compositae shrubs e.g. *Eupatorium* and *Vernonia* species plays an important role. Around the *Ceiba* trees the colonizing process usually starts by settling of royal palms distributed by both birds and mammals.

In the submontane evergreen forest belt savannization process starts with logging of timber trees,—like *Cedrela, Swietenia, Calophyllum, Terminalia, Bumelia, Micropholis, Manilkara, Ocotea* etc.—and a second growth forest develop dominated by fast growing soft woods,—*Cecropia peltata, Roystonea regia, Trichilia hirta, Spondias mombin, Muntingia calabura*—with a loose canopy which permit the abundant growth of tall grasses forming a rather dense herb layer. *Olyra latifolia, Pharus glaber, Pavonia fruticosa, Panicum glutinosum* and other forest weeds are the most common elements of this layer. After repeated burning a *Roystonea* grassland develops which is grazed intensively provoking heavy erosions and local landslides. At last the eroded bare slopes are artificially repopulated with introduced grasses, mostly with guinea grass *(Panicum maximum)* (Fig. 63).

b) Sabal savannas

The savannization process of the swamp forest starts by logging of timber species and fuel woods as Bucida, *Rhizophora* and *Avicennia* and *Tabebuia* species used for charcoal-burning. After logging a *Sabal* palm, swamp woodland develops and by burning and grazing it is converted into a *Sabal* wet grassland and lastly into a wet pasture with scattered *Sabal* palms (Fig. 64).

Hardpan soils or mocarrero soils are largely considered as habitats of natural grasslands. In spite of this we found that the original vegetation of these soil types was a thorny scrub-woodland consisting of endemic palms and trees. This vegetation, without having any economic value, had been very soon converted by burning into *Sabal* palm grasslands, or in eastern Cuba, into *Copernicia* palm grasslands and intensively used for pastures centuries ago. Recently these pastures are invaded by extremely aggressive alien shrubs and colonized within a few years,

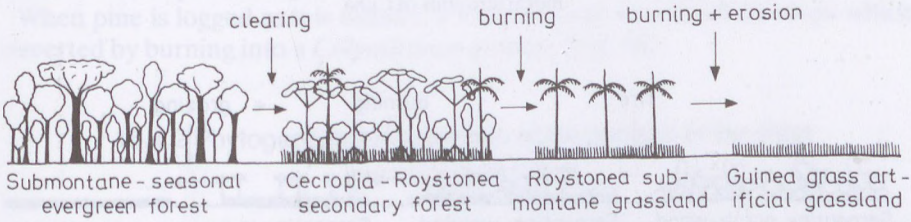


Fig. 63 Scheme of savannization process in the submontane evergreen forest belt in the Sierra del Rosario, on the southern slopes of Loma El Salon.

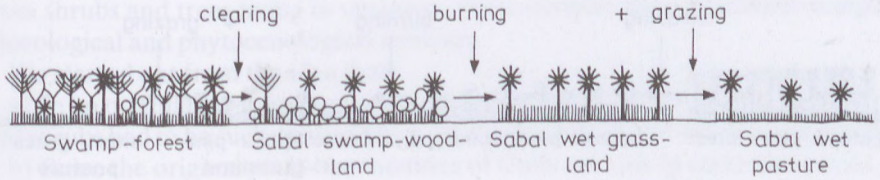


Fig. 64 Scheme of the evolutionary process of the *Sabal* wet savannas from alluvial and swamp forests in Cuba

like the African *Dichrostachys cinerea* introduced for its ornamental flowers some decades ago (Fig. 65).

c) Dwarf palm savannas

Savannas are more obviously expected on dry, nutrient-poor soils, e.g. in the serpentine and white sand areas, where several determinant factors listed above, as long dry period, low nutrient level, eventual fires and occasionally also deficient drainage are simultanously present. In spite of this, the original natural vegetation of these dry, nutrient-poor habitats are different woody plant communities and not grasslands.

In the serpentine areas on deep mature ferritic soils the climax vegetation as a dense pine forest of *Pinus caribaea* in West Cuba and of the *Pinus cubensis* in the east. On shallow or gravelly serpentine soils a very dense, thorny evergreen thicket is the original vegetation, which is transformed by burning and grazing into short grass savannas with scattered dwarf palms of the *Coccothrinax* and *Copernicia* genera (Fig. 66).

The degradation of the pine forests growing in ferritic soils can be seen in Fig. 67, that shows examples derived from the Cajalbana hills and the Nipe Mountains. The

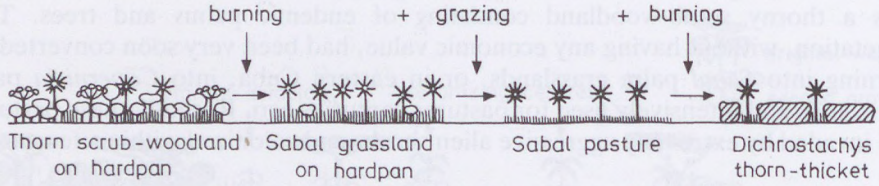


Fig. 65 Scheme of the evolutionary process of the *Sabal* pastures and *Dichrostachys*-thicket on the mocarrero soils of Cuba

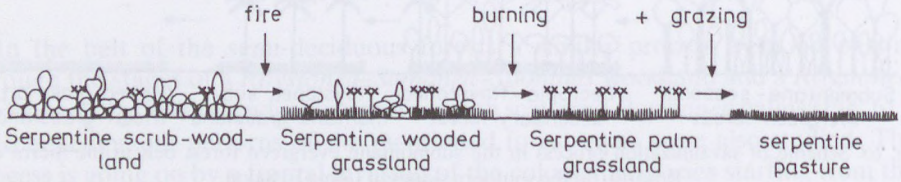


Fig. 66 Scheme of the successional process of the serpentine pastures ("savannas") from serpentine scrub-woodland in Cuba

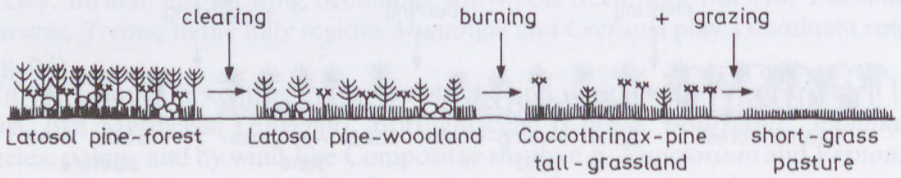


Fig. 67 Scheme of the successional process of the serpentine short grass pastures ("savannas") from the latosol pine woodland in Cuba

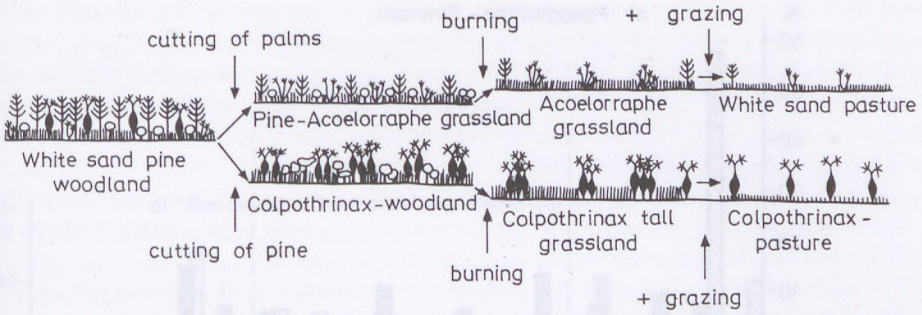


Fig. 68 Scheme of the evolutionary processes of the white sand savannas from pine woodland under different land use and control

originally closed pine forests after a deforestation become at first a woodland vegetation and after burning they turn into a pine *Coccothrinax* wooded grassland and lastly by overgrazing into a short grass pasture.

d) Savannization on white sand

In the white sand areas, in very nutrient poor acid soils the optimum of the vegetation is a pine-woodland with well-developed herb layer and scattered *Colpothrinax* palms of barrel-shaped trunk mixed into the canopy.

When palms are logged, which is uncommon in other communities and with other palms,—but *Colpothrinax* is often exploited for several uses,—a pine-dwarf palm savanna develops first and by burning and grazing, it is converted into an *Acoelorraphe* palm savanna, and at last, into a white sand pasture with scattered pines and dwarf palms (Fig. 68), as it was explained by Samek (1969).

When pine is logged as it is usually, a *Colpothrinax* woodland develops which is converted by burning into a *Colpothrinax* pasture (Fig. 68).

15.4.2 Phytogeographic approach of the genesis of the short grasslands of Cuba

Special attention was devoted to the serpentine savannas with short grasses and dwarf palms and to the pine savannas which the earlier authors all unequivocally regarded as natural savannas. Only Samek (1969) claimed that the pine savannas were the derivates of sandy pine forests. In these communities we used fractionated phytosociological analysis in such a way that the herb layer was sampled separately from shrubs and trees living in savannas; these samples were examined in separate chorological and phytocenological analyses.

We started out from the idea that:

a) In an original savanna vegetation, being a natural formation, the existing trees and shrubs had to be such species which do not occur in closed forests or shrublands.

b) Since the original plant communities of Cuba are rich in endemic species, it is to be expected that the savannas, as far as they are original, should be similarly rich in endemics, especially the serpentine savannas.

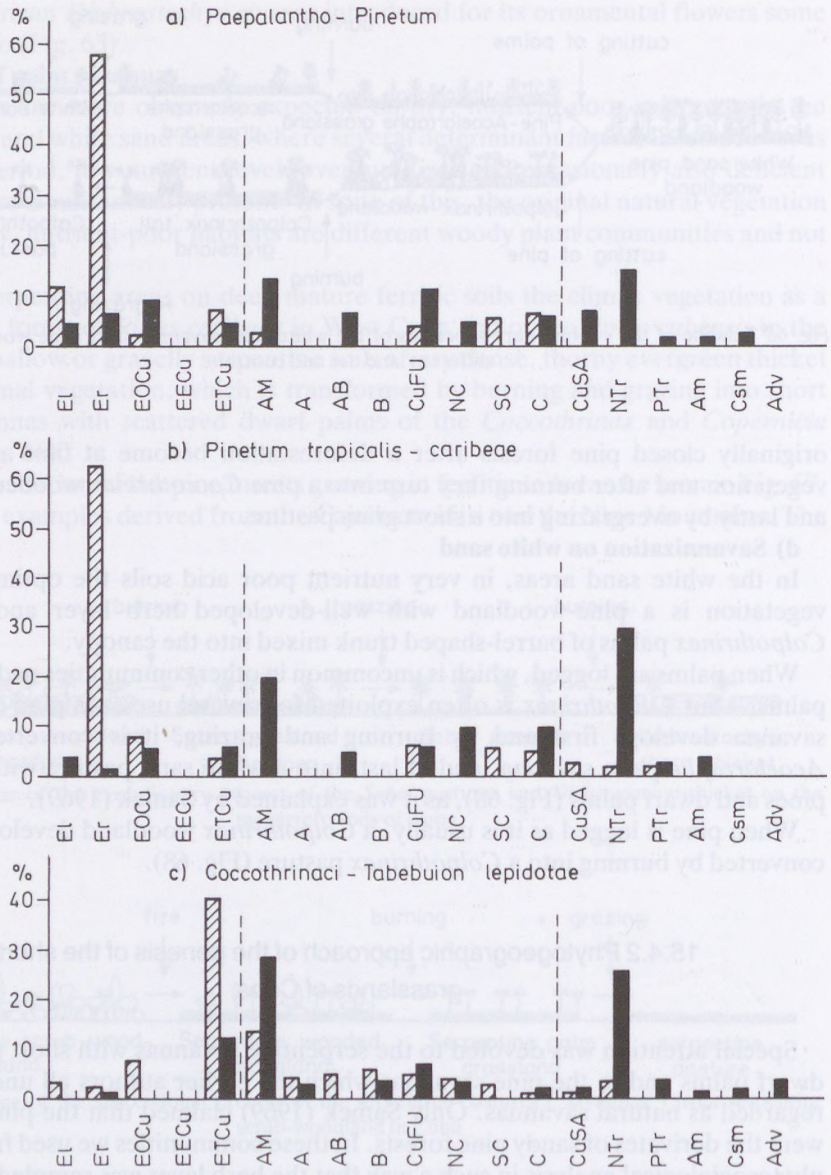
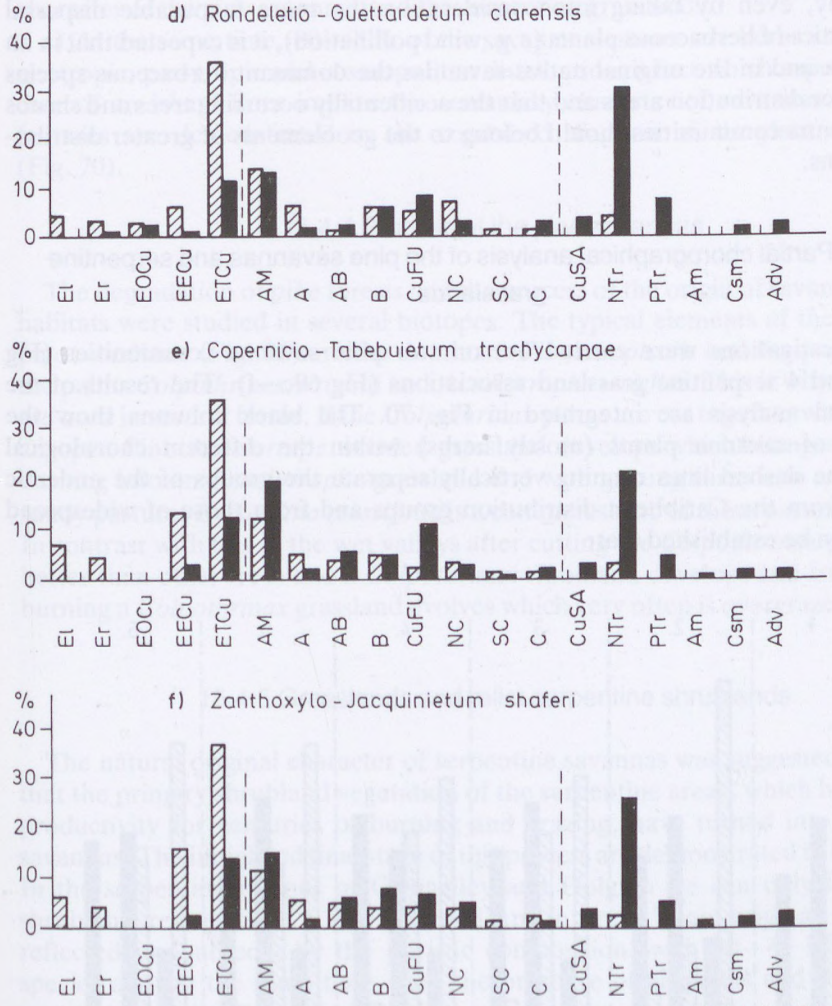


Fig. 69 Participation of the geoelements in two pine-savanna ecotones: a) *Paepalantho–Pinetum* on white sand and b) *Pinetum tropicalis–caribeae* on slate of Isle of Pine in four "serpentine savanna" communities (c) *Coccothrinaci-Tabebuion lepidotae* in Havanna and Mantanzas provinces, d) *Rondeletio–Guettardetum clarensis* in Las Villas Province e) *Copernicio–Tabebuietum trachycarpae* in Camagüey Province and f) *Zanthoxylo–Jacquinietum shaferi* in Oriente Province) based on the relative cover values of species. Lined columns: forest elements, black columns: savanna elements. Abbreviations: El=local endemics, Er=regional endemics, EOCu=West-Cuban endemics, EECu=East-Cuban



endemics, ETCu=Pan-Cuban endemics (occurring in the whole territory of Cuba); AM=species of the Greater Antilles, A=Antillean species, AB=species of the Antilles and the Bahamas, B=species of the Bahamas and Cuba, CuFU=species of Cuba, Florida and the SE States of the USA, NC=North Caribbean species, SC=South Caribbean species, C=Caribbean species, CuSA=species of Cuba and South America, NTr=Neotropical species, PTr=Pantropical species, Am=American species, Csm=cosmopolitan and adventive species

c) Whittaker (1954) demonstrated that in the temperate serpentine forest associations the ratio of endemic hemicryptophytes and phanerophytes is 6:1. If we consider that the tropical flora is richer in woody plants than the flora of the temperate zone, but the savanna predominantly consists of herbs, it is to be expected that in the original savannas the ratio of the endemic herbaceous and woody plants will not be less than 1:1.

d) Finally, even by taking into consideration the more favourable dispersal characteristics of herbaceous plants (e.g. wind pollination), it is expected that in an island flora and in the original native savannas the dominant herbaceous species have smaller distribution areas and that the accidentally occurring trees and shrubs in the savanna communities should belong to the geoelements of greater distribution patterns.

15.4.3 Partial chorographical analysis of the pine savannas and serpentine grasslands

Our investigations were carried out on two pine savanna communities (Fig 69a—b) and 4 serpentine grassland associations (Fig 69c—f). The results of the chorological analysis are integrated in Fig. 70. The black columns show the frequency of savanna plants (mostly herbs) within the different chorological groups. The dashed lines running vertically separate the groups of the endemic elements from the Caribbean distribution groups and from those of widespread areas. It can be established that:

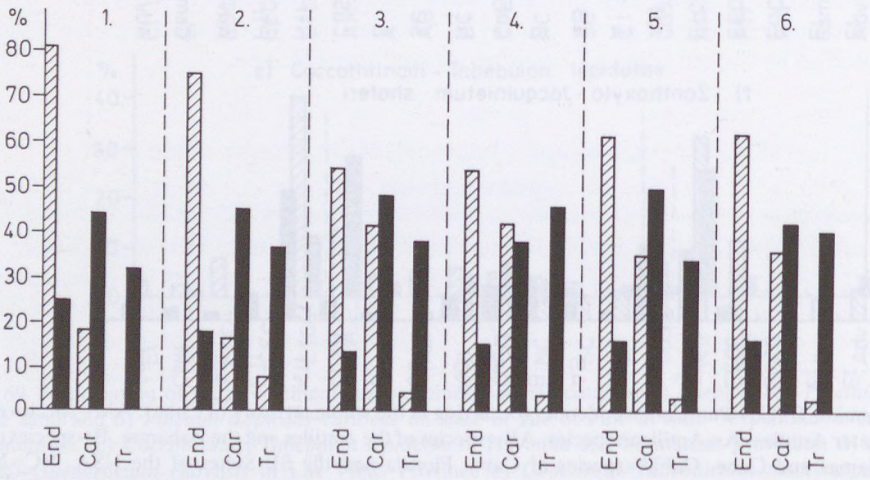


Fig. 70 Integrated diagram showing the participation of the geoelements in different pine woodland and serpentine scrub-savanna communities or ecotones, based on the relative cover values of the forest or scrub species (lined column) and savanna species (black column). 1. *Paepalantho–Pinetum*, 2. *Pinetum tropicalis–caribaeae*, 3. *Coccothrinaci–Tabebuion lepidotae*, 4. *Rondeletio–Guettardetum clarensis*, 5. *Copernicio–Tabebuietum trachycarpae*, 6. *Zanthoxylo–Jacquinietum shaferi*, Abbreviations: End=endemics of Cuba, Car=Caribbean species, Tr=tropical and other widely distributed species

a) The shrubs, palms and trees existing in the savannas have almost without exception a major role in the forest and shrubland communities, that is, they cannot be considered as savanna elements.

b) The overwhelming majority of endemic species living in savanna communities are trees and shrubs which are alien to savannas. Among the endemic species the ratio of herbaceous to woody plants is 1:4 to 1:7 which does not prove the original character of the pine savannas and the serpentine grasslands.

c) At the same time, 80—90% of the savanna elements are herbs and shrubs of neotropic, pan-tropic and cosmopolitan distribution, a fact which especially in the case of an island flora implies the secondary character of savannas. These two features are demonstrated in the combined diagram of six plant associations (Fig. 70).

15.4.4 Process of the pine savannas

The degradation of pine forests and the process of the origin of savannas on their habitats were studied in several biotopes. The typical elements of the white sand pine woodland (Fig. 71) are the dominant *Pinus tropicalis* and the populations of the palms *Colpothrinax wrightii* and *Acoelorraphe wrightii*. This is why their stands are used in several forms. If the *Colpothrinax* palms are cut together with the pines, an open Pine-*Acoelorrape* wooded grassland develops which changes by regular burning into an *Acoelorraphe*-grassland and with grazing turns into a rather poor sandy pasture. *Byrsonima crassifolia* is a common shrub of these pastures (Fig. 72). In contrast with this in the wet valleys after cutting the *Colpothtrinax* palms renew better than other trees and a *Colpothrinax* woodland develops and from this with burning a *Colpothrinax* grassland evolves which very often is overgrazed.

15.4.5 Grasslands and relict serpentine shrublands

The natural original character of serpentine savannas was suggested by the fact that the primary shrubland vegetation of the serpentine areas, which have had low productivity for centuries of burning and grazing, have turned into short grass savannas. The initial and final stage of this process are demonstrated in Figs 73—74. In the serpentine regions of Camagüey and Holguin we can only find original shrubland remnants of a few hundred km in area. Their original character is reflected undoubtedly by the floristic composition, with 30—40 local endemic species and, at the same time, with the presence of all palms and shrubs of the savannas as well as many herb species.

15.4.6 Conclusion and ecological classification of Cuban grasslands

Summarizing our studies on the nature of Cuban savannas we found that on the basis of the origin of grasslands we may allocate them into the following groups:

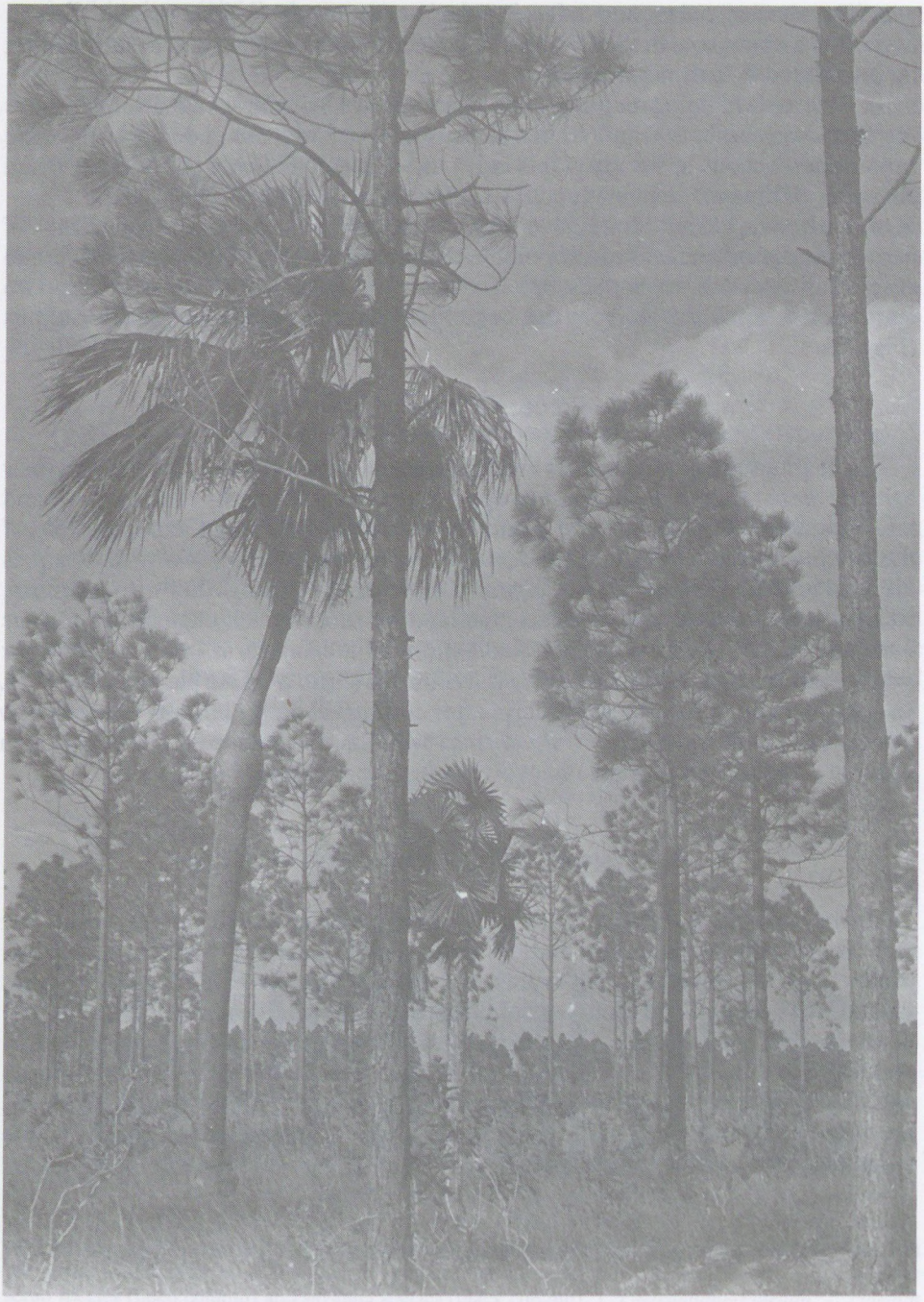


Fig. 71 Pine woodland of *Pinus tropicalis* in the white sand area of the southern lowland of Pinar del Rio Province, near to La Coloma, with young *Colpothrinax* and *Coccothrinax miraguama* ssp. *arenicola* palms (Photo: A. Borhidi)



Fig. 72 Byrsonima crassifolia (L.) HBK., a common shrub of the pine-woodlands and the secondary savannas in West Cuba (Photo: A. Borhidi)

Natural or original grasslands

Fire is a modifying but non-controlling factor (Vesey-FitzGerald 1963a, 1970) which can change the floristic composition but the grassland itself is not induced or maintained by it. The role of fire is mainly manifested in the flora selection and the control of nutrient cycling. It can be attributed to this selective effect that after a longer period of time the florulas and the phytosociological composition of the natural and derived grasslands may become similar and the differences between them may diminish.

a) Climatic grasslands

These develop under rather dry climates (Walter 1962, 1970) with 300—600 mm annual precipitation and 9—10 dry months. These ecological conditions characterize practically the semi-desert shrubland and thorn woodland belt. In contrast with this, the alluvial clays of valleys favour the development of climatic grassland vegetation.



Fig. 73 Remaining original dry evergreen serpentine scrub woodland at Cromo, north-east of Camagüey, with *Copernicia hospita* and many endemic shrubs (Photo: A. Borhidi)



Fig. 74 Secondary, overgrazed serpentine savanna with scattered *Copernicia* and *Coccothrinax* palms at the same place seven years later (Photo: A. Borhidi)

Thus, we consider them as the alternative edaphic climax of the semi-desert belt. Climatic grasslands are less widespread in America, they are mainly common in the semi-desert belt of south and south-western Africa (Walter 1968). In Cuba, they occur in the alluvial valleys of the coastal regions of South-Baracoa in very small areas (Guantanamo, San Antonio del Sur, Imias).

b) Edaphic grasslands

These are identical with Beard's (1953) drainage savannas and Vesey-FitzGerald's (1963a, 1970) edaphic valley grasslands. These savannas are controlled by unfavourable water drainage which in consequence of the seasonal climate creates drastic changes in water management. In Cuba, such areas of valley grasslands can be found in the valleys of the Zaza, Cauto, Yara, and Jatibonico del Sur rivers.

c) Swamp grasslands

They develop in constantly flooded or undrained basins mainly in the vicinity of sea coasts. Thus, in these areas in consequence of the high and low tides fresh and salt waters often mix. Swamp grasslands in Cuba in some areas become extensive (Cienaga de Zapata, Laguna del Leche, coastal area of La Fe and Los Arroyos de Mantua etc.). They are largely used for animal breeding and rice cultivation.

Anthropic, secondary or derived grasslands

It is characteristic for the grasslands that their origin and existence is the result of human activity. The extent of human interference and its intensity may be distinguished at three levels.

a) Semi-anthropic grasslands

It is characteristic of these grasslands that their floristic composition developed from the herbaceous flora of their own habitat or the surrounding natural plant communities. These grasslands were brought about by the less intensive and not regularly repeated human intervention (accidental burning, extensive grazing). In these grasslands the flora matches the habitat but the ecosystem does not correspond to it. They mainly occur in such areas which, although they were not grasslands originally, could potentially be converted easily into savanna even by a single drastic human intervention (Borhidi and Herrera 1977, Borhidi and Muñiz 1980). For their savannization it is sufficient to burn the plants only once or only a few times, depending on the organization level of the vegetation. In the sites of such grassland originally there were dry shrublands, thorny woodlands, pine woodlands, mainly on oligotrophic soils or on hardpans of bad water management on which in consequence of the small biomass and the slow nutrient cycling they have reduced accumulative capacity and regeneration. In Cuba the hardpan areas (mocarrero), the young serpentine belts and sand regions, especially the white sand areas (Fig. 75) possess these ecological characteristics.

b) Anthropic or derived grasslands

These are grasslands on fertile clays of lowlands and submontane belts, collines, as well as alluvial areas flooded for only short periods of time induced and maintained by regularly repeated intensive human intervention (deforestation, burning, grazing). In the case of these grasslands neither the flora nor the ecosystem correspond to the habitat, although in the course of degradation the derived community is in direct successional connection with the flora of the original ecosystem. In Cuba, these are actually the most extensive savannas and the best examples of these are the royal palm and broad-leaved tree savannas.

c) Artificial grasslands

These are intentionally planned and artificially created grasslands that follow the total destruction of the earlier, even anthropic, vegetation. In this case not only the grassland flora and ecosystem are completely alien to the original habitat but there is no continuous successional connection to the previous flora and vegetation. In Cuba, these kinds of grasslands include the artificial monocultural pastures of the Guinea grass, elephant grass, Bermuda grass, *Dichanthium caricosum* and *Digitaria decumbens* etc.

15.4.7 Historical and actual grassland pattern

To understand the anthropic process of savannization we studied the vegetation and examined the historical bibliography and archive materials of economic and land history (Borhidi and Herrera 1977). On the basis of these studies we tried to get approximately precise estimates on the size of grassland areas and their extent at the

Table 16 Savanna types and their distribution in Cuba

	Flora		Ecosystem		Spatial pattern in Cuba cover in % of the national territory		
	Fire as controlling factor	indigenous (+) anthropic (−)	adequate (+) non-adequate (−) to the catena	Successional pattern	in original state	in 1492	in 1976
Natural grasslands	−	+	+	progressive seral	3–5	3–5	⟨1
Semi-anthropic grasslands	±	+	−	regressive seral	⟨2	5–7	7–10
Anthropic or derived grasslands	+	−	−	regressive seral	—	5–10	20–25
Artificial grasslands and cultivated belts	+	−	−	non-seral	—	⟨2	58–60
Total grasslands					3–6	15–22	90–92
Forests					94–97	78–85	8–10



Fig. 75 The hypothetical distribution of the savannas of Cuba in 1492 (after Borhidi and Herrera 1977). Legend: 1. Original wet, periodically flooded tall grasslands; 2. Original marsh and swamp meadows, steadily flooded areas; 3. Easily savannizable ecosystems on nutrient poor soils; 4. Other vegetation types (forests, shrublands)

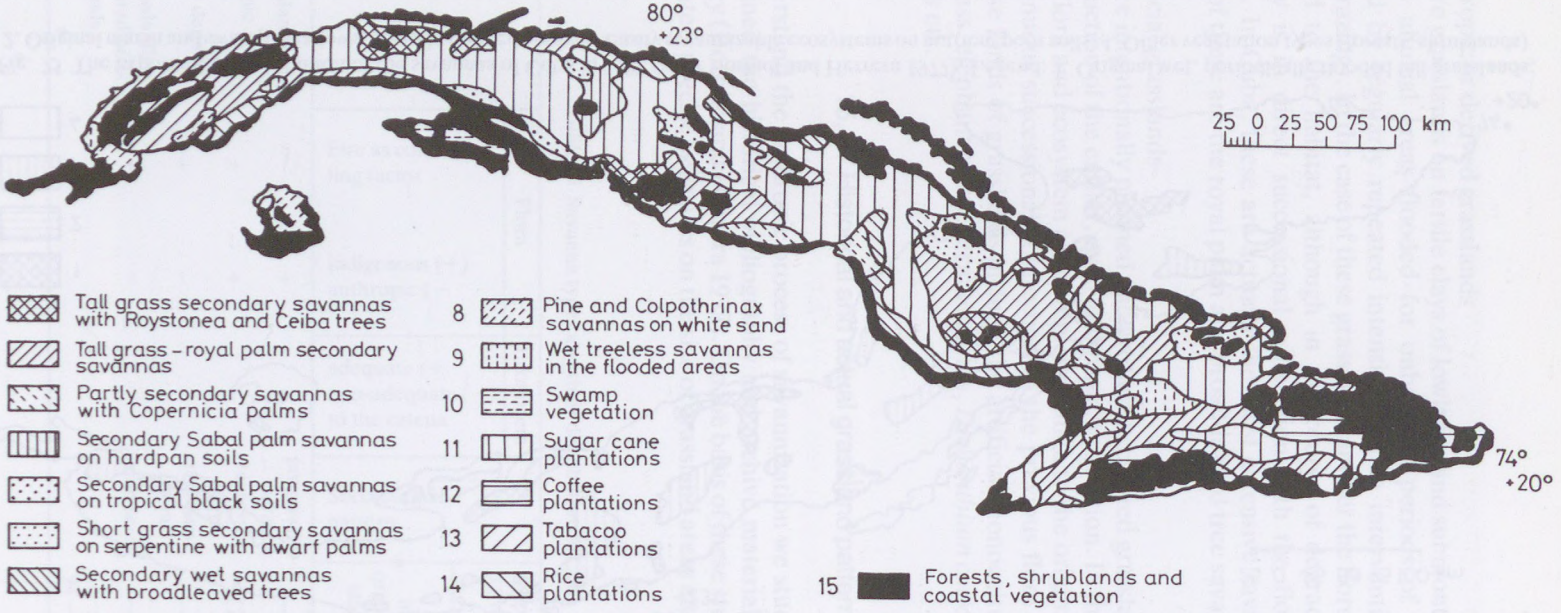


Fig. 76 The actual distribution of the savannas and the important crop fields in Cuba (after Borhidi and Herrera 1977).

time of the discovery of America, and to compare these estimates with the present state values (Table 16). In our estimation, at the time of Columbus' first landing, grasslands covered 15—20% of the whole area of the island. Of these 2—3% were natural grasslands, whereas the semi-anthropic grasslands accounted for 7% and the anthropic and derived grasslands 5—10% (see Fig. 75). Our viewpoint is in agreement with the opinion of Cuban researchers (Acuña, Muñiz) in that 95—97% of Cuba was originally covered by forests. From historical data, however, we may presume that in the pre-Columbian period the Indian cultures had brought about changes which cannot be disregarded. At present 87—90% of Cuba is a forestless land. The natural grasslands make up 1—2%, the semi-anthropic grasslands account for 7—10%, the anthropic savannas 20—25% and cultivated lands 50—60% of these areas (see Fig. 76).

PART III

FUNDAMENTALS OF THE PHYTOGEOGRAPHY OF CUBA

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The phytogeographic conditions of Cuba have not been overviewed or summarized in the literature as yet. Past contributions to this subject, the state of the art of research and future tasks have been mentioned in the Introduction and the long-needed relevant studies by the author and his co-workers are also outlined. In the sequel an attempt will be made to provide a comprehensive view of the subject using earlier results but relying primarily on our original research.

16 Life-forms and the biological spectrum of the flora of Cuba

Existing life-form schemes have been extensively and critically reviewed by Fekete and Szujkó-Lacza (1969—1972) in a paper consisting of four parts. The theoretical and practical problems of life-forms are not discussed here and repetitions will also be avoided so much the more because I share most of the views expressed by the authors referred to above.

16.1 Life-forms as a basis for the physiographic classification of vegetation

Raunkiaer's life-form categories play a role by far the most important in tropical vegetation surveys in both theoretical and practical respects (Richards *et al.* 1940, Richards 1952). Regardless (of the views of different phytosociological schools, the non-tropical plant communities are in fact characterized on the basis of relatively few species that are represented by many individuals. The floristic composition and the spatial and temporal structure of communities are maintained by the populations of characteristic species. In this regard the indicative role of life-forms is in fact indirect and the life-form spectra, as diagnostic tools, may only confirm the existence of the ecological trends recognized.

The situation is completely different in the tropical forest and scrub vegetation. Since the number of species is large and the number of individuals belonging to each species is small, the plant communities are primarily characterized by the spatial

structure. Due to the high floristic heterogeneity, the individuals of the majority of species are scattered within the stands to such an extent that populations cannot be defined in ecological terms. That is, most populations are 'dissolved' in the diverse community. At each stratum of the vegetation there are at least 6—8 species with the same life-form type. Regarding their ecological requirements, the individuals of these species can perfectly replace one another, not only in the visually observed structure of the community but also at the level of nutrient cycles and energy flow and even in the ecological niche space. An additional phenomenon is that similar vegetation types are completely different in species composition due to the presence of numerous endemic taxa and to the peculiarities in the evolution of the flora of different localities. In the tropical vegetation it is primarily the structure which repeatedly occurs as a consequence of ecological effects and sequences of habitats. The structure is determined by strata composed of similar life-form types and also by synusia composed of a single life-form type. Consequently, in the recognition and classification of tropical lignosa communities the mostly accidental and heterogeneous floristic composition is inevitably replaced by life-form spectra that are more stable in information content and diagnostic value. Thus, the indicator role of life-forms is of fundamental importance in any tropical vegetation survey no matter if that is a straight ecological study or a vegetation mapping.

16.2 Concerning the application of life-form categories

For the physiographic characterization of tropical vegetation types different improved versions of Raunkiaer's (1907) scheme have been used (e.g. Dansereau 1951, 1958, 1966, Cain and Castro 1959 etc.). The most detailed life-form classification is developed by Ellenberg and Mueller-Dombois (1967).

In analyzing the flora and vegetation types of Cuba we shall try to reach an ecological optimum regarding the information conveyed by the various life-forms. This is done according to the following considerations:

1. Any life-form exhibiting a significant indicator value of a given ecological pattern is treated as a separate category.

2. Furthermore, an effort is made to avoid the use of too few or too many categories. Therefore, certain morphologically or ontogenetically different groups that proved to be of no ecological distinctive value are combined.

16.3 A modified life-form scheme

The generally used life-form schemes are modified as follows:

a) It is necessary to distinguish between tree ferns and other pachycaul trees. They are treated as separate life-form categories because tree ferns are different from both palms and pachycaul trees of the deserts and high mountains with respect to their ecological requirements and behaviour, and also in their role played within the communities.

b) Despite their pachycaulic character, the agaves are not assigned to the groups of rosulate phanerophytes, but rather to the succulent phanerophytes. The rationale is that they usually occur in similar vegetation types replacing one another depending on the characteristics of parent rocks and soil. This is a typical example of pseudovicariancy.

c) No distinction is made among the pachycaul elements (Corner 1964) for several reasons. One reason is that there are no reliable data concerning the early stages in the ontogenesis of several Cuban species and it is therefore difficult to decide if they are pachycauls. Furthermore, the group of known pachycaul forms appears to be ecologically heterogeneous. Consequently, it should have been divided into several groups in accordance with the ecological concept described above.

d) The grass-like lianes are removed from the group of tree-sized herbs (cf. Ellenberg and Mueller-Dombois 1967) and assigned to the woody lianes.

e) There is no doubt that the category of hemi-epiphytes is heterogeneous if the morphology and their role in the community are considered. The liane-like climbing species which, in my opinion, should preferably be termed the hemi-lianes, are assigned to the lianes. On the contrary, the true epiphytic stranglers (*Ficus, Clusia* species) are considered to have potentially alternating life-forms. Most of them may survive as an independent phanerophyte. Therefore, although this difference is occasionally indicated (actually in the phytosociological tables), it is ignored in the analysis of flora as being an uncommon feature. Thus, potential stranglers are assigned to the respective group of phanerophytes.

f) Three important ecological groups of epiphytes are distinguished:

1. Woody epiphytes (semi-parasites and myrmecophilous plants).
2. Shade tolerant (sciophilous), mainly obligate epiphytes (e.g., certain species of *Lycopodium sensu lato, Hymenophyllaceae,* moss-inhabiting orchids with creeping stalks and roots, broad-leaved hygrophilous bromelias).
3. Heliophilous, usually potential epiphytes, rosette ferns, orchids, narrow-leaved bromelias, epiphytic cacti).

16.3.1 Máthé's method for determining life-form spectra

The life-form spectrum was obtained based on Máthé's (1942) original method, used for the first time in tropical surveys. Not only the frequency of life-forms but their relationship to each area type was also examined. In this manner I was allowed to draw conclusions regarding the history and migration of the flora elements.

16.4 The life-form spectrum of the spermatophytes of Cuba

The life-form spectrum for the higher plants (including only Spermatophytes) of Cuba is given in Tables 17. The percentage distribution and the phytogeographic and phytosociological importance of life-form types are illustrated below with examples. 6375 species and subspecies are included in the analysis.

Table 17 The life-form

Flora elements	Mg— MsP	Mc— MsP	McP	N— McP	NP	Ms P_{ros}	Mc P_{ros}	LP	EP
Group of endemic species									
Pinar del Rió endemics	2.0	4.7	15.8	1.5	28.7	2.9	0.9	1.7	1.5
Isla de Pinos endemics	1.8	3.6	7.1	—	10.7	—	1.8	3.6	—
Endemics to both Pinar del Rió and Isla de Pinos	3.0	1.0	13.4	3.0	11.3	1.0	1.0	—	—
Species endemic to western Cuba	2.8	5.0	13.9	6.1	21.1	4.4	1.1	0.6	—
Habana endemics	—	3.1	21.8	3.1	34.4	—	3.1	—	—
Matanzas endemics	—	4.2	12.5	4.2	16.6	4.2	8.3	—	8.3
Las Villas endemics	3.6	6.4	19.3	1.4	25.7	2.9	3.6	1.4	0.7
Camagüey endemics	3.2	—	12.9	6.5	35.5	—	9.7	—	—
Species endemic to eastern Cuba	6.2	3.8	13.8	6.9	33.2	4.6	3.1	3.8	1.5
Oriente endemics	4.6	6.7	21.2	4.0	34.3	2.2	1.5	2.9	0.5
Pan-Cuban endemics	6.2	7.8	15.9	3.8	20.8	1.7	1.1	1.6	1.4
Total endemics	4.2	5.9	18.4	3.8	30.9	2.3	2.0	2.6	0.8
Group of Caribbean species									
Greater Antillean species	19.9	8.9	13.0	2.6	12.6	0.4	0.4	4.7	3.0
Antillean species	10.5	13.7	8.6	4.6	10.5	0.6	0.6	2.0	2.0
Antillean — Bahamean species	2.7	6.7	9.3	14.7	9.3	1.3	1.3	9.3	2.7
Bahamean species	7.1	15.7	10.0	—	25.8	—	—	1.4	1.4
Species of the Antilles, Florida and SE USA	5.7	9.1	2.3	1.1	2.3	1.1	—	2.3	—
Species of Cuba the Bahamas and SE USA	—	14.6	12.2	3.7	7.3	—	1.2	—	1.2
Species of Cuba, Florida and SE USA	1.9	—	1.9	0.9	3.8	—	—	0.9	—
Northern Caribbean species	7.8	3.0	5.4	4.6	10.8	0.8	2.3	3.8	—
Southern Caribbean species	9.5	4.7	5.7	2.8	8.5	—	—	2.8	0.9
Pan-Caribbean species	7.6	11.2	9.5	2.6	8.2	—	0.8	3.9	—
Total Caribbean species	7.6	8.9	9.1	3.3	10.2	0.4	0.7	3.6	1.4
Tropical species with wider distribution									
Species of Cuba, the Antilles and South America	4.7	3.5	4.7	2.4	7.0	—	—	9.4	—
Species of Cuba, and South America	—	3.1	3.1	3.1	9.2	—	—	7.7	—
Neotropical species	4.7	5.1	4.1	2.0	6.5	0.4	—	5.4	0.8
Pan-tropical species	0.9	4.1	2.7	2.3	7.7	—	—	1.8	—
Total of widely distributed tropical species	3.6	4.6	3.8	2.1	7.0	0.3	—	5.1	0.6
Total of all tropical species	5.1	6.6	13.0	3.3	19.5	1.4	1.2	3.4	0.9
Group of extratropical species									
North and Central American species	2.4	—	—	—	—	—	—	—	—
American species	—	—	—	—	2.2	—	—	—	—
Cosmopolitan species	—	—	—	—	—	—	—	—	—
Amphiatlantic and circumpolar species	—	—	—	—	—	—	—	—	—
Total extratropical species	0.8	—	—	—	0.8	—	—	—	—
Group of adventive species									
Neotropical adventives	16.8	2.7	8.8	5.3	6.2	0.9	—	3.5	—
Palaeotropical adventives	17.1	4.4	3.8	—	9.3	1.1	—	5.5	—
Extratropical adventives	—	—	—	3.7	—	—	—	2.5	—
Total adventives	13.4	2.9	4.5	2.4	6.4	0.8	—	4.2	—
Total Cuban flora	5.5	6.2	12.2	3.2	18.3	1.3	1.2	3.4	0.8
Original flora of Cuba without adventives	5.0	6.4	12.7	3.2	19.2	1.3	1.2	3.3	0.9

spectrum of the flora of Cuba

SP	P_{Gr}	P	Ch	H	G	HH	Th	TH–H	L_H	E_H	E_{Ch}	S_{ch}	Ch–E
1.5	—	60.0	6.1	16.3	1.2	3.5	3.5	0.9	7.0	6.9	0.6	—	40.0
—	—	28.6	7.1	49.9	3.6	1.8	3.6	—	3.6	1.8	—	—	71.4
—	—	33.7	12.2	36.9	2.0	6.1	6.1	1.0	2.0	—	—	—	66.3
1.7	—	56.7	2.8	21.6	3.7	4.4	1.1	1.1	7.8	0.6	—	—	43.3
6.3	—	71.8	6.3	6.3	—	—	3.1	3.1	9.4	—	—	—	28.1
4.2	—	62.5	4.2	24.9	4.2	—	—	—	—	4.2	—	—	37.5
2.1	—	67.1	3.6	17.2	4.3	—	5.0	0.7	1.4	—	0.7	—	32.9
3.2	—	71.0	16.1	—	—	—	9.7	3.2	—	—	—	—	29.0
3.1	—	80.0	3.8	13.2	—	—	0.8	—	2.3	—	—	—	20.0
0.8	—	78.7	4.0	7.8	1.4	0.1	0.7	0.2	3.1	3.6	0.3	0.1	21.3
1.1	—	64.4	2.4	13.5	2.7	0.9	3.0	0.5	8.6	3.0	—	—	35.6
1.2	—	71.9	4.4	12.3	1.8	1.2	1.9	0.5	4.4	2.6	0.2	0.03	28.1
1.4	0.2	57.0	4.1	16.8	3.2	1.0	3.2	0.6	5.5	6.4	2.2	—	43.0
1.3	0.6	55.0	1.3	20.3	3.9	2.0	3.9	0.6	5.9	7.2	—	—	45.0
1.3	—	58.6	2.7	13.4	2.7	4.0	5.3	—	8.0	5.3	—	—	41.4
1.4	—	62.8	1.4	14.3	1.4	1.4	2.9	—	8.7	5.7	—	1.4	37.2
—	—	23.9	2.3	44.2	9.1	8.0	3.4	3.4	3.4	2.3	—	—	76.1
—	—	40.2	2.4	20.7	9.8	4.9	9.8	1.2	11.0	—	—	—	59.8
0.9	0.9	11.2	1.9	56.0	2.9	15.8	6.5	1.9	1.9	1.9	—	—	88.8
1.5	—	40.0	6.9	26.2	1.5	4.6	10.0	2.3	4.6	0.8	2.3	0.8	60.0
1.9	—	36.8	2.8	17.0	4.7	1.9	4.7	—	10.4	15.1	6.6	—	63.2
1.0	0.3	45.1	3.9	22.1	3.6	0.3	7.2	1.6	3.6	7.7	4.6	0.3	54.9
1.2	0.2	46.6	3.5	22.8	3.8	3.0	5.3	1.1	5.6	5.9	2.2	0.2	53.4
—	2.4	34.1	4.7	30.7	9.4	9.4	3.5	—	3.5	4.7	—	—	65.9
—	—	26.2	6.1	32.3	7.7	7.7	6.1	—	6.2	4.6	3.1	—	73.8
0.3	0.8	30.1	3.0	32.9	2.0	7.1	11.0	1.4	6.5	4.2	1.8	—	69.9
—	0.4	19.9	1.4	32.2	4.1	5.4	20.8	1.8	14.0	0.4	—	—	80.1
0.2	0.8	28.1	3.0	32.5	3.3	7.0	12.1	1.3	7.8	3.5	1.4	—	71.9
1.0	0.2	55.3	3.9	19.5	2.7	2.8	4.8	0.8	5.4	3.7	1.0	0.1	44.7
—	—	2.4	—	46.4	—	34.2	14.6	2.4	—	—	—	—	97.6
—	—	2.2	2.2	50.0	4.3	21.8	15.2	4.3	—	—	—	—	97.8
—	—	—	6.9	27.6	—	37.9	20.7	6.9	—	—	—	—	100.0
—	—	—	—	100.0	—	—	—	—	—	—	—	—	100.0
—	—	1.6	2.5	45.5	1.7	28.9	15.7	4.1	—	—	—	—	98.
7.1	0.9	52.2	1.8	15.0	5.3	1.8	15.2	1.8	8.0	—	0.9	—	47.8
0.5	4.4	46.1	1.1	24.9	2.7	1.1	14.3	1.1	8.2	0.5	—	—	53.9
—	—	6.2	3.7	28.4	3.7	1.2	45.7	11.1	—	—	—	—	93.8
2.4	2.4	39.4	1.9	22.6	3.7	1.3	20.6	3.5	6.4	0.3	0.3	—	60.6
1.1	0.4	53.3	3.7	20.3	2.7	3.2	6.0	1.0	5.4	3.4	0.9	0.1	46.7
1.0	0.2	54.2	3.8	20.0	2.7	3.4	5.0	0.9	5.3	3.6	1.0	0.1	45.8

These are plants with woody stalk or trunk and tree-sized herbs. 3493 species in Cuba (53.3% of the total flora).

Megaphanerophytes (MgP) Giant trees over 30 m. Two species in the Cuban flora (0.0003%): the pantropical *Ceiba pentandra* and the Neotropical *Carapa guianensis,* both characteristic of rainforests. *Ceiba* is an element of seasonal evergreen forests and semi-deciduous forests of lowlands. Under extremely favourable conditions some individuals of mesophanerophytes, such as *Hildegaardia cubensis, Guarea guara, Dipholis jubilla, Cupania americana, Cedrela mexicana* and *Spondias mombin* may also reach the height of giant trees in Cuba.

Mesophanerophytes (MsP) Trees of 15—30 m height. Their number in Cuba is 360 accounting for 5.5% of the total flora. These trees compose the second canopy level in submontane rainforests and the upper canopy level in seasonal evergreen forests, montane forests and semi-deciduous forests. Most of them (147) are endemics. The mountainous regions of Oriente are the richest in endemic species (91). The distribution of other species is Greater Antillean (50), Neotropical (33) and Caribbean (23). The number of introduced and successfully established species is also large (50), most of them (31 species) being timber or ornamental trees of paleotropical origin. Besides those listed in the previous paragraph it is worth mentioning the following species: *Mastichodendron foetidissimum, Swietenia mahagoni, Calophyllum antillanum, C. utile, Bursera simaruba, Pseudolmedia spuria, Matayba oppositifolia, Zizyphus rhodoxylon, Magnolia cubensis, Myrsine coriacea, Laplacea angustifolia, Sloanea curatellifolia,* and several species of *Hyeronima, Ocotea, Cinnamomum* and *Cordia.*

Micro-Mesophanerophytes (Mc-MsP) Small or medium-sized trees of 8—15 m height 381 species in Cuba represent 6.2% of the flora. The third level of submontane rainforests, the second canopy level of seasonal evergreen and deciduous forests, and the upper tree layer of dry evergreen forests and montane rainforests are composed of these species. Examples are: *Tabernaemontana amblyocarpa,* (Fig. 77.) *Celtis trinervia, Hebestigma cubense, Ehretia tinifolia, Chrysophyllum oliviforme, Oxandra lanceolata, Guajacum sanctum, Acacia, Erythroxylum* and *Pithecellobium* species and many representatives of genera *Persea, Pera,* and *Tabebuia.*

Microphanerophytes (McP) Small trees of height ranging from 5 to 10 m. 798 species, accounting for 12.2% of the flora. These species occur in dry evergreen forests, karstic woods, shrublands on serpentine and ferritic soils, semi-dry montane forests and mossy forests. 72% of them (593) are endemic to Cuba, 45% (346) to the former province of Oriente, 59 species to the entire country and 58 to Pinar del Rio. 65 species are Greater Antillean, 29 species each are Neotropical and Caribbean. For example, many species belonging to the genera of families Myrtaceae and Melastomataceae, such as *Eugenia, Calyptranthes* and *Psidium.* Also, many species of *Bourreria, Psychotria, Guettarda, Rondeletia* and *Tabebuia,* and *Ateramnus lucidus, Polygala cuneata* and *Guajacum officinale,* etc.

Micro-nanophanerophyta (N-McP) Woody plants of 2—5 m height. Both shrub and tree-sized individuals may occur. Their number is 194 (3.2% of the flora).



Fig. 77 Tabernaemontana amblyocarpa Urb. a Pan-Cuban endemic tree, characteristic of the semi-deciduous and seasonal evergreen forests (Photo: A. Borhidi)

These are the plants of evergreen shrublands, other scrub formations and semi-deserts. The majority of species belonging to this life-form are endemics, most of them (62) endemic to Oriente, 14 to the entire country and 11 to western Cuba. Examples are *Byrsonima crassifolia, Kodalyodendron cubense, Schaferocharis multiflora, Ouratea illicifolia, Maytenus buxifolia* and *Rondeletia odorata.*

Nanophanerophytes (NP) Shrubs between 0.5 and 2 m. 1249 species accounting for 18.3% of the flora. This life-form is the richest in species in Cuba. They are particularly widespread in woods, shrublands, scrub formations, semi-deserts, karstic woods and montane thickets. 76% of them are endemics, especially in Oriente (611), in Pinar del Rio (103) and in the entire country (78). There are 64 Greater Antillean and 46 Neotropical species. Most of them belong to the genera *Buxus, Ilex, Eupatorium, Vernonia, Lyonia, Ossaea, Gochnatia, Eugenia, Phyllanthus, Croton,* etc.

Rosulate mesophanerophytes (MsPros) Tall, rosulate trees between 8 and 30 m 81 species (1.3%). They are most abundant in different hygrophilous and mesophilous forests, semi-deciduous and karstic forests. 85% of them (69 species) are endemics, 40% (30 species) exclusively in Oriente. Only 6 species are present in the other regions of the Antilles, 3 are Neotropical. Typical representatives are *Roystonea regia* and *Prestoea montana* with pinnate leaves, *Gaussia princeps* and *Gastrococos crispa* with barrel-like trunks. Examples of fan palms are *Sabal parviflora, Thrinax radiata, Copernicia gigas, C. baileyana, C. vespertilionum, C.*



Fig. 78 The tree-fern-shaped Rutaceae: *Spathelia brittonii* P. Wils. an endemic of the conical karsts of West Cuba. (Photo: A. Borhidi)

fallaensis, Coccothrinax yuraguana, C. munizii and *C. allexandri,* as well as *Colpothrinax wrightii* with barrel-like trunks, etc. Dicotyledonous trees are several species of *Ficus* and *Zanthoxylum, Didymopanax morototoni,* the endemic *Megalopanax rex* and *Dendropanax cuneifolius.* Also, *Spathelia brittoni,* (Fig. 78) an endemic of mogotes and *Bombacopsis cubensis* with bottle-shaped trunks.

Rosulate microphanerophytes (McPros) Small, rosulate trees between 1 and 8 m in height. Their number is 75, 1% of the flora. Some representatives of this group, the so-called small or dwarf 'savanna palms', are actually found in sclerophyllous shrublands and scrub vegetation and karstic woods. 65 (83%) of them are endemics. In particular, Oriente (28), Las Villas (6) and eastern Cuba (9) are rich in endemic small palms. The 1—2 m tall dwarf palms growing on serpentine in Camagüey are notable (4 species). A further 5 species are in common in the Antilles, another 5 in the Caribbean region. Dicotyledonous trees are the species of *Comocladia, Plumeria* and *Spathelia,* and the Neotropical *Carica papaya.* Of the monocotyledonous species the relict *Dracaena cubensis, Yucca aloifolia* and fan palms, e.g., *Copernicia cowellii, C. curtissii, C. macroglossa, C. yarey, Coccothrinax miraguama, C. pseudorigida, C. hiorami, C. garciana,* etc., belong to this category. An ancient gymnospermous relict, *Microcycas calocoma* is also to be included here.

Woody epiphytes (EP) Plants with ligneous stalks living on trees. 53 species (0.8%). A common life-form in hygrophilous forests, particularly montane rainforests. Only 23 species (44%) are endemic. The number of Caribbean species is 23, most of them being Greater Antillean (15). Eight species are endemic to Oriente, six are Neotropical. The majority of these parasitic or semi-parasitic plants belong to the family Loranthaceae *(Dendropemon, Dendrophthora, Phoradendron). Hillia parasitica* and *Psychotria nutans* from the Rubiaceae are also to be mentioned.

Woody lianes (LP) their number is 209, 3.4% of the flora. These are present especially in semi-deciduous forests with relatively open canopy layer, karstic woods and evergreen shrub woods and also in montane rainforests. Only 80 species (38% of this category) are endemic, most of them in the highlands of Oriente (46). The distribution of many species is Neotropical (38), Greater Antillean (24) and Caribbean (12). Usually entire genera, such as the endemic *Lescaillea, Platygyne, Feddea* and *Harnackia,* and also *Serjania, Cissus, Bauhinia, Marcgravia* and *Triopteris* belong to this life-form category. Spiniferous lianes are *Caesalpinia bonduc* and *C. crista,* and succulent cacti, as *Hylocereus undatus* and *Selenicereus grandiflorus.* The graminoid lianes of montane rainforests and mossy forests (e.g., *Chusquea abietifolia*) may be also included.

Succulent phanerophytes (SP) Plants with succulent trunks and height up to 15 m 68 species (1.1%). These species are found in the shrub vegetation of semi-deserts, and in a lower number in scrubs, shrub woods, deciduous and semi-deciduous forest communities. 55% of them are endemic (38 species), most of those in Oriente (13). Many introduced Neotropical species (8). Seven species are Greater Antillean. Several cacti belong to this group that are either arborescent, such as *Dendrocereus nudiflorus* and *Consolea macracantha,* or columnar, for example, *Ritterocereus, Pilosocereus* and *Harrisia,* etc. The *Agave* species may also be assigned to this category.

Arborescent forbs and grasses (GrP) Mostly tall species of grasses and bananas. Their number is only 22, 0.4% of the flora. Most of them are introduced from the Old World and established, e.g., *Bambusa vulgaris*. Further representatives of this life-form group are the Neotropical species of swamps (6), e.g., *Gynerium sagittatum*. *Heliconia caribaea,* a relative to bananas characteristic of submontane rainforests, is also noted.

16.4.2 The pachycauly in Cuba

Despite the problems discussed earlier in *16.2/c,* the role of pachycaul elements (Corner 1964) will be dealt with. Corner showed that these are archaic elements in the development of flora, having a potentially significant role in the ancient floras of tropical islands, and also in the isolated tropical highlands, as pointed out by Mabberley (1975a, b) and Pócs (1976a, b) as well. In Cuba, pachycauls are found especially among small trees and shrubs, particularly in genera *Senecio, Gesneria, Rhytidophyllum, Tabebuia, Plumeria* and *Coccoloba.* The number of pachycaul elements recognized so far in Cuba is 327 (5.3% of the flora), including trunk succulents. 79% (259 species) of them are endemics. This group is represented in Cuba partly by very old relict elements *(Microcycas, Dracaena cubensis),* partly by species of highly specialized but still very adaptable genera at the highest evolutionary level (*Tabebuia, Gesneria).* The percentage distribution of pachycauls in the chorological categories is shown in Table 18.

Table 18 Percentage distribution of pachycauls in the distribution categories

Endemic species	No. of species	%
Pinar del Rio	26	8.0
Pinar del Rio + Isla de Pinos	4	1.2
Western Cuba	34	10.4
Las Villas	17	5.2
Eastern Cuba	22	6.7
Oriente	134	41.0
Cuba	22	6.7
Total:	259	79.2
Non-endemic species		
Greater Antillean	18	5.5
Antillean	7	2.1
Cuban – Bahamean	3	0.9
Antillean – Bahamean	4	1.2
Northern Caribbean	9	2.8
Southern Caribbean	3	0.9
Caribbean	5	1.5
Neotropical	7	2.1
Adventive	12	3.8
Total:	68	20.8

16.4.3 Non-woody plants

The different types of subshrubs and herbs are represented by 2882 species accounting for 46.7% of the flora.

Chamaephytes (Ch) Subshrubs. 230 species (3.7%). Plants present particularly in pine forests, montane and elfin thickets, rocky forests and serpentine shrublands. 57% (132) species are endemic, most of them to Oriente (61) and to the pine forest belts of Pinar del Rio and Isla de Pinos (36). Many species are Neotropical (21) and Greater Antillean (22). Several species of *Gesneria, Vernonia, Hypericum* and *Phyllanthus,* and *Phania cajalbanica, Croton nummulariifolius* and *Evolvulus arbuscula* belong to this group.

Hemicryptophytes (H) Perennial herbs with buds at the soil surface, 1251 species, 20.3% of the flora. Very common life-form, mainly in pine forests and woodlands, xerophilous forests, swampy and boggy meadows, natural and secondary savannas. Only 30.5% (389 species) are endemic, mostly in the coniferous zone of Oriente (130), Pinar del Rio and Isla de Pinos (123). Other common flora elements are: Neotropical (233), Greater Antillean and Antillean (116) and the species of the steppe zone of the southern United States (116). The number of introduced species of various origin (85) and that of the extratropical species (55) are also relatively high. The families Graminea and Cyperaceae are to be mentioned with the largest genera being *Aristida, Andropogon, Paspalum, Panicum, Cyperus* and *Rhynchospora.* Of the dicotyledonous plants the endemic *Heptanthus* and the species of *Stenandrium, Justicia* and *Hyptis* belong to this group.

Geophytes (G) Perennial plants with buds that are buried in the soil during the dormant period. 168 species (2.7%). Their role in vegetation is negligible, they occur mainly in the herb layer of rainforests. Only 32% of them are endemic, especially to Oriente (20) and to the entire country (10). The number of Neotropical species (27), including 13 species with disjunct geographical distribution, and of the Greater Antillean-Antillean (22), Caribbean (18) and Pan-tropical (9) species is surprisingly large. Most of the geophytes are terrestrial orchids or belong to the family Amaryllidaceae, for example, species of *Crinum, Hymenocallis, Habenaria, Spiranthes, Ponthieva* and *Corymborchis, Phaius tankervillae,* etc.

Helo-hydatophytes (HH) Water and swamp perennials with reproductive organs either below the water surface or in the mud, 199 species (3.2% of the flora). The percentage of endemics is just 18% (35 species), many of them (27) endemic to western Cuba. Most species of this category are Neotropical (50), extratropical American (42), Pan-tropical (12), cosmopolitan (11) or originated from the southern United States (28). These are floating freshwater weeds (*Eichhornia azurea, Utricularia,* sp.), submerged rooted pondweeds (*Potamogeton* sp. *Vallisneria neotropicalis*). Others have emerged leaves *(Nymphaea ampla, Nelumbo lutea, Nymphoides grayanum). Thalassia testudinium* is a submerged saltwater weed.

Therophytes (Th) Annuals. 370 species (6.0%). These are characteristic of sandy beaches, dry, loose soils and degraded habitats. The geographic distribution of numerous therophytes is Neotropical (78). Many introduced (78), Pan-tropical (46), Caribbean (40) and Greater Antillean (16) species. The proportion of

endemics is just 15% (56), most of those from the coniferous forests in western Cuba (20). Many species of *Eragrostis, Paspalum, Pilea, Mollugo, Chamaesyce* and *Polygala* and many *Compositae* sp. have this life-form.

Hemi-Therophytes (TH-H) Species exhibiting both biennal and perennial life-form represent an intermediate category. The life-form of an actual individual is determined by edaphic conditions and the intensity of anthropogenic effects. A total of 64 species (1% of the flora) show such a feature. Many of them are introduced (13), Neotropical (10) and Caribbean (8). The number of endemics is relatively low (14), accounting for 22% of this life-form class. Some characteristic examples are *Ageratum maritimum, Gnaphalium attenuatum, Epaltes mattfeldii, Pectis leptocephala, Sida rhombifolia, S. linifolia, Raphanus raphanistrum* and *Coronopus didymus.*

Herb lianes (LH) This group includes herbaceous lianes of either hemicryptophyte, geophyte or therophyte character. 329 taxa (5.4% of the flora). These plants are usually present in the communities of open, sunny and dry habitats including coastal and serpentine scrubs, shrublands and karstic woods. Approximately 40% of them are endemics (130 species), 48 being endemic to Oriente, 32 to the entire country and 24 to Pinar del Rio. Most of the widely distributed species are Neotropical (46), Pan-tropical (31) and Greater Antillean (28). Many paleotropical adventives. Entire genera with many species belong to this category, e.g. *Aristolochia, Dioscorea, Rajania, Cynanchum, Passiflora, Ipomoea,* and many species, such as *Anguria* and *Melothria,* etc.

Hygrophilous, mainly obligate epiphytic herbs (E_{G-H}). 208 taxa (3.4% of the flora). Epiphytes living on trunks and branches in the lower, shade tolerant epiphyte level of rainforests and mossy forests in high mountains. 35% (73 species) are endemics. 56 species are endemic to the mountain regions of Oriente. Other flora element types represented by numerous species are: Greater and Lesser Antillean (44), Caribbean (40) and Neotropical (30). Most representatives of this group are orchids, e.g., *Pleurothallis, Lepanthes, Maxillaria, Stelis, Epidendrum* s.l., *Polystachya, Dilomilis* and *Dichaea* spp.

Drought-resistant, mainly facultative epiphytic herbs (E_{Ch}). 59 taxa (0.9% of the flora). These are found in the upper level of submontane rainforests, in particular, and also in seasonal-evergreen forests, semi-deciduous and deciduous forests and dry evergreen forests. These are often abundant on emergent deciduous trees. In karstic woods they also inhabit the soil and rocks. The overwhelming majority of them are widely distributed Caribbean (24), Neotropical (13), and Greater Antillean (11) species. The percentage of endemics is just 12% in this life-form category. Drought-resistant orchids, such as *Ionopsis utricularioides* and *Cattleyopsis lindenii,* and many bromelias, e.g., most *Tillandsia* spp. and *Hohenbergia penduliflora* comprise this category.

Dwarf succulents of chamaephytic character (S_{Ch}). The four species belonging to this group play a negligible role in the communities. All of them are sparsely distributed in rocky forests and arid scrubs. One species, *Neobesseya cubensis,* is endemic. The others are either Caribbean or Bahamean.

16.4.4 A simplified ecological spectrum of the flora of Cuba

Based on the life-form analysis discussed above a simple ecological spectrum may be derived by combining related categories. The resulting spectrum is compatible with the earlier analyses. A comparison of Raunkiaer's spectrum generalized for the tropics yields a remarkable similarity (Table 18) with relatively significant differences occurring only in case of hemicryptophytes and therophytes. The reason for this discrepancy is presumably that the arid habitats favourable for therophytes are limited to a very small area in Cuba whereas the coniferous forests and the occurrence of serpentine bedrocks are advantageous for hemicryptophytes. The proportion of chamaephytes is lower than usual due to the lack of an alpine zone.

Table 19 The life-form spectrum of Cuba with that of an average tropical flora

	P	Ch	H	K	Th	E
Cuba (Borhidi)	53	4	20	6	7	10
Tropical regions (Raunkiaer)	51	6	12	5	16	10

16.5 The life-form analysis of the pteridophytes of Cuba

The pteridophytes may also be included in the life-form and flora element analysis of Cuba. However, a synthetic evaluation of the pteridophytes of Cuba has not yet been published. The first relevant studies were done as a preparation for this monograph (Borhidi and Acuña 1972, unpublished). It was found that 500 species occur in this country. The life-form and distribution types of these were also analyzed with results summarized in Table 20.

16.5.1 The life-form categories for the pteridophytes of Cuba

The life-form groups recognized for the pteridophyte species of Cuba are as follows:

Phanerophytic pteridophytes (P_{pt}), tree ferns. 39 species (7.8%). This life-form type has been established for ecological and cenological reasons. The tree ferns were assigned by Ellenberg and Mueller-Dombois (1966*b*) to the group of rosulate trees together with palms on the basis of their morphological similarity. In addition to their similar appearance, however, the only "character" they share is that palms and tree ferns cannot be assigned to any of Raunkiaer's leaf-size categories (Webb 1959). My field experience in Cuba suggests that due to ecological differences palms and tree ferns should be regarded as mutually exclusive, ecologically vicarious life-form types. Tree ferns are found almost exclusively in montane rainforests and mossy forests characterized by gently humid, regulated climate. On lowlands tree

Table 20 Life-form and chorological type analysis of Cuban pteridophytes

Life-forms	Chorological types												
	Endem.	G-Ant.	Ant.	N-Car.	S-Car.	Car.	Car. Amer	Neotr.	Amer.	Pan tr.	Cosmop.	Adv. Paleotr.	Total
Mesophanerophyte (MsPpt)	3	1	—	1	—	1	—	2	—	—	—	—	8
Microphanerophyte (McPpt)	2	4	2	2	—	1	1	2	—	—	—	—	14
Nanophanerophyte (NaPpt)	—	3	2	—	—	1	—	10	—	1	—	—	17
Chamaephyte (Ch)	3	11	5	2	1	3	—	11	1	12	4	—	57
Hemicryptophyte (H)	19	22	6	9	1	9	—	51	—	15	1	—	133
Geophyte (G)	13	19	12	8	2	6	2	48	—	15	5	1	131
Helo-hydatophyte (HH)	1	—	—	—	—	—	—	3	1	1	2	—	8
Lianes (L)	5	4	2	1	—	2	—	12	—	—	—	—	26
Epiphyte (E)	7	13	9	4	1	5	6	50	—	10	1	—	106
Total of Cuban pteridophytes	53	77	38	27	5	28	9	189	2	54	13	1	500
Life-form pattern of Cuban pteridophytes in percentages according to chorological types													
Mesophanerophyte (MsPpt)	37.5	12.5	—	12.5	—	12.5	—	25.0	—	—	—		
Microphanerophyte (McPpt)	14.3	28.6	14.3	14.3	—	7.1	7.1	14.3	—	—	—	—	100%

Nanophanerophyte (NaPpt)	—	17.6	11.8	—	—	5.9	—	58.8	—	5.9	—	—	100%
Chamaephyte (Ch)	5.3	19.3	8.8	3.5	1.7	5.3	—	19.3	1.7	21.1	7.0	—	100%
Hemicryptophyte (H)	14.3	16.5	4.5	6.8	0.8	6.8	—	38.3	—	11.3	0.7	—	100%
Geophyte (G)	9.9	14.5	9.2	6.1	1.5	4.6	1.5	36.7	—	11.4	3.8	0.8	100%
Helo-hydatophyte (HH)	12.5	—	—	—	—	—	—	37.5	12.5	12.5	25.0	—	100%
Lianes (L)	19.2	15.4	7.7	3.8	—	7.7	—	46.2	—	—	—	—	100%
Epiphyte (E)	6.6	12.3	8.5	3.8	0.9	4.7	5.7	47.2	—	9.4	0.9	—	100%
Total of Cuban pteridophytes	10.6	15.4	7.6	5.4	1.0	5.6	1.8	37.8	0.4	10.8	2.6	0.2	100%

Chorological patterns of Cuban pteridophytes in percentages according to the life-form categories

Mesophanerophyte (MsPpt)	5.7	1.3	—	3.7	—	3.6	—	1.1	—	—	—	—	1.6%
Microphanerophyte (McPpt)	3.8	5.2	5.3	7.4	—	3.6	11.1	1.1	—	—	—	—	2.8%
Nanophanerophyte (NaPpt)	—	3.9	5.3	—	—	3.6	—	5.3	—	1.8	—	—	3.4%
Chamaephyte (Ch)	5.7	14.3	13.2	7.4	20.0	10.7	—	5.8	50.0	22.3	30.7	—	11.4%
Hemicryptophyte (H)	35.8	28.5	18.5	33.4	20.0	32.1	—	27.0	—	27.8	7.7	—	26.6%
Geophyte (G)	24.5	24.7	31.5	29.6	40.0	21.4	22.2	25.4	—	27.8	38.5	100.0	26.2%
Helo-hydatophyte (HH)	1.9	—	—	—	—	—	—	1.6	50.0	1.8	15.4	—	1.6%
Lianes (L)	9.4	5.2	5.3	3.7	—	7.1	—	6.3	—	—	—	—	5.2%
Epiphyte (E)	13.2	16.9	23.6	14.8	20.0	17.9	66.7	26.4	—	18.5	7.7	—	21.2%
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0%

ferns grow only in gallery forests along water courses. Most tree ferns are widely distributed Neotropical (14, 36%) and relatively narrowly distributed Greater Antillean (8, 21%) elements. The number of endemics is surprisingly high (5, 13%) as a result of the early isolation of high mountains. This group is subdivided as follows:

Mesophanerophytic pteridophytes (MsP_{pt}). Tall tree ferns (5—12 m), e.g. *Alsophila aspera, Cyathea araneosa, C. arborea, Hemitelia horrida,* and *Lophosoria quadripinnata.*

Microphanerophytic pteridophytes (McP_{pt}). Small tree ferns (2—5 m). Examples are *Alsophila aquilina* and *Cyathea tenera* etc.

Nanophanerophytic pteridophytes (NaP_{pt}). Dwarf tree ferns (< 2 m), such as the *Diplazium* spp.

Chamaephytic ferns (Ch). 57 taxa (11.4%). They are present in montane rainforests and mossy forests, elfin thickets coniferous forests and occasionally in semi-arid habitats on rocks. Some species, for example *Gleichenia bifida,* may occur in great abundance forming a secondary community after destruction of the original vegetation. Most of them are Pan-tropical (12, 21%), Neotropical (11, 29%), Greater Antillean (11, 19%) and Antillean (5, 9%). Only three endemics occur (5%). Almost all species of *Lycopodium, Selaginella, Marattia* and *Pteris* belong to this life-form class.

Hemicryptophytes (H) Perennial ferns with buds above the soil surface. 133 species (26.6%). They are especially common in the herb layer of rainforests, seasonal-evergreen forests, karstic forests and coniferous forests. Some species appear in very dry rocky habitats. The most common type of geographical distribution is Neotropical (51, 38%), Greater Antillean (22, 17%) and Pan-tropical (15, 11%). This group includes a remarkably large number of endemics (19, 14%), most of them living on serpentine and laterite, such as the *Anemia* and *Polystichum* spp. In addition, most species of *Asplenium, Blechnum, Bolbitis, Lindsaya, Nephrolepis, Pityrogramma,* and *Tectaria* are of this life-form type.

Geophytes (G) Perennial ferns with rhizomes. 131 taxa, 26.2%. In ecological requirements these are similar to the hemi-cryptophytes. However, geophytes are more abundant in humid, shade habitats on rocks. Where humidity is high enough some species, e.g. *Polypodium astrolepis, P. capillare, P. lycopodioides, P. polypodioides,* etc. become facultative epiphytes. Most of the geophytic ferns are Neotropical (48, 37%), Greater Antillean (13, 12%), Pan-tropical (15, 11%) and Antillean (12, 9%). The number of endemics is also high (13, 10%). This category includes almost all species of *Botrychium, Ophioglossum, Adiantum, Osmunda, Polypodium* and *Thelypteris* occurring in Cuba.

Helo-hydatophytes (HH) Aquatic and uliginal ferns. 8 species, 1.6%. These are categorized as follows: floating freshwater ferns *(Azolla caroliniana, Salvinia auriculata, S. natans)*, rooted aquatic ferns *(Marsilia polycarpa)* and saltwater ferns of mangrove forests *(Acrostychum aureum, A. danaifolium).* All aquatic ferns are widely distributed being either Neotropical (3), cosmopolitan (2), Pan-tropical (1) or American (1). The only exception is the endemic *Isoëtes cubana.*

Lianes (L) 26 species (5.2%). This life-form occurs in fairly diverse habitats including montane rainforests and mossy forests (*Dennstaedtia* and *Gleichenia*)

where lianes are most abundant, and also in coniferous forests *(Odontosoria)* and dry shrublands *(Lygodium cubense)*. Having very strong stems, they are most similar to the graminoid lianes. Although their stems are not woody, they should be assigned to the phanerophytic lianes as in Table 24 (see Suppl. 7). Twelve species are Neotropical (46%). Most of the others are endemic (5, 19%) and Greater Antillean (4, 15%).

Epiphytic ferns (E) A remarkably large number of species (106, 21.2%) are included. These are abundant especially in submontane and montane rainforests, mossy forests, karstic forests and in the elfin thickets. The majority of species are Neotropical (50, 47%). The others are Pan-tropical (9, 8%), Greater Antillean (13, 12%) and Antillean (9, 8%). Only a few endemics occur (7, 7%). Most epiphytic ferns belong to the genera *Elaphoglossum, Hymenophyllum sensu lato* and *Trichomanes sensu lato,* and also to *Polypodium,* such as *P. duale. Lycopodium funiforme, Peltapteris peltata* and *Rhipidopteris peltata* are noted representatives of other genera.

16.5.2 A classification of epiphytic pteridophytes

For practical purposes, two types of epiphytic ferns can be distinguished. These are:

Membranous-leaved epiphytic pteridophytes (mE_{pt}) Film-ferns of the family Hymenophyllaceae. These are particularly characteristic of rainforests and mossy forests. Pócs (1976) observed a definite relationship between humidity and the number of species from this family in the rainforests of the Uluguru Mountains in East Africa.

Non-membranous epiphytic pteridophytes (nE_{pt}). Club mosses *(Lycopodium),* spike mosses *(Selaginella)* and ferns belonging to various families. These are less sensitive to humidity. Due to their hard or cariaceous leaves some species are explicitly drought-resistant.

Table 21 Geographical distribution of membranous-leaved (m E_{pt}) and non membranous-leaved (n E_{pt}) pteridophytes of Cuba

Flora element	m E_{pt}	%	n E_{pt}	%
Endemic to Cuba	1	2.3	6	9.7
Greater Antille	1	2.3	12	19.4
The Antille	4	9.1	5	8.1
Northern Caribbean	1	2.3	3	4.8
Southern Caribbean	1	2.3		—
Pan-Caribbean	2	4.5	3	4.8
Central American	3	6.8	3	4.8
Neotropical	23	52.2	27	43.6
Pan-tropical	7	15.9	3	4.8
Cosmopolitan	1	2.3		—
Total:	44	100.0	62	100.0

The geographical distribution of the above groups is shown in Table 21. It is seen that Hypenophyllaceae usually have larger geographic range than the other epiphytic pteridophytes.

16.5.3 The ecological spectrum of the pteridophytes of Cuba

Table 22 shows the ecological spectrum for the pteridophytes of Cuba obtained by combining related life-form categories. This spectrum corresponds to a typical tropical flora. The high percentage of phanerophytic and epiphytic species indicates the abundance of humid habitats in Cuba.

Table 22 The ecological spectrum of the pteridophytes of Cuba

	P	Ch	H	K	E	L
Cuban pteridophytes	7.8	11.4	26.6	27.8	21.2	5.2

16.6 Growth types and leaf-size classes

In addition to the analysis of life-forms, the growth types of plants are also worth examining. In tropical vegetation surveys the different crown types, leaf-size classes, trunk and bark forms of trees, and also the presence or absence of spinose structures are commonly used for forest typification. In the present study only leaf-size classes were analyzed. These classes proved to be meaningful in reflecting the ecological conditions of various habitats and communities.

16.6.1 Leaf-size classes

The different leaf-size classes were constructed following Raunkiaer (1908), Richards, Tansley and Watt (1940) and Webb (1959). These categories, together with their serial numbers to be used in the sequel are listed in Table 23.

Table 23 The leaf-size categories

Category	Abbreviation	Area cm^2
1 megaphyll	mg	>1640.20
2 macrophyll	ma	182.25–1640.20
3 mesophyll	ms	45.00– 182.25
4 notophyll	nt	20.25– 45.00
5 microphyll	mc	2.25– 20.25
6 nanophyll	na	.25– 2.25
7 leptophyll	lp	<0.25
8 aphyll	ap	0

16.6.2 Some remarks on the leaf-size classes

As suggested by Webb (1959), only the leaves of phanerophytes *sensu stricto* were examined. Life-form types, such as palms, rosulate trees, tree ferns and lianes, for which the classification is ambiguous, were excluded from the analysis. In case of compound leaves the class membership was determined by the size of leaflets. The leafless trunk-succculents were assigned to the group of aphylls.

Contrary to Aubréville's (1965) opinion, the notophyll category (Webb 1959) proved to be useful especially in distinguishing among the vertical belts of rainforests and between the vicarious vegetation types of limestone and serpentine.

16.6.3. A general leaf-size index

The average leaf size, I_f, was applied to the ecological characterization of vegetation types and plant communities. This index is obtained as follows. The number of occurrences in each class is multiplied by the serial number of the corresponding class (see Table 23). The sum of these products is then divided by the total number of occurrences as shown below:

$$I_f = \frac{I_1p_1 + I_2p_2 + \ldots + I_7p_7 + I_8p_8}{p_1 + p_2 + \ldots + p_8} = \frac{\sum_j I_jp_j}{\sum_j p_j}$$

where $p_1, p_2 \ldots p_8$ indicate the number of occurrences in leaf-size classes 1, 2...8, and $I_1, I_2 \ldots I_8$ are the serial numbers of the corresponding classes. It was found that there is a definite relationship between climate and the I_f value for each vegetation type and community (see Chapter 17. for details).

17 Life-form affinities and the dynamics of the life-form composition along environmental gradients

17.1 Introduction

Although tropical vegetation types are commonly characterized using life-form categories, the affinity of life-forms and growth types to the different vegetation types is largely ignored in most surveys. There are no data illustrating the change of life-form and growth type spectra as influenced by vegetation changes along geographic or climatic gradients. This insufficiency may be explained as follows.

In most tropical studies no data are avaliable on climatic or vegetation gradients, or very often on both. The lack of appropriate vegetation data is due to the fact that mapping surveys and ecological studies are usually performed independently by different research teams. While the change of vegetation types in mapped without quantitative analysis of vegetation structure, ecological studies are restricted to a

single vegetation type. Furthermore, any field work in the tropical environment presents numerous methodological problems and difficulties, making gradient analysis a troublesome task.

17.1.1 Affinity of life-form to vegetation types

Forty forest and shrubland communities and formations in Cuba (Table 24) were subjected to a comparative physiognomic and phytosociological analysis. Of the 40 vegetational noda 18 are considered to be climax, representing all climax formations of the island. (For composition of the communities see Table 25 in the Appendix)

Table 24 Major lignosa formations of Cuba

A. Western pine forests
1. *Paepalantho-Pinetum tropicalis* (Isla de Pinos, 11 plots) V. Samek
2. *Pinetum tropicalis-caribaeae* (Isla de Pinos, 10 plots) V. Samek
3. *Querco sagraeanae-Pinetum* (Pinar del Rio, 5 plots) A. Borhidi
4. *Neomazaeo-Pinetum* (Cajalbana, 5 plots) A. Borhidi
5. *Agavo cajalbanensi-Pinetum* (Cajalbana, 5 plots) Borhidi, Borhidi and Muñiz

B. Eastern pine forests
6. *Anemio-Pinetum cubensis* (Sierra de Nipe, 10 plots) Borhidi and Muñiz
7. *Rhynchosporo-Pinetum cubensis panicetosum* (Sierra de Nipe, 10 plots) Borhidi and Muñiz
8. *Rhynchosporo-Pinetum cubensis typicum* (Sierra de Nipe, 10 plots) Borhidi and Muñiz
9. *Agavo shaferi-Pinetum cubensis* (Sierra de Nipe, 5 plots) Borhidi and Muñiz
10. *Rhynchosporo-Pinetum cubensis euphorbietosum* (Sierra de Nipe, 5 plots) Borhidi and Muñiz
11. *Euphorbio helenae-Pinetum cubensis* (Moa: Cayo Chico, Cupeyal, Monte Libano, 5 plots) Borhidi and Muñiz
12. *Shafero-Pinetum cubensis* (Moa: Cupeyal, 10 plots) Borhidi and Muñiz
13. *Dracaeno-Pinetum cubensis* (Baracoa — Moa, 5 plots) Borhidi and Muñiz

C. Semi-arid montane rainforests
14. *Cyrillo nipensi-Pinetum* (Moa: Cupeyal, 5 plots) Borhidi and Muñiz
15. *Podocarpo-Bonnetietum cubensis* (Moa: Cupeyal, Iberia, Jaguani, 10 plots) Borhidi and Muñiz

D. Semi-arid serpentine shrubwoods
16. *Ilici-Laplaceion moaensis* (Moa: Iberia, Mina Delta, Jaguani, 5 plots) Borhidi and Muñiz
17. *Ariadno-Phyllanthion* (Moa: Playa Vaca, Yamanigüey, 5 plots) Borhidi and Muñiz
18. *Spathelio-Bourrerietum* (Sierra de Nipe, 5 plots) Borhidi and Muñiz

E. Submontane tropical rainforests
19. *Calophyllo-Carapetum guianensis* (Moa: Jaguani, 5 plots) Borhidi and Muñiz

F. Moist montane rainforests
20. *Magnolio-Laplaceetum angustifoliae* (Sierra Maestra, 10 plots) Borhidi and Muñiz, Borhidi
21. *Magnolio-Cyrilletum racemiflorae* (Sierra de Escambray, 5 plots) Borhidi and Muñiz, Borhidi

G. Cloudforests
22. *Myrsino-Nectandretum reticularis* (Sierra Maestra, Turquino, 5 plots) Borhidi and Muñiz

H. Moist high mountain shrubwoods
23. *Ilici-Myricion cacuminis* (Sierra Maestra, Turquino, 5 plots) Borhidi and Muñiz

I. Submontane seasonal rainforests
24. *Oxandro-Dipholietum jubillae* (Sierra Maestra, 5 plots) Borhidi and Muñiz

J. Karstic forests or mogotes
25. *Coccothrinaci-Tabebuietum bibracteolatae* (Sierra Maestra, 5 plots) Borhidi and Muñiz
26. *Ceratopyxidi-Gaussietum principis* (Sierra de los Organos, 5 plots) Borhidi and Muñiz, Borhidi et Capote,
27. *Tabebuio sauvallei-Garryetum* (Sierra de Escambray, 5 plots) Borhidi and Muñiz, Borhidi

K. Semi-deciduous seasonal forests
28. *Bombacopsi-Catalpetum* (Guanahacabibes, 5 plots) Borhidi and Muñiz, Borhidi et Capote,
29. *Coccolobo diversifoliae-Burseretum* (Isla de Pinos, 5 plots) Borhidi and Muñiz
30. *Zanthoxylo-Burseretum* (Habana, Zapata, Las Villas, Camagüey, 5 plots) Borhidi and Muñiz

L. Arid lowland serpentine shrubwoods
31. *Coccothrinacio-Tabebuion lepidotae* (Campo Florido, Canasi, 5 plots) Borhidi and Muñiz, O. Muñiz, A. Borhidi
32. *Rondeletio-Guettardetum clarensis* (Las Villas, 10 plots) Borhidi and Muñiz, Borhidi
33. *Copernicio-Tabebuietum trachyphyllae* (Camagüey, 5 plots) Borhidi and Muñiz
34. *Guettardo-Jacarandion cowellii* (Holguin, 5 plots) Borhidi und Muñiz, Borhidi and Capote

M. Evergreen oakvwoods
35. *Quercion sagraeanae* (Pinar del Rió, 5 plots) A. Borhidi, Borhidi and Capote,

N. Swampy forests
36. *Chrysobalano-Annonion palustris* (Isla de Pinos, Zapata, 5 plots) Borhidi and Muñiz, Borhidi and Del-Risco

O. Arid evergreen forests
37. *Bursero-Lysilometum bahamensis* (Guanahacabibes, Isla de Pinos, Zapata, Cienfuegos, 5 plots) Borhidi und Muñiz, A. Borhidi,
38. *Swietenio-Metopietum brownei* (Isla de Pinos, Zapata, Cienfuegos, 5 plots) A. Borhidi, Borhidi and Muñiz,

P. Spinose evergreen limestone scrubs
39. *Pseudocarpidio-Cordion* (S. Oriente, 10 plots) Borhidi, Borhidi and Muñiz

R. Semi-desert scrubs with columnar cacti
40. *Consoleo-Ritterocereion hystricis* (S. Oriente, 10 plots) Borhidi, Borhidi and Muñiz

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The spatial arrangement of my phytosociological plots allows for the study of actual vegetation transects both in vertical and horizontal direction. Having the bioclimatological results discussed in Part I, it was attempted to find explicit, quantitative relationships between different ecological and vegetational gradients by summarizing structural changes in an appropriate meteorological formula.

The phytosociological classification of the forty lignosa noda examined (see Chapter 23) was carried out using alternative input data sets. One of these analyses was based on the life-form structure of communities. The clustering algorithm used was the sum of squares agglomeration technique (Orlóci 1978). The classification was repeated several times using a different random selection of species in order to obtain a general view on the life-form structure of lignosa communities in Cuba.

The computations were based on the frequencies of life-form classes as input variables. The results obtained support the view by Fekete and Szujkó-Lacza (1971) that climatic conditions are clearly reflected by simple frequencies, rather than when cover or abundance is also considered. It is to be noted, however, that with the exception of marshes and coniferous forests, frequency data also indicate abundance because as the number of individuals increases the number of species usually also increases.

17.2 The affinity of life-forms to the different tropical forest communities of Cuba

The affinity of life-forms to the 40 lignosa noda examined is shown in Fig. 119 (see Table 25 for symbols of life-forms). Eight life form groups can be distinguished in the diagram.

a) The first group (B_2—M) contains the giant trees (A_3), macrophyll and mesophyll trees (B_2B_3) and tree-sized forbs (M), i.e., the characteristic structural elements of seasonal-evergreen forests and of the submontane rainforests with three canopy layers.

b) The second group is composed of tree ferns (N) and hygrophilous epiphytes (U). These life-forms are characteristic of montane rainforests and mossy forests. Tree ferns are scarcely found elsewhere, and the hygrophilous epiphytes are also most abundant in these formations.

c) The third group (J—I) includes life-forms with broad ecological tolerance. These occur in every kind of high forests, such as rainforests. The ecological optima of these life-forms are the semi-deciduous and karstic forest habitats, although they are also present to a smaller extent in all relatively arid vegetation types. The woody lianes (J), xerophilous epiphytes (X), geophytes (P), mesophyllous small trees and shrubs (D_3, E_3), tall palms (G) and the woody epiphytes (I) belong to this group.

d) The fourth group contains the ubiquitous woody life-forms. These are the notophyllous and microphyllous small trees and shrubs (D_4, D_5, E_4, E_5), very abundant in all lignosa noda.

e) In the fifth group the life-forms characteristic of pine forests, karstic forests and xerophilous shrublands are included. In particular, the annuals composing the herb layer (R), the perennial herbs (O), subshrubs (V), herbaceous lianes (T) and dwarf palms (H) are to be mentioned.

f) The helo-hydatophytes (Q) form the sixth group. This life-form is characteristic of swamps, gallery forests, and mangrove stands.

g) The seventh group contains trees composing seasonally dry forests. The notophyllous, microphyllous and nanophyllous tall trees and the notophyllous, microphyllous and leptophyllous microphanerophytes are dominant in the canopy layer of semi-deciduous forests, karstic forests and evergreen shrublands.

h) Finally, the eighth group includes the extremely drought-tolerant species of serpentine shrublands, thorny scrubs and semi-desert shrublands. These are nanophyllous emergents (C_6), nanophyllous and leptophyllous small trees and shrubs (D_6, D_7, E_6, E_7) and succulents (K_1, Y).

17.2.1 Conclusions

General relationships shown in Fig. 119 are as follows.

a) Rainforests are strikingly separated from all other seasonally dry vegetation types. There are eight life-form types in rainforests, that are not found in the other formations.

b) Every other life-form, except the helo-hydatophytes, is more or less abundant in all seasonally dry vegetation types, some of them in rainforests. The sequence of life-forms from left to right shows a continuously lessening affinity to rainforests.

c) Clearly, the cenological affinity between life-form classes which constitute corresponding vegetational strata is often very low, e.g., between hygrophilous epiphytes and lianes, between hygrophilous and xerophilous epiphytes, and between tree ferns and small palms, etc.

17.3 Life-form vicariancy

The vicarious life-forms and growth types may replace one another in a given layer of communities along geographic and climatic gradients. In this case, vicariancy refers to taxonomically heterogeneous groups rather than to the populations of two species. Therefore, there is an overlap between vicarious groups so that one life-form dominant in a given layer is continuously replaced by the other along the gradient.

17.3.1 Vicariancy between epiphytes and lianes

There is an obvious vicariancy between lianes and epiphytes constituting the trunk and branch layers. It was observed that lianes and xerophilous epiphytes are dominant in relatively open xeric communities with loose canopy layer. On the contrary, the hygrophilous epiphytes are dominant in more closed and more humid communities. For the comparison of the climatic conditions of communities a new index is suggested. This is Thornthwaite's humidity/aridity index (1948) modified such that PE is replaced by the mean annual temperature (T) in the denominator. The general humidity index is given by,

$$Qg_h = \frac{P - E_v}{T}$$

where P is the annual precipitation and E_v denotes the annual evaporation. The diagram in Fig. 80 shows the relationship between Qg_h and the sum of frequencies for lianes and hygrophilous epiphytes in all important climax formations and community types including semi-desert scrubs, semi-deciduous forests, rainforests, mossy forests and elfin thickets. It is seen that the rainforests and mossy forests have the most diverse trunk and branch layers. The general trend that dry climate is

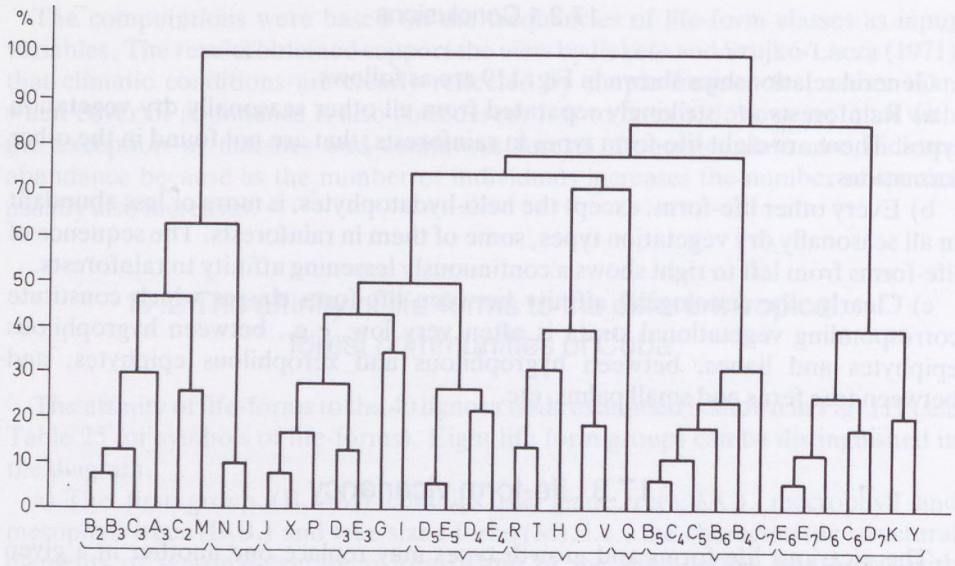


Fig. 79 The affinity of life-forms to the different *Lignosa* communities in Cuba. For abbreviations see Table 24

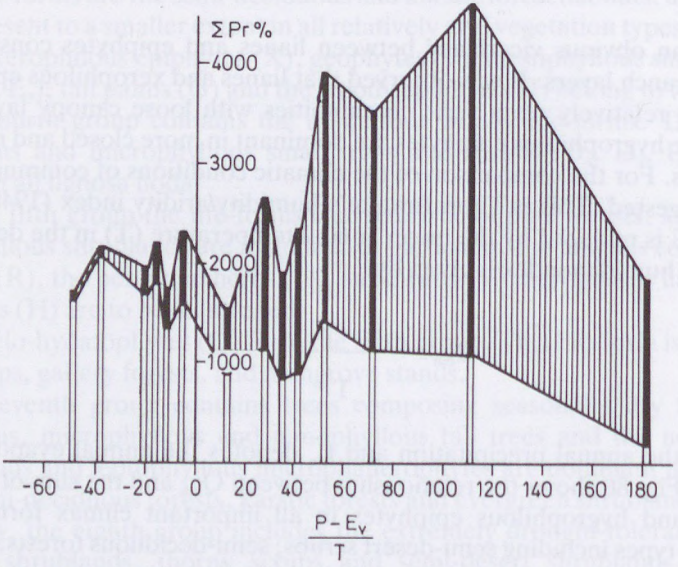


Fig. 80 The total frequency of lianes and epiphytes in the different Cuban climax plant communities, white columns: lianes, black columns: epiphytes

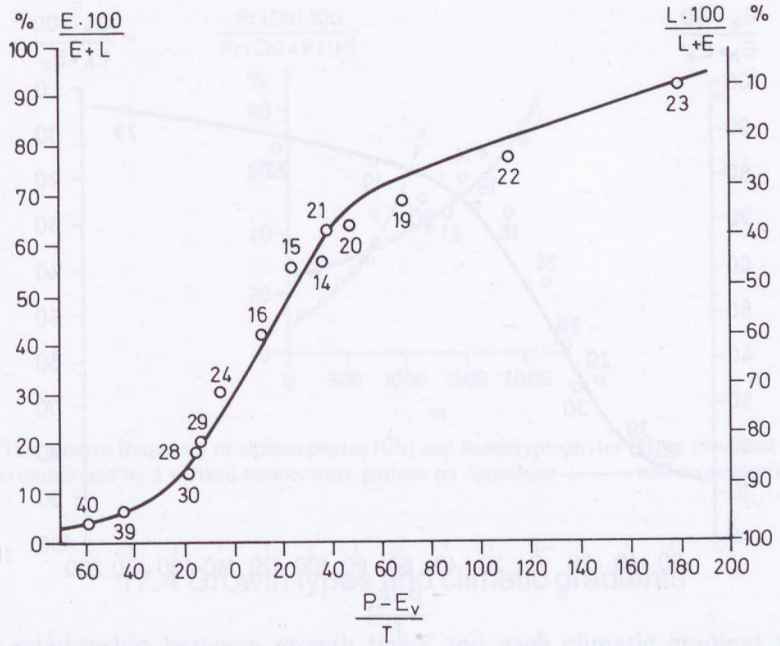


Fig. 81 Relative frequency of the lianes and epiphytes in zonal communities conditioned by humid and arid climates in Cuba. The numbers indicate the plant communities listed in Table 25

favourable for lianes and moisture is in favour of hygrophilous epiphytes may also be observed. The relationship is not best shown in this way, however. If the percentages of the two life-form classes,

$$\frac{Fr._{lianes} \times 100}{Fr._{lianes} + Fr._{epiph.}} \quad \text{and} \quad \frac{Fr._{epiph.} \times 100}{Fr._{lianes} + Fr._{epiph.}}$$

are taken as variables on the vertical axis, the resulting scattergram (Fig. 81.) will be easier to interpret. The shape of the curves suggests that Qg_h may be used for an adequate description of the relationships examined. The two life-forms appear to be balanced around the contact point between the seasonal-evergreen forests and semi-arid rainforests.

17.3.2 The relative distribution of xerophilous and hygrophilous epiphytes

The relationship between xerophilous and hygrophilous epiphytes was examined in a similar manner. The result (Fig. 82) resembles the one in Fig. 81 although the curve is shifted to the left. The reason for this difference is that the relative frequency of lianes, if compared to the hygrophilous epiphytes, is higher than that of the xerophilous epiphytes in almost all vegetation types studied. Exceptions are

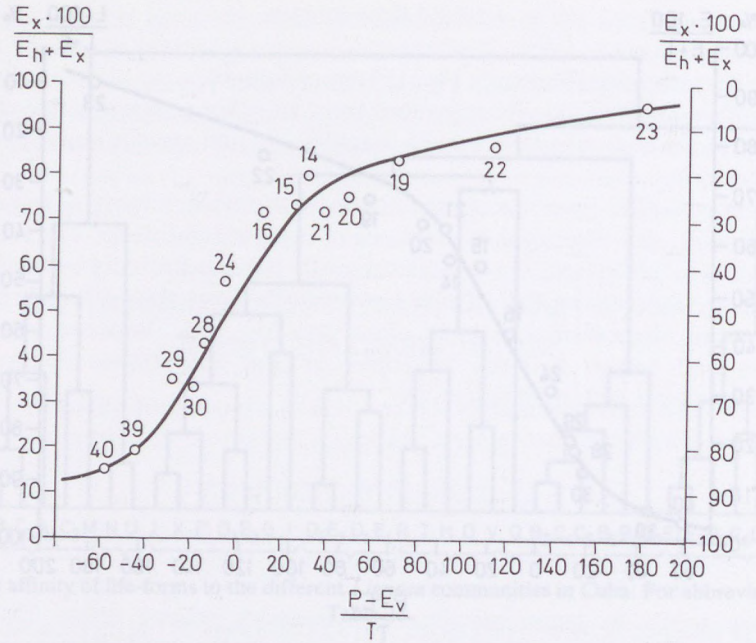


Fig. 82 The relative frequency of xerophytic (E_x) and hygrophilous epiphytes (E_h) in the different climax communities of Cuba. Numbers indicate the plant communities listed in Table 18

the karstic forests in which xerophilous epiphytes are much more frequent than lianes. Since karstic forests are predominantly edaphic communities of which the value of Qg_h is not characteristic, these are excluded from the comparison.

17.3.3 The vertical distribution of hemicryptophytes and chamaephytes

The influence of altitude upon the proportion of hemicryptophytes and chamaephytes in the herb layer was also examined. Raunkiaer (1908, 1934) has shown that the so-called "hemicryptophyte climate" is replaced by the "chamaephyte climate" between 2000 and 3000 m altitude in the temperate zone. The same trend may be observed in the tropical mountains, for example, in the paramos of the Andes, with a transition zone occurring between 4000 and 5000 m. It is to be noted, however, that similar trends are found in the forest belts of mountainous regions in the tropics. This is confirmed in Fig. 83 showing the percentage of chamaephytes in the forest communities of Sierra Maestra and Sierra de Moa at various altitudes. Both curves indicate a steep upward trend. It may be concluded that the percentage of chamaephytes much more rapidly increases on serpentine than on other bedrocks. This fact supports the author's view that given vegetation zones and the montane and subalpine elements occur at a much lower altitude on serpentine than on other geological formations.

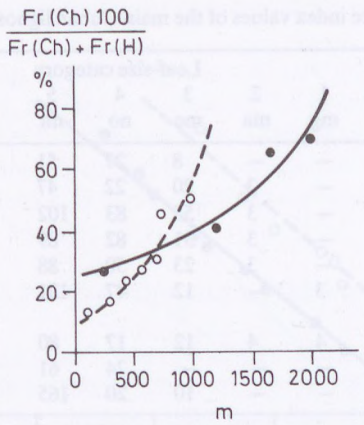


Fig. 83 The relative frequency of chamaephytes (Ch) and hemicryptophytes (H) in the zonal plant communities conditioned by a vertical temperature pattern on limestone ——— and on serpentine – – – –

17.4 Growth types and climatic gradients

The relationship between growth types and each climatic gradient was also studied in a manner already described. Clear-cut results were obtained with respect to the relationship between temperature and humidity gradients and the relative frequency of spinose elements and ecological leaf-size classes (see *18.6.1.*).

17.4.1 Leaf-size index as an ecological indicator

The average leaf-size index, I_f, was calculated for the formations and community types listed in Table 26. It was found that the value of I_f with some fluctuations is characteristic of the actual vegetation type and also of its ecological conditions, especially moisture (Table 26). 15 climax vegetation types, 9 on limestone and 6 on serpentine, were selected and the I_f values were contrasted with some simple climatic gradients.

17.4.2 Leaf-size index and humidity

Upon examining the relationships between annual precipitation and I_f (Fig. 84), the following statements can be made:

- There is a linear relationship between annual precipitation and I_f for the climax types of both bedrocks.
- Climax noda tend to become more xeromorph on serpentine than on limestone.

Supposing that the annual precipitation in a limestone and a serpentine habitat is the same, the latter will appear more arid as if the annual precipitation were

Table 26 Leaf-size index values of the main Cuban lignosa-communities

Communitites	Leaf-size category						Frequencies		1–8	Leaf index
	1 mg	2 ma	3 me	4 no	5 mi	6 na	7 lp	8 ap		
1. *Paepalantho-Pinetum*	—	—	8	27	51	8	—	—	94	4.63
2. *Pinetum tropicalis-caribaeae*	—	3	20	22	47	12	—	—	104	4.43
3. *Querco sagraeanae-Pinetum*	—	3	55	83	102	22	—	—	265	4.32
4. *Neomazaeo-Pinetum*	—	3	31	82	89	38	—	3	246	4.57
5. *Agavo cajalbanensi-Pinetum*	—	3	23	50	88	79	40	13	296	5.31
6. *Anemio-Pinetum cubensis*	3	—	12	47	121	24	4	—	211	4.76
7. *Rhynchosporo-Pinetum panicetosun*	4	4	12	17	80	18	8	—	143	4.76
8. *Rhynchosporo-Pinetum typicum*	—	—	—	24	61	15	—	—	100	4.91
9. *Agavo shaferi-Pinetum*	—	—	10	20	165	43	10	10	258	5.21
10. *Rhynchosporo-Pinetum euphorbietosum*	—	—	4	22	104	30	—	—	160	5.00
11. *Euphorbio helenae-Pinetum*	3	—	33	42	248	111	5	3	445	5.02
12. *Shafero-Pinetum cubensis*	9	—	34	75	239	48	—	—	405	4.68
13. *Dracaeno-Pinetum cubensis*	—	—	22	64	306	64	14	—	470	4.97
14. *Cyrillo nipensi-Pinetum*	20	10	94	103	132	60	6	—	425	4.23
15. *Podocarpo-Bonnetietum*	13	20	78	208	243	55	12	—	629	4.37
16. *Ilici-Laplaceion moaensis*	16	—	32	136	346	94	26	—	650	4.82
17. *Ariadno-Phyllanthion*	—	—	26	80	296	140	30	—	572	5.12
18. *Spathelio-Bourrerietum*	—	—	32	46	428	142	28	—	676	5.13
19. *Calophyllo-Carapetum*	38	48	196	124	94	8	—	—	508	3.42
20. *Magnolio-Laplaceetum*	64	11	77	173	234	22	—	—	581	3.98
21. *Magnolio-Cyrilletum*	55	16	114	134	90	10	—	—	419	3.52
22. *Myrsino-Nectandretum*	64	—	18	118	254	46	—	—	500	4.27
23. *Ilici-Myricion cacuminis*	4	—	4	44	196	54	10	10	322	5.11
24. *Oxandro-Dipholietum jubillae*	4	24	164	188	208	6	—	—	594	3.99
25. *Coccothrinaci-Tabebuietum*	—	6	10	140	364	52	24	24	650	4.68
26. *Ceratopyxideto-Gaussietum*	—	—	74	82	230	44	4	26	460	4.77
27. *Tabebuio-Garryetum*	—	4	66	176	254	64	4	16	584	4.66
28. *Bombacopsi-Catallpetum*	—	10	102	254	442	64	16	4	892	4.57
29. *Coccolobeto-Burseretum*	—	10	106	284	452	60	14	—	926	4.53
30. *Zanthoxylo-Burseretum*	4	10	86	286	370	40	8	4	808	4.46
31. *Coccothrinaci-Tabebuion lepidotae*	—	—	20	36	242	138	66	12	514	5.45
32. *Rondeletio-Guettardetum*	—	—	36	54	220	172	76	16	574	5.43
33. *Copernicio shaferi-Tabebuietum*	—	—	30	48	204	198	80	4	564	5.46
34. *Zanthoxylo-Jacarandion cowellii*	—	—	22	54	244	204	106	8	638	5.54
35. *Quercion sagraeanae*	6	8	116	168	262	34	—	4	598	4.33
36. *Chrysobalano-Annonion palustris*	—	—	34	96	98	12	4	—	244	4.41
37. *Bursero-Lysilometum bahamensis*	—	6	48	176	308	66	16	10	630	4.74
38. *Swietenio-Metopietum brownei*	—	—	78	168	454	110	48	24	882	4.95
39. *Pseudocarpidio-Cordion*	—	—	12	96	399	207	109	18	841	5.46
40. *Consoleo-Ritterocereion*	—	—	8	80	387	283	126	68	952	5.68

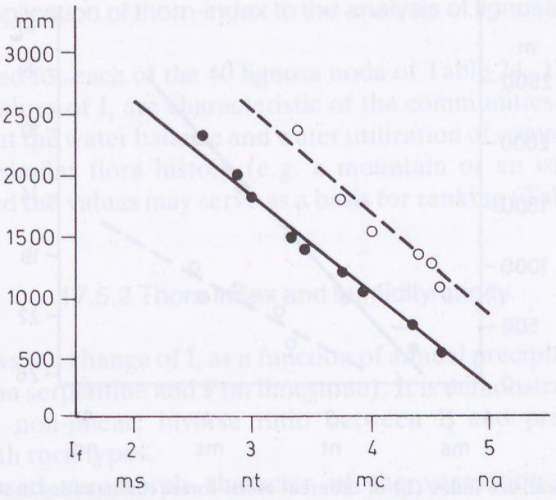


Fig. 84 The general leaf-size index (I_f) of different zonal plant communities in relation to the mean annual precipitation on limestone ———— and on serpentine – – – – – (Abbr. Table 23)

500—600 mm less than in the first. This is in part due to the unsatisfactory water balance of soils derived from serpentine: poor water permeability of upper strata, significant draining on the surface and strong desiccation through the capillaries. In addition, many physiological problems in plants are caused by abnormalities in the chemical composition of the soils, such as P shortage and too high magnesium and heavy metal concentrations. Thus, considering its structure, xeromorph appearance and the distribution of leaf-size classes, a given vegetation type on serpentine corresponds to a community of limestone habitats with 500—600 mm less annual precipitation.

With respect to the linear relationship mentioned it should be pointed out that the flora of Cuba has become highly specialized in xeromorph and sclerophyllous elements. The plants have become adapted to the dry climate using similar strategies in almost all vegetation types throughout the island.

• It may be assumed that the above relationship is not applicable to floras in which other adaptive mechanisms, e.g. abscission of leaves, are predominant.

17.4.3 Leaf-size index and temperature

Figure 85 shows the relationship between I_f for montane vegetation zones and the change of temperature and altitude. A serpentine mountain (Moa and Nipe) and an area with other bedrock types (Sierra Maestra) are contrasted. It can be seen that:

a) Temperature and precipitation have similar effects on the average leaf-size index. Microphylls become dominant as average temperature or total precipitation decreases. In other words, during the development of microphyllous vegetation types the alteration climatic factors will lead to a similar modification of leaf-size.

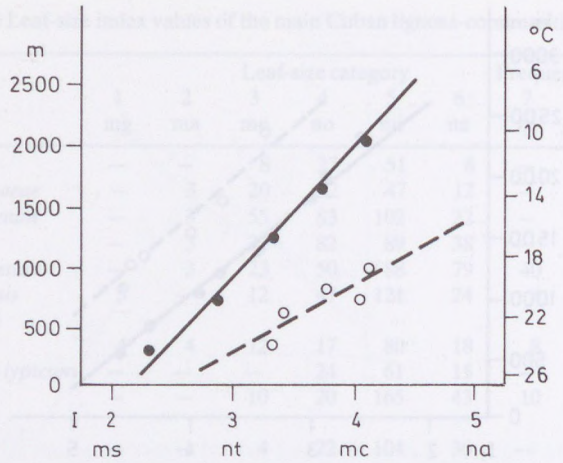


Fig. 85 The general leaf-size index (I_f) of different zonal forest communities in relation to the vertical temperature gradient on granodiorite ——— and on serpentine - - - - - (Abbr. Table 23)

b) The I_f values for the climax noda on both serpentine and other bedrocks linearly decreases as altitude increases or the annual mean temperature decreases, indicating the increasing dominance of nanophylls.

c) There is a remarkable difference between serpentine and all other rocks in the average leaf-size index for climax communities. In serpentine mountains a given leaf-size index may be observed at half the altitude where the same value is regularly indicated on other parent rocks. It means that the rate at which microphyllous vegetation develops along the altitude gradient is twice as high on serpentine than elsewhere.

d) As a consequence of this difference, a given vegetation type or belt occurs on serpentine at about half the altitude where a similar, structurally and physiognomically analogous vegetation is found in other regions.

17.5 "Thorn-index" as an ecological indicator

The above method was also applied to examine the frequency of spinous taxa, expressed by the "thorn-index", I_s, given below:

$$I_s = \frac{F_{spin.} \times 100}{F}$$

where $F_{spin.}$ is the frequency of spinous taxa (each indicated by an ! in the phytosociological table), and F is the sum of all frequency values in the community.

17.5.1 The application of thorn-index to the analysis of lignosa communitites

I_s was calculated for each of the 40 lignosa noda of Table 24. The results suggest that the actual values of I_s are characteristic of the communities. I_s gives valuable information about the water balance and water utilization of communities occurring in regions with similar flora history (e.g. a mountain or an island) or within a climatic zone, and the values may serve as a basis for ranking (Table 26).

17.5.2 Thorn index and humidity/aridity

Figure 86 shows the change of I_s as a function of annual precipitation in 16 climax lignosa noda (7 on serpentine and 9 on limestone). It is demonstrated that:

a) There is a non-linear, inverse ratio between I_s and precipitation in the vegetation of both rock types.

b) The increased xeromorph character of the vegetation on serpentine is reflected by the frequency of spinous plants: at similar amount and distribution of precipitation many more spinous elements occur on serpentine than on other parent material (i.e., I_s is higher in the first case). As aridity increases the difference between the I_s scores for limestone and serpentine also increases.

c) The two curves converge and both approach the Y-axis at an annual precipitation about 3000 mm. In lowlands and hilly regions only such a wet climate can prevent spinous plants from growing in the vegetation of both parent rock types. At lower annual precipitation the two curves continuously diverge. As precipitation decreases the "physiological aridity" of serpentine habitats more rapidly increases than that of the limestone habitats with similar annual precipitation. The difference arising from this "physiological aridity" is equivalent to a

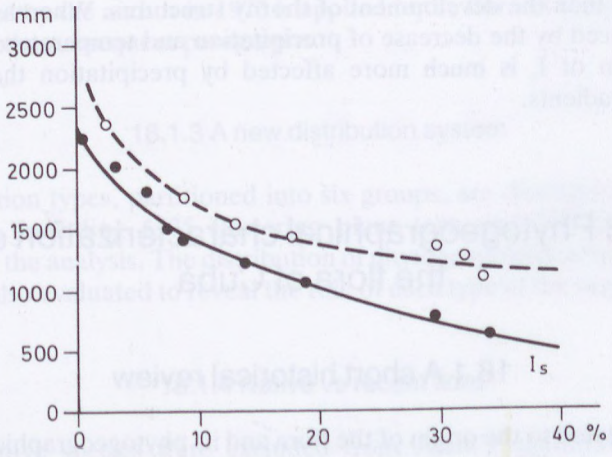


Fig. 86 The general "thorn index" (I_s) of the zonal plant communities in relation to the mean annual precipitation on limestone ——— and on serpentine - - - - -

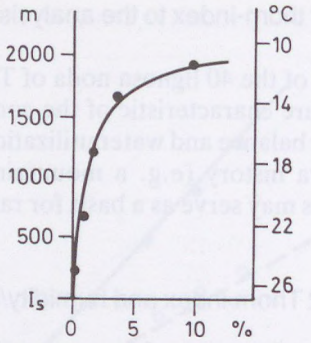


Fig. 87 The general spinosity index (I_s) of zonal plant communities of Cuba in relation to the vertical temperature gradient in an andesite mountain

shortage of 300 mm precipitation at 1500–2500 mm/year, and 400–500 mm if the annual precipitation is less than 1500 mm. This statement is in good agreement with those concluded from a comparative evaluation of the structure of vegetation types *(17.2)*

17.5.3 Thorn-index and temperature

The change of I_s as a function of temperature is shown in Fig. 87. Satisfactory data were obtained only in case of Sierra Maestra. A logarithmic relationship is indicated between I_s and altitude, whereas an inverse proportion between I_s and the annual mean temperature. The curve demonstrates that the relative frequency of spinous elements slowly and evenly changes up to the mossy forest belt and then, over the condensation level, more rapidly increases. The cooler temperature and stronger winds, as a result of the increased altitude, induce a reduction of assimilating surface, rather than the development of thorny structures. Whereas I_f was almost equally influenced by the decrease of precipitation and temperature (Figs 84–85), the distribution of I_s is much more affected by precipitation than by vertical temperature gradients.

18 Phytogeographical characterization of the flora of Cuba

18.1 A short historical review

Questions related to the origin of the flora and its phytogeographic characterization have been raised in several papers (Carabia 1945, Alain 1953, de Ponce-León 1955) published before completing 'The Flora of Cuba'. These papers, however,

contain many unreliable statements and lack precision. The only thorough relevant study is attributable to Alain (1958). Knowing the five volumes of 'The Flora of Cuba', Alain proposed the first phytogeographic categorization of species. Based on these findings many suggestions were made regarding the origin and the history of the flora of Cuba.

18.1.1 Alain's phytogeographic system

Alain (1958) proposed the use of seven distribution categories:

- Endemic species (no further refinement within this category)
- Antillean species: a. Greater Antillean, b. Antillean
- North American species, including three ecological groups: coastal, freshwater and savanna plants
- Central American and Mexican species
- South American species
- American species
- Cosmopolitan species.

18.1.2 Klotz's phytogeographic elements

Howard (1975) distinguishes among eleven geographic distribution types in the flora of Lesser Antilles. An improved version of Howard's chorographical system is outlined by Klotz (1978) who also considers both geographical and ecological aspects. However, these two aspects are confused by Klotz, and the system is too complex as the number of classes is unnecessarily large. Some details of this system are still undeveloped. For these reasons, Klotz's distribution categories will not be used in the present study. Instead, a similar but simpler phytogeographic classification developed by the author in 1973 is applied to the flora of Cuba. This system is introduced in the subsequent paragraphs.

18.1.3 A new distribution system

32 distribution types, partitioned into six groups, are distinguished. The entire known flora, including 6375 flowering plant taxa and 500 pteridophytes, is considered in the analysis. The distribution of phytogeographical types according to life-forms is also evaluated to reveal the role of each type in the vegetation. (Tables 27 and 28)

18.1.4 Native vs recent flora

The adventive species were excluded from Alain's quantitative studies, his conclusions refer only to the native (original) flora of the island. In order to compare his results with the findings of the present survey, the phytogeographical

Table 27 The phytogeographic analysis of the flora

Flora elements / Life-forms	Mg—MsP	Mc—MsP	McP	N—McP	NP	Ms P_{ros}	Mc P_{ros}	EP	LP
Group of endemic species									
Pinar del Rió endemics	177	16	58	5	103	10	3	5	7
Isla de Pinos endemics	1	2	4	—	9	—	1	—	2
Endemics to both Pinar del Rió and Isla de Pinos	3	1	13	13	11	1	1	—	—
Species endemic to western Cuba	5	19	26	11	39	8	3	—	1
Habana endemics	1	—	7	1	11	—	1	—	—
Matanzas endemics	—	1	5	1	5	1	3	2	—
Las Villas endemics	5	9	30	—	40	4	6	1	2
Camagüey endemics	1	—	4	3	13	—	4	—	—
Species endemic to eastern Cuba	8	5	38	9	64	9	10	2	5
Oriente endemics	91	103	346	62	611	30	28	9	46
Pan-Cuban endemics	27	29	62	14	78	6	5	5	17
Total endemics	149	175	593	109	984	69	65	24	80
Group of Caribbean species									
Greater Antillean species	50	45	65	13	64	2	2	15	24
Antillean species	16	21	13	7	16	1	1	3	3
Antillean—Bahamean species	2	5	7	11	7	1	1	2	7
Bahamean species	5	11	7	—	18	—	—	1	1
Species of the Antilles, Florida and SE USA	5	8	2	1	2	1	—	—	2
Species of Cuba the Bahamas and SE USA	—	12	10	3	6	—	1	1	—
Species of Cuba, Florida and SE USA	2	—	2	1	4	—	—	—	1
Northern Caribbean species	10	4	7	6	14	1	3	—	5
Southern Caribbean species	10	5	6	3	9	—	—	1	3
Pan-Caribbean species	23	34	29	8	25	—	2	—	12
Total Caribbean species	123	145	148	53	165	6	10	23	58
Tropical species with wider distribution									
Species of Cuba, the Antille and South America	4	3	4	2	6	—	—	—	8
Species of Cuba, and South America	—	2	2	2	6	—	—	—	5
Neotropical species	33	36	29	14	46	3	—	6	38
Pan-tropical species	2	9	6	5	17	—	—	—	4
Total of widely distributed tropical species	39	50	41	23	75	3	—	6	55
Total of all tropical species	311	370	781	185	1224	78	75	53	193
Group of extratropical species									
North and Central American species	1	—	—	—	—	—	—	—	—
American species	—	—	—	—	1	—	—	—	—
Amphiatlantic and circumpolar species	—	—	—	—	—	—	—	—	—
Cosmopolitan species	—	—	—	—	—	—	—	—	—
Group of adventive species									
Neotropical adventives	19	3	10	6	7	1	—	—	4
Palaeotropical adventives	31	8	7	—	17	2	—	—	10
Extratropical adventives	—	—	—	3	—	—	—	—	2
Total adventives	50	11	17	9	24	3	—	—	16
Total Cuban flora	362	381	798	194	1249	81	75	53	209

of Cuba I. (based on the number of species)

SP	P_{Gr}	ΣP	Ch	H	G	HH	Th	TH–H	L_H	E_H	E_{Ch}	S_{Ch}	ΣH	Total
7	–	221	20	59	4	12	12	3	24	3	2	–	137	358
–	–	19	4	28	2	1	2	–	2	1	–	–	40	59
–	–	33	12	36	2	6	6	1	2	–	–	–	65	98
3	–	105	5	39	7	8	2	2	14	1	–	–	78	183
2	–	23	2	2	–	–	1	1	3	–	–	–	9	32
1	–	19	1	6	1	–	–	–	–	1	–	–	9	28
3	–	100	7	25	6	–	7	1	2	–	1	–	49	149
1	–	26	5	–	–	–	3	1	–	–	–	–	9	35
4	–	154	6	27	–	–	1	–	3	–	–	–	37	191
13	–	1339	61	130	22	1	11	3	48	56	5	1	327	1666
4	–	247	9	50	10	7	11	2	32	11	–	–	132	379
38		2286	132	389	54	35	56	14	130	73	8	1	892	3178
7	1	288	21	85	16	5	16	3	28	33	11	–	218	506
2	1	84	2	31	6	3	6	1	9	11	–	–	69	153
1	–	44	2	10	2	3	4	–	6	4	–	–	31	75
1	–	44	1	10	1	1	2	–	6	4	–	1	26	70
–	–	21	2	39	8	7	3	3	3	2	–	–	67	88
–	–	33	2	17	8	4	8	1	9	–	–	–	49	82
1	1	12	2	60	3	17	7	2	2	2	–	–	95	107
2	–	52	9	34	2	6	13	3	6	1	3	1	78	130
2	–	39	3	18	5	2	5	–	11	16	7	–	67	106
3	1	137	12	67	11	1	22	5	11	23	14	1	167	304
19	4	754	56	371	62	49	86	18	91	96	35	3	867	1621
–	2	29	4	26	8	8	3	–	3	4	–	–	56	85
–	–	17	4	21	5	5	4	–	4	3	2	–	48	65
2	6	213	21	233	14	50	78	10	46	30	13	–	495	708
–	1	44	3	71	9	12	46	4	31	1	–	–	177	221
2	9	303	32	351	36	75	131	14	84	38	15	–	776	1079
59	13	3343	220	1111	152	159	273	46	305	207	58	4	2535	5878
–	–	1	–	19	–	14	6	1	–	–	–	–	40	41
–	–	1	1	23	2	10	7	2	–	–	–	–	45	46
–	–	–	–	5	–	–	–	–	–	–	–	–	5	5
–	–	–	2	8	–	11	6	2	–	–	–	–	29	29
8	1	59	2	17	6	2	15	2	9	–	1	–	54	113
1	8	84	2	45	5	2	26	2	15	1	–	–	98	182
–	–	5	3	23	3	1	37	9	–	–	–	–	76	81
9	9	148	7	85	14	5	78	13	24	1	1	–	228	376
68	22	3493	230	1251	168	199	370	64	329	208	59	4	2882	6375

Table 28 The phytogeographic analysis of

Flora elements	Life-forms	Mg—MsP	Mc—MsP	McP	N—McP	NP	Ms P_{ros}	Mc P_{ros}	EP	LP
Group of endemic species										
Pinar del Rió endemics		2.1	4.2	7.2	2.6	8.2	12.6	5.1	9.6	2.9
Isla de Pinos endemics		0.3	0.5	0.5	—	0.5	—	1.7	—	1.0
Endemics to both Pinar del Rió and Isla de Pinos		0.9	0.3	1.7	1.5	1.0	1.2	1.7	—	—
Species endemic to western Cuba		1.5	2.4	3.3	5.6	3.4	10.0	3.4	—	0.5
Habana endemics		0.3	—	0.9	0.5	1.0	—	1.7	—	—
Matanzas endemics		—	0.3	0.4	0.5	0.4	1.2	3.4	3.8	—
Las Villas endemics		1.5	2.4	3.6	1.0	3.2	5.0	8.5	1.9	1.0
Camagüey endemics		0.3	—	0.5	1.0	1.0	—	5.1	—	—
Species endemic to eastern Cuba		2.3	1.3	2.4	4.6	3.8	7.5	6.7	3.8	2.4
Oriente endemics		21.0	27.0	43.9	31.8	47.0	40.0	39.0	15.5	21.7
Pan-Cuban endemics		6.8	7.6	7.8	7.2	6.9	7.5	6.7	9.6	8.2
Total endemics:		37.0	46.0	72.2	56.3	76.4	85.0	83.0	44.2	37.7
Group of Caribbean species										
Greater Antillean species		14.9	11.8	8.7	6.8	5.7	2.5	3.4	28.9	11.6
Antillean species		4.7	5.5	1.9	3.6	1.4	1.2	1.7	5.8	1.4
Antillean—Bahamean species		0.6	1.3	1.1	5.6	0.6	1.2	1.7	3.8	3.4
Bahamean species		1.5	2.9	0.9	—	1.6	—	—	1.9	0.5
Species of the Antilles, Florida and SE USA		1.5	2.1	0.3	0.5	0.2	0.3	—	—	1.0
Species of Cuba the Bahamas and SE USA		—	3.1	1.3	1.5	0.5	—	1.7	1.9	—
Species of Cuba, Florida and SE USA		0.6	—	0.3	0.5	0.4	—	—	—	0.5
Northern Caribbean species		2.9	1.0	1.1	3.1	1.2	1.3	5.1	—	2.4
Southern Caribbean species		2.9	1.3	0.8	1.5	0.8	—	—	1.9	1.4
Pan-Caribbean species		6.8	8.9	3.8	4.1	2.2	—	3.4	—	5.8
Total Caribbean species:		36.4	37.9	20.2	27.2	14.6	7.5	17.0	44.2	28.0
Tropical species with wider distribution										
Species of Cuba, the Antilles and South America		1.2	0.8	0.5	1.0	0.5	—	—	—	3.9
Species of Cuba, and South America		—	0.5	0.3	1.0	0.5	—	—	—	2.4
Neotropical species		9.8	9.4	3.8	7.3	4.1	3.8	—	11.6	18.4
Pan-tropical species		0.6	2.4	0.8	2.6	1.6	—	—	—	1.9
Total of widely distributed tropical species		11.6	13.1	5.4	11.9	6.7	3.8	—	11.6	26.6
Total of all tropical species		85.0	97.0	97.8	95.4	97.7	96.3	100	100	92.3
Group of extratropical species										
North and Central American species		0.3	—	—	—	—	—	—	—	—
American species		—	—	—	—	0.1	—	—	—	—
Cosmopolitan species		—	—	—	—	—	—	—	—	—
Amphiatlantic and circumpolar species		—	—	—	—	—	—	—	—	—
Total extratropical species:		0.3	—	—	—	0.1	—	—	—	—
Group of adventive species										
Neotropical adventives		5.6	0.8	1.3	3.1	0.6	1.2	—	—	1.9
Palaeotropical adventives		9.1	2.2	0.9	—	1.6	2.5	—	—	4.8
Extratropical adventives		—	—	—	1.5	—	—	—	—	1.0
Total adventives:		14.7	3.0	2.2	4.6	2.1	3.7	—	—	7.7
Total Cuban flora (%)		100	100	100	100	100	100	100	100	100

the flora of Cuba II. (percentages)

SP	P_{Gr}	ΣP	Ch	H	G	HH	Th	TH–H	L_H	E_H	E_{Ch}	S_{Ch}	ΣH	Total
7.6	–	6.3	9.2	4.5	2.4	6.0	3.2	4.7	7.3	1.4	3.5	–	4.8	5.7
–	–	0.5	1.8	2.3	1.2	0.5	0.5	–	0.6	0.5	–	–	1.4	0.9
–	–	1.0	5.3	2.9	1.2	3.0	1.6	1.6	0.6	–	–	–	2.3	1.6
4.5	–	3.1	2.2	3.1	4.2	4.1	0.5	3.1	4.3	0.5	–	–	2.7	2.9
3.0	–	0.7	0.9	0.2	–	–	0.3	1.6	0.9	–	–	–	0.3	0.5
1.5	–	0.5	0.4	0.6	0.6	–	–	–	–	0.5	–	–	0.3	0.4
4.5	–	2.9	2.2	1.9	3.5	–	1.9	1.6	0.6	–	1.7	–	1.6	2.3
1.5	–	0.7	2.2	–	–	–	0.8	1.6	–	–	–	–	0.3	0.5
6.1	–	3.2	2.2	1.4	–	–	0.3	–	0.9	–	–	–	0.9	3.0
19.8	–	37.0	26.7	9.7	13.0	0.5	3.0	4.7	14.6	26.9	6.9	25.0	11.4	26.2
6.1	–	7.2	3.9	4.0	6.0	3.5	3.0	3.1	9.7	5.3	–	–	4.6	5.9
54.6	–	63.0	57.0	30.5	32.1	17.6	15.1	22.0	39.5	35.1	12.1	25.0	30.6	49.9
10.8	4.5	8.8	9.2	6.9	9.5	2.5	4.3	4.7	8.5	15.9	19.0	–	7.7	7.9
3.0	4.5	2.6	0.9	2.5	3.6	1.5	1.6	1.5	2.7	5.3	–	–	2.4	2.4
1.5	–	1.3	0.9	0.8	1.2	1.5	1.1	–	1.8	1.9	–	–	11	1.2
1.5	–	1.3	0.4	0.8	0.6	0.5	0.5	–	1.8	1.9	–	25.0	0.9	1.1
–	–	0.6	0.9	3.1	4.8	3.5	0.8	4.7	0.9	0.9	–	–	2.3	1.4
–	–	1.0	0.9	1.4	4.8	2.0	2.2	1.5	2.7	–	–	–	1.7	1.3
1.5	4.5	0.4	0.9	4.8	1.8	8.6	1.9	3.1	0.6	0.9	–	–	3.3	1.7
3.0	–	1.6	3.9	2.7	1.2	3.0	3.5	4.7	1.8	0.5	5.2	25.0	2.7	2.0
3.0	–	1.2	1.3	1.5	3.0	1.0	1.4	–	3.4	7.7	12.0	–	2.3	1.7
4.5	4.5	4.2	5.3	5.4	6.6	0.5	5.9	7.8	3.4	11.1	24.1	25.0	5.8	4.8
28.8	18.0	23.0	24.6	29.9	37.0	24.6	23.2	28.0	27.6	46.1	60.3	75.0	30.2	25.5
–	9.1	0.9	1.8	2.1	4.8	4.1	0.8	–	0.9	1.9	–	–	2.0	1.3
–	–	0.5	1.8	1.7	3.0	2.5	1.1	–	1.2	1.5	3.5	–	1.7	1.0
3.0	27.5	6.5	9.1	18.8	8.3	25.1	21.2	15.6	14.0	14.4	22.4	–	17.2	11.2
–	4.5	1.3	1.3	5.7	5.3	6.0	12.4	6.3	9.5	0.5	–	–	6.2	3.4
3.0	41.1	9.2	14.0	28.3	21.4	37.7	35.5	21.9	25.6	18.3	25.9	–	27.1	16.9
86.4	59.1	95.3	95.6	88.7	90.5	79.9	73.8	71.9	92.7	99.5	98.3	100	87.9	92.3
–	–	0.03	–	1.5	–	7.1	1.6	1.6	–	–	–	–	1.4	0.7
–	–	0.03	0.4	1.9	1.2	5.0	1.9	3.1	–	–	–	–	1.6	0.7
–	–	–	0.9	0.6	–	5.5	1.6	3.1	–	–	–	–	1.0	0.3
–	–	–	–	0.4	–	–	–	–	–	–	–	–	0.2	0.15
–	–	0.1	1.3	4.4	1.2	17.6	5.1	7.8	–	–	–	–	4.2	1.8
12.1	4.5	1.8	0.9	1.4	3.5	1.0	4.1	3.1	2.7	–	1.7	–	1.9	1.8
1.5	36.4	2.6	0.9	3.6	3.0	1.0	7.0	3.1	4.6	0.5	–	–	3.4	2.8
–	–	0.2	1.3	1.9	1.8	0.5	10.0	14.1	–	–	–	–	2.6	1.3
13.6	40.9	4.6	3.1	6.9	8.3	2.5	21.1	20.3	7.3	0.5	1.7	–	7.9	5.9
100	100	100	100	100	100	100	100	100	100	100	100	100	100.0	100.0

analysis was done in two different ways, one analysis is based on the native flora (NF, 5998 taxa) while the other uses the complete actual flora (AF, 6375 taxa) (Tables 27 and 28)

18.2 Phytogeographical types and their distribution

18.2.1 Endemics

The number of endemic taxa is 3178, 49.9 % and 53 % of the actual and native flora, respectively. This proportion is expected to increase as 90 % of the newly discovered species in Cuba are endemic (Borhidi and Muñiz 1971b, 1972a,b, 1973a,b, 1977a,b,c,d, 1978, Borhidi and Kereszty 1979, Muñiz and Borhidi 1981, Lippold 1970, 1975, 1978a, Hadač 1970, Bisse 1974, 1975, 1980 Fernandez and Borhidi 1983, 1985). As much as 71.9 % of endemics are phanerophytes, the others being herbs. Most endemics are shrubs (984 species, 30.9 %). The microphanerophytes (593 species, 18.4 %) and hemicryptophytes (389 species, 12.3 %) are the second and third largest life-form classes within this chorological category. These figures indicate that communities with rich shrub layers, such as serpentine shrubwoods, scrubs, mogotes, semi-arid and humid montane shrublands were the most important evolutionary centres yielding new species.

18.2.2 The subdivision of endemics

For a better understanding of endemic elements they need to be subdivided so much the more because only a small percentage of them occur in the entire island. The majority of endemics are restricted to a given flora district or a flora sector (local and regional endemics). The system to be discussed below contains some artificial categories since the available distribution data of many species refer to administrative boundaries. Therefore, I had no choice but to make a distinction among the endemics of provinces, and those of western and eastern Cuba and the whole island. (It is noted that the taxa listed in the cenological tables are local endemics grouped (Fig. 88) into 14 districts and 4 regional endemics (Fig. 89) for sectors with natural phytogeographic boundaries. This classification maintains the three major groups mentioned above, because they are natural.)

18.2.3 The distribution patterns of endemics

The endemics are partitioned as follows:

a) **Pinar del Rió endemics.** 358 taxa (AF : 5.7%, NF : 5.9%). The majority are shrubs (103 species, 28.7%), hemicryptophytes (59, 16.3%) and microphanerophytes (58, 15.8%). The percentages of herb lianes dominant in karstic forests (24,

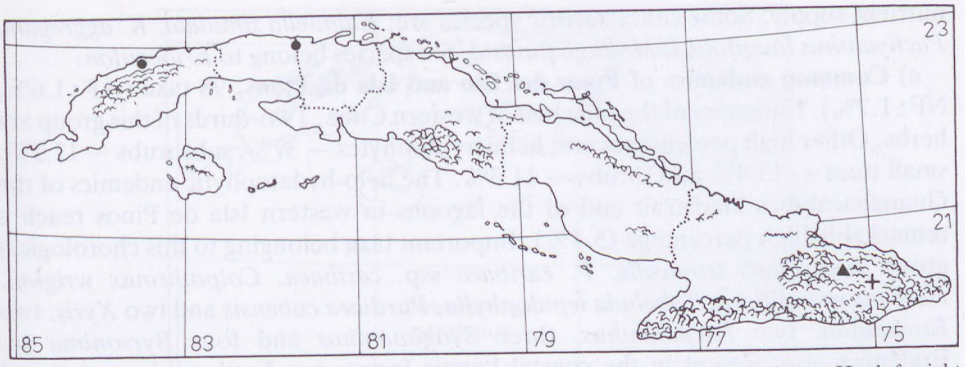


Fig. 88 Distribution of some local endemics in Cuba; left dot: *Phyllacanthus grisebachianus* Hook.f.; right dot: *Coccothrinax borhidiana* Muñiz; triangle: *Eosanthe cubensis* Urb.; cross *Clusia alainii* Borhidi

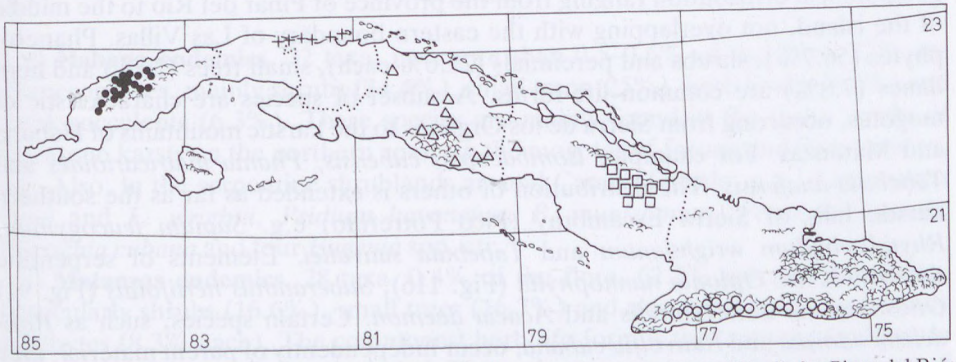


Fig. 89 Distribution of some regional endemics of Cuba; dot: *Gaussia princeps* Wendl. for Pinar del Rió; cross: *Guettarda undulata* Griseb. for Matanzas; triangles: *Machaonia subinermis* Urb. for Las Villas; squares: *Copernicia cowellii* Britt. et. Wils. for Camagüey and circles: *Pinus maestrensis* Bisse for the Maestra range of Oriente (after Klotz 1978, Fernandez and Borhidi 1979)

7%) and of chamaephytes characteristic of coniferous forests (20, 6.1%) are also significant. The ratio of trees and herbs is 60 : 40. A variety of geographic and cenological distribution types are found, they are discussed in detail in chapter 19. Most famous representatives are: *Microcycas calocoma,* a 'living fossil' presumably with a Cretaceous origin, *Quercus oleoides* ssp. *sagraeana, Pachyanthus poiretii, P. tetramerus Neomazaea phialanthoides* and *Spathelia brittonii* (Fig. 89), 9 *Erioculon,* 10 *Pilea,* 10 *Calyptranthes,* 17 *Eugenia* and 8 *Ipomoea* sp.

b) **Isla de Pinos endemics.** 59 taxa (AF : 0.9%), NF : 1.0%). Apart from the only endemic genus *Lepturidium,* these are mostly neoendemics. That is, they are morphologically similar vicariants of the corresponding Pinar del Rio endemics. This fact demonstrates that Isla de Pinos and western Cuba became geographically isolated only at the end of the Quaternary. Since then only a relatively small differentiation of the flora was allowed. 71.4% are herbs, 50% are hemicryptophytes. The shrubs account for 11%, whereas small trees and dwarf shrubs give a total of 7.7%. Most species grow in open pine woodlands on sandy soils with poor

nutrient supply. Some characteristic species are: *Kalmiella simulata, K. aggregata, Pachyanthus longifolius, Mollugo pinosia.* Six species belong to *Eriocaulon.*

c) **Common endemics of Pinar del Rio and Isla de Pinos.** 98 taxa (AF : 1.6%, NF : 1.7%). Endemics of the pine belt of western Cuba. Two-thirds of this group are herbs. Other high percentages are: hemicryptophytes — 37%, subshrubs — 12.2%, small trees — 13.4% and shrubs — 11.3%. The helo-hydatophytic endemics of the Guanahacabibes landstrait and of the lagoons in western Isla de Pinos reach a remarkably high percentage (5.1%). Important taxa belonging to this chorological group are: *Pinus tropicalis, P. caribaea* ssp. *caribaea, Colpothrinax wrightii, Herpyza grandiflora, Tabebuia lepidophylla, Purdiaea cubensis* and two *Xyris,* two *Eriocaulon,* two *Paepalanthus,* three *Syngonanthus* and four *Byrsonima* sp. Endemics also present in the coastal karstic forests are *Erythroxylon roigii* and *Allophylus roigii.* (Fig. 90).

d) **Endemics of western Cuba.** 183 taxa (AF : 2.9%, NF : 3.1%). Species with a geographical distribution ranging from the province of Pinar del Rio to the middle of the island, not overlapping with the eastern boundary of Las Villas. Phanerophytes (56.7%), shrubs and perennials (21.6% each), small trees (20%) and herb lianes (7.8%) are common life-forms. A subset of species are characteristic of mogotes, occurring from Sierra de los Organos to the karstic mountains of Habana and Matanzas. For example, *Bombacopsis cubensis, Phania matricarioides* and *Tabebuia anafensis.* The distribution of others is extended as far as the southern karstic hills of Sierra Escambray (Pico Potrerillo) e.g. *Sapium leucogynum, Rhytidophyllum wrightianum* and *Tabebuia sauvallei.* Elements of serpentine shrublands are *Oplonia nannophylla* (Fig. 116), *Suberanthus neriifolius* (Fig. 91) *Ottoschmidtia dorsiventralis* and *Acacia daemon.* Certain species, such as *Rondeletia odorata* and *Rauvolfia cubana,* occur independently of parent material, they have different ecotypes on each rock type. This chorological category is not equally represented in the provinces. Most species occur in Pinar del Rio (155, 83%) and Las Villas (111, 61.7%). The lowest number of taxa have been indicated from Isla de Pinos (53, 29%) and Matanzas (71, 38%).

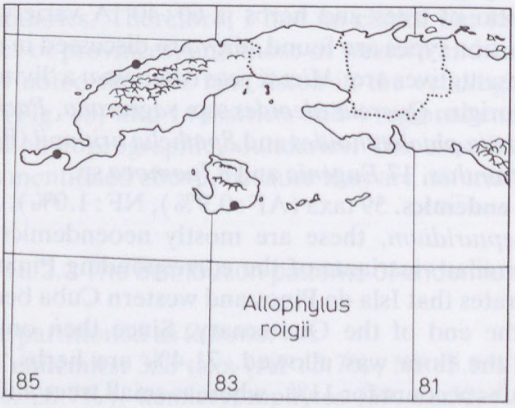


Fig. 90 Distribution of a coastal Pinar del Rio, Isle of Pines endemic *Allophylus roigii* Lippold

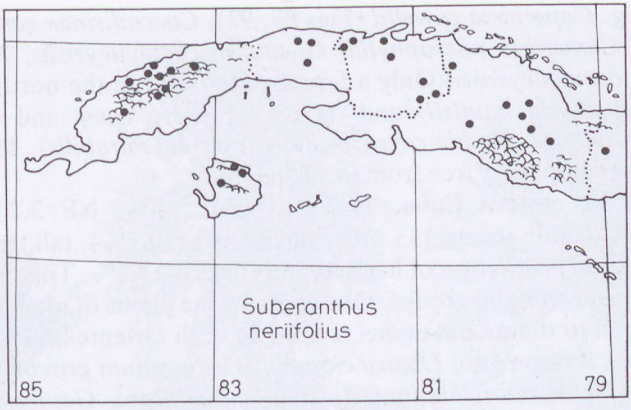


Fig. 91 Distribution of a typical West Cuban endemic *Suberanthus neriifolius* (A. Rich.) Borhidi and Fernandez

e) **Habana endemics.** 32 taxa, not more than 0.5–0.6% of the flora. 72% are phanerophytes, mainly shrubs (34.4%), small trees (25%), herb lianes (9.4%) and trunk-succulents (6.3%). These species are mainly found in the thorn scrubs of limestone karsts on the northern coast, in the mogotes of Jaruco and Somorrostro, etc. Also, in the serpentine shrublands around Campo Florido, e.g., *Leptocereus leoni* and *L. wrightii, Psidium havanense, P. munizianum, Pectis havanensis, Borrichia cubana* and four *Eugenia* spp. etc.

f) **Matanzas endemics.** 28 taxa, 0.4% of the flora. 62.5% are phanerophytes, particularly shrubs (16.6%), small trees (16.7%) and also small palms and woody epiphytes (8.3% each). The commonest herb life-form is the hemicryptophyte, in which 25% of the species are included. These plants occur especially in the karsts of the northern coast (Seboruco plato) e.g. *Guettarda undulata* (Fig. 89) and *Coccothrinax borhidiana* (Fig. 88), and in the arid serpentine vegetation of Canasi e.g. *Borreria matanzasia, Melocactus matanzanus, Buxus gonoclada* and *Moacroton revolutus,* etc.

g) **Las Villas endemics.** 149 taxa, 2.4% of the flora. 67% are phanerophytes including 26% shrubs, 20.7% small trees, 10% tall trees and 6% palms. The largest herbaceous life-form class is the hemicryptophyte (17%). Especially the montane rainforests and seasonal forests of Sierra Escambray are rich in endemics e.g. *Neobracea howardii, Psychotria martii* and four *Dorstenia,* five *Pilea* and four *Calyptranthes* spp. The serpentine hills of Santa Clara and Motembo also have many endemics e.g. *Karwinskia oblongifolia, Eugenia subdisticha, E. clarensis, Guettarda roigiana, G. clarensis, Xylosma acunae, Paspalum motemboënse* and *Scleria motemboënsis* etc. A number of endemic species are found in the arid evergreen forests on the southern rocky coast (four *Cheilophyllum* species) and in the savannas of eastern and western Las Villas (three *Copernicia* species).

h) **Camagüey endemics.** 35 taxa, 0.5% of the flora. 75% are phanerophytes, mainly shrubs (35.5%), small trees (19.5%) and dwarf palms (9.7%). The percentage of subshrubs (16.1%) and annuals (9.7%) is also significant. The majority of these species are endemic to the serpentine region north of the town of

Camagüey, e.g. *Copernicia cowellii* (Figs 89, 92), *Coccothrinax camagüeyana, C. pseudorigida, Cameraria microphylla, Guettarda camagüeyensis, Randia acunae* and *Reynosia camagüeyensis*. Only a few species occur in the northern limestone mountains *(Guettarda munizii)* and on the northern coast and in the islands (*Guettarda lanuginosa, Nashia cayensis* and *Crescentia mirabilis*). The wide plains in the south are completely free from local endemics.

i) **Endemics of eastern Cuba.** 191 taxa (AF: 3.0%, NF: 3.2%). 80% are phanerophytes, mainly shrubs (33.2%), small trees (20.7%), tall trees (10%) and palms (7.7%). The proportion of hemicryptophytes is 13.2%. This category can be partitioned into meaningful groups. One contains the plants of montane rainforests that are endemic to the mountainous regions of both Oriente and Las Villas, e.g. *Magnolia cubensis sensu lato, Ocotea ekmanii, Hedyosmum grisebachii, Meliosma oppositifolia, Ossaea ottoschmidtii, Clidemia capituliflora, Gesneria viridis sensu lato* and *G. clarensis* etc. The endemics of the plains in eastern Cuba have to be distinguished from the previous group. The largest section of flatland endemics includes those found in serpentine areas, e.g. *Coccoloba geniculata, Jacaranda cowellii, Zanthoxylum minutifolium, Daphnopsis oblongifolia, Machaonia microphylla* and *Myrtus anomala* etc. The palms of microphyllous evergreen forests and derived savannas represent a smaller group (*Copernicia gigas, C. vesper-*



Fig. 92 Copernicia cowellii Britt. et Wils. the smallest wax-palm, endemic to the serpentine savannas and scrubs of Camagüey (Photo: A. Borhidi)



Fig. 93 Copernicia rigida Britt. et Wils. a tall wax palm endemic to the eastern lowland of Cuba (Photo: A. Borhidi)

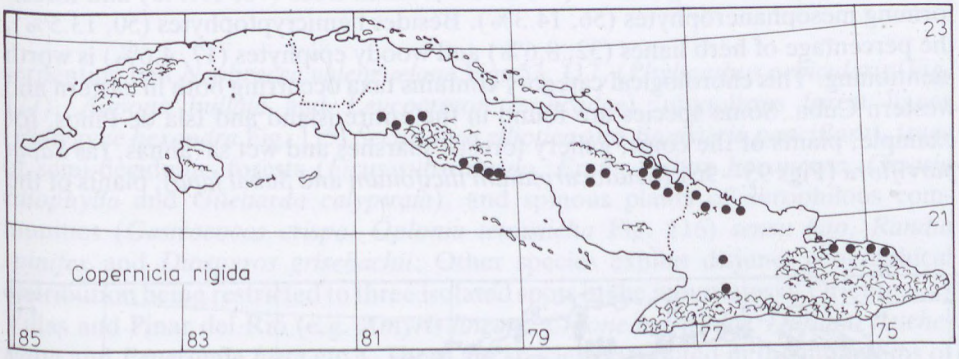


Fig. 94 Distribution of a typical east Cuban endemic *Copernicia rigida* Britt. et Wils. (Dahlgren and Glassman 1963, complemented)

tilionum, C. rigida (Figs 93–94), *C. baileyana* and *C. sueroana* etc.). Others are plants of moist floodplain forests (*Hildegaardia cubensis and Hymenaea torrei* etc.) and xerophilous elements on the southern coast of Oriente and Las Villas (*Rhodocactus cubensis, Harrisia taylori, Pilosocereus brooksianus* and *Bourreria taylori* etc.). Consequently, this chorological type is more frequent in Oriente (123, 92%) and Las Villas (106, 81.5%) than in Camagüey (67, 49%).

j) **Endemics of the former Oriente Province.** 1666 species (AF: 26.2%, NF: 27.8%). Oriente has a key position regarding the development of the flora since 53.4% of the species endemic to Cuba are restricted to barely one-third of the area of this country. Also, Oriente endemics account for one-fourth of the total flora. The majority of them are phanerophytes (78.7%), including 611 shrub species (34.3%), 406 microphanerophytes (25.2%) and 194 mesophanerophytes (11.3%). Particular attention should be paid to the 39 endemic palm species that represent 40% of the palms in this island. Major life-form categories of herbs are the hemicryptophytes (130, 7.8%) and chamaephytes (61, 4%). A considerable part of lianes and epiphytes characteristic of tropical forests are Oriente endemics (94, 6.5% and 70, 4.4% respectively). Many geographic and cenological distribution types can be distinguished, their detailed discussion will be given later, under phytogeographic subprovince C. Genera with many Oriente endemics (numbers given in brackets) are: *Coccothrinax* 17, (see Fig. 109), *Lepanthes* (16), *Pleurothallis* (22), *Pilea* (37), *Coccoloba* (14), *Spathelia,* 10, (see Fig. 109), *Phyllanthus* (36), *Leucocroton* (16), *Buxus* (23), *Ilex* (17), *Calyptranthes,* (25), *Eugenia* (53), *Miconia* (24), *Ossaea* (40), *Lyonia* (21), *Cordia* (23), *Callicarpa* (19), *Tabebuia* (38), *Gesneria* (27), *Rondeletia* (40), *Psychotria* (28), *Senecio* (17), *Eupatorium* (28) and *Vernonia* (35). A random selection of noted species includes *Pinus cubensis, Podocarpus ekmanii, Dracaena cubensis, Illicium cubense, Persea anomala, Alvaradoa arborescens, Euphorbia helenae, Cyrilla cubensis, Bonnetia cubensis, Clethra cubensis, Consolea macracantha, Spirotecoma spiralis, Jacaranda arborea* and *Tocoyena cubensis* etc.

k) **Pan-Cuban endemics.** 379 taxa (AF: 6%, NF: 6.4%). 64.4% are phanerophytes including shrubs (78, 20.8%), small trees (76, 19.7%) and forest-forming mesophanerophytes (56, 14.3%). Besides hemicryptophytes (50, 13.5%), the percentage of herb lianes (32, 8.6%) and woody epiphytes (17, 4.6%) is worth mentioning. This chorological category contains taxa occurring both in eastern and western Cuba. Some species are found in the entire island and Isla de Pinos, for example, plants of the coast, gallery forests, marshes and wet savannas, (as *Sabal parviflora* (Figs 95—96) *Pseudocarpidium ilicifolium* and *Sabal japa*), plants of the

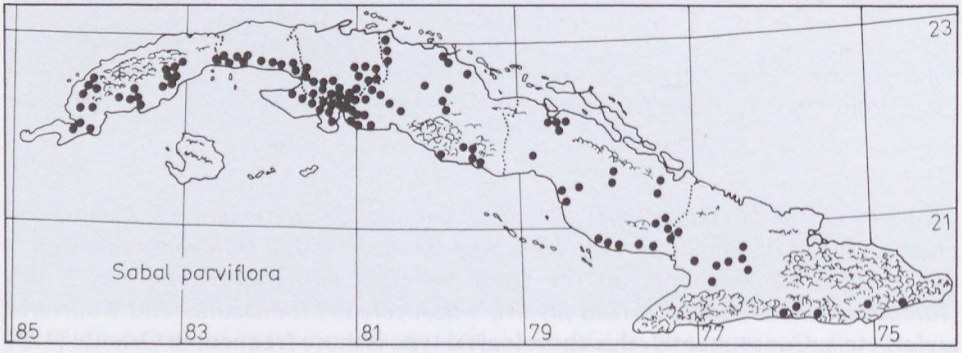


Fig. 95 Distribution of a Pan-Cuban endemic *Sabal parviflora* Becc. (Saakov 1970)



Fig. 96 Wet savanna of Sabal parviflora at the habitat of the original alluvial and swamp forests in the Zapata Peninsula (Photo: A. Borhidi)

serpentine belt *Neobracea valenzuelana* Figs 53, 117, *(Phyllanthus orbicularis* (Fig. 127), *Annona bullata* and *Leucocroton moncadae*), ubiquitous forest lianes (*Platygyne hexandra* Fig. 115) *Securidaca elliptica* and *Banisteria pauciflora*), trees of semi-deciduous forests (*Ficus subscabrida, Erythroxylum havanense, Casasia calophylla* and *Guettarda calyptrata*), and spinous plants of xerophilous communities (*Gastrococos crispa, Oplonia tetrasticha* Fig. 116) *sensu lato, Randia spinifex* and *Diospyros grisebachii*. Other species exhibit disjunct geographical distribution being restricted to three isolated spots in the mountains of Oriente, Las Villas and Pinar del Rió (e.g. *Amyris lineata, Chione myrtifolia, Duranta fletcheriana* and *Peperomia hirta* etc.). There are species distributed in the mountains of Oriente and Las Villas and also in the coniferous region of western Cuba and Isla de Pinos. These are sometimes divisible into vicarious subspecies, e.g. *Hypericum styphelioides* (Lippold 1970). The number of species with a disjunct distribution confined to the ends of the island is also large. Most of these occur in the karstic forests, serpentine communities and mesophyllous forests (*Sloanea amygdalina* and *Mecranium haemanthum*) of Oriente and Pinar del Rió. There is a species endemic to the arid zones of southern Oriente and northern Matanzas *(Croton litoralis sensu lato)* and others present in Oriente and Isla de Pinos (e.g. *Margaritara scandens, Tetramicra simplex* and *Erythroxylon longipes* etc.). Due to the disjunct geographi-

cal distribution of most species, this chorological type is overrepresented in Oriente (83%) and Pinar del Rio (72%) and underrepresented in Las Villas (57%), Habana (53%), Matanzas (36%), Camagüey (33.5%) and Isla de Pinos (30.5%).

18.2.4 Caribbean elements

This group is composed of species originating from within the Caribbean flora region that occur in the islands of Antilles and Bahamas, Central America or the northern part of South America. 1621 species belong to this chorological group (AF : 26.4%, NF : 28.2%). The origin of the flora of Cuba and its relationship to others are well-demonstrated by the fact that approximately three-fourth of the species (AF : 74.3%, NF : 79.2%) are endemic and Caribbean. 53.4% are herbs, the others being phanerophytes. Most species of wide geographical range are herbs whereas the narrowly distributed species are mostly phanerophytes.

The eventful geological past of the Caribbean region, the successive isolation of the archipelago and repeated transgressions of the sea explain that ten different chorological types may be recognized within the Caribbean species group. These are:

a) **Greater Antillean species.** They occur in at least two of four islands, Cuba, Jamaica, Hispaniola and Puerto Rico. 506 species in Cuba (AF : 8.2%, NF : 8.8%). Major life-form categories are: mesophanerophytes (95, 18%), microphanerophytes (77, 15.2%), shrubs (65, 12.9%) and hemicryptophytes (85, 16.8%). The proportion of epiphytes (58, 11.6%) and lianes (52, 10.2%) is relatively large because many rainforest species are of this chorological type. Most Greater Antillean elements of Cuba are also found in Hispaniola (391, 76%). Cuba and Jamaica have 212 (41.9%) species, Cuba and Puerto Rico have only 123 (24.3%) species in common. The Greater Antillean elements are not evenly distributed over the provinces. Oriente is the richest in this chorological type (401, 79%), Las Villas (224, 45%), Pinar del Rió (202, 41%), Habana (150, 31%), Isla de Pinos (110, 22%) and Matanzas (109, 22%) are relatively poor. These percentages clearly indicate that Hispaniola resembles Cuba the most, especially Oriente, in floristic composition. The close relationship between the two floras is confirmed by the presence of 103 species (20.4%) not found outside Oriente and Hispaniola. At the same time, Oriente and Jamaica have as few as 31 (6%) species in common, half of those being epiphytic orchids easily propagated through aerial dispersion. Some important examples are: *Dilomilis montana, Oxandra lanceolata, Phoebe montana, Ocotea cuneata, Brya ebenus, Bernardia dichotoma, Ditta myricoides, Hibiscus elatus, Garrya fadyenii, Dipholis cubensis* and *Chrysophyllum argenteum.*

b) **Antillean species.** Species with geographical range including at least one island from the Greater Antilles and another from the Lesser Antilles. 153 taxa (AF : 2.5 %, NP : 2.7%). 55% are phanerophytes, most of them are medium-sized mesophanerophytes (37, 12.4%), microphanerophytes (20, 13.2%) and shrubs (16, 10.5%). The number of hemicryptophytic taxa is 31 (20.3%). Many lianes (12, 7%) and epiphytes (14, 9.2%) occur since rainforests and mossy forests are rich in Antillean species. The number of Antillean elements decreases from east to the

west in Cuba. 83% of them are present in Oriente, 48% in Las Villas and 45% in Pinar del Rio. The fewest Antillean species are indicated from Matanzas and Isla de Pinos (31% in each). Noted species are: *Prestoea montana, Dichaea hystricina, Oxandra laurifolia, Cinnamomum elongatum, Ocotea leucoxylon, Lonchocarpus domingensis, Savia sessiliflora, Forestiera rhamnifolia, Calophyllum antillanum* and *Plumeria obtusa.*

c) **Antillean-Bahamean species.** This group includes taxa occurring both in the Antilles and in the Bahamas. Two subgroups are distinguished:

- Species of the Greater Antilles and the Bahamas absent from the Lesser Antilles, and
- Species present in both the Lesser and the Greater Antilles and also in the Bahamas.

This chorological type is represented by 75 species in Cuba (1.3% of the flora). 58, 6% are woody plants, mostly microphanerophytes (18, 25%) and woody and herbaceous lianes (13, 17.3%) because this chorological type includes many plants characteristic of coastal evergreen dry forests and other dry shrublands. The hemicryptophytes (10, 13.4%) and mesophanerophytes (8, 10.7%) are the next largest life-form categories. The richest province is Oriente (86%), the percentages are much lower elsewhere, e.g., 65% in Las Villas, 65% in Pinar del Rio and 56% in Camagüey. The relative frequency of Antillean–Bahamean species is the highest in Camagüey (3.11% of the flora). Some important species are: *Juniperus lucayana, Arthrostylidium capillifolium, Cattleyopsis lindenii, Ficus jacquinifolia, Lysiloma latisiliqua, Erythroxylon areolatum, E. confusum, Zanthoxylum cubense, Croton lucidus, Grimmeodendron eglandulosum, Buxus bahamensis, Maytenus buxifolia, Allophylus cominia, Evolvulus arbuscula* and *Oplonia spinosa sensu lato.*

d) **Bahamean elements.** As a matter of fact, this is a marginal case of the preceding category since the common species of Cuba and the Bahamas are included here. Only 70 species (1.1% of the flora). 62.8% are woody plants, mainly shrubs (18, 25.8%), mesophanerophytes (16, 22.8%) and microphanerophytes (7, 10%). Major herbaceous life-forms are the hemicryptophytes (10, 14.3%) and lianes (7, 10%). The number of Bahamean elements tends to decrease towards western Cuba, 75.7% of these species are present in Oriente, 65.7% in Camagüey, 48.5% in Las Villas and 42.8% in Matanzas. The relative frequency is the highest in Camagüey: 3.58% of the flora of this province. Mostly xerophilous species widely distributed in the island belong to this category. Small-leaved species of coastal dry evergreen forests and shrubwoods are: *Picrodendron macrocarpum, Pithecellobium hystrix, Caesalipinia bahamensis, Peltophorum adnatum, Croton rosmarinioides, Bucida spinosa, Lasiocroton bahamensis, Scolosanthus bahamensis* and *Jacaranda coerulea.* Others are characteristic of the serpentine shrubwoods, e.g. *Pseudocarpidium wrightii* and *Tabebuia lepidota.* Some species do not reach the main island, occurring only in the sandbanks parallel to the northern coast of Camagüey, e.g. *Pilosocereus millspaughi, Callicarpa hitchcockii* and *Cestrum bahamense.*

e) **Florida—Antillean species.** Their geographical range includes the Antilles and Florida. some of them may be absent from the Lesser Antilles (e.g. *Roystonea regia*) and others may be found as far as the southern plains of the United States, e.g. *Panicum condensum* and *P. scoparium.* 88 species in Cuba (1.4–1.5% of the

flora). 76% are herbs including 33 hemicryptophytes (44.2%), 8 geophytes (9.4%) and 7 helo-hydatophytes (8%). Of the woody plants the mesophanerophytes comprise the largest group (13, 14.8%). This chorological type is the most common in western Cuba, 65 species are present in Pinar del Rio (75.6 %). The highest relative frequency is indicated from Isla de Pinos (3.21% of the total flora). In addition to the species already given, the following are worth mentioning: *Nelumbo lutea, Swietenia mahagoni, Hypelate trifoliata, Canella winterana, Eugenia axillaris, E. maleolens (buxifolia),* and *Mastichodendron foetidissimum.*

f) **Florida—Antillean—Bahamean elements.** They differ from the preceding type in that the Bahamas are also within their geographical range. 82 taxa (AF : 1.3%, OF : 1.4%). 59.8% are herbs, especially hemicryptophytes (20.7%), lianes (9, 11%) and also geophytes and therophytes (9.8% each). The microphanerophytes (13, 15.9%) and mesophanerophytes (12, 14.6%) are the largest woody life-form classes. The plants of this chorological type are fairly evenly distributed over the country, 65% is the maximum (Habana) and 42% in the minimum (Matanzas). 55–56% of them occur in other four provinces. Many species common to the dry coastal evergreen forests and semi-deciduous forests are included, e.g. *Smilax havanensis, Ficus aurea, Schoepfia chrysophylloides, Zanthoxylum coriaceum, Picramnia pentandra, Alvaradoa amorphoides, Metopium toxiferum* and *Tetrazygia bicolor.*

g) **Species of Cuba, Florida and the south-western United States.** The origin of most taxa is not the tropical Caribbean region but the states of Georgia, South Carolina and Virginia in the temperate zone. It may be assumed that during the cool periods in the Quaternary these species migrated to the south through Florida without getting beyond Cuba. 107 species (AF : 1.8%, NF : 1.9%). 95 species (88.8%) are herbs: 56% are hemi-cryptophytes and 15.8% are helo-hydatophytes. The latter category probably includes species immigrated during the historic ages. They are most frequent in western Cuba, 58% of them are present in Pinar del Rio, 32% in Isla de Pinos. Their relative frequency is also the highest in these two provinces (approx. 2.5% of the flora). On the contrary, this chorological category represents only 4% of the flora in Oriente. The majority of species occur in pine forests and moist savannas, e.g. *Rhus copallina* ssp. *leucantha, Lyonia lucida, Erianthus giganteus, Xyris ambigua, Rhynchospora* spp. *Scleria* spp. and *Hypericum fasciculatum.* Others are aquatic or uliginal, e.g. *Fraxinus caroliniana* ssp. *cubensis* (Fig. 147), *Drosera brevifolia, Cabomba caroliniana, Tradescantia virginiana.* The range of some species is limited to Cuba and Florida. These tropical-subtropical plants are, for example, *Oncidium floridanum, Vallisneria neotropicalis* and *Bourreria cassinifolia* etc.

h) **North Caribbean species.** Their geographic range extends to Central America or Mexico (at least to the Yucatan peninsula) and also to the Bahamas and Florida. At the same time however, they are absent from the southern Caribbean region; Costa Rica, Panama, Colombia and Venezuela. 130 species in Cuba (AF : 2.1%, NF : 2.3%). 60% are herbs, mainly hemicryptophytes (34, 26.2%) and annuals (13, 10%). The proportion of mesophanerophytes (15, 11.6%), micro- and nanophanerophytes (14, 10.8% each) is also remarkable. The provinces of Habana (88, 67.7%) and Pinar del Rio (81, 62.3%) are the richest in species of this

chorological type. Some species, such as *Cassia ekmaniana, Diospyros anisandra, Neomacfadya podopogon* and *Cissus formosa,* are narrowly distributed being present only in Yucatan and the western end of Cuba. *Forchhammeria trifoliata,* a species more widespread in Central America, is to be also mentioned here. Another group with wider geographical range includes trees characteristic of coastal shrubwoods and forests, e.g. *Nectandra coriacea, Lysiloma bahamense, Caesalpinia vesicaria, Guajacum sanctum, Gyminda latifolia, Opuntia dillenii, Bumelia salicifolia, Jacquemontia jamaicensis, Citharexylum caudatum, Rachicallis americana, Strumpfia maritima, Picrodendron macrocarpum* (Fig. 97).

i) **South Caribbean species.** Species common to the Antilles and the northern part of South America, but missing from Central America, Mexico and Florida, that is, they occur exclusively in the southern Caribbean region. 106 species in Cuba (1.8% of the flora). The proportion of phanerophytes is 36.8%, these are largely mesophanerophytes (15, 14.6%). The largest group of herbs is the epiphytes (23 species, 21.7%), outnumbering the hemicryptophytes (18, 17%) and lianes (11, 10.4%). The greatest number of south Caribbean elements occur in Oriente (81, 78%). This number is reduced to 48 in Las Villas and to 44 in Pinar del Rio. Camagüey (20), Matanzas (20) and Isla de Pinos (21) have only quarter the number of species in Oriente. Some characteristic species are *Tillandsia caribaea, T. pulchella, Pleurothallis racemiflora, Amyris balsamifera, Zuelania guidonia, Ixora ferrea, Mikania hastata* and the *Peperomia* spp. etc.

j) **Pan-Caribbean species.** The geographical range of these species includes with some potential breaks the entire Caribbean region from Colombia and Venezuela to Mexico, Florida and the Antilles. The number of such species in Cuba is 304 (AF : 5%, NF : 5.3%). The ratio of phanerophytes and herbs is 45 : 55. The most

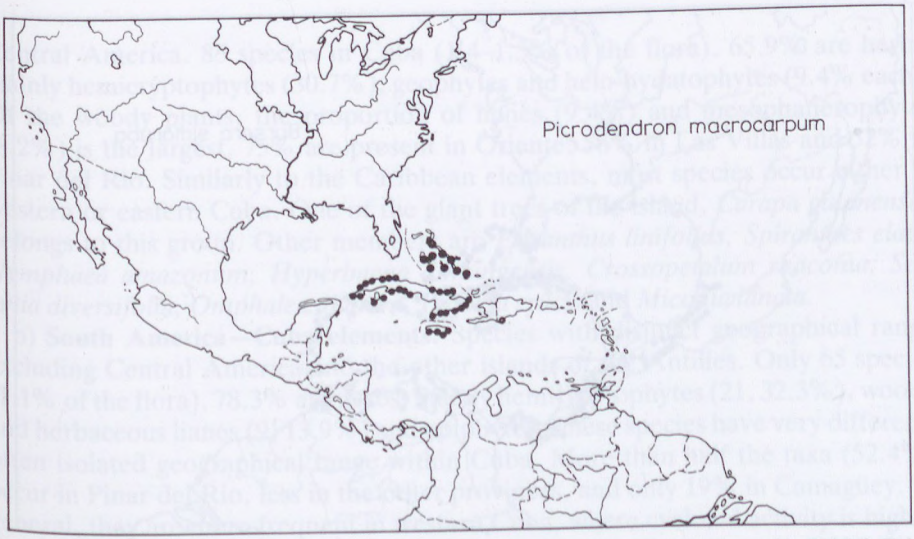


Fig. 97 Distribution of a North-Caribbean element, *Picrodendron macrocarpum* (A. Rich.) Britt. (after Klotz 1978)

frequent life-forms are hemicryptophytes (67, 22.1%), mesophanerophytes (57, 18.8%), epiphytes (37, 12.3%), and microphanerophytes (37, 12.3%). Almost half the species are distributed over the entire country, as the common elements of coastal evergreen forests, semi-deciduous forests and mesophilous forests. Others are found only at one or both ends of the island. As a consequence of this, the largest number of Caribbean species are detected in Oriente (236, 77.6%) and Pinar del Rio (213, 70%). Noted representatives are: *Tillandsia fasciculata, T. valenzuelana, Rhoeo discolor, Bletia purpurea, Celtis trinervia, Pseudolmedia spuria, Chrysobalanus icaco, Pithecellobium arboreum, Bursera simaruba* (Fig. 98), *Haematoxylon campechianum, Byrsonima crassifolia* (Fig. 72), *Ateramnus lucidus, Cyrilla racemiflora, Cupania glabra, Krugiodendron ferreum, Cordia gerascanthus, Antirhea lucida, Erithalis fruticosa, Swietenia mahagoni* (Fig. 99) and nine *Epidendrum* spp.

18.2.5 The group of neotropical elements

The third largest chorological group in the flora of Cuba is represented by 858 species (AF : 14%, NF : 14.9%). These species are derived from tropical South America and migrated to Cuba through many different ways. In Cuba they are among the most widely distributed and most abundant species, contrary to the majority of endemic species. Three types are recognized within this chorological group:

a) **South American—Antillean or eastern neotropical species.** Their geographic range extends from the tropical South America to the Antilles, as far north as Cuba. They may be absent from some islands in between and are completely missing from

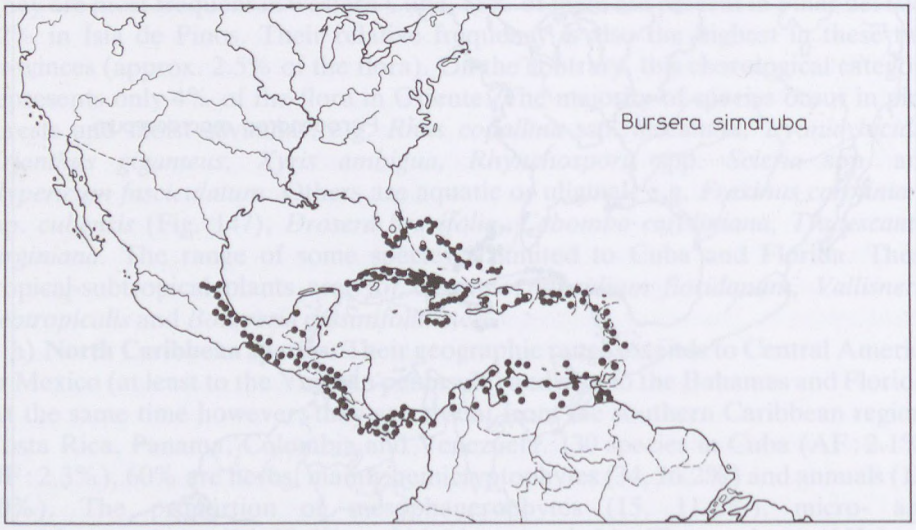


Fig. 98 Distribution of a Pan-Caribbean element, *Bursera simaruba* (L.) Sarg. (Klotz 1978, complemented)



Fig. 99 The most appreciated timber tree of the Cuban flora, the Cuban mahagony *(Swietenia mahagoni)* with fruits in the littoral semi-deciduous limestone forest of Isle of Pine at Punta del Este (Photo: A. Borhidi)

Central America. 85 species in Cuba (1.4–1.5% of the flora). 65.9% are herbs, mainly hemicryptophytes (30.7%), geophytes and helo-hydatophytes (9.4% each). Of the woody plants, the proportion of lianes (9.4%) and mesophanerophytes (8.2%) is the largest. 75% are present in Oriente, 56% in Las Villas and 52% in Pinar del Rio. Similarly to the Caribbean elements, most species occur either in western or eastern Cuba. One of the giant trees of the island, *Carapa guianensis,* belongs to this group. Other members are *Elleanthus linifolius, Spiranthes elata, Nymphaea amazonum, Hyperbaena domingensis, Crossopetalum rhacoma, Serjania diversifolia, Omphalea diandra, Prockia crucis* and *Miconia lanata.*

b) **South America—Cuba elements.** Species with disjunct geographical range excluding Central America and the other islands of the Antilles. Only 65 species (1.1% of the flora). 78.3% are herbs, mainly hemicryptophytes (21, 32.3%), woody and herbaceous lianes (9, 13.9%) and epiphytes. These species have very different, often isolated geographical range within Cuba. More than half the taxa (52.4%) occur in Pinar del Rio, less in the other provinces, and only 19% in Camagüey. In general, they are more frequent in western Cuba, where cyclonal activity is higher than in the east. As mentioned in section *5.3* the chorological characteristics of this group are most obviously explained by assuming cyclonal migration. Examples are:

The genus *Bonnetia* (Figs 100, 101), *Eragrostis salzmannii, Reimarochloa brasiliensis, Sorghastrum stipoides, Bulbostylis paradoxa, Burmannia bicolor, Epidendrum ionosmum, Gossypiospermum praecox, Drosera tenella* and *Byrsonima verbascifolia.*

c) **Neotropical elements.** Widely distributed species occurring in the tropical regions of Central and South America as well as in the West Indies. 708 species in Cuba (AF : 11.5%, NF : 12.3%), representing the second largest chorological type following the Oriente endemics. Their role in the vegetation is even more significant, because the majority of them are ubiquitous meadow and forest species, constant and even dominant in several plant formation. More than 45% occur in every province, the number of species in Oriente is 552 (79.5%). 70% are herbs, including hemicryptophytes (233 species, 32.9%) and therophytes (78 species, 11%). The groups of woody and herbaceous lianes (84 species, 11.9%), mesophanerophytes (72, 10.2%), epiphytes (49, 6.9%) and helo-hydatophytes (50, 7.1%) are also large. Aquatic and uliginal species belonging to this group are *Typha domingensis, Gynerium sagittatum, Limnocharis flava, Thalassia testudinum* and *Nymphaea blanda.* Plants of the littoral zone are *Batis maritima, Coccoloba uvifera* and *Avicennia germinans.* Examples for ubiquitous forest species are *Pharus glaber, Olyra latifolia, Lasiacis divaricata, Bocconia frutescens, Cecropia peltata, Trichilia hirta, Urera baccifera, Chlorophora tinctoria, Clusia rosea, Tillandsia usenoides.* Some species of the coastal and rocky dry and evergreen forests: *Capparis flexuosa, C. cynophallophora, Guajacum officinale, Amyris elemifera* and

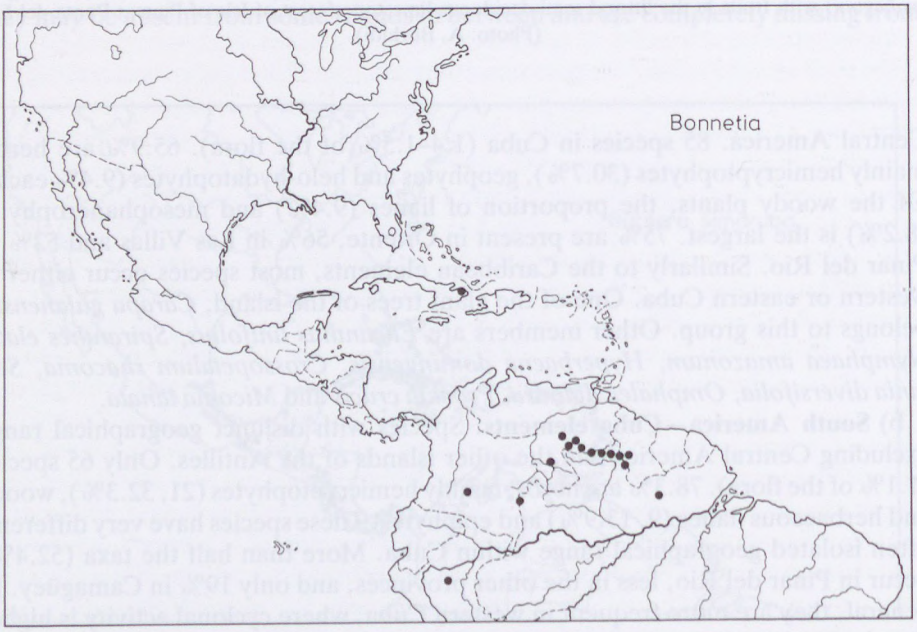


Fig. 100 Geographical distribution of a Cuban–South American genus, *Bonnetia* Mart. et Zucc. (Kobuski 1948)



Fig. 101 Bonnetia cubensis (Britt.) Howard an endemic tree of the sclerophyllous montane rain forests of the Moa range at Alto de la Iberia (Photo: A. Borhidi)

Andira inermis. Plants of semi-deciduous and mesophilous forests: *Cedrela mexicana, Guarea guidonia, Zanthoxylum martinicense, Hymenaea courbaril, Psidium guajava, Faramea occidentalis, Amaioua corymbosa, Alibertia edulis* and *Chiococca alba* (Fig. 102). Rainforest elements: *Brunellia comocladifolia, Weinmannia pinnata* and *Didymopanax morototoni*. Savanna species are *Samanea saman* and *Curatella americana* etc.

18.2.6 Pan-tropical elements

In a wider sense this group includes species occurring in the tropical or subtropical regions of the world. Many subgroups can be distinguished, for example, African-Neotropical, Asiatic-Neotropical, Pacific-Neotropical etc. and the group of Palaeotropical species also present in the Antilles, e.g. *Phaius tankervilliae*. This classification is not detailed here, since these elements appear less significant in the study of the origin and development of the Cuban flora. The number of pan-tropical *sensu lato* species is 221 (AF : 3.6%, NF : 3.8%). 80% are herbs. Major life-form categories are the hemicryptophytes (71, 32.9%), therophytes (46, 20.8%) and lianes (35, 15.8%). Most of them are distributed all over the country, more than 55% of the pan-tropical species occur in every province. Oriente is the richest in pan-tropical species (187, 85.6%). Plants of the seashore and mangrove vegetation: *Philoxerus vermicularis, Sesuvium portulacastrum, Canavalia maritima, Ipomoea pes-caprae, Leucaena leucocephala, Rhizophora mangle* and *Conocarpus erecta*. Others, such as *Paspalum vaginatum, Fimbristylis*

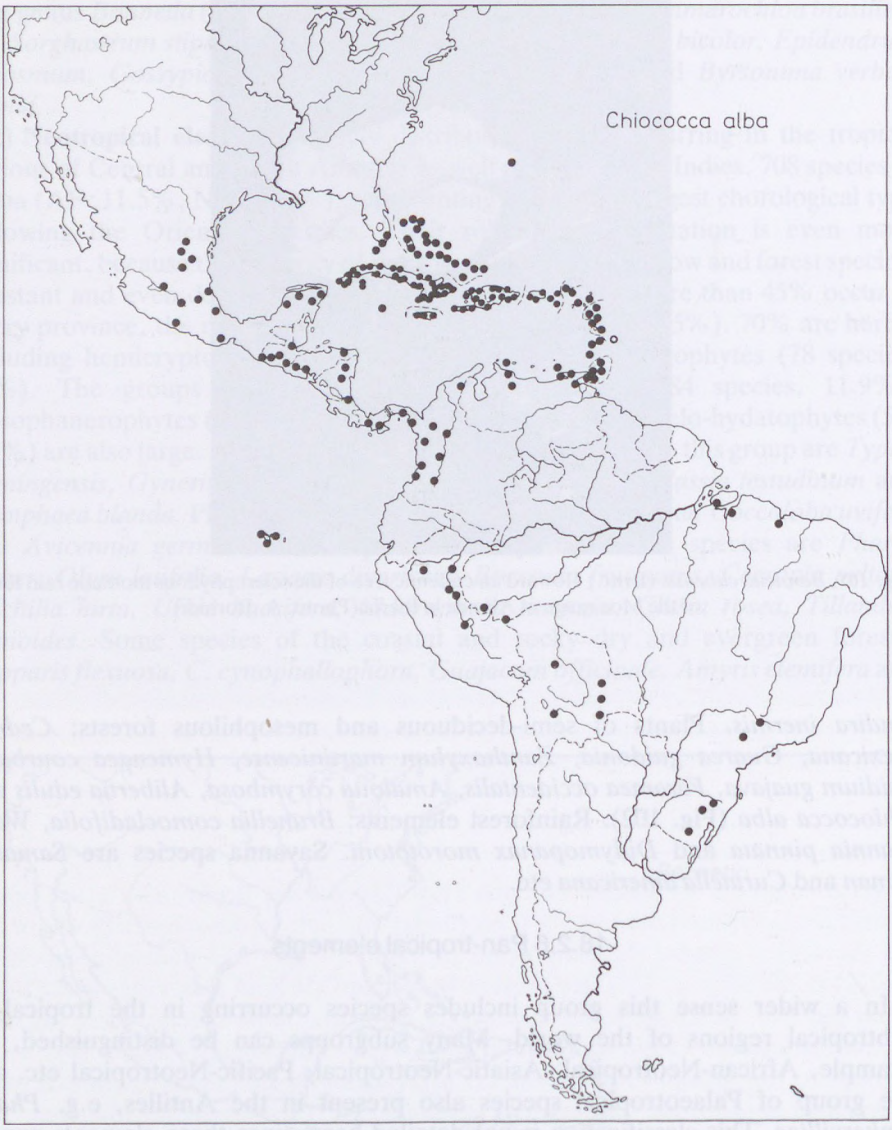


Fig. 102 Geographical distribution of a neotropical element. *Chiococca alba* (L.) Hitchc. (Svenson 1946)

squarrosa, F. annua, F. spathacea and sixteen *Cyperus* spp. occur in swampy meadows. Some trees *(Ceiba pentandra, Acacia farnesiana),* lianes (*Caesalpinia crista* and *C. bonduc, Abrus precatorius* and sixteen *Ipomoea* sp. and weeds (*Mimosa pudica* and *M. pigra*) are also worth mentioning.

18.2.7 The group of extratropical species

Species assigned to this chorological group have a tropical geographic range significantly extended to the temperate zone, or vice-versa. Four types are recognized in Cuba including 121 species altogether (1.6% of the flora). The overwhelming majority of species are herbs (119, 98.4%). The types are as follows:

a) **North and Central American species.** 41 taxa (0.7% of the flora), herbs with one exception. 46.4% are hemicryptophytes and 32.2% are helo-hydatophytes. Their distribution in Cuba is sporadic, usually restricted to one province. Most species are found in western Cuba (52.7% in Pinar del Rio, 45.7% in Habana). Important representatives are *Panicum virgatum, Andropogon virginicus, Scirpus olneyi, S. validus, Proserpinaca palustris* and *Teucrium canadense.*

b) **American species.** Besides the neotropical region these are also found in the temperate zone of South and North America. 46 taxa (0.7% of the flora). 45 species are herbs (97.8%), mainly hemicryptophytes (23, 50%), helo-hydatophytes (10, 21.8%) and therophytes (7, 15.2%). These are concentrated to western Cuba, the greatest number of species occur in Habana (76.6%) and Pinar del Rio (68.1%), while Oriente (38.3%) and Camagüey (27.7%) have much less. *Brachiaria extensa, Fimbristylis spadicea, Pontederia lanceolata, Nymphaea odorata, Jussiaea peruviana* und *Teucrium cubense* are examples.

c) **Amphiatlantic and circumpolar species.** These otherwise well-separated types are combined to simplify the discussion. Only five herbs are present in Cuba (.08%), all hemicryptophytes. The circumpolar species *(Drosera rotundifolia, D. intermedia)* occur exclusively in the bogs of western Cuba. The amphiatlantic species (*Eleocharis parvula, Salicornia perennis* and *Suaeda fruticosa*) are more widely distributed seashore plants.

d) **Cosmopolitan species.** Their number is 29 (.5%). All herbs, including aquatic and uliginal plants and weeds, e.g. *Najas marina, Ruppia maritima, Lemna trisulca, Cynodon dactylon, Solanum nigrum, Datura stramonium* and *Ambrosia elatior.*

18.2.8 Adventive elements

The number of cultivated and introduced species naturalized in Cuba is relatively high (376, AF: 6.1%). 39.4% are phanerophytes, especially mesophanerophytes (61, 16.3%). The majority of herbs are hemicryptophytes (85, 16.3%) and therophytes (78, 20.6%). According to origin three groups are distinguished.

a) **Neotropical adventives.** 113 species (1.8% of the flora). 52.2% are woody plants, 2.5% are mesophanerophytes and 14.4% microphanerophytes. Most herbs are hemicryptophytes (15%), therophytes (13.2%), lianes (8%) and tree-sized forbs (7.1%). Examples are *Ananas comosus, Agave furcroydes, Castilloa elastica, Myroxylon balsamum, Annona muricata, Euphorbia pulcherrima, Theobroma cacao, Sterculia apetala, Ipomoea batatas, Anacardium edule* and *Thevetia peruviana.*

b) **Palaeotropical adventives.** 182 species (3% of the flora). 46% are woody plants, mainly mesophanerophytes (39, 21.5%). Dominant herbaceous life-forms

are the hemicryptophytes (24.9%), therophytes (14.3%) and lianes (8.2%). For simplicity, no distinction is made among adventives of African, Asiatic and Pacific origin. Moreover, species introduced from Australia, New Zealand and the tropical East Asia are also included here. Some examples: *Dichrostychys cinerea* (a deleterious tree-weed epidemic in Cuba), *Tamarindus indica, Delonix regia, Indigofera tinctoria, Ricinus communis, Euphorbia lactea, Cryptostegia grandiflora, Catharanthus roseus, Lagerstroemia indica, Terminalia catappa, Syzygium jambos, Bambusa vulgaris, Cocos nucifera, Artocarpus incisa, Musa paradisiaca, Casuarina equisetifolia* and eight *Citrus* spp.

c) **Extratropical adventives.** Vegetable plants, ornamental garden plants and weeds originating from Eurasia or North America. 81 species (1.3% of the flora). 93.8% are herbs, mainly annuals and perennials (46, 56.8%) and hemicryptophytes (23, 28.4%). Particularly widespread in the province of Habana due to intensive anthropogenic effects and commercial transport. Some examples are *Lolium temulentum, Medicago lupulina, Hypericum perforatum, Daucus carota, Senecio vulgaris* and *Taraxacum officinale* etc.

18.3 A phytogeographical analysis of the pteridophytes of Cuba

Only twelve types are distinguished within this chorological group since Cuba, as well as the other countries of the Caribbean, are much less intensively surveyed for ferns than for flowering plants. Therefore, our present knowledge is not sufficient for subdividing even the endemics. Nevertheless, it is possible to make some general comments regarding the pteridophyte "flora" of Cuba. The proportion of endemics is much lower, whereas that of the widely distributed species is much higher than in case of the flowering plants. The reason is that pteridophytes are much older (time factor) and their migratory characteristics are more advantageous (Table 19).

18.3.1 Endemics

53 species (10.6% of the flora). Alain (1958) estimated the number of endemic species at 64 (12–13%). Proctor (1971/b and Walker (1954), however, showed that many taxa considered earlier as Cuban endemics are in fact present in Jamaica as well. Mainly terrestrial hemicryptophytic and geophytic ferns (19, 35.8% and 13, 24.5%), but the percentage of tree ferns (5, 9.5%), epiphytic ferns (7, 13.2%) and lianes (5, 9.5%) is also significant, indicating a relatively early isolation of montane rainforests. Examples are: *Isoëtes cubana, Alsophila strigillosa, Anemia cajalbanica, A. coriacea, A. cuneata, Cyathea araneosa, C. cubensis, Dryopteris crypta, Polypodium flexuosum, Polystichum decoratum, Gymnogramma cubensis, Lindsaya cubensis* and *Lygodium cubense* etc.

18.3.2 Caribbean species

184 species altogether (36.8% of the flora). This chorological group may be subdivided into five types as follows:

a) **Greater Antillean elements.** 77 species (15.4% of the flora). Mainly hemicryptophytes (22, 28.5%) and geophytes (19, 24.7%), although the number of epiphytes (13, 16.9%), chamaephytes (11, 14.3%) and tree ferns (8, 10.4%) is also remarkable. More common species are *Selaginella stolonifera, Botrychium underwoodianum, Adiantopsis paupercula, Cheilanthes harrisii, Cyathea furfuracea* (Fig. 103), *C. pubescens, Diplazium unilobum, Elaphoglossum eggersii, Fadyenia hookeri* and *Maxonia apiifolia* etc.

b) **Antillean elements.** 38 species (7.6%). More than half the species are geophytes (12, 31.5%) and epiphytes (9, 23.6%). The hemicryptophytes (6, 15.8%), chamaephytes (5, 13.2%) and tree ferns (4, 10.6%) are less significant. Species belonging to this group are *Thelypteris pinnata, Stenochlaena sorbifolia, Pityrogramma sulphurea, Oleandra articulata, Odontosoria aculeata, O. uncinella, Hymenophyllum lanatum, Elaphoglossum martinicense, Dryopteris hastata, Cyathea arborea* (Figs 104, 105).

c) **Northern Caribbean elements.** 27 species (5.4% of the flora). Mostly hemicryptophytes (8, 33.4%), geophytes (8, 29.6%) and epiphytes (4, 14.8%). *Cyathea tenera, Adiantum deltoideum* and *Lycopodium montanum* are examples.

d) **Southern Caribbean elements.** Only five species, accounting for 1% of the flora. No tree-sized ferns and lianes occur in this group. Examples: *Adiantum cristatum, Dryopteris incisa* and *Hymenophyllum axillare.*



Fig. 103 Geographical distributions of a typical element of the Greater Antilles, *Cyathea furfuracea* Bak. (Tryon 1976)

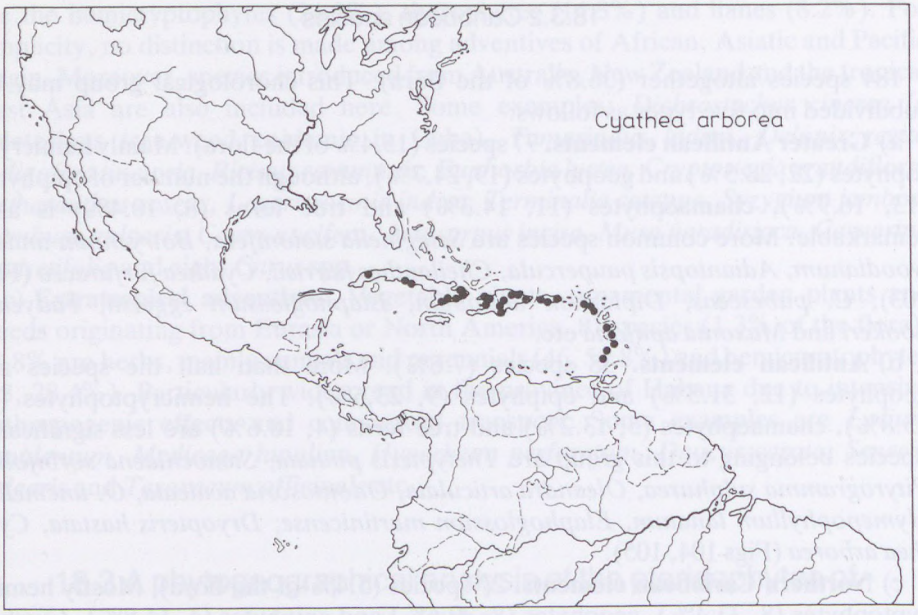


Fig. 104 Geographical distribution of an Antillean element, *Cyathea arborea* (L.) Sm. (Tryon 1976)

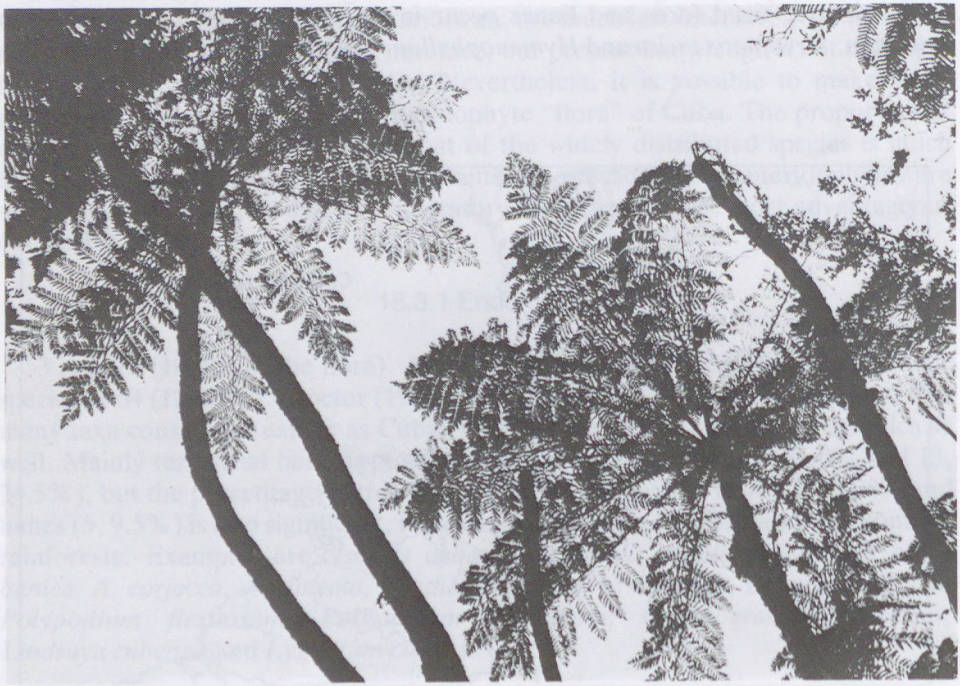


Fig. 105 Silhouettes of the leaf crown of the *Cyathea arborea* (L.) Sm. tree ferns on the Gran Piedra, Maestra range, at 1100 m a.s.l. (Photo: A. Borhidi)

e) **Pan-Caribbean elements.** 28 species (5.6% of the flora). Mainly hemicryptophytes (9, 32.1%) and geophytes (6, 21.4%), and also epiphytes (5, 17.9%), chamaephytes and tree ferns (3, 10.7% each). Noted species are *Alsophila aspera, Asplenium dentatum, Bolbitis nicotianifolia, Diplazium arboreum, Dryopteris sancta, Paltonium lanceolatum, Polypodium costatum, Hymenodium crinitum* etc.

f) **Central American elements, not found outside Cuba in the Antilles.** Nine species (1.8%). Six epiphytic rainforest ferns are of this chorological type. Examples: *Alsophila myosuroides, Anemia wrightii, Dryopteris asterothrix, Elaphoglossum revolutum* and *Hymenophyllum contortum.*

18.3.3 Neotropical elements

The largest chorological group of pteridophytes with 189 species (37.8%). Three life-forms, the hemicryptophytes (51, 27%), epiphytes (50, 26.4%) and geophytes (48, 25.4%) are fairly evenly represented. Other important life-forms are the tree ferns (14, 7.5%) and lianes (12, 6.3%). Some examples are *Lycopodium taxifolium, Equisetum giganteum, Marattia alata, Acrostychum danaifolium, Alsophila aquilina, Anemia adiantifolia. Asplenium cristatum, Blechnum occidentale, Cyathea arborea, Dennstaedtia cicutaria, Doryopteris pedata, Elaphoglossum firmum, Hemionitis palmata, Hymenophyllum sericeum, Lindsaya stricta, Nephrolepis rivularis, Peltapteris peltata, Pityrogramma tartarea, Polypodium phyllitidis* and *Rhipidopteris peltata* etc.

18.3.4 American species

These elements also occur in the temperate zone of the continent. Two species, *Azolla caroliniana* and *Selaginella apus* accounting for 0.4% of the flora.

18.3.5 Pantropical elements

54 species (10.8% of the flora). Significant life-forms are the hemicryptophytes and geophytes (15, 27.8% each) and also the chamaephytes (12, 22.3%) and epiphytes (10, 18.5%). Examples are *Lycopodium cernuum, Psilotum nudum, Acrostychum aureum, Asplenium cuneatum, Blechnum serrulatum, Dryopteris dentata, Elaphoglossum hirtum, Hymenophyllum polyanthos, Pityrogramma calomelanos, Polypodium duale* and *Trichomanes rigidum.*

18.3.6 Cosmopolitan elements

13 species (2.6% of the flora). Mainly geophytes (38.5%) and chamaephytes (30.7%) and also some aquatic ferns. *Lycopodium clavatum, Botrychium virginianum, Ophioglossum vulgatum, Adiantum capillus-veneris, Osmunda regalis, Pteris longifolia* and *Salvinia natans* are examples.

18.4 Some special distribution patterns

Further valuable information may be revealed regarding the origin and distribution of the flora if the importance of each chorological element in the provinces (floristic subsets) and in the whole country (floristic universal set) is examined and these importance values are compared. The results are summarized in Table 28 and Fig. 106. The latter illustrates the percentage distribution of chorological elements in the complete set of species, Fig. 106 shows the same for the flora of each province. In case of floristic subsets empty columns indicate chorological elements with a percentage lower than in the complete flora. Full columns refer to those having larger percentage and, consequently, an increased "role" in the corresponding subflora.

18.4.1 The importance of endemic and Neotropical elements

The most striking characteristic of the flora is the different role of endemics and Neotropical elements. Comprising two-third of total flora, these two chorological types are predominant in Cuba. More than half the species are endemics, many of them being restricted to one province (local endemics: El). Oriente is the only province where the percentage of local endemics exceeds the proportion of locals in the entire flora. The other extreme is represented by the Pan-Cuban elements (PCu) with local percentages always larger than their proportion in the total. The same holds true in respect of Neotropical (NTr), pan-tropical (PTr) and Antillean—South American (ASA) elements.

18.4.2 Greater Antillean elements and the species of Cuba, Florida and the south-eastern States

There is also a big contrast between the Greater Antillean species (GA) and those distributed in Cuba, Florida and the southeastern United States (CuFU). The first group is relatively more important only in Oriente and Las Villas. The other type however, has a percentage larger in western Cuba (Pinar del Rió and Isla de Pinos) than in the whole country.

18.4.3 Extratropical and cosmopolitan elements

The fact that the percentage of North American extratropicals (NAm) and cosmopolitans (Csm) is larger only in Habana and Matanzas than their quota in the complete flora also deserves attention. This is a consequence of the intensive anthropogenic influence on the flora of these two provinces.

18.4.4 Conclusions

It may be concluded from the foregoing that

- The majority of endemics came into being under extreme environmental conditions and became highly specialized and isolated. They were unable to colonize larger areas having unsufficient space or time, or migratory power and competitiveness.
- The widely distributed species originated from outside Cuba were more adaptive and competitive. These euryoecic species aggressively penetrated to Cuba and took a prominent part in the evolution of flora and vegetation.
- The island is not homogeneous in respect of flora evolution: there are at least two ancient and possibly some younger evolutionary centres. The largest and, probably, the oldest centre is Oriente, although the flora of western Cuba (Pinar del Rio and Isla de Pinos) is also of similar age and significance.

18.5 Chorological types of bryophytes

Crosby (1969) analyzed the geographic range of 230 selected moss species and came to conclusions concerning the distribution of mosses in the Antilles. Duarte (1979), at a conference held at the Botanical Institute of the Cuban Academy of Sciences, presented a new chorological analysis of the mosses of Cuba.

19 The phytogeographic characteristics of Cuba

19.1 Some outstanding phytogeographic features of Cuba

The floristic analysis and the study of chorological types suggest that the most important and most typical characteristics of the flora of Cuba are as follows: 1. Dominance of endemics, 2. Disjunction, 3. Vicariancy, 4. Inversion, 5. Microphyllia, 6. Micranthia, 7. Relics, and 8. Vulnerability.

19.2 The dominance of endemics

As shown earlier (Table 28), the endemics comprise a total of 51.4% native flora. This is outstandingly the largest percentage in the Antilles. Marie-Victorin and León (1942, 1944, 1956) attributed this to the high Mg and Fe concentrations of "limonite areas". According to Alain's (1958: 16) hypothesis, the reasons are the early isolation of the flora during the upper Miocene, the diverse edaphic conditions of the country and the arid climate of certain areas.

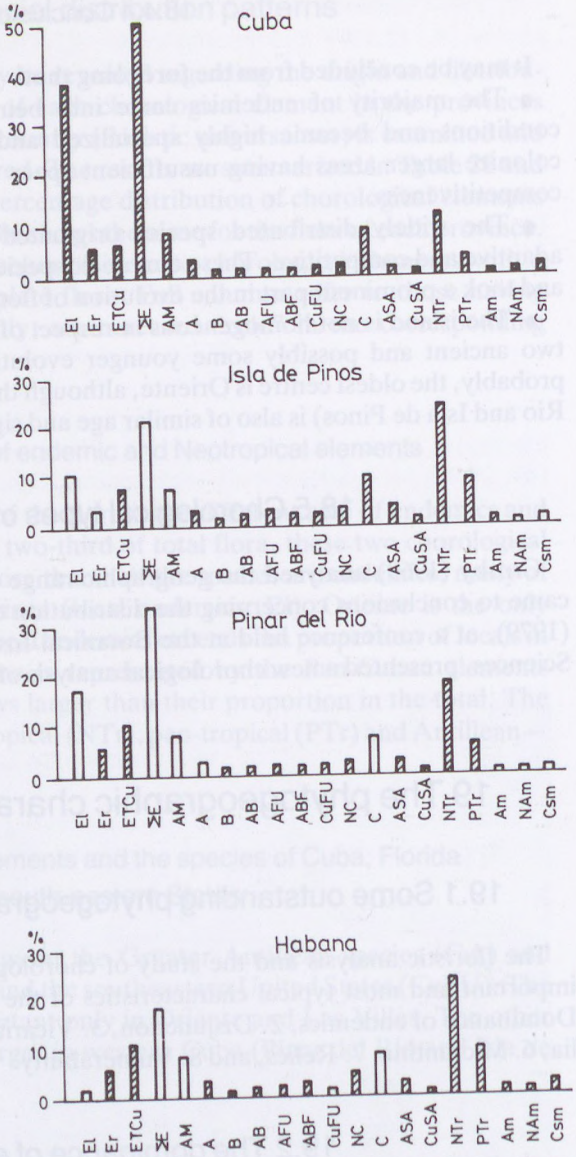
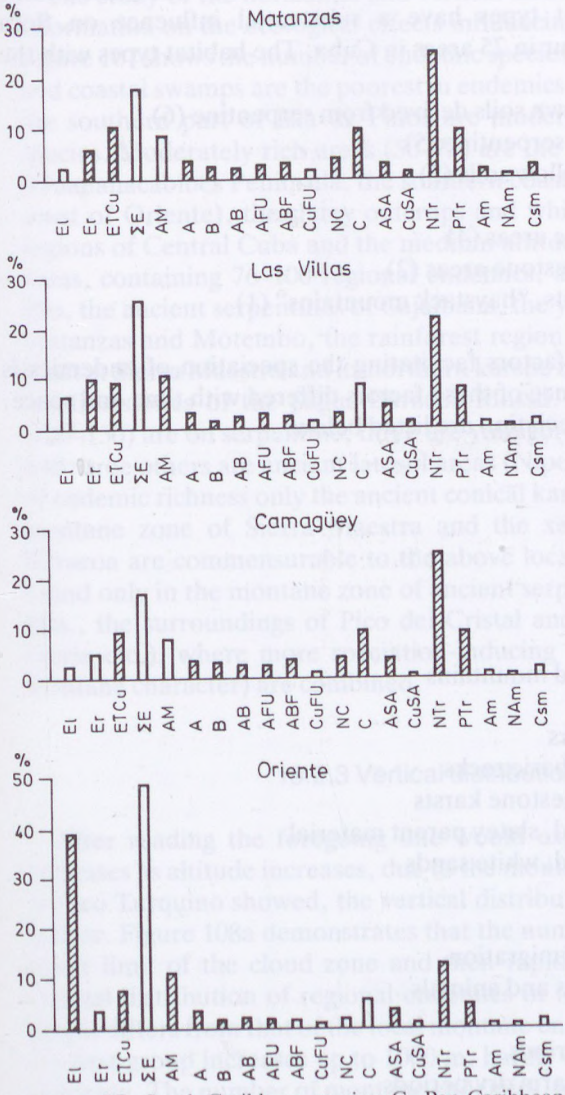


Fig. 106 Chorological analysis of the flora of Cuba and the partial florulas of the provinces. Abbreviations: El=endemic local; Er=endemic regional; ETCu=Pan-Cuban endemics; ΣE=all the endemics of Cuba; AM=species of the Greater Antilles; A=Antillean species; B=species of Cuba and the Bahamas; AB=species of the Antilles and the Bahamas; AFU=species of the Antilles, Florida and Southern United States; ABF=species of the Antilles, Bahamas and Florida; NC=North-Caribbean



species; SC=South-Caribbean species; C=Pan-Caribbean species; ASA=species of the Antilles and South America; CuSA=species of Cuba and South America; NTr= Neotropical elements; PTr=Pan-tropical elements; Am=American species; NAm=North American species; Csm=Cosmopolitan species

19.2.1 The ecology of endemic speciation

In examining the ecological background of the speciation of endemics Muñiz (1970) found that eight habitat types have a substantial influence on flora development. These habitats occur in 25 areas in Cuba. The habitat types with the number of areas in brackets are:

- Ferritic soils and tropical brown soils derived from serpentine (6)
- Ferrallitic soils derived from serpentine (5)
- Oligotrophic quartz-allitic yellow soils (2)
- White sandy habitats (2)
- Young, dry, coastal limestone areas (4)
- Young, montane, karstic limestone areas (2)
- Old, montane limestone karsts, "haystack mountains" (1)
- High montane areas

No doubt that the number of factors facilitating the speciation of endemics is large. The influence and importance of these factors differed with time and space. Factors potentially influencing speciation are listed below:

Insularity and isolation

Geographic factors
— external (insularity)
— internal (isolation)
Ecological factors
Orographic factors
— alternation of lowlands and mountains
— great relief-energy
Geological and edaphic factors
— serpentine and other ultrabasic rocks
— frequent occurrence of limestone karsts
— frequent occurrence of acid, slatey parent material
— frequent occurrence of acid, white sands
Sociological factors
— community mosaics
— communities as barriers of migration
— interactions between plants and animals

Climatic changes

Alternation of wet and dry periods
Alternation of cool wet and warm dry periods

Genetic factors

Mutagenic speciation
Hybridogenic speciation, introgression
Genetic drift

19.2.2 Horizontal distribution of endemics

The study of the horizontal and vertical distribution of endemics yields valuable information on the ecological effects influencing speciation and geographic range. Figure 107 shows the number of endemic species per area. The intertidal mangroves and coastal swamps are the poorest in endemics. The lowlands of Central Cuba and the southern part of Isla de Pinos are moderately poor, having 25–50 endemic species. Moderately rich areas (50–75) are the younger coastal limestone habitats (Guanahacabibes Peninsula, the southern coast of Las Villas and the northwestern coast of Oriente), the slatey outcrops and white sands in Isla de Pinos, the hilly regions of Central Cuba and the medium altitude zone of Sierra Maestra. The rich areas, containing 76–100 regional endemics, are the slatey outcrops of Pinar del Rio, the ancient serpentines of Cajalbana, the younger serpentine zone of Habana, Matanzas and Motembo, the rainforest region of Sierra Escambray, the southern coast at Sierra Maestra and its northern karstic zone (Guisa—Baire) in Oriente, and the limestones of the Sagua-Baracoa Massif. Most areas very rich in endemics (100–150) are on serpentine, three are younger (Santa Clara, Camagüey, Holguin) and three others are ancient latosol areas (Nipe, Cristal, Moa-Baracoa). In respect of endemic richness only the ancient conical karsts in the Sierra de los Organos, the montane zone of Sierra Maestra and the xerotherm semi-deserts of southern Baracoa are commensurable to the above localities. Outstandingly rich areas are found only in the montane zone of ancient serpentine mountains, such as the Nipe Mts., the surroundings of Pico del Cristal and the highlands of Moa (El Toldo, Iberia etc.), where more speciation-inducing factors (age, serpentine, isolation, montane character) are combined.

19.2.3 Vertical distribution of endemics

After reading the foregoing one would expect that the number of endemics increases as altitude increases, due to the montane effects. However, as our studies in Pico Turquino showed, the vertical distribution of endemics is a more complex matter. Figure 108a demonstrates that the number of endemics increases up to the lower limit of the cloud zone and then rapidly decreases. Its reason is that the vertical distribution of regional endemies of lowlands and mountains of medium height differs from that of the local montane endemics. The number of species from the first group increases up to 1000 m, hardly changes up to 1500 m and then falls suddenly. The number of montane endemics, however, abruptly increases between 1000 and 1500 m and does not change anymore. The disappearance of lowland regional endemics from the high altitude zone causes the decrease of endemic species (Fig. 108b). Contrary to the absolute figures, the relative proportion of endemics rapidly increases with altitude. That is, the few endemics occurring become predominant at higher elevations.

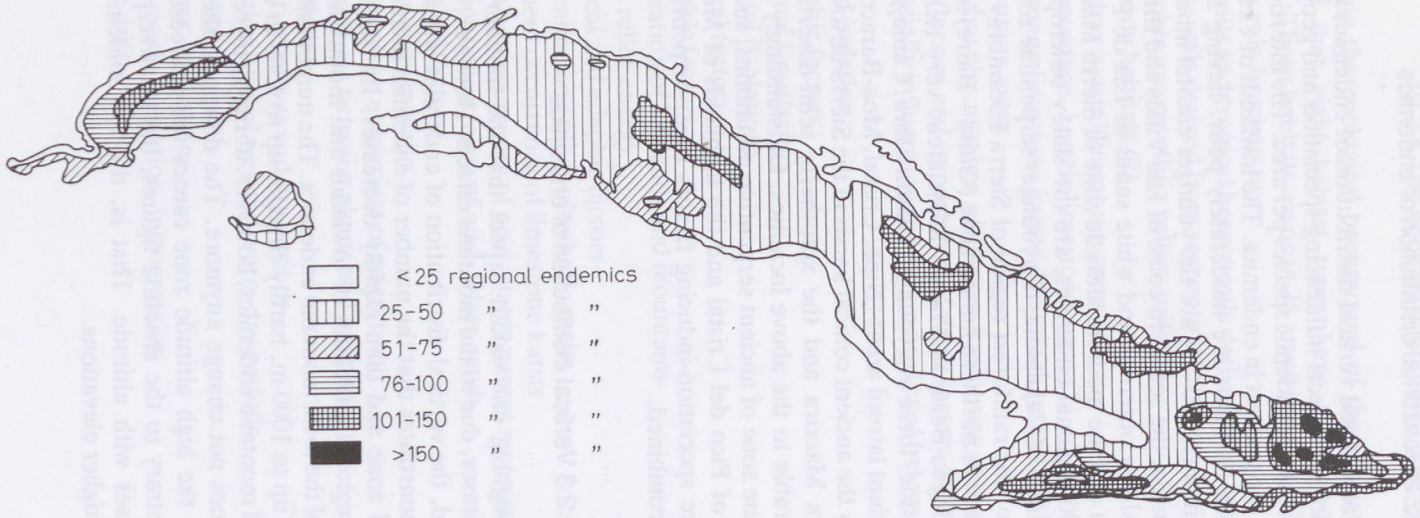


Fig. 107 The number of endemics in the different geographical regions of Cuba (Samek 1973, modified by Borhidi 1985)

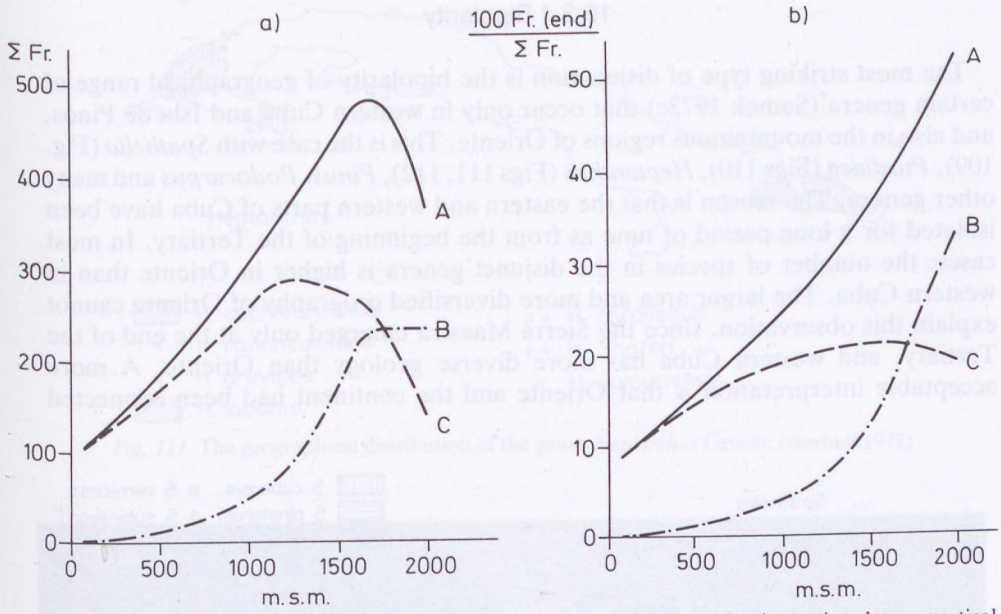


Fig. 108 Changes of the total a) and the relative frequency b) of the endemic species along a vertical gradient in Cuba. A: total of endemics; B: local endemics; C: regional endemics

19.2.4 Relationship between aridity and the number of endemics

Stebbins (1952) pointed out that ecological drought stimulates speciation. The ecological and chorological study of many Cuban endemics provides evidence for this phenomenon. The largest number and highest density of endemics may be observed in the arid zones (semi-desert, coast) and in the physiologically dry habitats (serpentines, limestone karsts, white sands). Also, the majority of endemics have xeromorphic leaves. Table 29 and Fig. 54 show the leaf-size distribution of 1115 tree and shrub species occurring in forty forest communities endemic to Cuba. Among macrophylls and mesophylls the widely distributed species dominate, but in the microphyll, nanophyll, leptophyll and aphyll categories the endemics outnumber the others and their proportion increases as leaf-size decreases.

19.3 Disjunction

Another chorological characteristic of the flora is disjunction, the separation of the geographic range of a given taxon into several isolated areas. Many different types of disjunction, such as bipolarity, bi-, tri- and multisectorial distribution may be observed in Cuba.

19.3.1 Bipolarity

The most striking type of disjunction is the bipolarity of geographical range of certain genera (Samek 1973c) that occur only in western Cuba and Isla de Pinos, and also in the mountainous regions of Oriente. This is the case with *Spathelia* (Fig. 109), *Purdiaea* (Figs 110), *Heptanthus* (Figs 111, 112), *Pinus, Podocarpus* and many other genera. The reason is that the eastern and western parts of Cuba have been isolated for a long period of time as from the beginning of the Tertiary. In most cases, the number of species in the disjunct genera is higher in Oriente than in western Cuba. The larger area and more diversified orography of Oriente cannot explain this observation, since the Sierra Maestra emerged only at the end of the Tertiary, and western Cuba has more diverse geology than Oriente. A more acceptable interpretation is that Oriente and the continent had been connected

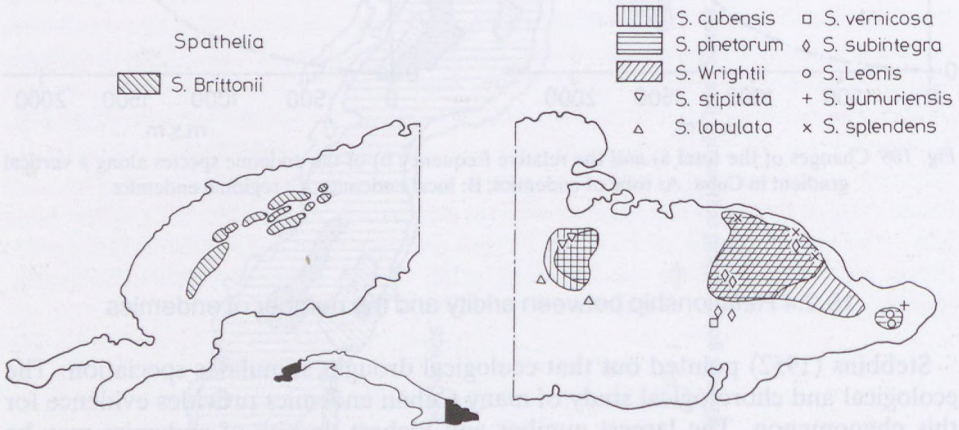


Fig. 109 The geographical distribution of the genus *Spathelia* in Cuba (Samek 1973 and Borhidi 1985)

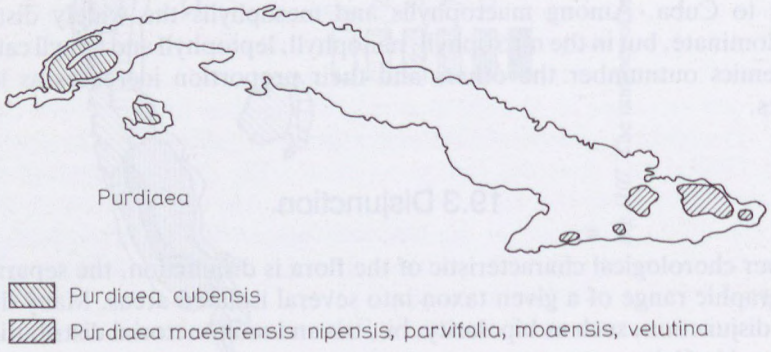


Fig. 110 The geographical distribution of the genus *Purdiaea* in Cuba (Thomas 1960, Samek 1973 and Borhidi 1985)

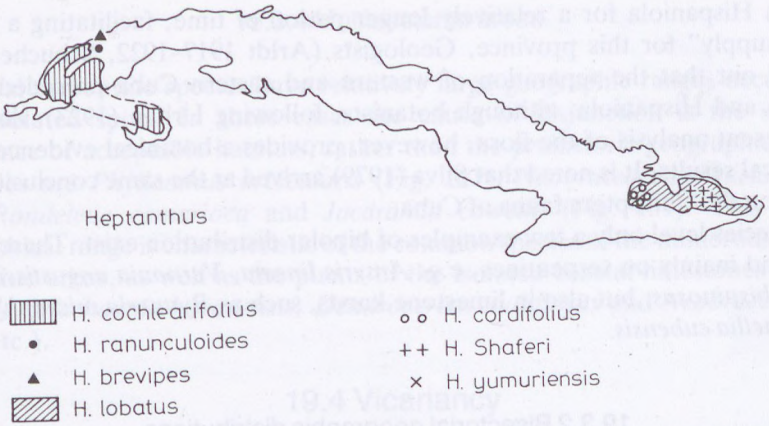


Fig. 111 The geographical distribution of the genus *Heptanthus* Griseb. (Borhidi 1972)



Fig. 112 A little endemic herbaceous plant of the riverside scrub vegetation: *Heptanthus lobatus* Britt. in the Nipe Mts. (Photo: A. Borhidi)

through Hispaniola for a relatively longer period of time, facilitating a steadier "gene supply" for this province, Geologists (Arldt 1917–1922, Schuchert 1935) pointed out that the separation of western and eastern Cuba preceded that of Oriente and Hispaniola, although botanists, following Urban (1923), disagreed. The present analysis of the flora, however, provides a botanical evidence for the geological results. It is noted that Silva (1979) arrived at the same conclusion in his studies on the Chiroptera fauna of Cuba.

At species level only a few examples of bipolar distribution exist. These species are found mainly on serpentines, e.g. *Amyris lineata, Vernonia angustissima* and *Croton bispinosus,* but also in limestone karsts, such as *Byttneria microphylla* and *Neoregnellia cubensis.*

19.3.2 Bisectorial geographic distributions

Another type of disjunction is represented by some rainforest species (*Magnolia cubensis, Hedyosmum grisebachii, Ocotea ekmanii;* see Figs 138, 245) occurring both in the mountains of Oriente and the Guamuhaya Massif. Up to the early Tertiary, these regions were connected as still indicated by the presence of the relict block-mountains of Sierra de Najasa. This connection, however, must have come to an end in a short time, since most common elements belong to ancient dicotyledonous families (Magnoliaceae, Lauraceae, Chloranthaceae, etc.). Two other types of bisectorial distribution have developed between the mountainous region of western Cuba and the Guamuhaya Massif: 1. the plants of karstic forests and other limestone areas (*Sapium leucogynum* and *Miconia cubensis*) and 2. species on serpentines in Pinar del Rio and the Escambray mountains (*Coccothrinax crinita* and *Linodendron venosum*).

19.3.3 Trisectorial distributions

The occurrence of several taxa at three isolated spots (western Cuba, Guamuhaya massif, Oriente) indicates that these areas had been separated for a long period of time in the Tertiary as a result of shallow-sea transgression of the island. The genera of *Lyonia* and *Vaccinium* some montane forest species, such as *Tetrazygiopsis laxiflora* and *Sapium pallens,* and some acidophilous species e.g. *Hypericum styphelioides* exhibit such a trisectorial distribution. As a consequence of longer geographic and ecological isolation of the *Hypericum styphelioides* populations, this species is divided into three subspecies (Lippold 1970). Some taxa considered earlier to have bi- or tri-sectorial distribution, proved to be taxonomically heterogeneous, such as *Amyris lineata, Croton brittonianus, Ditta myricoides, Lyonia elliptica, Vaccinium cubense* etc.

19.3.4 Multisectorial areas

Several serpentine species have relatively large geographic ranges occurring in many isolated spots. In these cases the cause of disjunction is the scattered occurrence of acceptable habitats, rather than the prehistoric geographic effects. Examples are *Phyllanthus orbicularis* (Fig. 127), *Neobracea valenzuelana* (Fig. 117), *Rondeletia camarioca* and *Jacaranda cowellii* (Fig. 131). This type of geographical range is characteristic of the common species of the numerous isolated serpentine areas, as well as the plants of the isolated coastal limestones (*Castela calcicola, Machaonia havanensis, Dendrocereus nudiflorus* and *Neobracea angustifolia* etc.).

19.4 Vicariancy

The third characteristic feature of the flora of Cuba is the abundance of vicarious taxa. All types of vicariancy are widespread. This fact indicates prehistoric isolations and allows to surveyor to make inferences concerning the influence of ecological factors on evolution and the development of certain related taxa.

19.4.1 Geographic vicariancy

Many examples exist in Cuba. Figure 113 shows the range of two endemic vicarious genera of lianes, *Lescaillea* and *Harnackia*. Both occur in pinewoods and evergreen shrublands on latosols derived from serpentine. This serves as an evidence suggesting a relationship not only between the recent vegetation of the Cajalbana and Nipe Mountains, but also in the past flora development of these regions. Further examples are *Anemia coriacea* (Fig. 128) and *Moacroton* (Fig. 130) among many others. The ranges of the subgenera *Thrinax* and *Hemithrinax* also exemplify geographic vicariancy (Fig. 114). *Thrinax radiata* is a species of rocky and sandy beaches, whereas *Th. morrisi* and *Th. drudei* occur in the karsts of western

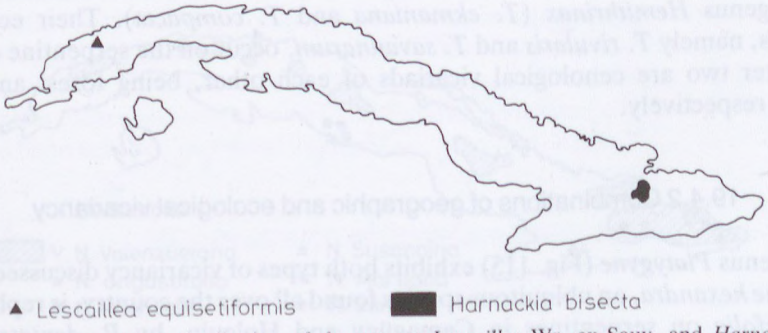


Fig. 113 The geographical distribution of the genera *Lescaillea* Wr. ex Sauv. and *Harnackia* Urb. (Borhidi 1985)

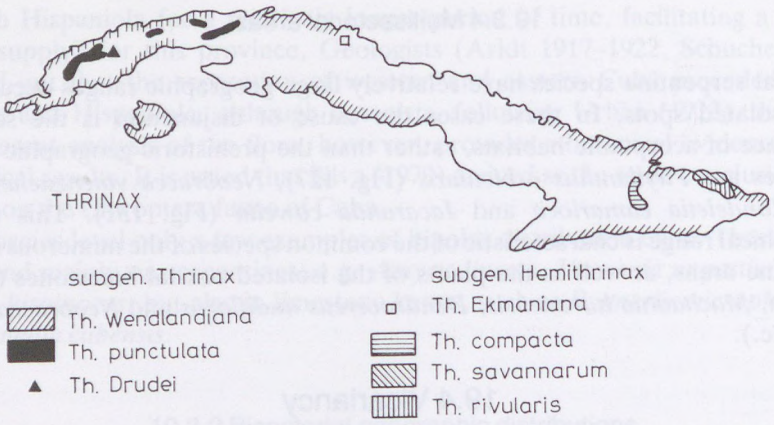


Fig. 114 The geographical distribution of the genus *Thrinax* in Cuba (Borhidi 1985)

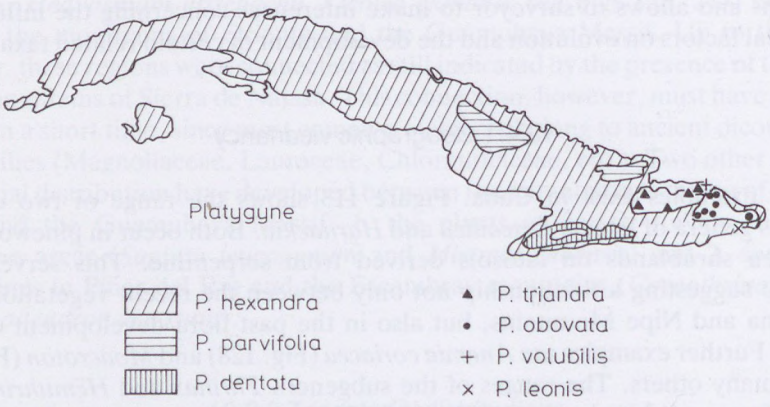


Fig. 115 The geographical distribution of the species of genus *Platygyne* Muell. Arg. (after Borhidi 1972)

Cuba replacing each other. In central and eastern Cuba *Thrinax* is substituted by the subgenus *Hemithrinax* (*T. ekmaniana* and *T. compacta*). Their ecological vicariads, namely *T. rivularis* and *T. savannarum,* occur on the serpentine of Moa. The latter two are cenological vicariads of each other, being forest and scrub species, respectively.

19.4.2 Combinations of geographic and ecological vicariancy

The genus *Platygyne* (Fig. 115) exhibits both types of vicariancy discussed so far. *Platygyne hexandra,* an ubiquitous species found all over the country, is replaced by *P. parvifolia* on serpentines in Camagüey and Holguin, by *P. dentata* in the montane zone of Sierra Maestra, and by four other species in the serpentine

mountains of northeastern Oriente. Furthermore, the latter four species are also vicarious in their geographic distribution within the province. This observation supports the view that speciation is more intensive on serpentines than on other bedrocks (Borhidi 1972*a*). For this process the Cuban species of the *Oplonia* genus serve also as a good example (Fig. 116). An interesting exception is genus *Neobracea* (Fig. 117) with two species on serpentine, *N. ekmanii* endemic to Moa and the Pan-Cuban *N. valenzuelana*. Although the latter occurs on all serpentine outcrops in Cuba, the morphological variability of populations living under different climatic conditions remains within specific limits. Conversely, the ancestral form of the limestone species has been broken into four vicarious species along the coasts consisting of primitive and recent limestones. These species constitute morphologically well-separated small populations with considerably isolated geographic distributions.

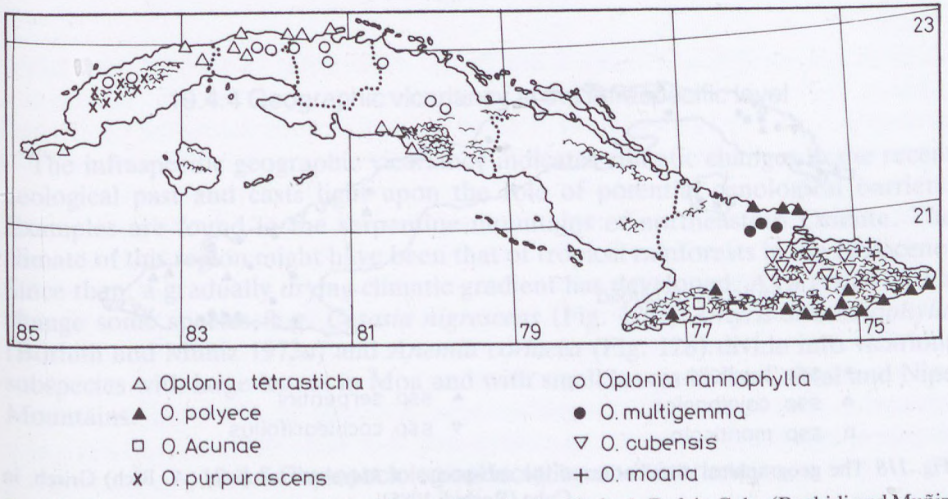


Fig. 116 The geographical distribution of the species of genus *Oplonia* Raf. in Cuba (Borhidi and Muñiz 1978)

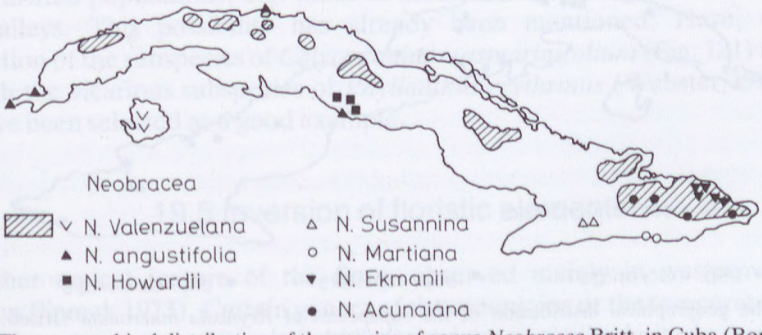


Fig. 117 The geographical distribution of the species of genus *Neobracea* Britt. in Cuba (Borhidi 1985)

19.4.3 Ecological vicariancy at the infraspecific level

The ecological factors affecting speciation may be best investigated and demonstrated through examples of infraspecific vicariancy. This term means that a young species of great migratory and penetrative power colonizes new habitats which in turn modify the populations. *Maytenus buxifolia* (Fig. 118), an Antillean species is a good example. It separates into five vicarious subspecies in Cuba: the widely spread ancestor, two subspecies on serpentines (ssp. *cajalbanica* in western Cuba and ssp. *serpentini* in the east), and an extremely drought-tolerant subspecies in the semi-desert belt (ssp. *cochlearifolia*). An endemic microphyllous drought-tolerant shrub, *Reynosia mucronata* (Fig. 119) exhibits similar vicariancy. The ancestor occurs in the shrublands of central Cuba with preference in favour of neither limestone nor serpentine. However, the populations on the latosols of Nipe Mts. (ssp. *nipensis*) and the stands occurring in the semi-desert zone of southern Baracoa (ssp. *azulensis*) are geographically isolated subspecies (Borhidi and Muñiz 1971).



Fig. 118 The geographical distribution of the subspecies of *Maytenus buxifolia* (A. Rich) Griseb. in Cuba (Borhidi 1985)

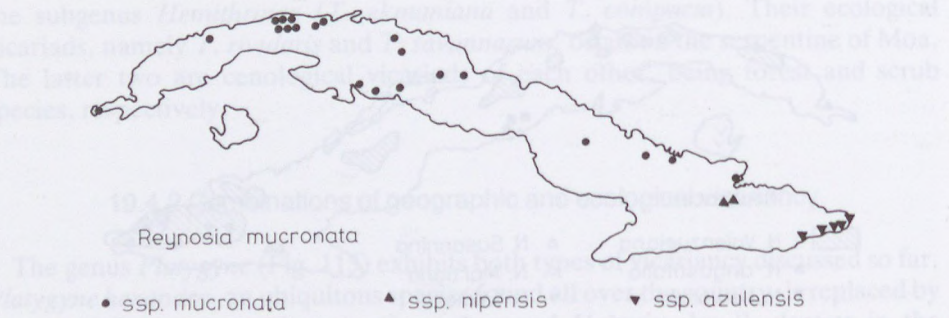


Fig. 119 The geographical distribution of the subspecies of *Reynosia mucronata* Griseb. in Cuba (Borhidi 1985)

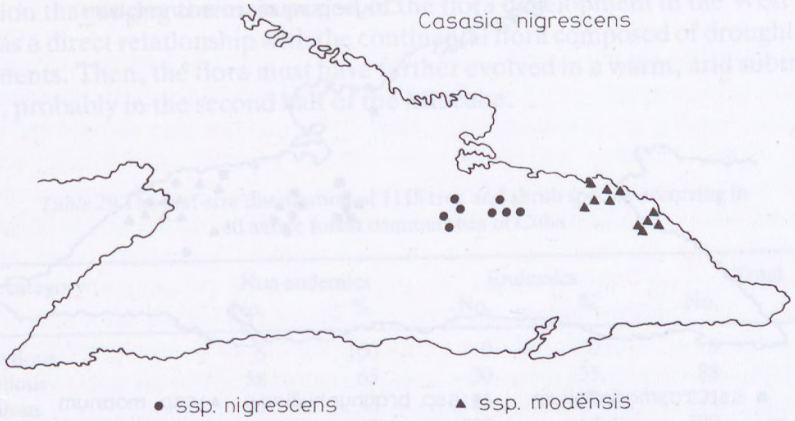


Fig. 120 The geographical distribution of the subspecies of *Casasia nigrescens* (Griseb.) Wr. ex Urb. in Cuba (Borhidi 1985)

19.4.4 Geographic vicariancy at the infraspecific level

The infraspecific geographic vicariancy indicates climatic changes in the recent geological past and casts light upon the role of potential cenological barriers. Examples are found in the serpentine mountains of northeastern Oriente. The climate of this region might have been that of tropical rainforests in the Holocene. Since then, a gradually drying climatic gradient has developed. As a result of this change some species, e.g. *Casasia nigrescens* (Fig. 120), *Amyris stromatophylla* (Borhidi and Muñiz 1973*a*) and *Anemia coriacea* (Fig. 128) divide into vicarious subspecies with large leaves in Moa and with small leaves in the Cristal and Nipe Mountains.

19.4.5 Phytosociological isolation and vicariancy

The geographic vicariancy of subspecies may often be facilitated by the existence of species-saturated communities or vegetation types in different habitats separating the drifted populations, e.g. those of mountains alternating with more or less wide valleys. This possibility has already been mentioned. Here, only the distribution of the subspecies of *Calycogonium rosmarinifolium* (Fig. 121) is shown, although the vicarious subspecies of *Phyllanthus erythrinus* (Webster 1958) could also have been selected as a good example.

19.5 Inversion of floristic elements

Another typical feature of the flora, observed mainly in western Cuba, is inversion (Samek 1973). Certain genera of the mountains or the temperate regions, which otherwise occur positively in high mountains at similar latitude, are found in

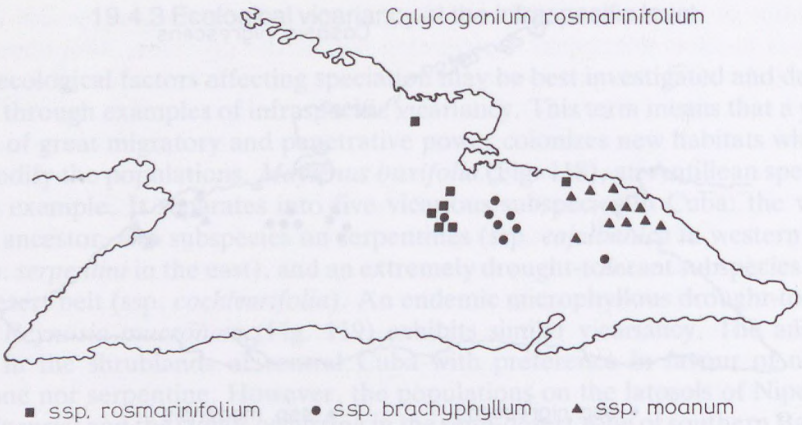


Fig. 121 The geographical distribution of the taxa of the *Calycogonium rosmarinifolium* Griseb. group (Borhidi 1985)

Cuba at low elevation. Examples are *Pinus, Podocarpus, Kalmiella, Vaccinium, Lyonia, Befaria cubensis* and *Quercus oleoides* ssp. *sagraeana* etc. Inversion is probably caused by two factors: 1. One of the cool periods during the Quaternary when these species or their ancestors reached Cuba and became established in the lowlands and hills 2. The abundance of serpentines and other rocks and soils (e.g. slate and quartz sand) of poor nutrient supply, which might have facilitated the adaptation of cool-resistant species to the increasing mean temperature (such inversions may develop under the same conditions even today). The vegetation inversion occurring on soils derived from serpentine is discussed in detail in Chapter 13. Of course, this is accompanied with the inversion of floristic elements constituting the corresponding vegetation type. In addition to the above-mentioned taxa, this phenomenon is exemplified by the species of *Myrica, Ilex, Lobelia, Laplacea* and *Baccharis* occurring on serpentines or white sands.

19.6 Microphyllia

This is an important feature characteristic not only of the flora of Cuba but also of the flora of the West Indies. As pointed out in *19.2.4* aridity must have had an important role in influencing speciation. Table 29 shows that of the 1115 species examined, 800 (72 %) proved to be microphyll, nanophyll, leptophyll and aphyll, most of those (563 species) being endemics. There are numerous genera represented in Cuba and the Antilles by highly specialized microphyll, sclerophyll or spinous sections or species, but the corresponding taxa in the continent are broad-leaved. Examples are *Plinia, Myrcia, Calyptranthes, Eugenia, Rondeletia, Machaonia, Psychotria, Phyllanthus, Croton, Acalypha, Jacaranda, Tabebuia, Byrsonima* and *Malpighia* etc. Typical West Indian genera are *Catesbaea, Scolosanthus, Ottoschmidtia, Acidocroton, Picrodendron, Krugiodendron* and *Sarcomphalus* etc. Their abundance and substantial cover in the vegetation may advance the

conclusion that during the main period of the flora development in the West Indies there was a direct relationship with the continental flora composed of drought-tolerant elements. Then, the flora must have further evolved in a warm, arid subtropical climate, probably in the second half of the Miocene.

Table 29 The leaf-size distribution of 1115 tree and shrub species occurring in 40 native forest communities of Cuba

Leaf-size category	Non endemics		Endemics		Total	
	No.	%	No.	%	No.	%
macrophyllous	6	100	0	0	6	100
mesophyllous	58	65	30	35	88	100
notophyllous	96	43	125	57	221	100
microphyllous	163	33	337	67	500	100
nanophyllous	45	22	155	80	200	100
leptophyllous	14	20	56	80	70	100
aphyllous	5	18	25	82	30	100

19.7 Micranthia

A striking feature of the flora of the Antilles, and particularly of Cuba, is its richness in small-flowered plants, whereas the floras of Palaeotropical and Neotropical regions in the continents abound in showy, big-flowered species. Among many thousands of plant species illustrated in Botanical Magazine and Gardenflora, Antillean species only occur occasionally. (None of the 3000 endemics in the exceptionally rich flora of Cuba has large enough flowers to deserve the honour of being the 'national flower', so *Hedychium coronarium,* an Asiatic species was given this title.) The small flowers are pollinated by endemic, highly specialized microscopic-sized insects that are usually not capable of long distance flying. To avoid strong winds blowing from the sea, these insects stay in the shelter of plants. Thus, gene flow between remote plant populations is occasional, if not impossible. This barrier must have contributed significantly to the isolation of populations subjected to genetic drift, and resulted in the formation of numerous vicarious endemics. The fact that most vicariads differ very little from one another indicates the influence of genetic drift. Therefore, some taxonomists consider these vicariads as simple varieties. However, this view is unacceptable since the morphology of these microspecies is stable, the segregation is complete and no intermediate forms and genetic relationships exist. Micranthia may be a partial explanation of the discrepancy that genera represented by only one or two widespread species in the continent may fall into a dozen of endemic species with geographic range restricted to a single mountainous region in the Antilles.

19.8 Relict character

The flora of tropical moist vegetation types, such as lowland and submontane rainforests and seasonal evergreen forests in the Antilles is relatively young and contains few endemics. It is likely that these types had become widespread only at the end of the Pliocene and during the pluvial periods synchronous with the Pleistocene inter-glacials. During the Pleistocene the flora rich in Tertiary xerophilous and sclerophyll elements retreated. This process still goes on. In my opinion the recent climate is far too moist for the sclerophyll vegetation types and the constituting species. The increase in the number of permanently established deciduous and semi-deciduous species deriving from other community types supports this view. This degradation process is significantly accelerated by human impact. The formerly widespread by evergreen formations (thickets, woodlands, forest and pinewoods) composed of Tertiary sclerophylls are now restricted to relict habitats, serpentines and the slopes and cliffs of conical karsts. The geographic range of endemic sclerophylls, which account for 40% of the flora, covers not exactly 20% of the area of the island. The relict character of the flora is clearly demonstrated by the presence of primitive, taxonomically isolated groups (*Microcycas, Dracaena, Cneorum, Spathelia* sect. *Brittonii* and sect. *Splendentes,* and *Harpalyce* sect. *Cubenses,* etc.), the abundance of disjunct geographical distribution types, and the large number of local endemics represented by small populations.

19.9 Vulnerability

In general, island floras are vulnerable for several reasons:

a) the populations colonizing new biotopes are selected from a reduced gene pool.

b) There has been no possibility of changing this gene pool for millions of years.

c) As a consequence of isolation, the ecological tolerance and genetic flexibility of populations decreased, so that

d) The competitiveness of species generally decreased or even disappeared in all but one respect.

e) Therefore, they cannot react satisfactorily upon new ecological impacts, cannot take the advantage of succession, and cannot resist to or force back new competitors.

Island floras are usually composed of ecologically rigid populations not qualified to adapt to major environmental changes. The social recuperability is reduced, the populations and communities are vulnerable to external effects. The vulnerability of the flora of Cuba is more pronounced for the following reasons:

- The island flora itself is constituted of sets of ancient, isolated floras,
- Most endemics have adapted to the extreme ecological conditions of oligotrophic or bare areas. Thus, the level of metabolism became low in these organisms and their competitiveness diminished.
- The sociability of many endemics is low.

There are some rare taxa represented by few populations, and few individuals

therein. Consequently, the flora of Cuba is one of the most endangered island floras of the world. The list of endangered species of Cuba contains about a thousand items which amount to 16.5% of the entire set of flowering species in the island. Approximately 30% of the endemics are endangered.

20 The origin and migration of the flora of Cuba

20.1 Palaeobotanical and geological evidence

Our knowledge on the origin and migration of the flora of Cuba is insufficient. As few as three noteworthy findings have been reported, one probably from the Eocene and another from the Pleistocene of Sierra de Chorrillo, and the third from the Miocene of Yumuri Valley in Matanzas (Graham 1974). The total number of taxa coming from these three periods is still below fifty. Moreover, no palynological data are available from the Quaternary of Cuba. Then, the only possibility to give a rough picture on past changes in the flora is offered by the simultaneous analysis of the recent flora, geographical distribution types and of the tectonic events revealed by structural geology.

20.1.1 Corral's version of Wegener's theory

The geological past of the Antilles has been described by Corral (1939, 1940) in accordance with Wegener's theory (Fig. 122). It is conceivable that portions of the Greater Antilles used to be connected to one another and to South America, as Corral claims. However, these lands must have started to become separated from the continent not later than the Upper Triassic. Due to chronological unreliabilities and consequential inconsistencies in Corral's theory, it was soon rejected (Alain 1958) and Schuchert's (1935) concepts were accepted.

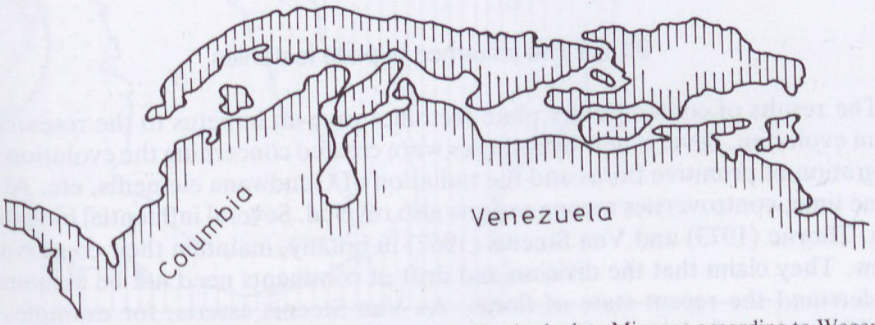


Fig. 122 The geographical position of the Greater Antilles in the late Miocene according to Wegener's theory in the interpretation of Corral (1939)

20.1.2 Schuchert's concepts on the Tertiary in the Antilles

According to Schuchert, the Greater Antilles had been connected to Central America via a land strip of Honduras from the Triassic to the Late Pliocene, apart from short intervals in the Upper Cretaceous and the Upper Oligocene. Eastern Cuba was connected to the continent via the Cayman Ridge and indirectly via the Nicaragua Ridge, Jamaica and Hispaniola. In addition, there was also a connection to the Bahamas and Florida during the Upper Cretaceous and the Eocene. In the Upper Oligocene Cuba became separated from Hispaniola and Yucatan, and its connection to the continent ceased to exist any longer. Although in the Middle Miocene Cuba and Hispaniola had been united again for a short time, no link was formed between the Antilles and Honduras. In the Upper Miocene Cuba finally became completely separated from all the other islands of the Antilles and the continent. According to Schuchert, the Honduras—Jamaica—Hispaniola land strip was finally broken only at the beginning of the Pleistocene. In my view, however, this break up must have been completed in the Miocene, as suggested by the very primitive mammal fauna of the Greater Antilles.

20.1.3 The influence of Schuchert's concepts on phytogeographical interpretations

The recent position of the West Indies, which is wedged in between two continents and surrounded by narrows and closed bays, gives the impression as if the West Indies were a sort of appendage of the continent that became separated not long before. Some botanists consider the flora of the West Indies as a descendant of the continental flora in which the widespread and highly variable continental species are represented by endemic subspecies or varieties. This is, however, an illusory view formed under the influence of Schuchert's theories discussed above. Given this knowledge, the first fundamental statements regarding the origin of the flora of Cuba were made by Alain (1958). He suggests that the flora is mainly of Neotropical origin and the elements immigrated from five different directions (Fig. 123). This problem will be considered later in more detail.

20.1.4 The influence of plate tectonics

The results of contemporary plate tectonics gave an impetus to the research of flora evolution. Several new hypotheses were created concerning the evolution and migration of primitive floras and the radiation of Gondwana elements, etc. At the same time, controversies among experts also revived. Several influential biologists, e.g. Thorne (1973) and Van Steenis (1962) in botany, maintain their conservative view. They claim that the division and drift of continents need not be assumed to understand the recent state of floras. As Van Steenis asserts, for example, the Pacific and the Indonesian flora may have directly originated from Asia via land bridges that have now been covered by sea. Even if the land bridge theory is

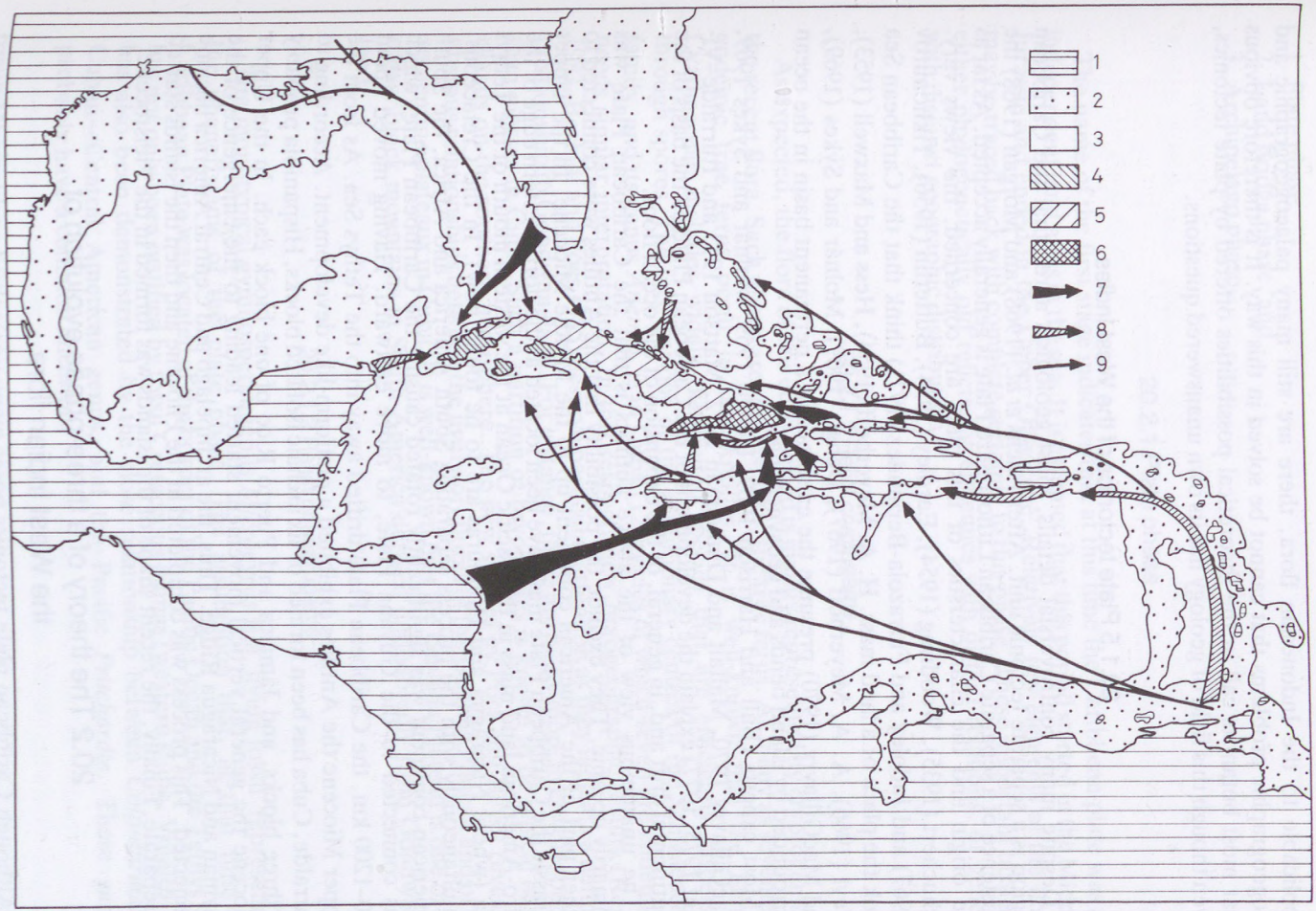


Fig. 123 Origins of the flora of Cuba. (Alain Liogier 1958, strongly modified). 1. Continents and islands, 2. Shallow seas (<, M 1000 m deep), 3. Deep seas (depth more than 1000 m), 4. West Cuban plant-geographical subprovince, 5. Middle Cuban plant-geographical subprovince, 6. East Cuban plant-geographical subprovince, 7. Main migration routes of the flora, strong floristic affinity, 8. Important migration routes of the flora, characteristic floristic relations, 9. Less important migration routes of the flora, clearly recognizable floristic effects

applicable to the Indonesian flora, there are still many palaeogeographic and biogeographic problems that cannot be solved in this way. It is therefore obvious that most botanists call in the theoretical possibilities offered by plate tectonics, even though this field of geology has its own unanswered questions.

20.1.5 Plate tectonics of the West Indies

Despite many controversial details, most geologists agree that the Caribbean region is a separate tectonic unit. After Isachs *et al.* (1968) and Morgan (1968) the existence of a separate Caribbean Lithosphere Plate is generally accepted. As far as the origin and the characterstics of this plate are concerned, the views vary. Schuchert (1935), Woodring (1954), Eardley (1954), Butterlin (1956), Tikhomirov (1967) and Judoley and Furrazola-Bermudez (1971) think that the Caribbean Sea took the place of a land mass. H. A. Meyerhoff (1954), Hess and Maxwell (1953), Weyl (1966), A. A. Meyerhoff (1967), Dengo (1969), Molnár and Sykes (1969), and MacGillavry (1970) presume the existence of a permanent basin in the ocean surrounded by island bends and geosynchlinals.

Most experts (Ball and Harrison 1969, Dengo 1969, Molnár and Sykes 1969, MacGillavry 1970, Malfait and Dinkelman 1972, Mattson 1973 and Iturralde–Vinent 1975, 1977) explain the development of the Caribbean Plate on the basis of the continental drift and, in general, of the expansion of the ocean floor.

The unanimous view of the above authors is that the Caribbean Plate was primarily oceanic. They exclude the possibility that the Antilles were connected to either part of the American continent up to the Middle Miocene. In the Upper Jurassic the Caribbean Plate may have been located at the northwestern edge of the Afro-American land mass in the Pacific Ocean at the western mouth of the Tethys Sea (where Nicaragua and Honduras are to be found now). In the Cretaceous, simultaneously with the process separating South America and Africa, the South American continent was significantly rotated causing the Caribbean Plate, which was connected to the Guyana Plate, to move eastward. Having moved about 800–1200 km, the Caribbean Plate drifted away into the Tethys Sea. As from the Upper Miocene the Antilles exhibited a platform-like development. According to Iturralde, Cuba has been formed of six archaic isolated blocks, Hispaniola probably of three blocks, and Jamaica and Puerto Rico of one block each. In the Upper Miocene the general vertical movement started leading to the emergence of the Cayman and Nicaragua Ridge. Thus, the archipelago and Central America became connected. This process was completed in the Pliocene and then the islands started to separate. Finally, the recent shape of the islands was formed in the Pleistocene.

20.2 The theory of a three-phase evolution of the West Indian flora

Although Caribbean plate tectonics poses many unresolved problems (Howard 1979: 244) it is now attempted to outline the general history of the Antillean flora. Three major periods are recognized, each corresponding to a given geological stage:

1. Plate phase,
2. Land bridge phase, and
3. Archipelago phase.

20.2.1 Plate phase

The name of the first stage indicates that at this time the Caribbean plate was an independent land mass in the sea. It is assumed that this period started in the Middle Jurassic and ended in the Upper Oligocene. Relatively few elements of the flora may be traced back with complete certainty to this phase. These important taxa are either phylogenetically old relicts, or endemics with distant relations, or genera with disjunct geographic distribution.

20.2.1.1 Relict cryptogams

As expected, the flora of this early period is mainly represented by cryptogams in the recent flora. Such plants are, for instance, the tree ferns. As many as seventeen endemic tree ferns occur in the Antilles. It is well-known that the family Cyatheaceae includes widely distributed species that are efficiently dispersed through spores. The fact that one of the evolutionary centres of the Schizaeaceae family, and its genus *Anemia,* is in Cuba (12 species of which seven are endemics) needs similar interpretation. In this respect, new bryogeographic results (Reyes 1982, Borhidi and Pócs 1985) deserve particular attention as they indicate a definite relationship to Gondwanaland. For instance, there are many more liverwort species than mosses in Cuba. Such a partition of bryophytes is known to be typical of the islands on the southern hemisphere. The new studies by Pócs and Reyes revealed obvious relationships between the liverwort floras of the Guyana Plateau and of the serpentine plateaux in Cuba. It is well-known that the Guyana Plateau is one of the oldest block mountains in South America derived undoubtedly from Gondwanaland.

20.2.1.2 Relict phanerogams

The monotypical gymnosperm genus *Microcycas* is a 'living fossil' representing the phanerogams of the plate phase. The assumption that, at that time the Caribbean Plate was located at the border of the Pacific Ocean and the Tethys Sea, has not only been justified by fossil Cretaceous faunas (western Cuba, Viñales) but has also been demonstrated by the close relationship between *Colpothrinax,* a Cuban—Central American genus, and the Pacific *Pritchardia.* These genera probably have a common ancestor.

20.2.1.3 Peri-Afro-American elements

The evolution of the specially distributed peri-Afro-American elements may also be dated back to the plate phase. Table 30 lists typical peri-Afro-American phanerogam genera that occur in the tropical America, East Africa and/or Madagascar but are absent from West and Central Africa.

Table 30 Examples of peri-Afro-American genera

Genus, Family	Total species	South America, West Indies	West and Central Africa	East Africa, Madagascar
Desmanthus (Fabaceae)	22	15	1	6
Echinochlaena (Poaceae)	7	6	—	1
Ocotea (Lauraceae)	400	380	3	18
Oliganthes (Asteraceae)	21	12	—	9
Carpodiptera (Tiliaceae)	6	5	—	1
Oplonia (Acanthaceae)	18	13	—	5
Phenax (Urticaceae)	28	25	—	3
Piriqueta (Turneraceae)	28	24	1	3
Rheedia (Clusiaceae)	50	37	—	13
Ravenala (Musaceae)	2	1	—	1
Savia (Euphorbiaceae)	25	15	1	9
Stenandrium (Acanthaceae)	25	22	—	3

Of the fifteen genera listed, eleven occur in Cuba, four genera (*Carpodiptera, Savia, Oplonia* Fig. 124) and *Stenandrium* have their evolutionary centres in the Antilles.

According to Stearn (1971) this distribution type may have developed as a result of drastic climatic changes. Many taxa became extinct in the interior of the Afro-American supercontinent due to the extreme continental climate. The flora of Central Africa became relatively poor in species. On the contrary, along the coasts of Madagascar, East Africa, North Africa and the northern part of South America an extensive coastal zone was formed which had a temperate climate. The abundance of diverse habitats in this region was advantageous for survival so that a very rich vegetation developed. Besides the Madagascar Plate, the Macaronesian and Caribbean Plates were probably also parts of this coastal zone.

In addition to the genera mentioned so far, a similarly close relationship is indicated for *Dracaena cubensis* from Cuba, *D. draco* from Macaronesia and *D. reflexa* from Madagascar. The primitive Cneoreaceae family may also be mentioned as a good example. It has only three living species, one in the Mediterranean of Europe, another in the Canary Islands and the third in eastern Cuba on the southern slopes of Sierra Maestra (Fig. 125). Further evidence confirming the existence of these relationships is that amongst the cryptogams there are not only genera but also some species exhibiting peri-Afro-American distribution (e.g. liverworts; see Gradstein *et al.* 1983).

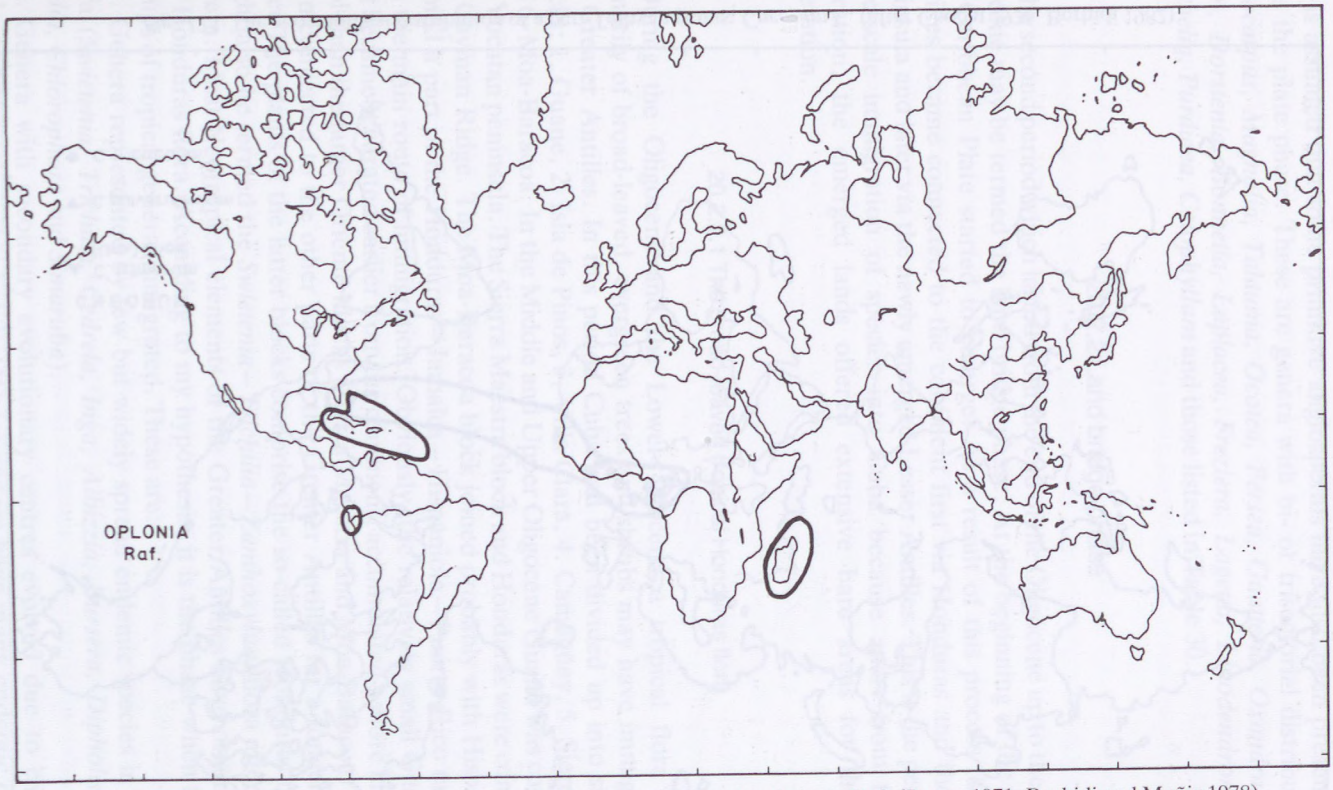


Fig. 124 The geographical distribution of a peri-Afro-American genus: *Oplonia* Raf. (Stearn 1971, Borhidi and Muñiz 1978)

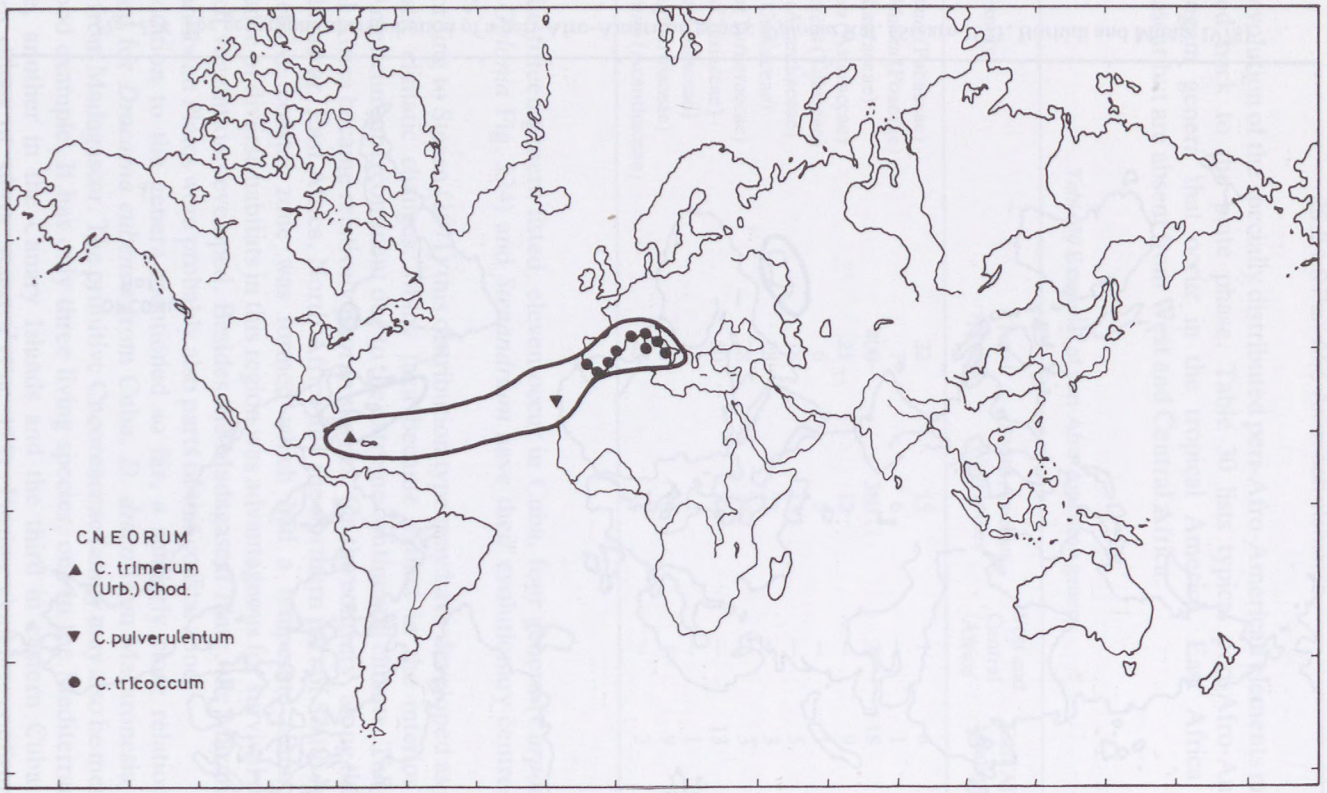


Fig. 125 The geographical distribution of a peri-Tethyan genus: *Cneorum* L. (after Chodat 1926, Borhidi 1982)

It is assumed that some primitive angiosperms have also been present in Cuba since the plate phase. These are genera with bi- or trisectorial distribution, e.g. *Podocarpus, Magnolia, Talauma, Ocotea, Persea, Guatteria, Oxandra, Hedyosmum, Dorstenia, Bonnetia, Laplacea, Freziera, Lagetta, Linodendron, Myrica, Spathelia, Purdiaea, Calophyllum* and those listed in Table 30.

20.2.2 Land bridge phase

The second period which lasted from the end of the Oligocene up to the end of the Pliocene may be termed the land bridge phase. At the beginning of the Oligocene the Caribbean Plate started to emerge. As a result of this process the Greater Antilles became connected to the continent first via Honduras and the Yucatan peninsula and later via the newly emerged Lesser Antilles. This is the period of the large-scale immigration of species into Cuba because apart from facilitating migration, the emerged lands offered extensive bare areas for the pioneer vegetation.

20.2.2.1 The broad-leaved tropical Honduras flora

During the Oligocene and the Lower Miocene a tropical flora consisting primarily of broad-leaved, evergreen trees and shrubs may have immigrated into the Greater Antilles. In this period Cuba had been divided up into six isolated blocks: 1. Guane, 2. Isla de Pinos, 3. Villa Clara, 4. Camagüey, 5. Sierra Maestra and 6. Moa-Baracoa. In the Middle and Upper Oligocene Guane was connected to the Yucatan peninsula. The Sierra Maestra block and Honduras were connected via the Cayman Ridge. The Moa-Baracoa block joined probably with Hispaniola and formed a part of the Honduras—Jamaica—Hispaniola—Puerto Rico range which was the main route of immigration. Obviously, the relatively small Guane block, that became separated earlier from the continent, accumulated a more limited gene pool than the larger Oriente blocks (Sierra Maestra and Moa-Baracoa) which had been connected to the other parts of the Greater Antilles for a longer period of time. The plants of the latter blocks comprise the so-called Honduras flora which might also be termed the *Swietenia—Trichilia—Zanthoxylum* flora after its typical genera. Most Neotropical elements of the Greater Antilles have originated from the Honduras flora. According to my hypothesis, it is the phase when three main groups of tropical genera immigrated. These are:

1. Genera represented by few but widely spread endemic species in the recent flora (*Swietenia, Trichilia, Cedrela, Inga, Albizzia, Bursera, Dipholis, Pseudolmedia, Chlorophora* and *Simaruba*).

2. Genera with secondary evolutionary centres evolved due to climatic and geological changes in the Antilles. These genera have many endemic representatives in the recent flora (*Pithecellobium, Cassia, Caesalpinia, Copernicia, Eugenia, Calyptranthes, Fagara, Pilea, Rondeletia, Psychotria, Guettarda, Miconia, Ossaea* and *Phyllanthus* etc.), and

3. Presumably extinct genera that are ancestors of typical endemic genera or genus groups characteristic of the Antilles, e.g. the group *Portlandia—Cubanola—Thogsennia;* the group *Schmidtottia—Isidorea;* the group *Phialanthus—Ceratopyxis—Shaferocharis;* the group *Antillia—Urbananthus—Spaniopappus;* the group *Scolosanthus—Eosanthe;* the group *Pinillosia—Tetraperone—Koehneola* and the group of *Espadaea—Goetzea—Henoonia* etc.

20.2.2.2 The sclerophyllous broad-leaved Madrean–Tethyan vegetation

Axelrod (1975) recognizes that the high similarity between the mediterranean vegetation of North America and Eurasia—North Africa is not merely a physiognomic resemblance because most genera occurring are common to both regions. He shows that a sclerophyllous broad-leaved vegetation developed in the Eocene and Oligocene of Sierra Madre (Mexico) and the southern United States, and also in the

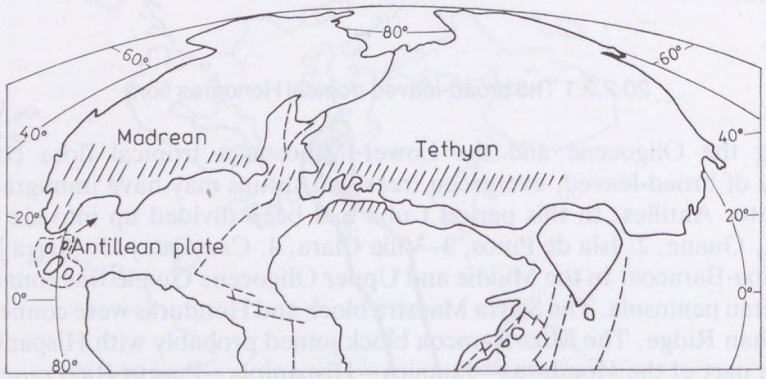


Fig. 126 Early Tertiary position of the continents and the Antillean plate; areas (hanchured) potentially occupied by Madrean-Tethyan or Peri-Tethyan sclerophyllous vegetation (Axelrod 1975, with some reconstructions)

Oligocene and Miocene of southern Eurasia, with many species in common. This vegetation, quite uniform in appearance, was named the Madrean–Tethyan vegetation after its westernmost limit, Sierra Madre, and the Tethys Sea, along the northern coast of which this vegetation type was spread (Fig. 126). It was extensive too, in the Upper Miocene of Central Europe. For example, the Sarmatian flora described from Hungary (Andreánszky 1956, 1962*a,b*) is also designated by Axelrod as being part of the Madrean-Tethyan vegetation. This sclerophyllous broad-leaved vegetation, which was formed by plants highly adapted to the increasing summer droughts in the Tertiary, has now been split into remote, isolated stands living under very different ecological conditions. In California and Europe the summer is dry and the winter is wet, in Arizona and New Mexico there are two dry seasons. This vegetation type occurs under the dry winter and rainy summer climate of Mexico and the West Indies. Moreover, extensive stands are

also found in places where the climate is wet throughout the year, but there are some sufficiently dry or nutrient-poor habitats thanks to edaphic effects (e.g. white sand, serpentine, granite-gneis domes, lava, limestone dog-tooth areas etc.).

20.2.2.3 The southern link

Axelrod pointed out correctly that the laurel forests of the Canary Islands belong to the Madrean-Tethyan vegetation, representing its southernmost portion. However, he did not consider the sclerophyllous communities of the Antilles which are also a part of that section. In the Miocene Honduras, the Yucatan peninsula and the Greater Antilles, which were connected to the first two, formed the southern coast of the Tethys Sea in America. These areas were similar in effect to the northern coast of Africa and the Canary Islands on the other side of the Tethys Sea. Accordingly, a special type of the sclerophyllous Madrean–Tethyan vegetation, which should preferably be termed the Peri-Tethyan sclerophyllous vegetation, developed in the Greater Antilles. In addition to the Madrean-Tethyan elements, this Antillean type is characterized by its richness in Neotropical sclerophylls and particularly in endemics, and also by its isolation. No doubt that the serpentine charrascals (dry evergreen shrublands), pine-oak woodlands, coniferous-laurel forests, and pine-Dracaena forests of Cuba are relicts left of the southern portion of the Madrean–Tethyan vegetation.

20.2.2.4 The Madrean–Tethyan flora in Cuba

The sclerophyllous broad-leaved Madrean–Tethyan flora immigrated into the Antilles presumably in the Lower and Middle Miocene. It was probably a direct continuation of the former invasion of the Honduras flora. In this period an increasingly arid subtropical climate was predominant not only in the tropical zone but also in most parts of the warm temperate zone. More recently, this unusual expansion of the subtropical zone is attributed to a temporarily formed ring around the Earth, similar to that of the Saturn. This dry period displayed a strong influence on the evolution of the Cuban flora, in which the sclerophylls are still dominant. 75 % of the endemic species are micro- or nanophanerophytes (2265 species), most of them (86 %) being micro-, nano- and leptophylls. Many genera typical of the Madrean–Tethyan vegetation immigrated into Cuba and became important elements of the flora supposedly in this period. These genera are: *Pinus, Juniperus, Quercus, Juglans, Buxus, Ilex, Lyonia, Vaccinium, Pieris, Kalmiella, Berberis, Celtis, Prunus, Myrica, Acacia, Calliandra, Erythrina, Karwinskia, Zizyphus, Reynosia, Colubrina, Thouinia, Dodonaea, Myrtus, Psidium, Euphorbia, Amyris, Helietta, Auerodendron, Sarcomphalus, Rhacoma, Forestiera, Sabal, Coccothrinax, Maytenus, Paepalanthus, Lachnocaulon, Syngonanthus, Eriocaulon, Chaetolepis, Befaria* and *Garrya*.

20.2.2.5 Neotropical sclerophylls in the Madrean–Tethyan vegetation of Cuba

The southern part of the Madrean–Tethyan vegetation has its own typical features. Numerous species of the earlier established tropical broad-leaved Honduras flora became adapted to the new arid climate, and several secondary evolutionary centres developed. Different Neotropical families and genera, represented by membranous leaved macrophylls and mesophylls in the continent, suffered a change so that new species group or entire sections containing only sclerophylls and coriaceous-leaved microphylls appeared in Cuba. Such genera are, for example, *Croton, Phyllanthus, Harpalyce, Miconia, Ossaea, Plumeria, Jacquinia, Plinia, Eugenia, Diospyros, Antirhea, Exostema, Rondeletia, Guettarda, Machaonia, Melocactus* and *Gesneria* etc. The endemic genera of the Antilles, Hispaniola and Cuba, that are typical of the sclerophyllous vegetation types, may also be considered as results of this climatic change: Examples are *Acrosynanthus, Phialanthus, Neomazaea, Ariadne, Phyllacanthus, Sarcomphalus, Doerpfeldia, Pachyanthus, Scolosanthus, Catesbaea, Notodon, Nashia, Sauvalella, Leucocroton, Phidiasia, Lescaillea, Harnackia, Phania, Shafera, Moacroton, Hemithrinax, Ceuthocarpus, Schmidtottia, Roigella, Suberanthus, Kodalyodendron, Henoonia, Linodendron, Adenoa* and *Tetralix* etc.

20.2.2.6 Drought-resistant ecotypes

The numerous newly occurring sclerophyllous species and genera were only one indication of the adaptation to the dry climate of the Miocene. The thin-leaved trees of the Honduras flora also became adapted to aridity by developing drought-resistant ecotypes. Although there are very little morphological differences between these ecotypes and the corresponding Central American populations, the habitats of these species are apparently drier in Cuba than on the continent. Examples are *Ceiba pentandra, Trichilia glabra, T. hirta, Cupania macrophylla* and *Bursera simaruba* etc.

20.2.3 Archipelago phase

The third period is termed the archipelago phase. It came about at different points of time over the Greater Antilles. In Cuba it started at the end of the Miocene, when the Bartlett Trench, that separates Cuba from Jamaica and Hispaniola, was formed. Of these islands Jamaica had been connected to the continent for the longest time, as clearly indicated by the floristic composition of this island (Asprey and Robbins 1953, Adams 1972). Changes typical of that period are the ecological specialization of floras isolated from one another and, as a consequence of this, the internal migration of species. In that phase the flora and fauna of Cuba were subjected to severe climatic and geological changes. In the Pliocene and the Pleistocene the humid climate frequently alternated with dry periods. The effects of this climate are clearly indicated by the stratification of latosols in the Nipe Mts. Cooler periods, too, were frequent in the Pleistocene.

Large-scale tectonic events took place simultaneously with the climatic changes. The most effective of them was that the six, formerly separate land blocks emerged and joined to form a single island with extensive bare areas. The colonization of these lands required further differentiation and migration of the flora and the adaptation of species to the new environmental conditions. Other external effects, independently of the geological changes, also influenced the flora of Cuba.

20.2.3.1 The broad-leaved rainforest flora of Guyana

The direct land connections between Cuba and Central America disappeared by the end of the Miocene. Later, in the early Pliocene, the climate became wetter. In the second half of the Pliocene the arch of many young volcanoes, i.e. the Lesser Antilles, emerged and the islands of the Greater Antilles also reached the maximum elevation. Presumably, this is the period when the South American elements immigrated into Cuba via the Lesser Antilles, although at that time land strips no longer existed. Yet, the genera *Carapa, Ochroma, Coussarea, Tocoyena, Paratheria, Phinaea, Proustia, Guarea* and the *Myrsine guianensis* group must have originated in this way.

20.2.3.2 The broad-leaved semi-deciduous Yucatan flora

It is striking that there are numerous species common to the semi-deciduous forests of lowlands and hill-countries in western Cuba and Yucatan. Some of them occur solely in the Guanahacabibes peninsula and Yucatan. As examples the genera *Hirtella, Poiretia, Eriosema, Belotia, Luehea, Schwenckia, Chimarrhis, Calycophyllum, Elaeagia, Deherainia, Ateleia, Forchhammeria* and *Neomacfadya* are worth mentioning. Although the presence of these elements suggests a direct relationship between the Miocene flora of Mexico and Cuba, there are neither geological nor biogeographical evidences supporting the existence of land connections in that period.

20.2.3.3 Elements from the temperate North America

The next most important region influencing the flora of Cuba, particularly western Cuba, is Florida and the south-eastern United States. Several elements, such as *Pinus, Quercus, Fraxinus* and many species of *Ericaceae, Gramineae* and *Cyperaceae* etc. of the temperate zone immigrated from the north and became predominant in some parts of western Cuba. Alain (1958: 19) presumes the existence of a former land connection between western Cuba and Florida, although according to geologists this possibility has been excluded since the Eocene. In my view, the flora of the temperate zone in western Cuba developed during the glacial periods in the Pleistocene, that took place simultaneously in the whole continent as pointed out by van der Hammen (1961) and Vuilleumier (1971). Consequently,

instead of assuming a land bridge it is more reasonable to trace back the Florida — western Cuba relationship to the Madrean–Tethyan flora. As already seen, this sclerophyllous evergreen flora originally contained several genera from the families of the temperate zone. In addition, there was adequate time during the Miocene available for a fairly uniform vegetation to develop, first on the coast of the Tethys Sea and later, following the emergence of Central America, along the Gulf of Mexico. This flora was exposed to the cooler climatic periods occurring many times in the Pliocene and the Pleistocene. In particular, the coastal region of the Gulf of Mexico was affected, since the cold Labrador Current often reached this zone during the Pleistocene. The new environmental conditions, e.g. modified soil types, and the adaptive responses of plant populations generated by this cooling process were probably similar on both sides of the gulf. The standardization of the flora may have been furthered, also by the strong northerly and westerly winds during the glacial periods and by the more intensive bird migration. In Cuba, the expansion of this flora was also promoted by the newly emerged lands and white sands that offered extensive bare areas for plants. Thus, the recent flora elements common to western Cuba and Florida are remnants of a Pleistocene flora spread along the entire coast of the Gulf of Mexico. The continuity of this flora was broken in the post-glacial period, when the Central American subtropical flora retreated to the western coast of the gulf, forcing back the remnants of the Madrean–Tethyan flora to a north-western and north-eastern direction.

20.2.3.4 Remarks on the driving forces of migration

In connection with the above discussion, it has to be emphasized that very little is known about the water and aerial dispersal of seeds. Seed dispersal is likely to be more important than generally thought of, and the explanation of floristic relationships does not necessarily require a search for disappeared land strips. Only confirmed geological results may serve as a basis for hypotheses on the distribution, development and migration of the flora. Moreover, even undoubtful land connections may prove to be of no help in promoting dispersal. For instance, *Befaria cubensis, Microcycas calocoma* and *Rhus copallina* did not reach Isla de Pinos despite the direct terrestrial contact to Cuba in the Pleistocene. Although *Fraxinus caroliniana* ssp. *cubensis* produces easily flying seeds, it could not become established on moorlands outside the Zapata peninsula. Many genera (e.g. *Victorinia*) and species (e.g. *Omphalea commutata*) are still restricted to an area along the former contact line between Cuba and Hispaniola (Fig 135) although the ecological conditions would allow a larger geographic range on both islands. Many elements of the Bahamas, that managed to get across the wide and deep Bahama Trench and became established on the reefs around northern Camagüey, Tunas and Holguin, were unable to penetrate into Cuba through the narrow and shallow bays and even via the former land strips. Consequently, a terrestrial contact may not necessarily be enough by itself and cannot be a single explanation for migration. The migratory activity of taxa does not always coincide in time with the possibilities. In other cases unfavourable ecological and cenological conditions, such as the saturation of the flora, may prevent otherwise feasible migration.

20.3 Flora migration in the interior of Cuba

The chorological groups reflecting the origin of the Cuban flora, the approximate time of their manifestation and the potential migratory routes have already been discussed. These are, however, only the initial steps toward a complete flora development. The actual floristic composition is a result of further differentiation, adaptation and internal migration. Two fundamental principles should be considered in this regard.

20.3.1 Two principles of internal floristic changes in Cuba

1. Oriente is the earliest cradle of the Cuban flora, a starting point for the most important migrations.
2. The floras of mountains are older than those of the lowlands. The flora and vegetation of plains originated from the mountainous regions.

20.3.2 Three stages of internal migration

According to time, starting point and direction, three stages of internal migration can be distinguished.

a) Migrations in the early Tertiary (Eocene to Miocene). The centre of these movements, that were directed from the east to the west, was the mountains of Oriente. The low differentiation and specialization of the flora is typical of this stage. Several migratory waves may be recognized, these are associated with different periods. The radius of action was determined in each case by geological events, transgression and the emergence of lands, that actually happened. The serpentine and karst flora of western Cuba and then the montane flora of the Escambray Mts were originated in this way. Later, the submontane tropical flora, which subsequently colonized the rising plains, took refuge in the valleys.

b) Migrations in the late Tertiary and in the Quaternary (Pliocene and Pleistocene). Starting from both tips of the island the migrations were directed toward the interior. As a result, a new flora in the central plains of Cuba became established at the end of the Pliocene. The migrations of alternate direction in the Pleistocene are also mentioned here. During cooler periods these migratory waves swept over Cuba from the west to the east, but in the warm periods the migration was from the opposite direction. This is the time of ecological and cenological adaptation and specialization. The vegetation zones and, among others, the formation of the endemic montane flora of Turquino may also be dated back to this stage. Furthermore, the homogenization of the flora and vegetation, that originated from different mountains, may have been caused by the repeated "shake up" of the flora of the plains.

c) Migrations driven by anthropogenic forces during the historical ages The starting point for these migrations is usually western Cuba, so the direction is

toward the east. The reason for this is that western Cuba was the sanctuary of many savanna and prairie elements in the Pleistocene, that found refuge particularly in the herb layer of the pine forests. The migration of these plants was made possible by tropical deforestation, which is mainly responsible for secondary savannas and the recent landscape of Cuba. In addition to the migration of native plants, many species were introduced most recently by man. These elements, too, migrate usually from the west to the east.

20.4 Evolutionary centres and the migration of ecological groups

The evolutionary centres and the migratory characteristics of genera, families and sections may be explored by comprehensive morphological and microevolutionary studies at the given taxonomic level. However, only a few relevant works have been published, for instance, Webster (1958) on *Phyllanthus,* Judd (1981) on *Lyonia,* Dahlgren and Glassman (1963) on *Copernicia* and Howard (1947) on *Coccoloba.* Of course, besides the analysis of taxonomic categories, the evolutionary centres and migratory pathways of life forms or vegetation types may also be revealed by thorough studies. For example, the mangrove communities reach the highest diversity in the Indonesian archipelago, which may be considered the evolutionary centre of the mangrove vegetation type (Andreánszky 1954). The localization of the richest and the poorest stands of each vegetation type or plant community in Cuba may be readily determined based on phytosociological relevés and vegetation maps. In the present study relevés taken by Borhidi, Muñiz, Del Risco, Capote and Samek are used together with published data (León 1936, 1939, Marie–Victorin and León 1942, 1944, 1956, Webster 1956–58, Borhidi and Muñiz 1977, Klotz 1978, Borhidi and Fernandez 1984 and Borhidi 1973, 1981, 1985, 1986).

20.4.1 Evolutionary centres and migratory routes of the serpentine vegetation

The distribution of some typical elements of the serpentine vegetation is shown in Figs 127, 131. The evolutionary centres and principal migratory routes are illustrated in Fig. 132. The section *Orbicularia* of the genus *Phyllanthus* is a typical serpentinophilous group that includes many species occurring on the old latosols of northeastern Oriente. Of this section. *Ph. orbicularis* is the only species that is found on all the serpentine outcrops of the island (Fig. 127). Like *Neobracea valenzuelana* (Fig. 117), this species must have reached its suitable habitats along the route indicated by arrows in the figure. León (1946) and Webster (1958) assumed that this migration took place along a continuous serpentine 'axis' ('eje serpentinoso'). Such a serpentine strip could not have existed later than the Oligocene, due to the long transgression of central Cuba. It is doubtful, however, whether such a large continuous serpentine area could have been denuded by that time, although the distributions of vicarious genera (Fig. 113) and species (Figs

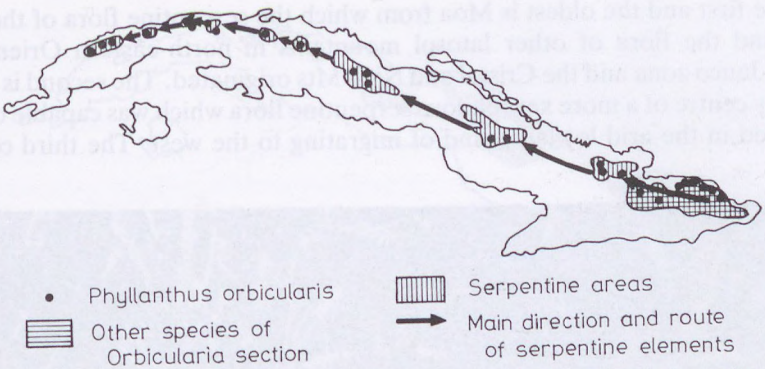


Fig. 127 Geographical distribution of the serpentine areas and the *Orbicularia* section of genus *Phyllanthus* in Cuba (Webster 1958)

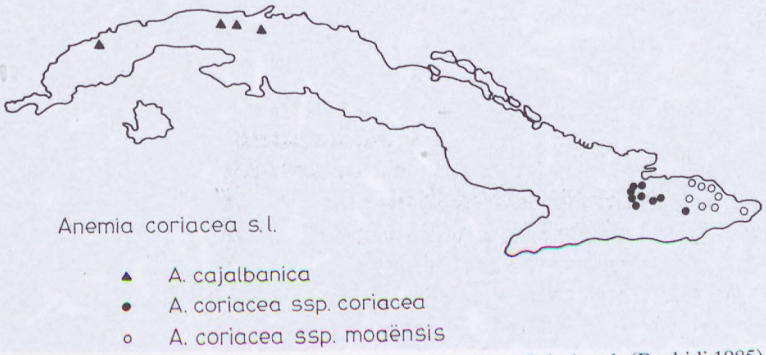


Fig. 128 Geographical distribution of *Anemia coriacea* Griseb. s.l. (Borhidi 1985)

128–131) of the Nipe Mts and Cajalbana suggest that a direct relationship may have existed. Yet, according to our recent geological knowledge, it is more likely that the serpentine blocks were more or less separated all the time. The serpentinophilous species were presumably distributed either by wind *(Neobracea)* or by animals *(Phyllanthus)*. They may have had wider distribution earlier, but due to the depletion of habitats (Kruckeberg 1954) they survived only on serpentines and became subjects of intensive speciation. It seems that there were several stages of the east-west migration of the serpentine flora. Taxa with strongly disjunct geographical range, e.g. *Anemia* (Fig. 128), *Moacroton* (Fig. 130), *Lescaillea* (Fig. 113) and *Harnackia* etc., were distributed during the earlier stages. Later, some serpentinophilous species, e.g. *Jacaranda cowellii, Coccoloba geniculata, Zanthoxylum nannophyllum* (Fig. 131) and *Platygyne parviflora* (Fig. 115), migrated replacing the above mentioned taxa in the plains of eastern Cuba. In these stages the species with continuous distribution, such as *Neobracea valenzuelana* and *Phyllanthus orbicularis* became also widespread. On the basis of all these, three evolutionary centres of the serpentine flora may be distinguished in Cuba (Fig.

132). The first and the oldest is Moa from which the serpentine flora of the entire island, and the flora of other latosol mountains in north-eastern Oriente, the Baracoa-Jauco zone and the Cristal and Nipe Mts originated. The second is Nipe, a migratory centre of a more xerophilous serpentine flora which was capable of being established in the arid lowlands and of migrating to the west. The third centre is



Fig. 129 *Moacroton trigonocarpus* (Wr. ex Griseb.) Croiz. an endemic characteristic element of the dry evergreen serpentine scrub "charrascal" of the Cajalbana range (Photo: A. Borhidi)

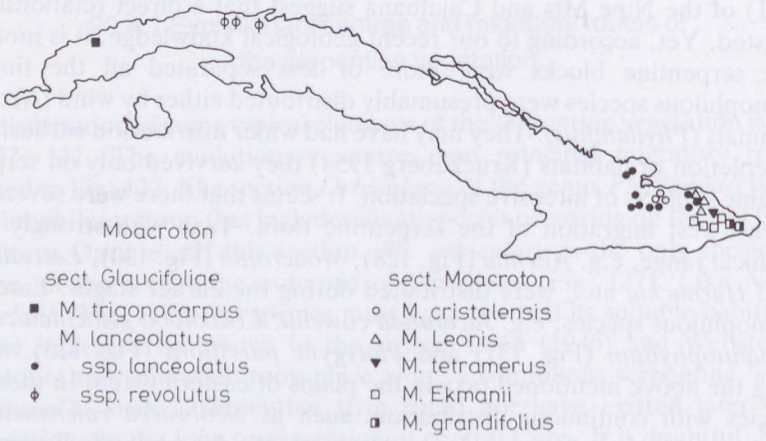


Fig. 130 Geographical distribution of the serpentinicolous, endemic Cuban genus: *Moacroton* Croiz. (Borhidi 1985)



Fig. 131 Geographical distribution of *Coccoloba geniculata* Lindau, *Jacaranda cowellii* Britt. and Wils and *Zanthoxylum nannophyllum* Urb.

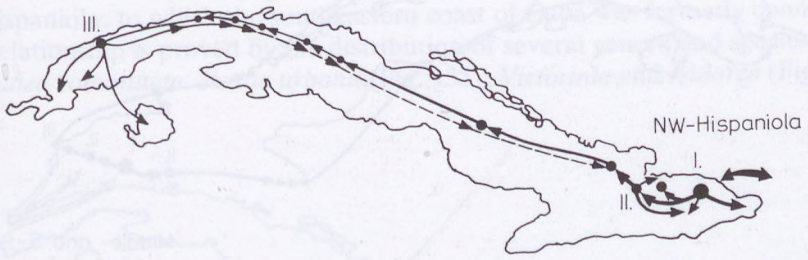


Fig. 132 Centres of evolution and routes of migration of the serpentinicolous flora in Cuba (Borhidi 1985)

Cajalbana in western Cuba. A part of its flora retreated to the serpentine blocks which rose later in central Cuba, especially to Habana and Matanzas. Many latosol elements of this flora became adapted to the acidic slatey habitats of Pinar del Rio and Isla de Pinos. In Fig. 132 the dotted line directed to the east indicates the secondary migration of serpentine elements from areas which subsequently became secondary savannas under the influence of man.

20.4.2 Evolutionary centres and migratory routes of the flora of limestone cliffs

The flora of limestone karsts has two primary evolutionary centres (Fig. 133). One of them is in the conical karsts of Sierra de los Organos in western Cuba, which is considered to be the oldest geological formation on the surface of the island. The majority of species found here remained endemics, although a portion of the flora spread to the younger Tertiary karsts in the Habana and Matanzas Hills, e.g. *Bombacopsis cubensis, Thrinax morrisii* (Fig. 114) and *Phania matricarioides*. Certain elements managed to get dispersed as far as to the high-altitude mogotes and to the southern coast at the Escambray Mts. During the transgression, inland

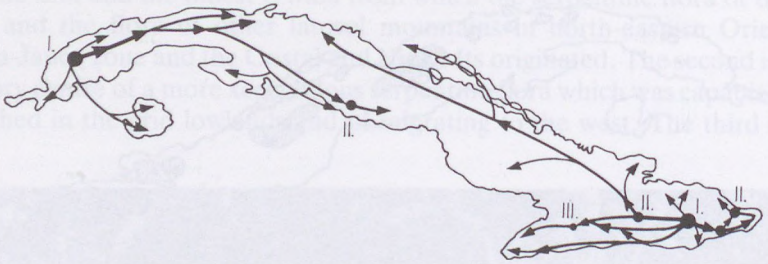


Fig. 133 Centres of evolution and possible routes of migration of the flora of the limestone tropical karsts (mogote formations) (Borhidi 1985)



Fig. 134 Possible centres of evolution and routes of migration of the semi-desert, xero-megathermophilous elements in Cuba (Borhidi 1985)

mountains of Cuba itself were old coastal zones serving as refuges of the vegetation of coastal karsts. This vegetation started to spread over the recent coastal zone at the end of the Tertiary. The other primary evolutionary centre is the mountains of Oriente. Here, the development of the karstic flora is not as clear-cut as in western Cuba, since the karsts of Oriente are younger than the serpentine formations and, also, a part of the limestone flora originated from primary soils derived from serpentine (e.g. Nipe Mts, Monte Libano). Of the many isolated karstic regions, the group of Monte Libano and Monte Verde appears the most peculiar evolutionary centre, so much the more because this area was crossed by many migratory paths of varying nature and direction. From this old coastal karstic zone spread the karst flora over the country, first along the coastline. In the westerly direction two secondary evolutionary centres developed: the karsts southwest of the Nipe Mts, and at the northern border of Sierra Maestra. In both areas the montane elements descending from the mountains were mixed with the karstic flora spread along the coast. The influence of this flora was extended to the east as far as the Yumuri karsts and Yunque de Baracoa, with a secondary evolutionary centre developed in the latter place. The rise of the terraces in southern Baracoa made it possible for the flora of Monte Libano to spread over the semi-desert coastal zone. As a result of

this migration, xero-megatherm species evolved (see *20.4.3)*. Some elements of the Oriente karstic flora migrated along the southern coast at the Sierra Maestra. The others spread to the west from the Nipe Mts via the former Limestone block mountains along the north-western coast of central Cuba, forming the flora of the Cubitas and Najasa Mts and, too, the flora of coastal shelves. The influence of this migration may be seen even in the mogotes of Caguaguas (see the distribution of *Thrinax;* Fig. 114). This bidirectional distribution exhibited by karstic elements is an important characterstic of the recent flora, too, so it was considered in the delimitation of the phytogeographical sectors of central Cuba (see Fig. 187)

20.4.3 Evolutionary centres and migratory routes of the xero-megatherm elements (Fig. 134)

Some semi-desert xero-megatherm elements originating from central and southern Hispaniola, to which the southeastern coast of Cuba was formerly connected. This relationship is proved by the distribution of several genera and species, e.g., *Omphalea commutata, Petitia urbanii* (Fig. 135), *Victorinia* and *Isidorea* (Fig. 136)



Fig. 135 Geographical distribution of *Omphalea commutata* Muell. Arg. and *Petitia urbanii* Ekm. (Alain 1972 and Borhidi 1985)



Fig. 136 Geographical distribution of the genus *Isidorea* A. Rich. (Borhidi 1985)

etc., now restricted to the actual and previous coastlines. These elements, thanks to the gradual rising of the southern Baracoa coast, were intermixed with the endemic flora of karstic slopes. As a result, several centres of speciation developed, the richest of them being the Guantanamo Basin. The flora of Macambo-Imias and Maisi, and the Daiquiri-Siboney-Santiago area in the west are almost as rich as that of the Guantanamo Basin, so they can be considered as secondary and tertiary evolutionary centres, respectively. The number of xero-megatherm elements on the southern coast at Sierra Maestra, on the coasts of north-western Oriente and northern Camagüey, in the southern foothills of Escambray Mts, and on the northern rocky coast between Habana and Matanzas decreases in that order.

20.4.4 Evolutionary centres and migratory routes of the montane rainforest elements (Fig. 137)

The evolutionary centres and migratory routes of the flora in the montane rainforests are shown in Fig. 137. The distribution of *Hedyosmum* serves as an example (Fig. 138). Again, the main centre is the lower and old mountains in the

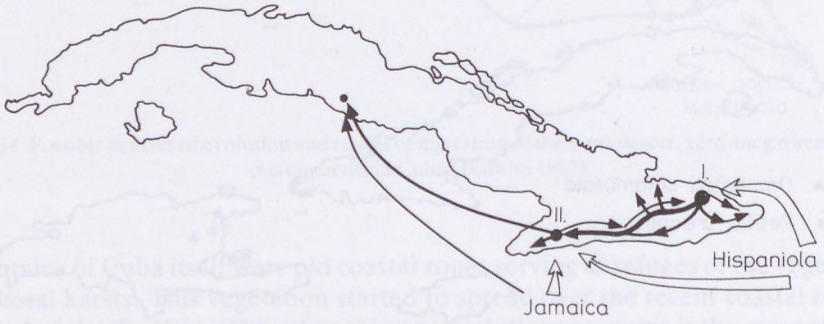


Fig. 137 Centres of evolution and possible routes of migration of the montane rainforest elements in Cuba (Borhidi 1985)

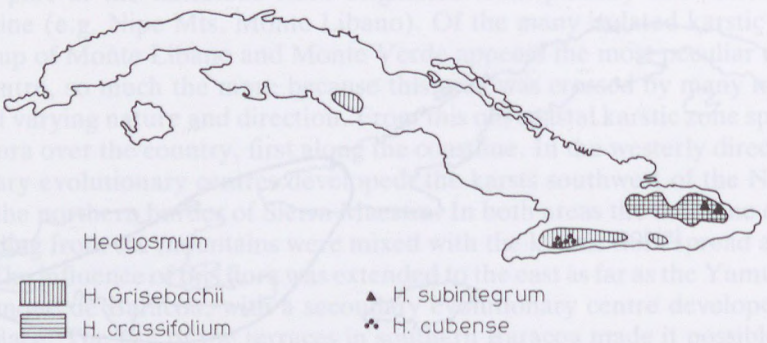


Fig. 138 Geographical distribution of the *Hedyosmum* species in Cuba (Borhidi 1985)

Sagua-Baracoa Massif, especially the Moa-Toa area. According to my hypothesis, this region received its montane elements via Hispaniola, and served as a new centre for their further migration to Cristal, Nipe, Purial, Imias, and, in particular, to Sierra Maestra. The first stage of this process took place presumably in the mountain-range connecting Oriente and Escambray. The more permanent changes, however, are results of migrations during the cooler periods of the Quaternary between Sierra del Cristal and Gran Piedra through the Central Valley area which subsided later. At that time the lower border of montane rainforests may have extended to as 200–300 m altitude. This montane flora was mixed with Jamaican and southern Hispaniolan montane elements and, during the cool periods in the Pleistocene, may have repeatedly retreated to the subalpine-alpine zone in the Turquino group. In this place a secondary centre of speciation developed. It is likely that even at that time some montane elements of Sierra Maestra got across to the Escambray Mts, which received elements from the montane flora of Jamaica, too.

20.4.5 Distribution centres and migratory routes of the semi-deciduous elements

The origin and migration of the elements of semi-deciduous forests and seasonal rainforests in the lowlands pose different problems. Alain (1958) traces the origin of some elements back to Mexico, assuming a west-east migration of these forests. It is my conviction that this flora survived in the refuge of valleys at the time of transgression, and subsequently spread over to every direction. Especially the mountains of Oriente, northern Camagüey, Pinar del Rio and the Escambray Mts should be mentioned as potential refuges. The high similarity between the characteristic composition of lowland and submontane forest formations also supports this fact (see Figs 331–336).

PART IV

THE PHYTOGEOGRAPHICAL SUBDIVISION OF CUBA

(WITH THE CONTRIBUTION OF O. MUÑIZ)

PART IV

THE PHYTOGEOGRAPHICAL SUBDIVISION OF CUBA

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21 The phytogeographical status of Cuba

21.1 Good's phytogeographic regionalization of the Caribbean

Cuba belongs to the Neotropical floristic kingdom whose phytogeographic subdivision has been defined by Good (1954) and, later by Takhtadjan (1970). According to these authors, the Neotropical kingdom is divided into seven floristic regions and is characterized by 32 endemic plant families, 10 of which occur in Cuba. These are: Marcgraviaceae, Bixaceae, Cochlospermaceae, Brunelliaceae, Picrodendraceae, Calyceraceae, Bromeliaceae, Cyclanthaceae, Heliconiaceae and Cannaceae. The Caribbean floristic region has been divided into four provinces: 1. Southern California—Mexico, 2. Caribbean, 3. Guatemala—Panama, and 4. North Colombia—North Venezuela, Cuba, as a separate sub-province, belongs to the Caribbean province.

21.2 A new proposal for the phytogeographic regionalization of the Caribbean area

In the author's opinion the above-mentioned phytogeographic classification does not reflect correctly the evolutionary history and the present floristic conditions of the Caribbean. In addition, the early isolation of the Antilles and the rich endemic flora of the archipelago are not considered satisfactorily. For these reasons it seems justified to make a distinction between two equally important subregions, continental and Antillean, within the Caribbean floristic region and, further, to modify the regionalization as follows (see Fig. 139).

Neotropical kingdom (32 endemic families)
Caribbean region (2 endemic families, Goetzeaceae and Plocospermataceae, and more than 500 endemic genera).

A) Mexican–Venezuelan sub-region (a single endemic family, Plocospermataceae, and approximately 200 endemic genera)

Provinces:
1. Baja–California–Mexico
2. Guatemala–Panama
3. North Colombia–North Venezuela (including Trinidad and Tobago)

B) Antillean sub-region (a single endemic family, Goetzeaceae, and about 200 endemic genera and 7500 endemic species)

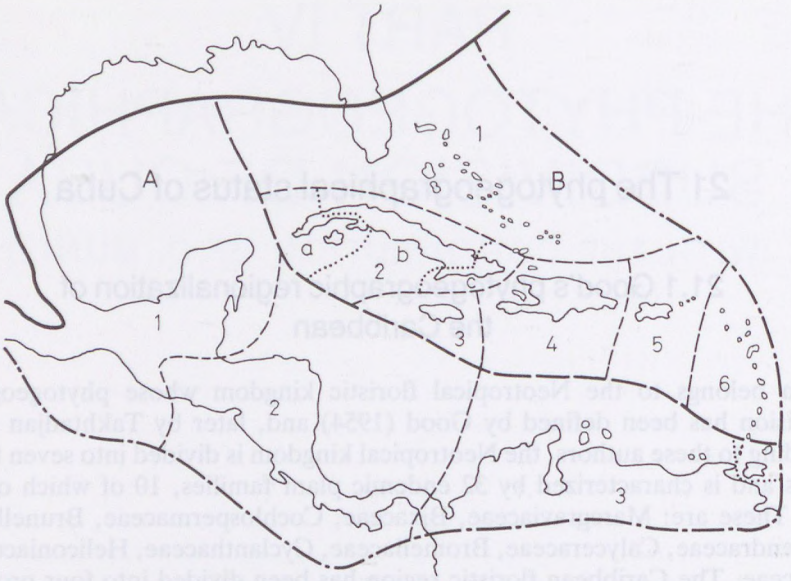


Fig. 139 Phytogeographical regions of the Caribbean territory (after Good 1954, strongly modified). —— border of the phytogeographical kingdom, –·–·– border of the phytogeographical territory, – – – – – border of the phytogeographical subterritory, – – – – – border of the phytogeographical province, ····· border of phytogeographical subprovince

Provinces:

1. South Florida–Bahamas–Bermuda (7%, 10% and 8% endemics, respectively)
2. Cuba (51.4% endemics, 72 endemic genera and approximately 3200 endemic species)
3. Jamaica (20–22 % endemics, 8 endemic genera)
4. Hispaniola (39.2% endemics, 37 endemic genera approximately 1800 endemic species)
5. Puerto Rico (13% endemics, 2 endemic genera)
6. Lesser Antilles (10—12% endemics)

21.3 Relationships within the flora of the West Indies

In the paper on the vegetation of the Antilles by Howard (1974), the relationships between the flora of the islands and the distribution patterns of plants, rather than the vegetation, are discussed. In Howard's views the geobotanical relationship between the continent and the islands should be evaluated on the basis of genera, rather than species. The results of this analysis are presented in 30 tables where only those genera are listed which were considered by Howard to be free from taxonomic problems. Based on this analysis the following statements were made.

In the Antilles several endemic genera are restricted to one or two islands and there are only two endemic genera with more than 20 species. Picrodendraceae,

including a single genus and three species, is the only family restricted to the Antilles in distribution.

The flora of the Greater Antilles has several genera in common with central America which are otherwise absent from the Lesser Antilles. Contrarywise, the Lesser Antilles have several South American genera that are missing from the Greater Antilles.

Howard's study suggests that the flora of the West Indies is not uniform and its development is not completely independent, since inner disjunctions are more characteristic than close relationships. This idea has been manifested in Klotz's (1978) work in which a northern Caribbean subregion is distinguished within the Caribbean floristic region by excluding the Lesser Antilles. Within this sub-region a Greater Antillean province is delimited.

The regionalization concept described above was developed (Borhidi 1973) in the year of Howard's publication and the studies carried out since then appear to support the author's early view. In the meantime, the Picrodendraceae family, considered earlier as being endemic to this area, was incorporated into Euphorbiaceae, whereas the family status of Geotzeaceae was restored (Airy Shaw 1965, Hunziker 1979, Fuentes 1982). The latter family comprises four genera, all endemic to the Antilles. Several new genera were described from the Antillean area (Borhidi 1973, 1977, 1981, 1982, Aiello 1979, Alain H. Liogier 1981) and new species of West Indian genera were discovered. Following Howard's pioneer studies, some problems concerning the floristic relationships between the Lesser and Greater Antilles were clarified. Also, the presence of some South American genera in the Lasser Antilles turned out to be the result of secondary introduction (Howard 1982).

In the sequel some tables will summarize the genera whose distribution is confined to the West Indian subregion (in the sense of Borhidi). In addition, genera having the evolutionary centre in the West Indies but also represented by as few as 1—2 species in the South or Central American continent are listed, these are indicated by an asterisk (Table 31).

Table 31 Genera with West Indian distribution pattern

Borrichia (Compositae) 2 species
Calycogonium (Melastomataceae) 33 species
Cataesbaea (Rubiaceae) 20 species
Coccothrinax (Palmae) 55 species (1 in Mexico)
Consolea (Cactaceae) 14 species
Ernodea (Rubiaceae) 3 species
Gesneria (Gesneriaceae) 55 species
Gundlachia (Compositae) 10 species
Hypelate (Sapindaceae) 1 species
Metopium (Anacardiaceae) 3 species
Neolagueria (Rubiaceae) 5 species
Oplonia (Acanthaceae) 20 species (2 in Peru and 3 in Madagascar)
Oxandra (Lauraceae) 2 species
Petitia (Verbenaceae) 2 species
Reynosia (Rhamnaceae) 18 species (1 in Central America)
Rhytidophyllum (Gesneriaceae) 22 species (2 in South America)
Rochefortia (Borraginaceae) 12 species (1 in Central and South America)
Rondeletia (Rubiaceae) 130 species (2 in Central and 12 in South America)
Sarcomphalus (Rhamnaceae) 12 species
Scolosanthus (Rubiaceae) 22 species
Strumpfia (Rubiaceae) 1 species
Tetrazygia (Melastomataceae) 15 species
Tetrazygiopsis (Melastomataceae) 13 species
Thrinax (Palmae) 8 species
Wallenia (Myrsinaceae) 26 species (2 in Central America)

In summary, not less than 27 flowering plant genera are considered as being endemic to, or having the evolutionary centre in the West Indies. These genera are represented by a total of 500 species, approximately.

The number of endemic genera common in the Greater Antilles is 15, most of those occurring in the Bahamas as well (Table 32). They include more than 100 species. This indicates that the flora of Bahamas is closely related to that of the Greater Antilles, in particular, of Hispaniola. The floristic relationships among the islands of West Indies are best illustrated by examining the number of endemic genera found only in the combination of three, or two islands or in a single island.

Table 32 Genera endemic to the Greater Antillas and partly to the Bahamas

Auerodendron (Rhamnaceae) C. J. B. 8 species	*Phialanthus* (Rubiaceae) C. J. PR. B. 18 species
Bonania (Euphorbiaceae) C. H. B. 8 species	*Picrodendron* (Euphorbiaceae) C. J. H. B. 3 species
Grimmeodendron (Euphorbiaceae) C. J. H. B. 2 species	*Pseudocarpidium* (Verbenaceae) C. H. B. 8 species
Lasiocroton (Euphorbiaceae) C. J. H. B. 4 species	*Sachsia* (Compositae) C. H. J. PR. B. Fl. 2 species
Leptocereus (Cactaceae) C. H. J. PR 14 species	*Spathelia* (Rutaceae) C. J. D. 15 species
Nashia (Verbenaceae) C. H. B. 6 species	*Tetranthus* (Compositae) H. B. 2 species
Neobracea (Apocynaceae) C. B. 8 species	*Triopteris* (Malpighiaceae) C. J. H. B. 5 species
Neothymopsis (Compositae) C. B. 2 species	

The importance of insularity in evolution is emphasized by the fact that the number of endemics occurring on three islands is lower than that on two islands. This number is the highest for the single islands. When Cuba, Jamaica and Hispaniola are viewed together, then there are 7 endemic genera with 44 species (Table 33). Cuba, Hispaniola and Puerto Rico together possess 3 endemic genera with 7 species, so the total is 10 genera with 51 species (Table 34).

Table 33 Genera occurring only in Cuba, Jamaica and Hispaniola

Acidocroton (Euphorbiaceae) 10 species	*Gyrotaenia* (Urticaceae) 5 species
Broughtonia (Orchidaceae) 2 species	*Haenianthus* (Oleaceae) 4 species
Brya (Fabaceae) 12 species	*Lagetta* (Thymelaeaceae) 5 species
Cameraria (Apocynaceae) 6 species	

Table 34 Genera occurring only in Cuba, Hispaniola and Puerto Rico

Ditta (Euphorbiaceae) 2 species	*Torralbasia* (Celastraceae) 2 species
Ottoschulzia (Icacinaceae) 3 species	

If pairwise combinations are taken, the following figures are obtained: Cuba and Hispaniola have in common 30 endemic genera with 168 species (Table 35). Cuba and Jamaica have 10 genera with 32 species (Table 36). There is only a single genus with two species common to Cuba and Puerto Rico (Table 37). Hispaniola and

Table 35 Genera endemic to Cuba and Hispaniola

Ampelocera (Ulmaceae) 2 species	*Neoregnellia* (Sterculiaceae) 1 species
Barleriola (Acanthaceae) 5 species	*Ottoschmidtia* (Rubiaceae) 1 species
Bellonia (Acanthaceae) 2 species	*Pachyanthus* (Melastomataceae) 24+1 species in SA!
Bisgoeppertia (Gentianaceae) 2 species	*Peratanthe* (Rubiaceae) 2 species
Chascotheca (Euphorbiaceae) 1 species	*Picardaea* (Rubiaceae) 2 species
Cubanola (Rubiaceae) 1 species	*Pinillosia* (Compositae) 1 species
Cubanthus (Euphorbiaceae) 3 species	*Plethadenia* (Rutaceae) 2 species
Ekmanianthe (Bignoniaceae) 2 species	*Saugetia* (Gramineae) 2 species
Fuertesiella (Orchidaceae) 2 species	*Scutachne* (Gramineae) 2 species
Isidorea (Rubiaceae) 20 species	*Spirotecoma* (Bignoniaceae) 5 species
Lantanopsis (Compositae) 3 species	*Suberanthus* (Rubiaceae) 7 species
Leucocroton (Euphorbiaceae) 27 species	*Thogsennia* (Rubiaceae) 1 species
Macrocarpaea (Gentianaceae) 2 species	*Verhuellia* (Piperaceae) 3 species
Margaritopsis (Rubiaceae) 3 species	*Victorinia* (Euphorbiaceae) 1 species
Mozartia (Myrtaceae) 9 species	

Table 36 Genera endemic to Cuba and Jamaica

Acrosynanthus (Rubiaceae) 7 species	*Homalopetalum* (Orchidaceae) 1 species
Calyptronoma (Palmae) 2 species	*Neo-Urbania* (Orchidaceae) 2 species
Cheilophyllum (Scrophulariaceae) 8 species	*Pheidonocarpa* (Gesneriaceae) 2 species
Cionosicyos (Cucurbitaceae) 1 species	*Strempeliopsis* (Apocynaceae) 2 species
Dinema (Orchidaceae) 2 species	*Urbananthus* (Compositae) 2 species

Table 37 Genera occurring only in Cuba and Puerto Rico

Gaussia (Palmae) 2 species

Table 38 Genera endemic to Hispaniola and Puerto Rico

Goetzea (Solanaceae) 1 species	*Pleodendron* (Canellaceae) 2 species
Piptocoma (Compositae) 1 species	*Stahlia* (Leguminosae) 2 species

Puerto Rico have in common four species, each representing a different genus (Table 38). The totals are 45 and 206, respectively, for genera and species.

Finally, the number of genera confined to one island is 121 altogether (237 species) (Tables 39, 40, 41, 42). The number of species per endemic genus in 2.27 in Cuba, 1.4 in Hispaniola, 2.12 in Jamaica and 1 in Puerto Rico. This ratio is 5.6 for Cuba and Hispaniola taken together, 3.2 for the pair of Cuba and Jamaica, 2 for Cuba and Puerto Rico, and 1 for Hispaniola and Puerto Rico.

Table 39 Endemic genera of Cuba and the ecological characteristics of their occurrence

	No. of species	Limestone	Sandstone	White sand	Serpentine	Other bedrocks
Acunaeanthus (Rubiaceae)	1	–	–	–	1	–
Adenoa (Flacourtiaceae)	1	–	–	–	1	–
Amphiolanthus (Scrophulariaceae)	3	+	+	+	–	+
Ancistranthus (Acanthaceae)	1	1	–	–	–	–
Antillia (Asteraceae)	1	–	–	–	–	1
Ariadne (Rubiaceae)	2	–	–	–	2	–
Asciadium (Apiaceae)	1	–	–	1	–	–
Behaimia (Fabaceae)	2	+	+	–	+	+
Belairia (Fabaceae)	6	3	1	1	1	1
Bembicidium (Fabaceae)	1	1	–	–	–	–
Caribaea (Nyctagynaceae)	1	1	–	–	–	–
Ceratopyxis (Rubiaceae)	1	1	–	–	–	–
Ceuthocarpus (Rubiaceae)	1	–	–	–	1	–
Chaetium (Poaceae)	*1*	+	–	–	+	–
Ciceronia (Asteraceae)	1	–	–	–	1	–
Cubacroton (Euphorbiaceae)	1	1	–	–	–	–
Daystropis (Acanthaceae)	1	–	–	–	1	–
Dendrocereus (Cactaceae)	1	1	–	–	–	–
Doerpfeldia (Rhamnaceae)	1	1	–	–	–	–
Ekmania (Asteraceae)	1	1	–	–	–	–
Ekmanochloa (Poaceae)	2	–	–	–	2	–
Encopella (Scrophulariaceae)	1	–	–	+	–	+
Eosanthe (Rubiaceae)	1	–	–	–	1	–
Espadaea (Geoetzeaceae)	1	+	+	–	+	+
Euchorium (Sapindaceae)	1	1	–	–	–	–
Euleria (Anacardiaceae)	1	1	–	–	–	–
Feddea (Asteraceae)	1	–	–	–	1	–
Gastrococos (Arecaceae)	1	+	–	–	+	+
Goerziella (Amaranthaceae)	1	1	–	–	–	–
Grisebachianthus (Asteraceae)	7	2	–	–	5	–
Harnackia (Asteraceae)	1	–	–	–	1	–
Hebestigma (Fabaceae)	1	+	+	–	+	+
Henleophytum (Malpighiaceae)	1	+	–	–	+	–
Henoonia (Goetzeaceae)	1	+	–	–	+	–
Heptanthus (Asteraceae)	7	1	1	1	4	–
Herpyza (Fabaceae)	1	–	+	+	–	–
Kodalyodendron (Rutaceae)	1	–	–	–	1	–
Koehneola (Asteraceae)	1	–	–	–	1	–
Krokia s. l. (Myrtaceae)	11	2	–	–	8	1
Lachnorrhiza (Asteraceae)	1	–	+	+	+	–
Lepturidium (Poaceae)	1	–	–	1	–	–
Lescaillea (Asteraceae)	–	–	–	–	1	–
Linodendron (Thymelaeaceae)	3	–	–	–	2	1
Megalopanax (Araliaceae)	1	1	–	–	–	–
Microcycas (Cycadaceae)	1	+	+	–	–	–
Mniochloa (Poaceae)	2	+	+	–	+	+
Moacroton (Euphorbiaceae)	7	–	–	–	7	–

	No. of species	Limestone	Sandstone	White sand	Serpentine	Other bedrocks
Neomazaea (Rubiaceae)	1	–	–	–	1	–
Nodocarpaea (Rubiaceae)	1	–	–	1	–	–
Notodon (Fabaceae)	4	2	–	–	2	–
Phania (Asteraceae)	2	1	+	–	1	–
Phidiasia (Acanthaceae)	1	–	–	–	1	–
Phyllacanthus (Rubiaceae)	1	–	–	–	?	–
Phyllomelia (Rubiaceae)	1	–	–	–	1	–
Pinosia (Caryophyllaceae)	2	1	–	1	–	–
Platygyne (Euphorbiaceae)	7	1	1	1	4	2
Rhodogeron (Asteraceae)	1	–	–	–	–	1
Roigella (Rubiaceae)	1	–	+	+	+	–
Sapphoa (Acanteaceae)	2	–	–	–	2	–
Sauvallella (Fabaceae)	1	–	–	–	1	–
Schmidtottia (Rubiaceae)	16	–	–	–	16	–
Shafera (Asteraceae)	1	–	–	–	1	–
Shaferocharis (Rubiaceae)	3	–	–	–	3	–
Siemensia (Rubiaceae)	1	1	–	–	–	–
Solonia (Myrsinaceae)	1	–	–	–	–	1
Spaniopappus (Asteraceae)	5	1	–	–	3	1
Synapsis (Bigroniaceae)	1	1	–	–	–	–
Tetralix (Tiliaceae)	5	–	–	–	5	–
Tetraperone (Asteraceae)	1	–	1	–	–	–
Triscenia (Poaceae)	1	+	–	–	+	+
Woehleria (Amaranthaceae)	1	+	–	–	–	+
Zonanthus (Gentianaceae)	1	1(?)	–	–	–	–

Table 40 Genera endemic to Hispaniola

Anacaona (Cucurbitaceae) 1 species
Arcoa (Caesalpiniaceae) 2 species
Casabitoa (Euphorbiaceae) 1 species
Coeloneurum (Solanaceae) 1 species
Cryptorhiza (Myrtaceae) 1 species
Ekmaniocharis (Melastomataceae) 1 species
Eupatorina (Asteraceae) 1 species
Fuertesia (Loasaceae) 1 species
Haitia (Lythraceae) 1 species
Herodotia (Asteraceae) 2 species
Hottea (Myrtaceae) 4 species
Leptogonum (Polygonaceae) 3 species
Manekia (Piperaceae) 1 species
Mattfeldia (Asteraceae) 1 species
Mommsenia (Melastomataceae) 1 species
Narvalina (Asteraceae) 1 species
Neoabbottia (Cactaceae) 2 species
Neobuchia (Bombacaceae) 1 species
Neocogniauxia (Orchidaceae) 2 species
Pedinopetalum (Umbelliferae) 1 species
Penelopeia (Cucurbitaceae) 1 species
Poitaea (Fabaceae) 5 species
Priamosia (Flacourtiaceae) 1 species
Pterocissus (Vitaceae) 1 species
Rhodopis (Fabaceae) 1 species
Samuelssonia (Acanthaceae) 2 species
Sarcopilea (Urticaceae) 1 species
Selleola (Caryophyllaceae) 1 species
Selleophytum (Asteraceae) 3 species
Stevensia (Rubiaceae) 6 species
Theophrasta (Theophrastaceae) 1 species
Tortuella (Rubiaceae) 1 species
Ulbrichia (Malvaceae) 1 species
Vegaea (Myrsinaceae) 1 species
Wunschmannia (Bignoniaceae) 1 species
Xymeniopsis (Olacaceae) 1 species
Zombia (Arecaceae) 1 species

Table 41 Genera endemic to Jamaica

Acanthodesmos(Asteraceae) 1 species	*Odontocline* (Asteraceae) 2 species
Dendrocousinia (Asteraceae) 1 species	*Peltostigma* (Rutaceae) 1 species
Jacaima (Asclepiadaceae) 1 species	*Portlandia* (Rubiaceae) 6 species
Jacmaia (Asteraceae) 1 species	*Tetrasiphon* (Celastraceae) 1 species

Table 42 Genera endemic to Puerto Rico

Cybianthus (Myrsinaceae) 1 species	*Neorudolphia* (Leguminosae) 1 species

21.4 The phytogeographical subdivision of Cuba

Two proposals for the geobotanical subdivision (Fig. 140) of Cuba have been published. León (1946) makes a distinction among three floristic sectors and 9 districts and gives a short description of the flora and vegetation of each. Voronov (1970) also distinguishes 3 sectors within which 11 districts plus 5 sub-districts are differentiated without detailed characterization. Samek (1973c) elaborated the first comprehensive phytogeographic regionalization of Cuba distinguishing 3 sectors, 7 subsectors and 39 districts and describing some of the main characteristics of the Cuban flora. The regionalization presented here is based on the geographical, geological and soil conditions and the flora and vegetation, giving equal weight to each. As a result, the suggested geobotanical system distinguishes 3 sub-provinces, 9 sectors and 36 floristic districts (see Fig. 140, and Borhidi and Muñiz and Borhidi 1973, 1985).

SUB-PROVINCE A. WESTERN CUBA (Occidento-Cubanicum) (Fig. 141)

The western part of Cuba to Bahia Honda, to Cayajabos, River San Juan and Laguna de Piedras the southern swampy coast of the Habana province and the entire Isla de Pinos and the Zapata peninsula plus the adjacent marshland belong to this category. The geological and soil conditions are highly varied, the landscape is characterized by mountains of medium height, sandy plains, lagoons, marshes, flat and conical karsts. 16 endemic genera and approximately 500 endemic species occur. Important features of the flora are the high proportion of elements from Florida, south-western USA and the northern areas, as well as the occurrence of Mexico–Yucatan elements. Several genera, such as *Befaria, Kalmiella, Chaetolepis, Rhexia, Pieris, Syngonanthus, Xyris* and *Eriocaulon* (with one exception) do not occur elsewhere in Cuba. Coniferous forests of flat and rolling countries and tropical karstic forests are the predominant and characteristic vegetation types. Swamps, marshes and, on the flat karsts, semi-deciduous and dry evergreen forests also cover extensive areas.

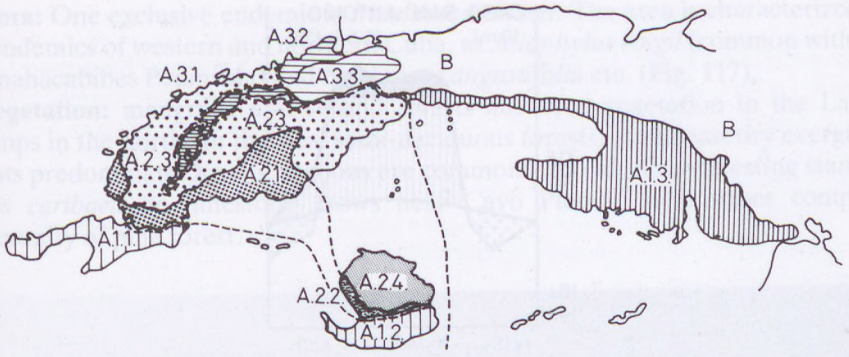


Fig. 141 The phytogeographic subdivision of the West Cuban sub-province

A.1. Sector: Peninsularicum
- A.1.1. District: Guanahacabibense
- A.1.2. District: Sudpineroënse
- A.1.3. District: Zapatense

A.2. Sector: Pinaricum
- A.2.1. District: Sabaloënse
- A.2.2. District: Indiosense
- A.2.3. District: Pinarense
- A.2.4. District: Geronense

A.3. Sector: Rosaricum
- A.3.1. District: Viñalense
- A.3.2. District: Cajalbanënse
- A.3.3. District: Rosariense

Sector A.1. Karstic peninsulas (Peninsularicum) (Fig. 141)

Guanahacabibes, southern Isla de Pinos and Zapata, the three spatially isolated peninsulas that comprise this sector, have a similar geological past, vegetation and a relatively monotonous flora poor in endemics. These lands formed a common shoreline at the end of the Pliocene. This land contact has been reflected by the similarity between the forest and shrub vegetation of marshes and flat karsts. The relationship between the flora of Guanahacabibes peninsula and Isla de Pinos is best shown by the presence of some common endemics *(Erythroxylon roigii, Allophylus roigii)* and rare floristic elements, e.g., *Bauhinia jenningsii* which is also present in Central America, and *Diospyros tetrasperma,* also occurring in Jamaica. The flora of Zapata peninsula includes some elements common with Guanahacabibes, as *Cissus formosa, Pontederia lanceolata* and *Heliotropium antillarum.*

District A.1.1. Guanahacabibes Peninsula (Guanahacabibense) (Fig. 141)

Geography: Flat karsts composed of coral limestone originated from neritic medium of the Quaternary. Shallow ferralitic soils (Fig. 142).

Climate: Seasonal tropical climate with 5—6 arid months, tending to be bixeric in the east.

Flora: A single endemic genus, *Goerziella,* occurs. Important endemic species are *Harrisia teatra* (Fig. 143), *Piper guanahacabibense, Galactia acunaena, Callicarpa roigii, Vitex acunae, V. guanahacabibensis, Serjania occidentalis,* and *Tabebuia capotei. Diospyros anisandra, Forchhammeria trifoliata* and *Bumelia retusa* originate probably from the Yucatan Peninsula reaching only this part of Cuba.

Vegetation: Mangrove on the peaty silt deposits on the northern shore. Dry evergreen shrubwoods on the rocky southern shore. In the inner part of the peninsula semi-deciduous forests predominate (Fig. 144).

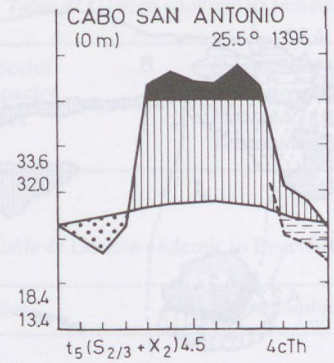


Fig. 142 Characteristic climate type in Guanahacibibes Peninsula at Cabo San Antonio



Fig. 143 Harrisia teatra Areces an endemic cactus of the dry deciduous littoral scrub of the Guanahacabibes Peninsula (Photo: A. Borhidi)

District A.1.2. Southern Isle of Youth (Isla de la Juventud, Sudpineroënse) (Fig. 141)

Geography: Marine limestone deposited in the Neogene shallow tropical brown soils in the west, humic carbonated skeletal soils in the east.

Climate: Semi-arid seasonal with 5–6 dry months, tending to be bixeric in the west. Annual precipitation is 1200—1600 mm (Fig. 145).

Flora: One exclusive endemic is *Phialanthus bissei.* The area is characterized by the endemics of western and northern Cuba, as *Allophylus roigii* (common with the Guanahacabibes Peninsula) and *Neobracea angustifolia* etc. (Fig. 117).

Vegetation: mangrove and swamp forests and reed vegetation in the Lanier Swamps in the north. In the west semi-deciduous forests, in the east dry evergreen forests predominate. Karstic lagoons are commonly found. An interesting stand of *Pinus caribaea* on limestone grows near Cayo Piedra, in a rather complete community of pine forest.



Fig. 144 Cutting of a semi-deciduous littoral limestone forest in the Guanahacabibes Peninsula (Photo: A. Borhidi)

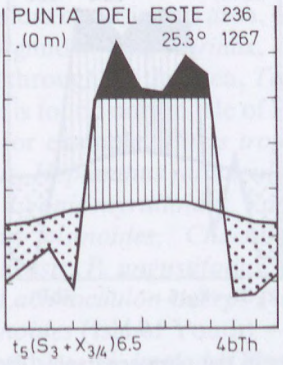


Fig. 145 Characteristic climate type in the southern part of Isle of Pine at Punta del Este

District A.1.3. Zapata Peninsula (Zapatanse) (Fig. 141)

The Zapata Peninsula (Fig. 141) the Hatiguanico river basin and the surrounding swamps, Laguna del Tesoro, the eastern marshlands of Zapata, the karstic lowland and the marshy mangrove coast of southern Habana province to Majana belong to this district.

Geography: Young, mainly peaty and boggy areas with a Neogene limestone ridge of NW—SE direction in the middle. Occasionally, flatland karsts, dissected by lagoons, with shallow, humic carbonated soils.

Climate: Seasonal, dry in the winter. 5—6 dry months, 1200—1700 mm annual precipitation (Fig. 146).

Flora: Very few exclusive endemics *(Acacia zapatensis, Phoradendron zapatanum, Bucida palustris, Calyptranthes peninsularis, Guapira peninsularis).* Furthermore, some species also occurring in the swamps of Florida and Virginia,

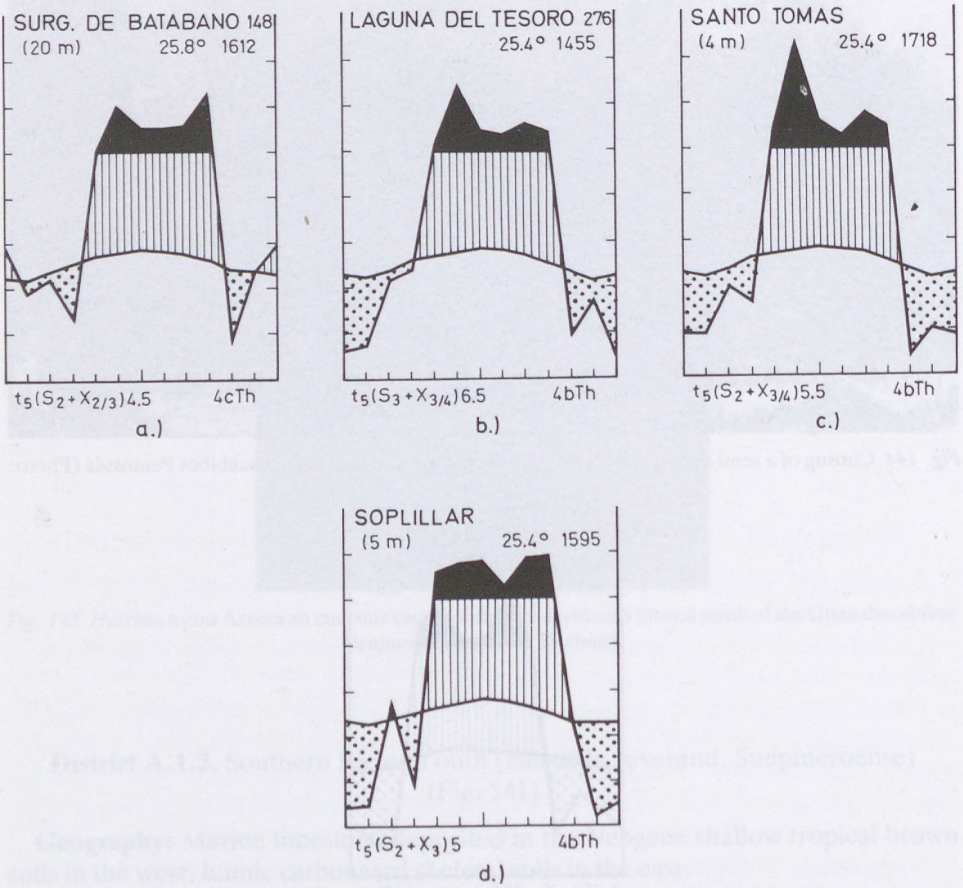


Fig. 146 Characteristic climate types in the phytogeographic district Zapatense at a) Surgidero de Batabanò, b) Laguna del Tesoro, c) Santo Tomas and d) Soplillar

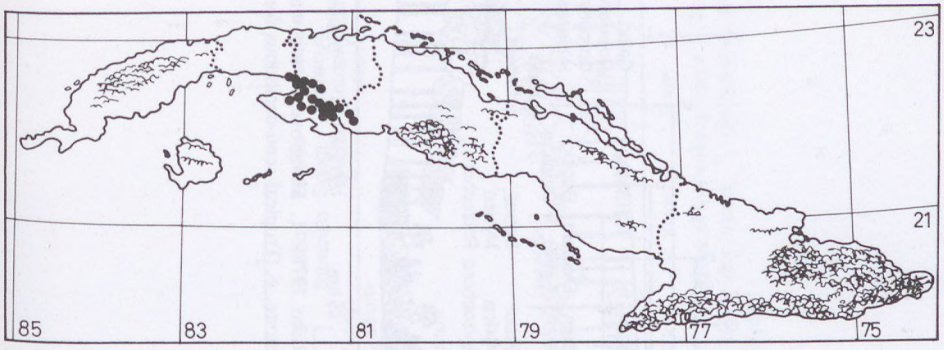


Fig. 147 Geographical distribution of *Fraxinus caroliniana* Mill. ssp. *cubensis* (Griseb.) Borhidi (Samek 1973, modified)

e.g., *Fraxinus caroliniana* ssp. *cubensis* (Fig. 147), *Vallisneria neotropicalis* (Marie-Victorin 1944) and *Polygala carteri,* are characteristic.

Vegetation: Extensive mangrove and swamp vegetation, (Figs 148, 149, 150) alluval forests and derived *Sabal* savannas on the northern edge. Semi-deciduous forests, dry evergreen forests and patches of shrubwoods occur on the karsts.

National park, beard and crocodile protection areas (Fig. 151).

Sector A.2. The flatland and hill-country of Pinar del Rio Province and north of Isle of Pines (actually Isle of Youth, Pinaricum)

This sector comprises the northern Isle of Pines (Fig. 141) (Isla de la Juventud) and the province of Pinar del Rio, excluding Sierra del Rosario, the mogotes of Sierra del los Organos and the serpentine area of Cajalbana. Mainly hills, with sandstone and slate as chief rocks, and flatlands covered by oligotrophic soil with quartz sand underneath. The dominant vegetation types are closed and open coniferous forests and their derived savannas, sandy lagoons and swampy patches with palms. Eight endemic genera occur in this area, one of them (*Microcycas*) also present in Sierra de los Organos. *Colpothrinax, Herpyza, Nodocarpaea* and *Roigella* (Fig. 152), are found throughout the area, *Tetraperone* is confined to Pinar del Rio, whereas *Lepturidium* is found only in Isle of Pines. In addition, 95 endemic species have been detected, for example, *Pinus tropicalis, Colpothrinax wrightii* (Fig. 154), *Phyllanthus junceus, Heptanthus ranunculoides, Syngonanthus wilsonii, Kalmiella ericoides* (Fig. 153). *Lyonia myrtilloides, Vaccinium cubense* ssp. *ramonii, Pieris cubensis, Paepalanthus alsinoides, Chaetolepis cubensis, Miconia adrosaemifolia, Pachyanthus cubensis, P. angustifolius, P. wrightii.* Several vicarious species pairs occur, such as *Lachnocaulon anceps* (Isle of Youth) — *L. ekmanii* (Pinar del Rio); *Lyonia vaccinoides* (Isle of Youth) — *L. ekmanii* (Pinar del Rio); *Galactia jenningsii* (Isle of Youth) — *G. isopoda* (Pinar del Rio); and others in the genera of *Phyllanthus, Tabebuia, Eugenia* and *Eriocaulon.*

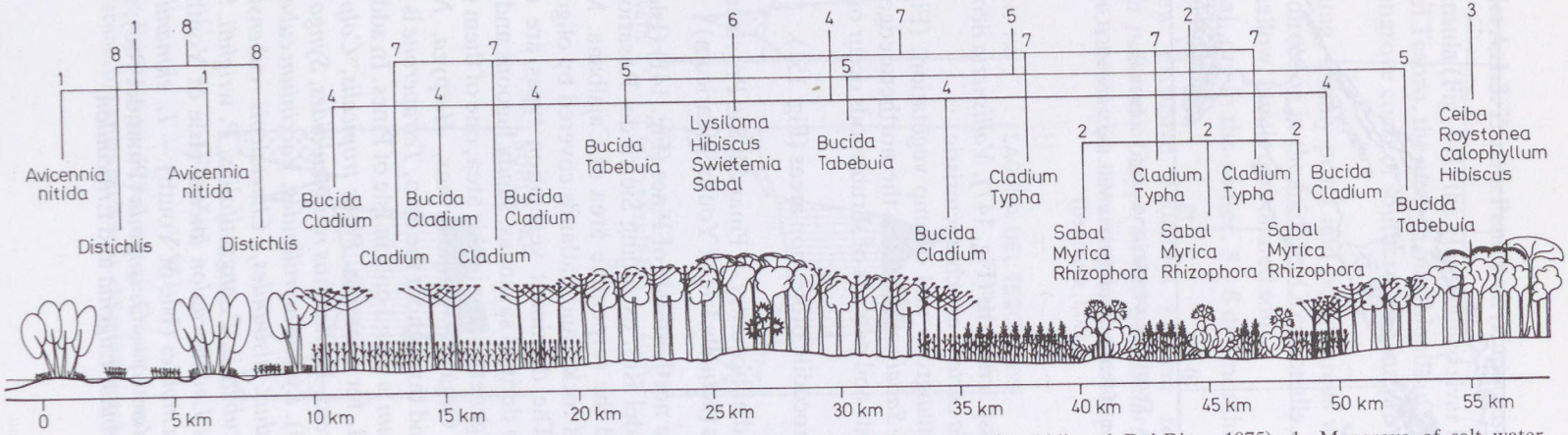


Fig. 148 Vegetation transect through the western basin of the Zapata Swamp in north-south direction (Borhidi and Del-Risco 1975). 1. Mangrove of salt water, 2. Mangrove of low salinity water, 3. Tropical evergreen seasonal forest, 4. Swamp forest on peat. 5. Swamp forest on limestone, 6. Tropical semi-deciduous forest, 7. Herbaceous swamp, 8. Salt herbaceous swamp

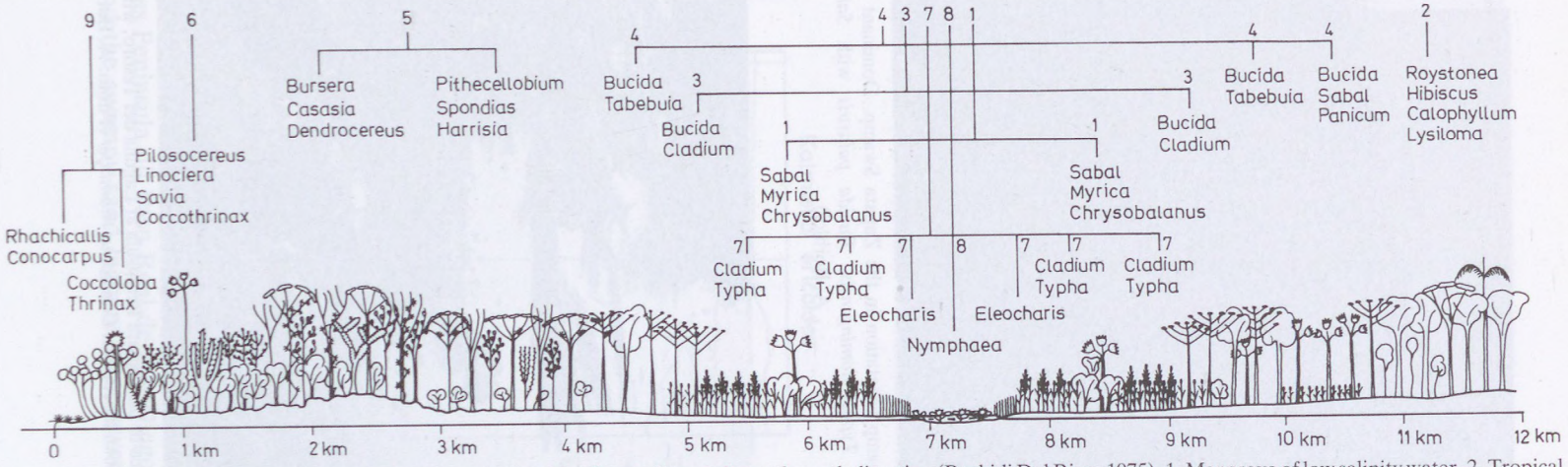


Fig. 149 Vegetation transect through the eastern basin of the Zapata Swamp in north-south direction (Borhidi Del Risco 1975). 1. Mangrove of low salinity water, 2. Tropical evergreen seasonal forest, 3. Swamp forest on peat, 4. Swamp forest on limestone 5. Tropical deciduous forest, 6. Thorn dry forest, 7. Herbaceous swamp, 8. Freshwater vegetation of the ponds and canals, 9. Littoral rock pavement and littoral thicket



Fig. 150 Zonation of the swamp vegetation in the Zapata Swamp. Dominant species are: *Nymphaea blanda, Thalia geniculata, Typha domingensis, Bucida palustris* with *Sabal parviflora* (Photo: A. Borhidi)



Fig. 151 Crocodile reserve area in the Zapata Peninsula at Laguna del Tesoro, with a large population of endemic Cuban crocodiles: *Crocodilus rhombifer* (Photo: A. Borhidi)



Fig. 152 An endemic genus and species of the pinewoodlands and savannas of West Cuba: *Roigella (Rondeletia) correifolia* (Griseb.) Borhidi et Fernandez (Photo: A. Borhidi)

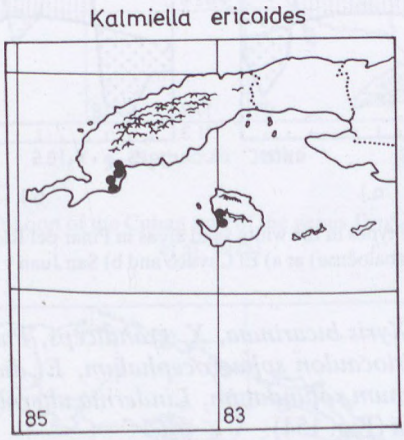


Fig. 153 Geographical distribution of *Kalmiella ericoides* (Wr. ex Griseb.) Small, a common endemic of the phytogeographical subregion of the white sand areas (Klotz 1978)

Sub-sector A.2.a. White sandlands (Sabalo-Indiosense) (Fig. 141)

Light-coloured sandy areas with low nutrient content on the western and southern border of Isle of Youth and South Pinar del Rio from the pre-isthmus of the Guanahacabibes Peninsula till Paso Real de San Diego (Fig. 141). The open pine woodlands and the swampy sand lagoons have several endemic species in

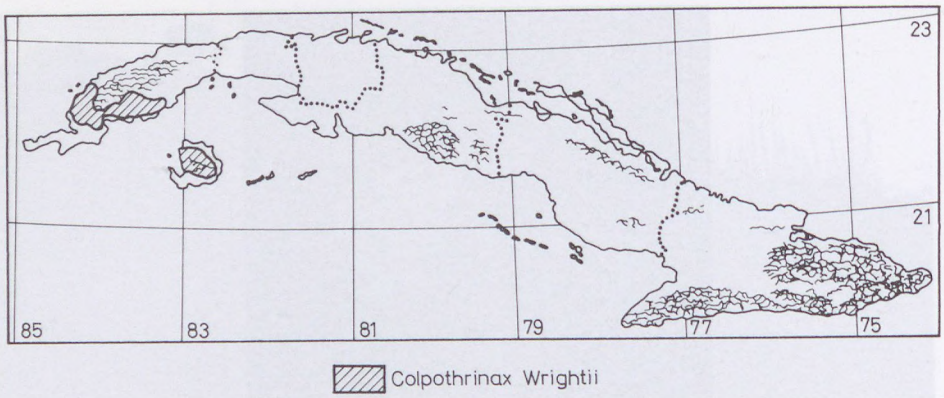


Fig. 154 Geographical distribution of *Colpothrinax wrightii* Griseb. et Wendl. (Marie-Victorin and León 1942, Samek 1973 and personal observations)

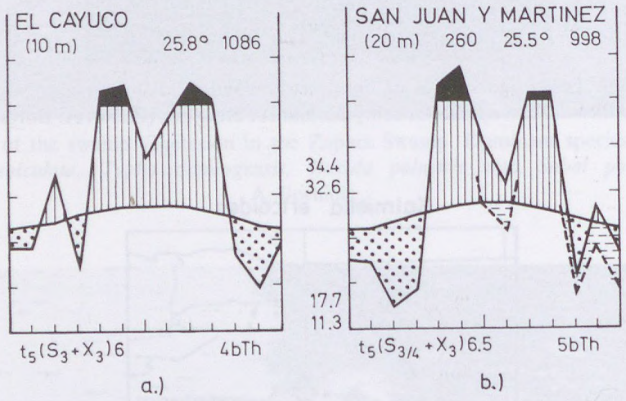


Fig. 155 Characteristic climate types in the white sand areas in Pinar del Rió Province (phytogeographical district: Sabaloënse) at a) El Cayuco and b) San Juan y Martinez

common, for example, *Xyris bicarinata, X. grandiceps, Paepalanthus seslerioides, Aristida brittonorum, Eriocaulon sphaerocephalum, E. dioecum, Amphiolanthus arenarioides, Micranthemum rotundatum, Lindernia alternifolia, Bacopa longipes,* and *Colpothrinax wrightii* (Fig. 154).

District A.2.1. White sandlands of South West Pinar del Rio (Sabaloënse) (Fig. 141)

Geography: Flatland covered by soils of mild glei character with quartz sand underneath. The area is relatively abundant in oligotrophic lakes.

Climate: Seasonal with dry winter, 5—6 dry months. Annual precipitation is 1000–1400 mm on the average (Fig. 155).

Flora: Several endemics common to this district and the pinewoods of slate areas. These are *Befaria cubensis, Gochnatia ekmanii, Pinguicula albida* (Fig. 156),

Byrsonima pinetorum, Quercus oleoides ssp. *sagraeana* (Fig. 157). Approximately 30 exclusive endemics, for example: *Aristida fragilis, Syngonanthus leoni,* eight *Eriocaulon* species, *Hibiscus urbanii, Mollugo enneandra, M. brevipes, Pachyan thus mantuensis* and *Plinia ramosissima.*

Vegetation: Mixed palm-pine woodlands with loose canopy layer *(Eragrosti cubensi-Pinetum Samek)* was the original vegetation in which *Colpothrinax wrightii,* (Fig. 154). *Acoeloraphe wrightii* and *Pinus tropicalis* were dominant. Also, derived savannas, wet *Acoelorraphe* palm groves (Fig. 158) swampy and freshwater vegetation rich in Eriocaulaceae.

District A.2.2. White sandlands of Isle of Youth (Indiosense)

Geography: The area of El Soldado—Los Indios, San Pedro and Santa Isabel, is located north of the Lanier Swamp and on the westerns shore of the island (Fig. 141). Similarly to the preceding area, it is a humid, acidic, quartz sand plain.

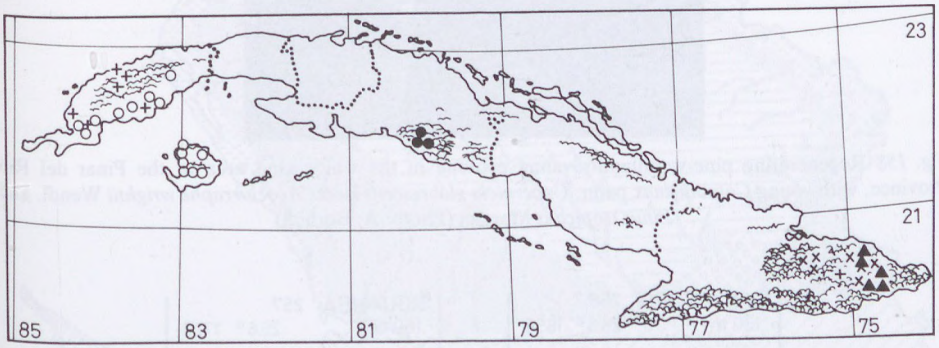


Fig. 156 Geographical distribution of the Cuban taxa of the genus *Pinguicula (Lentibulariaceae)* (Bisse et al. 1975)

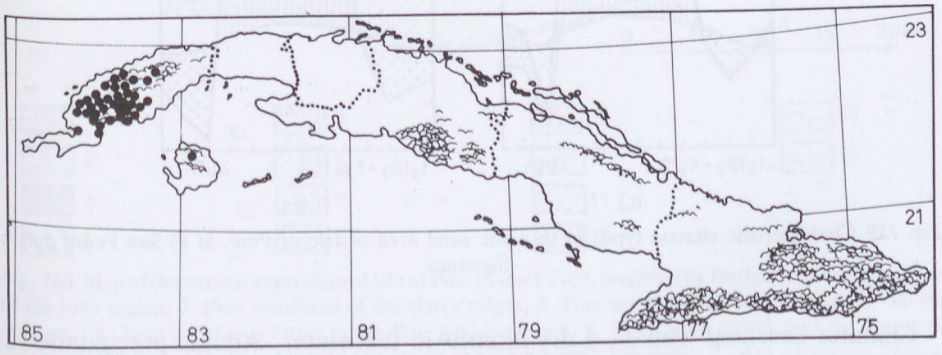


Fig. 157 Geographical distribution of *Quercus oleoides* Schlecht. et Cham. ssp. *sagraeana* (Nutt.) Borhidi (Borhidi and Capote)



Fig. 158 Regenerating pine-woodland-savanna ecotone in the white sand area of the Pinar del Rió Province, with young *Colpothrinax* palm, *Copernicia glabrescens* Becc. *Acoelorraphe wrightii* Wendl. and *Pinus tropicalis* Morelet (Photo: A. Borhidi)

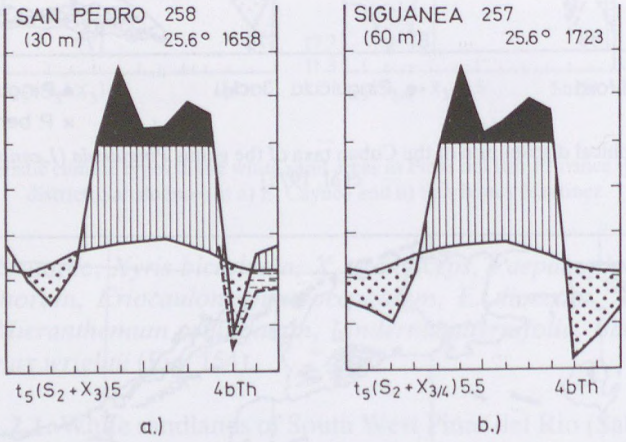


Fig. 159 Characteristic climate types in th white sand area of Isle of Pine, at a) San Pedro and b) Siguanea

Climate: Seasonal with 3—4 dry months in the winter. Annual precipitation is 1400—1600 mm (Fig. 159).

Flora: A single endemic genus, *Lepturidium,* and approximately 20 endemic species, such as *Eugenia victorini, Mollugo pinosia, Pectis pinosia, Pachyanthus*

longifolius, Kalmiella aggregata, K. simulata, Phyllanthus selbyi, Evolvulus siliceus and six species of *Eriocaulon* characterize this floristic district. *Bulbostylis paradoxa* is found only here in Cuba, the savanna plant *Byrsonima verbascifolia* occurs here and in Oriente.

Vegetation: Open pinewoods on sandy soils (*Paepalantho-Pinetum tropicalis* Samek), derived savannas, wet *Acoelorraphe* groves. Swampy and freshwater vegetation rich in *Eriocaulons* (Fig. 160).

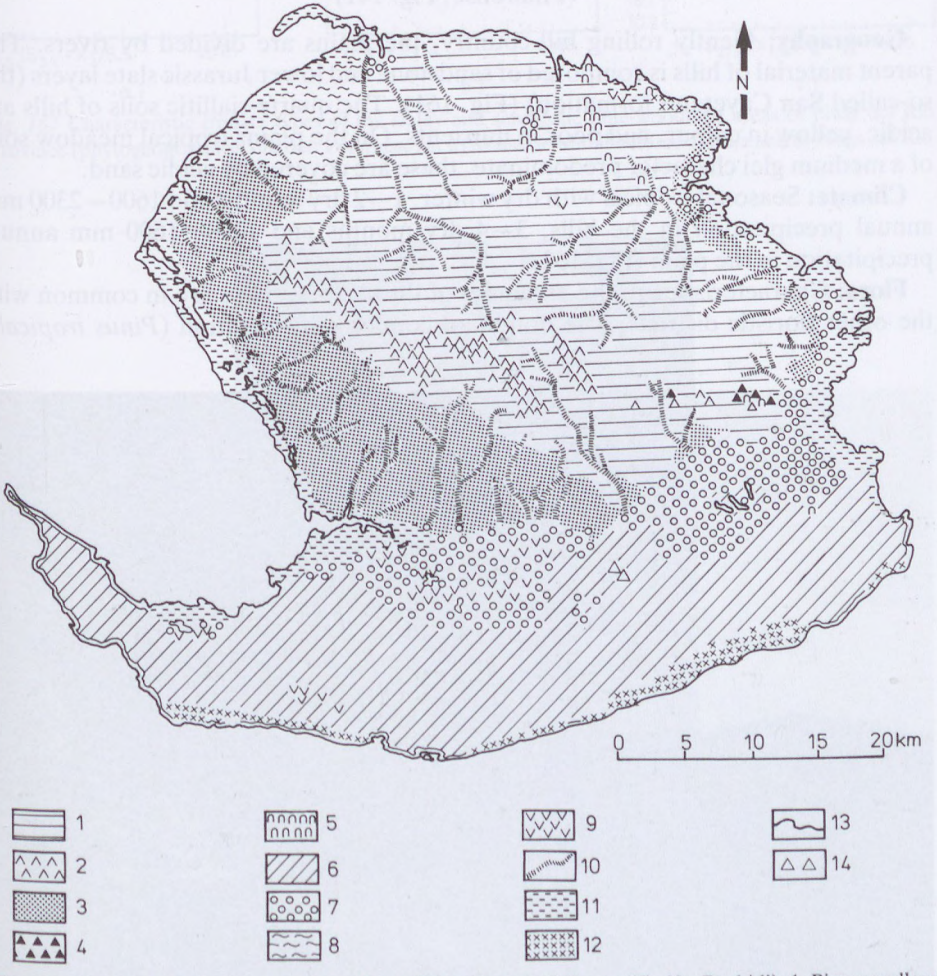


Fig. 160 Map of the natural vegetation of Isle of Pine (Samek 1969, modified by Borhidi). 1. Pine woodland of the hilly region; 2. Pine woodland of the slatey ridges; 3. Pine woodland of the white sand, "sabana arenosa"; 4. Semi-deciduous forest in the Pine woodland belt; 5. Vegetation complex of the limestone "haystack hills"; 6. Dry broad-leaved forests on the "dog-tooth" limestone; 7. Wet evergreen lowland forest; 8. Vegetation complex of the "Great Savanna"; 9. Swamps; 10. Riverain forests; 11. Mangroves; 12. Sandy beach vegetation; 13. Vegetation of the coastal embankments; 14. Pine woodland on "dog-tooth" limestone

Sub-sector A.2.b. Silicate heights and their alluvial plains (Eu-Pinaricum, Fig. 141)

This area includes the silicate heights in the north and south side of Sierra de los Organos, with the adjacent alluvial sites and the northern and north-eastern part of Isle of Youth. Two endemic genera, *Roigella* and *Nodocarpaea,* and about 70 endemic species occur, some of them listed in A.2.

District A.2.3. The slatey heights and plains of Pinar del Rio (Pinarense, Fig. 141)

Geography: Gently rolling hill-country, the plains are divided by rivers. The parent material of hills is composed of sandstone and lower Jurassic slate layers (the so-called San Cayetano formation) (Fig. 161). The quartz-siallitic soils of hills are acidic, yellow in colour, and poor in nutrients. On the plains tropical meadow soils of a medium glei character predominate, these are covered by acidic sand.

Climate: Seasonal tropical with dry winter. 1—2 dry months and 1600—2300 mm annual precipitation in the hills, 3—4 dry months and 1200—1600 mm annual precipitation in the plain (Fig. 162).

Flora: Characteristic are the endemics of the sectors, these are in common with the other floristic districts. The dominant coniferous vegetation (*Pinus tropicalis*



Fig. 161 Profile of the Cayetano-sandstone in the Sierra de los Organos, covered by pine forest of *Pinus caribaea* Morelet (Photo: A. Borhidi)

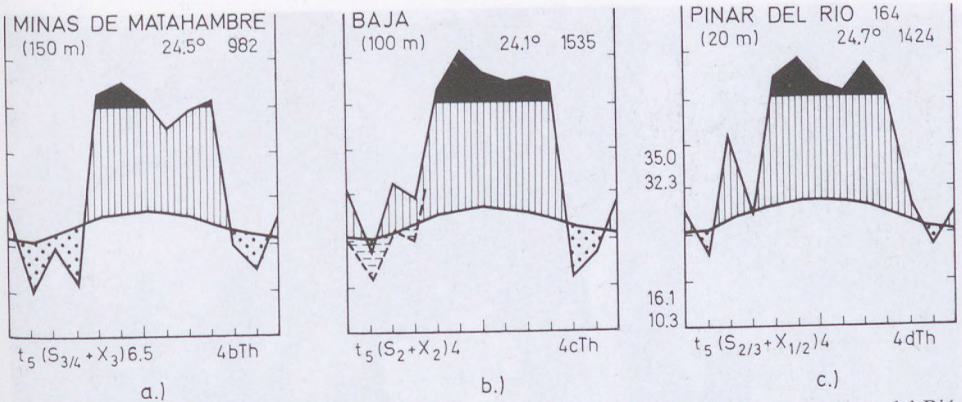


Fig. 162 Characteristic climate types of the slatey and sandstone pine-woodland areas of Pinar del Rió Province (phytogeographical district: Pinarense) at a) Minas de Matahambre, b) Baja and c) Pinar del Rió



Fig. 163 Befaria cubensis Griseb., an endemic element of the pine woodlands of West-Cuba growing on sandstone and slatey soils (Photo: A. Borhidi)

and *P. caribaea*) causes certain floristic uniformity. Additional characteristic elements are *Quercus oleoides* ssp. *sagraeana* (Fig. 157) in the tree layer, and *Befaria cubensis* (Fig. 163), *Vaccinium cubense* ssp. *ramonii, Lyonia myrtilloides, Miconia ibaguensis, M. splendens, Pachyanthus poiretii, P. angustifolius, Tabebuia lepidophylla* (Fig. 164), *Roigella correifolia* (Fig. 152), *Rhus copallina* ssp. *leucantha*



Fig. 164 Tabebuia lepidophylla (A. Rich.) Greenm. an endemic shrub of the savannas of West Cuba. (Photo: A. Borhidi)



Fig. 165 Geographical distribution of *Microcycas calocoma* (Miq.) A. DC. (Marie-Victorin and León 1942, Samek 1973, Klotz 1978 and personal observations)

in the shrub layer. Species in common with *Cajalbana*, but rare, are *Acunaeanthus tinifolius, Hyperbaena columbica* and *Pisonia petiolaris. Microcycas calocoma* (Figs 165–166) is common to this district and the limestone karsts. Local endemics are lacking with the exception of *Cassia roigii* in Cerro de Cabras. In the southern plains, however, several local endemics appear, such as *Gochnatia mantuensis, G.*



Fig. 166 The famous living fossil of the flora of West Cuba: *Microcycas calocoma* Miq., a Cretaceous Angiosperm growing in the deciduous shrub forest of the mogotes at Santo Tomas (Photo: A. Borhidi)

ekmanii, Peperomia nummularia, Hyptis cubensis, Galactia herradurensis, Lyonia ekmanii and *Melochia manducata,* usually at the edge of the plain.

Vegetation: On the hard cristalline slates an open pine woodland formed by *Pinus tropicalis* (Fig. 167) and *P. caribaea* was the original dominant vegetation, but it is mostly replaced by secondary grasslands of *Hyparrhenia rufa* and *Andropogon bicornis.* In the areas of the softer sandstone bedrock (San Cayetano formation) a deeper brownish-yellow soil has developed covered mostly by evergreen sclerophyllous oak forests of *Quercus oleoides* ssp. *sagraeana* (Figs 157, 168), *Buchenavia capitata, Pithecellobium cubense, Xylopia aromatica.* On the southern slopes and foothills a narrow strip of tropical semi-deciduous forest has developed frequently transformed into orchards or plantations of vegetables. In the lowland areas *Colpothrinax* palm-pine woodland was extended, but its sites actually are used as rice fields, pastures and secondary grasslands. The district may be subdivided into two sub-districts: the slatey heights (Eu-Pinarense) and the alluvial plains (Herradurense).

District A.2.4. North of Isle of Youth (Geronense, Fig. 141)

Geography: Alluvial plain is the most extensive with some karstic limestone mountains (Sierra de las Casas, Sierra de Caballos) and low silicate hills (Sierra de la Cañada, Sierra de La Siguanea, Loma de Mal Pais etc.). The dominant soil types are yellow quartz-allitic or yellow pseudoglei soils.

Climate: Seasonal tropical. The dry season is winter. 5—6 dry months, 1400—1700 mm annual precipitation.

Flora: Very similar to that of the preceding flora district, although several elements (*Microcycas* Figs 165—166) have not reached this area despite the land connection at the end of the Tertiary and during the glacials of the Quaternary. Some characteristic endemic species are *Hyeronima crassistipula, Stenandrium pinetorum, Machaonia acunae, M. pauciflora, Miconia perelegans, Jacquinia curtissii, Hypericum incurvum* and, on the limestone mountains, *Tabebuia geronensis* and *Eugenia ignota.*

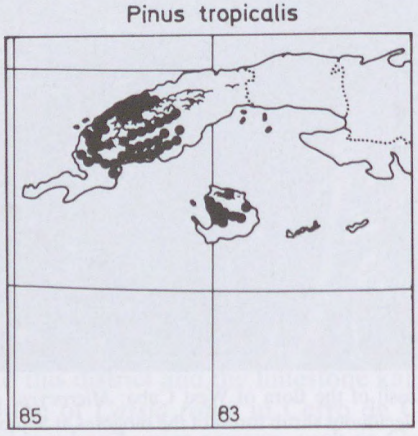


Fig. 167 Geographical distribution of *Pinus tropicalis* Morelet (Klotz, 1979 and personal observations)

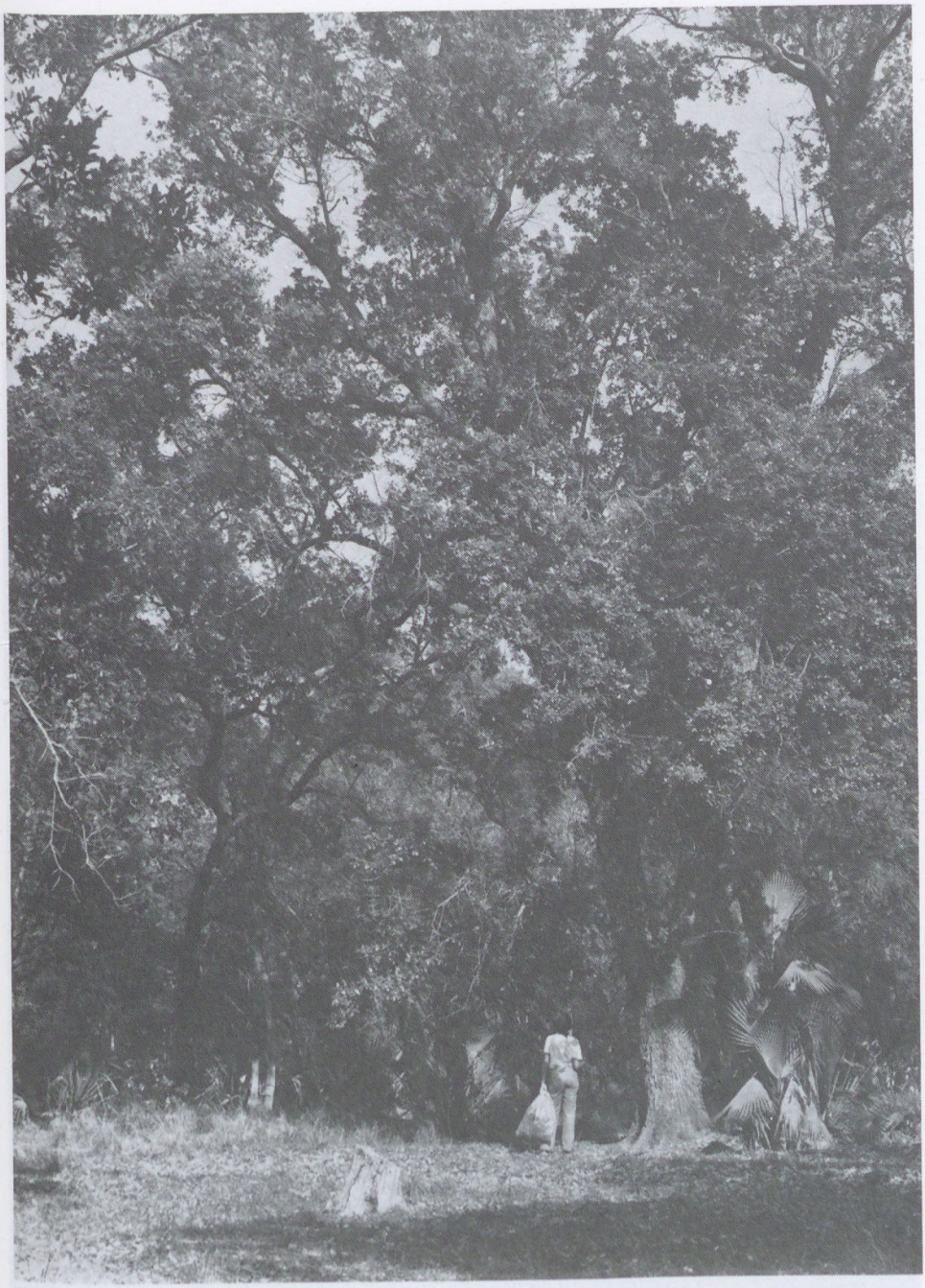


Fig. 168 Evergreen oak-forest on white sand at El Cayuco, Pinar del Rió Province, formed by old individuals of *Quercus oleoides* C. H. Muell. ssp. *sagraeana* (Nutt.) Borhidi (Photo: A. Borhidi)

Vegetation: Forests of *Pinus tropicalis,* in some places mixed with *P. caribaea,* mostly replaced by pastures. On the limestone hills semi-deciduous forests at the foothill areas and karstic forests on the steep formations.

Sector A.3. The mountainous Pinar del Rio (Rosaricum) (Fig. 141)

Three mountainous areas of very different geological structure, geomorphology and vegetation have been included: the haystack mountains of Sierra de los Organos (Fig. 169). the serpentine area of Cajalbana and vicinity, and the geologically highly varied mountain range of Sierra del Rosario. The main justification for considering these three fundamentally different areas as parts of the same flora sector is that the mountains form an unbroken system, and many species from the limestone flora of Sierra de los Organos and the serpentinophilous flora of Cajalbana are found together in Sierra del Rosario.

Ten endemic genera characterize this sector, these are *Euchorium* (Sapindaceae), *Ancistranthus* (Acanthaceae), *Neomazaea* (Rubiaceae), *Phyllomelia* (Rubiaceae), *Phyllacanthus* (Rubiaceae), *Sauvallea* (Commelinaceae), *Sauvallella* (Fabaceae), *Lescaillea* (Compositae), *Siemensia* (Rubiaceae) (Fig. 170) and *Ceratopyxis* (Rubiaceae). Genera common to Sierra de los Organos and Sierra del Rosario are *Siemensia, Ceratopyxis* and *Gaussia,* whereas *Phyllomelia* is common to Cajalbana and Sierra del Rosario. Here is the distributional centre of the genera *Acunaeanthus* and *Phania* which occur sporadically in the east, in the provinces of Matanzas and Las Villas. In addition to the endemic genera, about 150 endemic



Fig. 169 Isolated haystack hills in the Sierra de los Organos formed by Jurassic hard limestone deposited on the acid Cayetano formation at San Vicente (Photo: A. Borhidi)



Fig. 170 An endemic genus and species of Organos range: *Siemensia pendula* (Wr. ex Griseb.) Urban a Rubiaceae climber hanging from the perpendicular walls (Photo: A. Borhidi)

species prove the ancient character of the western Cuban mountains and the long, isolated development of their flora.

The vegetation of this area is also characterized by high diversity and intensive mingling. The vegetation of limestone rocks of Sierra de los Organos is also found in several localities in Sierra del Rosario (Pan de Guajaibón, Peña Blanca, Monte Toro). Communites similar to the pinewoods and scrubs of Cajalbana occur at several points in Sierra del Rosario (Loma Zambumbia near Rancho Mundito, Rangel, Cuzco, Loma Pelada de Cayajabos). Despite these similarities, the three mountainous areas are sharply different from one another in geomorphology, flora and vegetation.

District A.3.1. Sierra de los Organos (Viñalense) (Fig. 141)

Geography: Deeply inclined, tower-like karstic hills with narrow and deep gorges, hidden cave systems and a long valley separating the mountains in a SW-NE direction (Fig. 171). The surface of mountains is usually bare rock or more or less eroded skeletal soils. In the gorges deep humic-carbonated rendzina soils are deposited, whereas in the so-called intercolline valleys tropical brown and red soils predominate.

Climate: Seasonal tropical with dry winter. The dry season is shortened in the SW-NE direction. In the west and north 3—4, in the south and east 1—2 dry months. In some centrally situated areas humid rainforest climate may occur mesoclimatically. The annual precipitation is 1500—2200 mm (Fig. 172).

Flora: The mountains composed of old, very hard upper Jurassic rocks, the so-called blue limestone, emerged in the Cretaceous. They have been dry lands since then. Due to the gradual erosion of soft rocks, free-standing limestone cliffs were formed. On the top of rocks a very ancient and highly specialized flora



Fig. 171 Extremely sharp morphological and ecological limit of the basic limestone and the acid sandstone areas near San Cayetano (Photo: A. Borhidi)

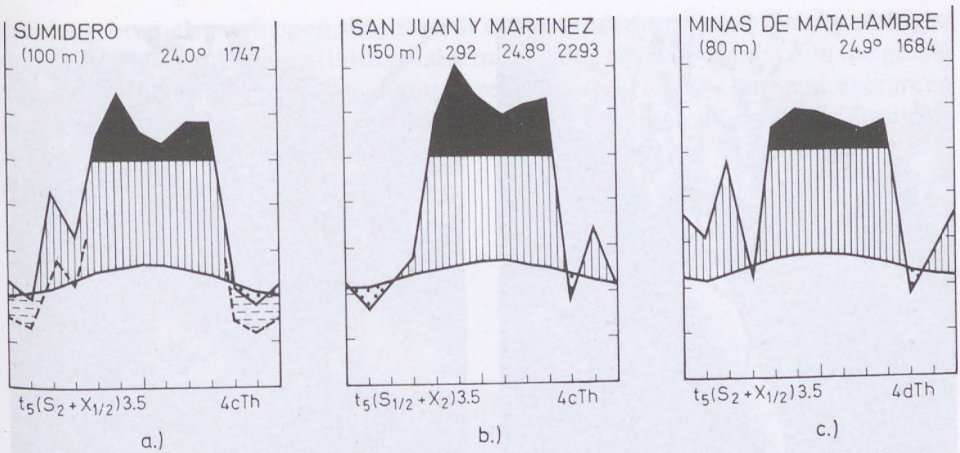


Fig. 172 Characteristic climate types of the limestone mogote district of the Sierra de los Organos (Viñalense) at a) Sumidero, b) north to San Juan y Martinez and c) south to Minas de Matahambre

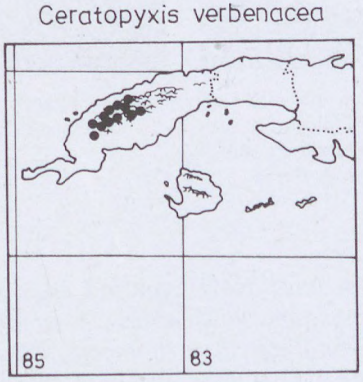


Fig. 173 Geographical distribution of *Ceratopyxis verbenacea* (Griseb.) Hook.f.

developed preserving several taxonomically isolated relicts, conditioned by the decreased competition in the extremely unfavourable habitats.

Two monospecific genera, *Euchorium* and *Ancistranthus,* and two other genera common to this district and Sierra del Rosario (*Ceratopyxis* and *Siemensia*), as well as *Microcycas* (Figs 165—166) (which is also present in the slatey heights) illustrate the richness of the flora, likewise the 90 endemic species (e.g., *Gaussia princeps* (Fig. 89), *Ancistranthus harpochiloides, Ceratopyxis verbenacea* (Fig. 173), *Siemensia pendula* (Fig. 170), *Ekmanianthe actinophylla, Spathelia brittonii* (Fig. 78), *Bourreria polyneura, Eugenia galeata, Gesneria celsioides, Omphalea hypoleuca, Annona cascarilloides, Malphighia roigiana, Anthurium venosum, Philodendron urbanianum, Bursera shaferi,* etc.).

Important species of karstic woods are the endemic *Bombacopsis cubensis* (Fig. 174—175), *Thrinax morrisii* and *Agave tubulata.* Many local endemics have been



Fig. 174 The water accumulating bottle-shaped trunk of *Bombacopsis cubensis* indicates an extremely dry habitat on the steep limestone slopes of the "mogotes" (Photo: A. Borhidi)



Fig. 175 Flowering branches of *Bombacopsis cubensis* A. Robyns (Photo: A. Borhidi)

discovered here. The most intensively explored area is Viñales where 17 local endemics were found, for example: *Pilea affinis, P. simplex, Salmea glaberrima, S. umbratilis, S. caleoides, Rhytidophyllum rupincola, Clusia brittonii* and *Acalypha mogotensis,* (for others, see the list above). Sumidero has 10 local endemics, e.g., *Piper sumideranum, Calycogonium saxicola, Plinia rubrinervis, Cissus dichroa,* and *Chaetocarpus humilis,* Cerro de Guane has 5, e.g., *Eugenia guanensis, Peperomia guanensis* and *Caesalpinia guanensis. Dorstenia roigii* is an endemic of Mogote la Jagua, whereas *Gouania ekmanii* is endemic to Mogote de la Baliza. Five endemics have been found in the Sierra de la Güira (*Pilea güirana, Bourreria mucronata, Tetrazygia minor, Guettarda amblyophylla* and *Rondeletia susannae*). In the mountains isolated by coombs from one another a number of local vicarious endemics occur, e.g., *Leptocereus assurgens* (Viñales) — *L. prostratus* (Sumidero) — *L. ekmanii* (Cerro de Guane); *Psidium vicentinum* (Viñales) — *P. nummularium* (Pand de Guajaibón). *Pilea hemisphaerica* (Viñales) — *P. sumideroensis* (Sumidero). The mountains of Viñales and Sumidero may be regarded as being the most important centres of speciation.

Vegetation: The karstic hills (mogotes or haystack hills) are covered by a unique mogote vegetation (Fig. 176) including the open *Agave* scrub of sunny cliffs with *Mammillaria* in the slits (Fig. 177) the veil-communities of shady rock walls and

crevices, bromelia-rich open shrubwoods of the eroded tops, and the closed forest on gravel slides and ravines (intrazonal semi-deciduous shrubwoods). On the gravel slides at the foothills semi-deciduous forests, in the coombs seasonal evergreen forests and extrazonal rainforest patches develop. The intercolline valley, formerly covered by seasonal evergreen forests, is a cultivated land with fragments of a *Roystonea – Ceiba* secondary savanna.



Fig. 176 Elephant-shaped mount of the tropical conical karsts in the Ancón range of the Sierra de los Organos with perpendicular walls densely covered by vegetation (Photo: A. Borhidi)



Fig. 177 Mamillaria prolifera (Mill.) Haw. a nice little characteristic cactus of the limestone rocks (Photo: A. Borhidi)

District A.3.2. Cajalbana Mountains (Cajalbanense) (Fig. 141)

Geography: Due to the red ferritic soils and the very rich flora, this small (about 70 km^2) area of old serpentine mountains extending to the coastal lowland of La Mulata satisfies the criteria of being a separate floristic district. The relief is characterized by wide, flat hilltops and deep valleys with steep slopes. Regarding physiognomy, soil and vegetation, this area is a smaller, vicarious complement of Sierra de Nipe of eastern Cuba.

Loma Preluda to the west, and the range of serpentine hills from Las Pozas to south of Bahia-Honda and the coastal area of Toscano-Morrillo are also included in the district. The adjacent northern coast, composed mainly of serpentine or young sedimentary rocks as the top layer, is also considered here.

Climate: Seasonal with dry winter, 3—4 rainy months, 1400—1600 mm annual precipitaton (Fig. 178).

Flora: Four monospecific endemic genera: *Neomazaea, Sauvallella, Phyllacanthus* and *Lescaillea,* and 40 endemic species, including several palaeoendemics characterize the district. Of the endemics of pinewoods *Tetrazygia coriacea, Psidium cymosum, Phania cajalbanica, Tabebuia leptopoda, Plinia dermatodes, Rondeletia venosa, Coccothrinax yuraguana* (Fig. 179), *Phyllanthus sagraeanus, Chaptalia ekmanii,* and *Eupatorium grisebachianum* are noteworthy. Noted species of the evergreen shrubwoods are *Agave cajalbanensis, Moacroton trigonocarpus*

(Fig. 130), *Euphorbia cubensis, Zanthoxylum dumosum* s.str. *Gesneria ferruginea, Gochnatia intertexta, Guapira cajalbanensis, Machaonia dumosa, Phialanthus rigidus,* and *Scolosanthus acunae.* Several floristic elements are vicariads of Nipe and Moa endemics, for example, *Lescaillea—Harnackia* (Fig. 113), *Euphorbia cubensis—E. helenae, Moacroton trigonocarpus—M. lanceolatus* (Fig. 130), *Anemia cajalbanica—A. coriacea* (Fig. 128), and *Helicteres trapezifolia—H. nipensis.* Isolated populations of several species may also be encountered in the serpentine areas of central Cuba, e.g., *Ottoschmidtia dorsiventralis, Anemia cajalbanica, Harpalyce cubensis* (Matanzas), *Acunaeanthus tinifolius, Leucocroton revolutus, Linodendron venosum, Coccothrinax crinita* (Macizo de Guamuhaya).

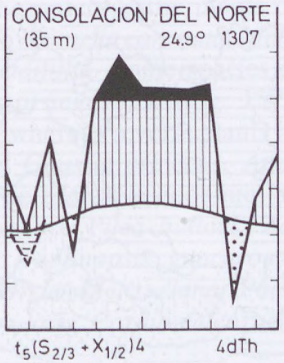


Fig. 178 Characteristic climate type of the Cajalbana region (Phytographical district: Cajalbanense) at Consolacion del Norte

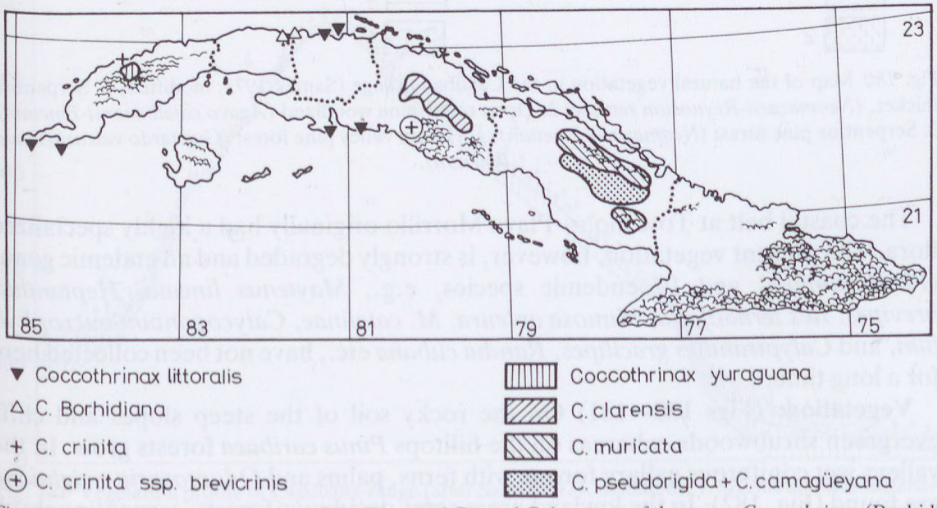


Fig. 179 Geographical distribution of the West and Central Cuban taxa of the genus *Coccothrinax* (Borhidi 1973, modified)

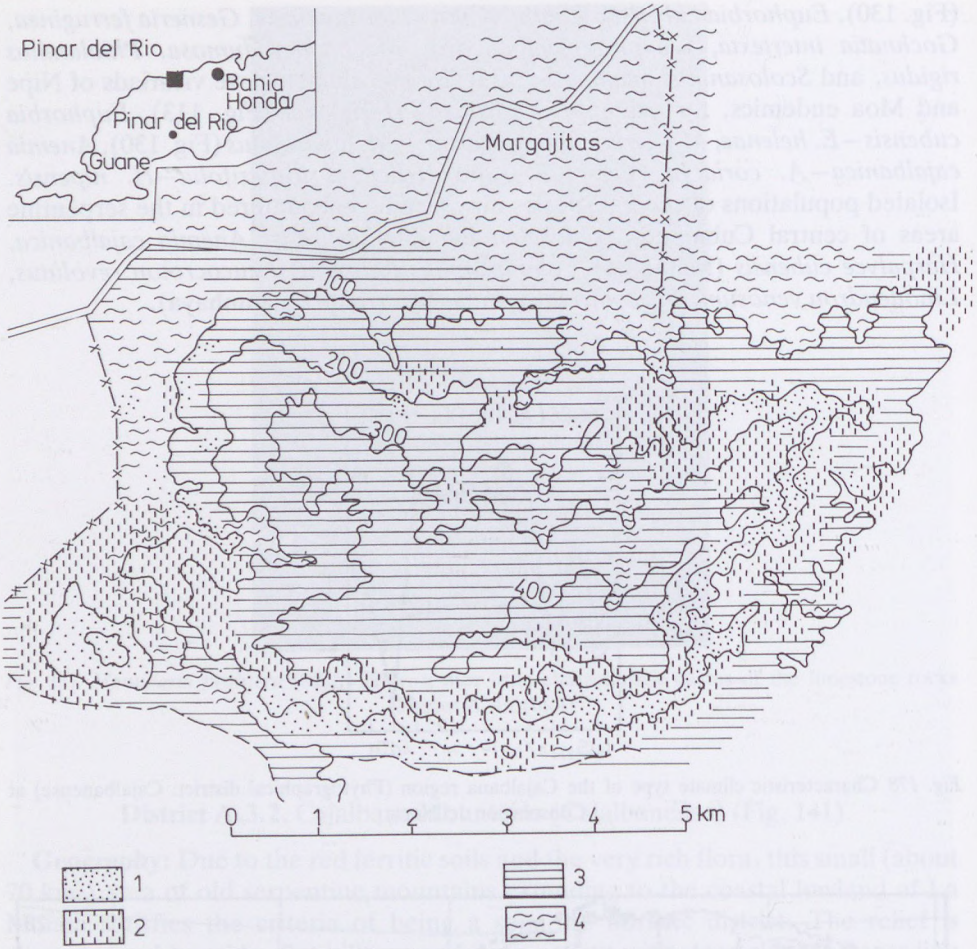


Fig. 180 Map of the natural vegetation in the Cajalbana range (Samek 1973, modified) 1. Serpentine thicket, *(Neomazaeo-Reynosion retusae)* 2. Open rocky pine woodland *(Agavo cajalbanensi-Pinetum)*, 3. Serpentine pine forest *(Neomazaeo-Pinetum)*, 4. Humid valley pine forest *(Guettardo valenzuelanae-Pinetum)*.

The coastal belt at Toscano – Playa Morrillo originally had a highly specialized flora. The present vegetation, however, is strongly degraded and an endemic genus *(Phyllacanthus)* and 19 endemic species, e.g., *Maytenus lineata, Heptanthus brevipes, Ilex ternatifolia, Mimosa apleura, M. catalinae, Calycogonium microphyllum,* and *Calyptranthes gracilipes, Randia cubana* etc., have not been collected here for a long time.

Vegetation: (Figs 180–181) On the rocky soil of the steep slopes and cliffs evergreen shrubwoods, whereas on the hilltops *Pinus caribaea* forests grow. In the valleys wet coniferous gallery forests with ferns, palms and *Odontosoria wrightiana* are found (Fig. 182). In the lowland areas semi-deciduous forests, serpentine shrub woods, and mangrove vegetation grow.

District A.3.3. Sierra del Rosario (Rosariense) (Fig. 141)

Geography: Mountainous formations composed primarily of upper Jurassic limestone and, to a lesser extent, of sandstone, gneis and others. Serpentine intrusions often reach the surface forming more or less extensive patches. Two parallel ranges reach the altitude of 500—600 m, some peaks (Monte Toro, Peña Blanca, Piedra Calzada, Pan de Guajaibón) are elevated over 600 m. The relief is highly varied. Tropical brown soils predominate but there are also yellow quartz-allitic soils on sandstone, red ferrallitic soils on serpentine and tropical rendzina on limestone.

Climate: Tropical climate with 1—2 months long dry winter. In the central basin, particularly in the east, rainforest climate occurs humid throughout the year.

Flora: Rich and diverse, thanks to the high geological variability of the mountains. On the serpentine outcrops the plants of the Cajalbana Mts and its vicinity occur, for example, *Phyllomelia coronata, Malpighia wrightiana, Rondeletia chamaebuxifolia, Eugenia rigidifolia.* Some species of slatey heights, e.g., *Pinus caribaea, Quercus oleoides* ssp. *sagraeana* (Fig. 157) and *Byrsonima pinetorum,* occur in the sandstone areas, whereas several plants from the karst of Sierra de los Organos *(Siemensia pendula, Gaussia princeps, Auerodendron acuminatum)* are found on limestone rocks. The exclusive endemics are relatively few in number, totalling about 25. Examples are *Pilea bullata, Zanthoxylum ekmanii, Z. organosium, Banara acunae, Daphnopsis guacacoa, Lagetta wrightiana, Plinia recurvata, Myrtus sagraei, Myrcia valenzuelana, Pachyanthus tertamerus, Mouriri valenzuelana, Henriettea granularis, Cordia valenzuelana,* and *Gochnatia ekmanii.*

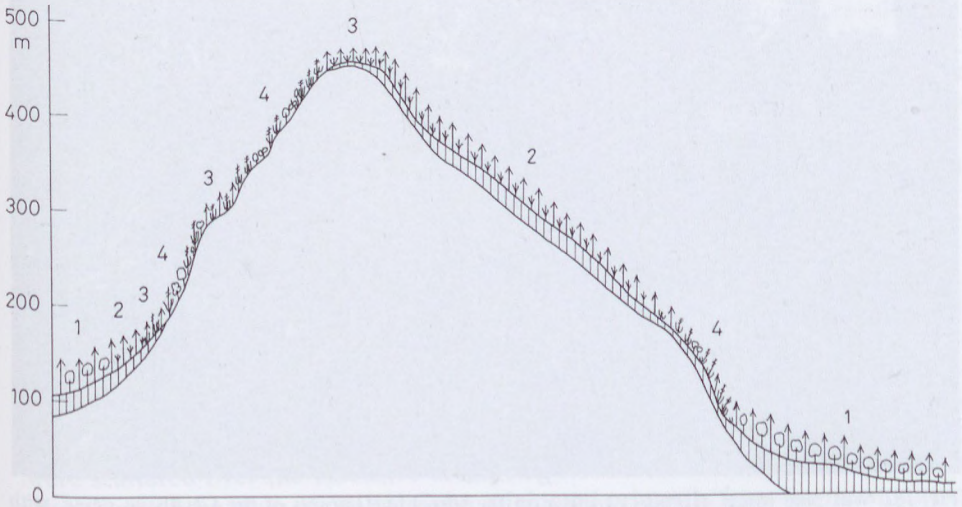


Fig. 181 Vegetation profile of Cajalbana-range (after Samek 1973, modified). 1. *Guettardo valenzuelanae-Pinetum* 2. *Neomazaeo-Pinetum,* 3. *Agavo cajalbanensi-Pinetum* 4. Sclerophyllous evergreen serpentine scrub *(Neomazaeo-Reynosion retusae)*



Fig. 182 Wet pine forest of *Pinus caribaea* on the serpentine latosols of the Cajalbana range, with characteristic *Copernicia glabrescens* palms (Photo: A. Borhidi)

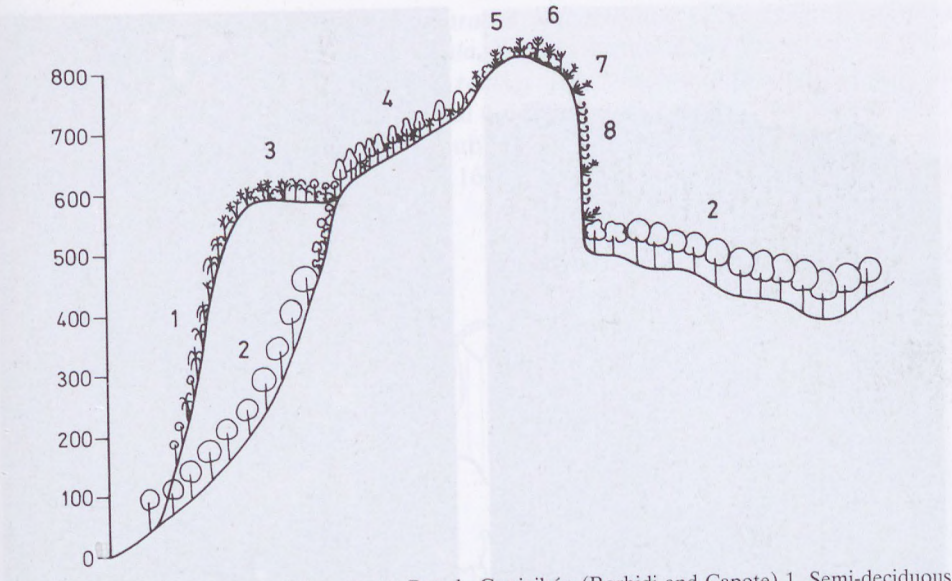


Fig. 183 Vegetation transect of the mogote Pan de Guajaibón (Borhidi and Capote) 1. Semi-deciduous forest; 2. Seasonal evergreen forest; 3. Tropical karstic forest; 4. Montane rainforest; 5. Deciduous shrubwood; 6. Agave thicket; 7. Vegetation of insolated limestone crevices

Four local endemics are known from Pan de Guajaibón (Fig. 183), namely *Gesneria brevifolia, Piper perditum, Psidium nummularia* and *Tetrazygia lanceolata.*

Vegetation: Originally seasonal evergreen tropical forests (Figs 184—185) predominated. Most of the native vegetation was replaced by coffee plantations in the second half of the last century, but these fields were abandoned resulting in degraded, secondary forests. Below the peak of Pan de Guajaibón (Fig. 183) developed a small stand of montane rainforest. On the southern slopes and the foothills semi-deciduous forests grow. The mogotes are covered by deciduous shrubwoods, whereas on the sandstone outcrops pinewoods and mixed pine-oak-woods are found. The serpentine areas are covered by microphyllous thorn scrubs.

SUB-PROVINCE B. CENTRAL CUBA (Centro-Cubanicum Fig. 187)

The plains, isolated mountains and hills of central Cuba are included in this sub-province which extends from Bahia Honda and the Rosario Mountains in the west to the Cauto Basin and the central valley of Oriente in the east, reaching the feet of Sagua-Baracoa and Sierra Maestra. This area has been a contiguous land mass since the end of the Pliocene only. Before that period, the terrestrial plants were scattered over the extensive archipelago of limestone mountains and cliffs. The plants of the plain of central Cuba originated primarily from the mountains of Oriente, and also from Pinar del Rio. This view is supported by the fact that the plains are poor in exclusive endemics most of which being local or vicariant

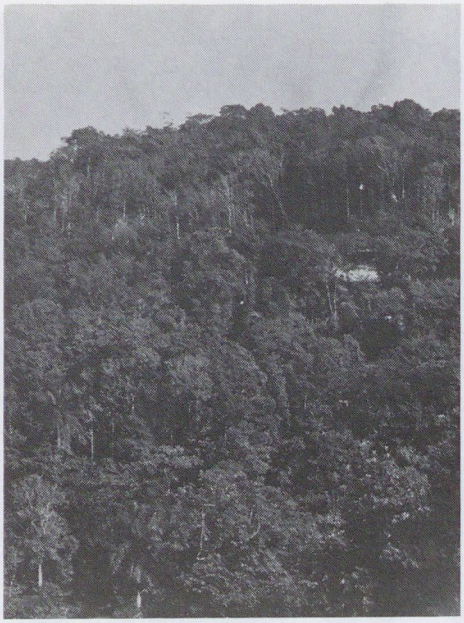


Fig. 184 Seasonal evergreen submontane forest belt in the Sierra del Rosario at 450 m a.s.l. (Photo: A. Borhidi)



Fig. 185 Zanthoxylum martinicense (Lam.) DC. one of the emergent and upper canopy trees of the seasonal evergreen submontane forest, Loma El Salon, Sierra del Rosario (Photo: A. Borhidi)

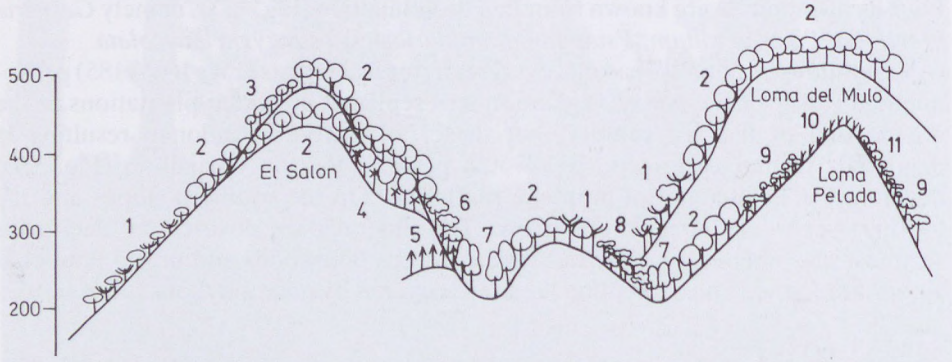


Fig. 186 Vegetation transect of the eastern Sierra del Rosario through the Loma El Salon (Borhidi and Capote) 1. Semi-deciduous forest; 2. Seasonal evergreen forest; 3. Montane evergreen forest; 4. Submontane rainforest; 5. Pine forest; 6. *Syzygium jambos* secondary forest; 7. Riveraine forest; 8. Dry evergreen forest on sandstone; 9. Sclerophyllous serpentine forest; 10. Secondary grassland, 11. Serpentine shrubwood.

endemics. Those distributed all over the area, partly serpentine plants partly coastal elements, are in common with western or eastern Cuba or both nearly without exception. The landscape and the vegetation are characterized by dominant Antillean, Caribbean and Neotropical species that are also found elsewhere. Being most abundant, however, these plants may be considered as the most typical species of the area.

Of the serpentine endemics *Neobracea valenzuelana* (Fig. 117), *Phyllanthus orbicularis* (Fig. 127), *Annona bullata,* of the mesophilous forest species *Ficus subscabrida, F. combsii, Coccoloba retusa, Tabernaemontana amblyocarpa, Espadaea amoena, Casasia calophylla* and *Guettarda calyptrata* are mentioned here.

Pan-Cuban endemics of the dry shrublands and coastal communities are *Belairia mucronata, Oplonia tetrasticha* (Fig. 116), *Randia spinifex, Platygyne hexandra* and *Gastrococos crispa* (Fig. 188).

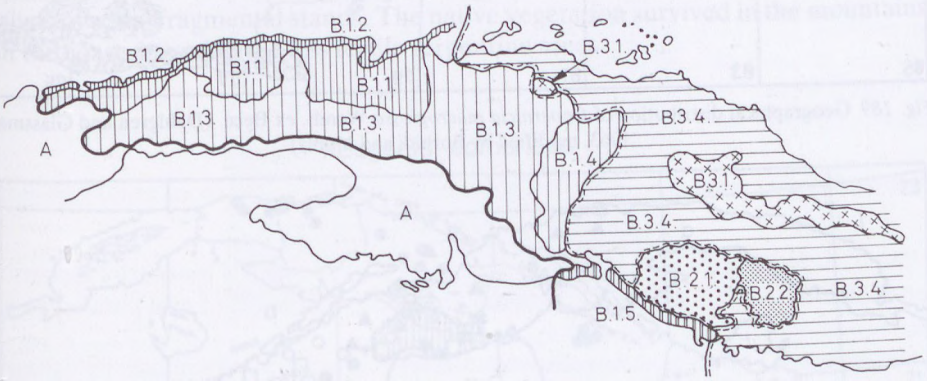


Fig. 187 The phytogeographical subdivision of the western part of the Central Cuban sub-province

B.1. Sector: Western Central Cuba (Havanicum)
B.1.1. District: Jarucoënse B.1.3. District: Güinense
B.1.2. District: Havanense B.1.4. District: Cascajalense
B.1.5. District: Casildense

B.2. Sector: The Guamuhaya Massif of Escambray (Trinidadicum)
B.2.1. District: Trinidadense B.2.2. District: Spirituënse

B.3. Sector: Eastern Central Cuba (Camagüeyicum)
B.3.1. District: Claraënse B.3.2. District: Sagüense



Fig. 188 Geographical distribution of *Gastrococos crispa* (Saakov 1970, modified)

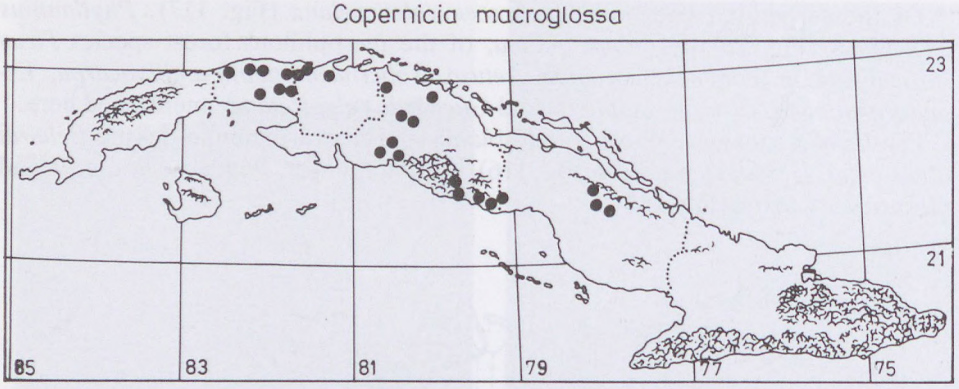


Fig. 189 Geographical distribution of *Copernicia macroglossa* Wendl. ex Becc. (Dahlgren and Glassman 1963, modified by Borhidi and Muñiz)

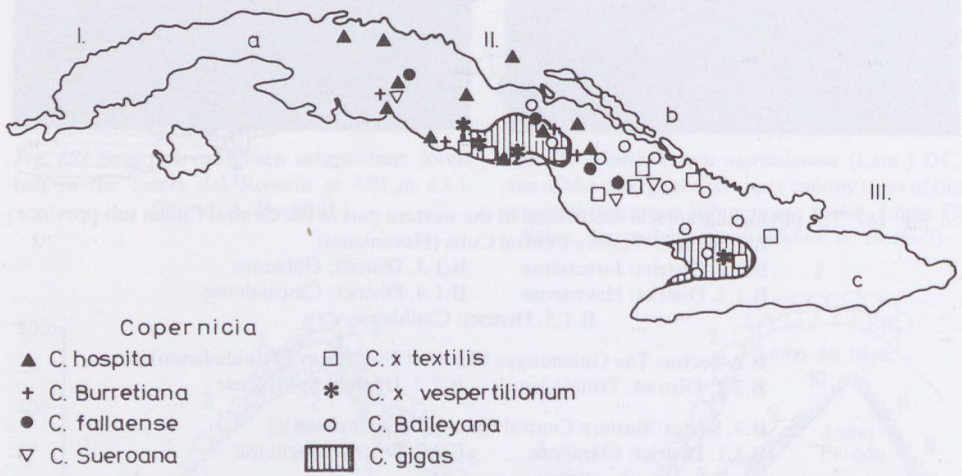


Fig. 190 Geographical distribution of some Central and East Cuban taxa of the genus *Copernicia* (Dahlgren and Glassman 1963, modified)

Further characteristic elements of the landscape are non-endemics, such as *Roystonea regia, Ceiba pentandra, Bucida buceras, Cecropia peltata, Samanea saman, Croton lucidus, Eugenia maleolens,* these are the most common in this area. In addition, species whose dispersal is facilitated by human activity are *Comocladia dentata, Glyricidia sepium, Dichrostachys cinerea* and *Rhynchelytrum roseum.* In the floristic sub-province of Central Cuba 21 endemic Cuban genera occur, seven being confined to this area. Of these *Megalopanax, Euleria* and *Rhodogeron* have a local distribution pattern, and only 4 genera, *Gastrococos, Behaimia, Henleophytum* and *Chaetium,* have been widely distributed all over the area, although the role of the latter in the vegetation is negligible. There are only about 25—30 non-local endemics characterizing this sub-province although their distribution extends a little to the neighbouring areas (e.g., on the southern coast of Oriente).

Examples are *Andropogon multinervosus, Scleria havanensis, Agave legrelliana, Copernicia macroglossa* (Fig. 189), *C. baileyana* (Fig. 190), *Coccothrinax miraguama* p. maj. p. (Fig. 179), *Behaimia cubensis, Piscidia cubensis, Malpighia nummulariifolia, Byrsonima motembensis, Leucocroton moncadae, L. havanensis, Chamaesyce paucipila, Tabebuia lepidota, Cissus torreana, Eugenia camarioca* (Fig. 191), *Rondeletia camarioca, Machaonia subinermis* s. l. (Figs 89, 192), *Plumeria cubensis, P. keyensis, Mesechites minima, Scolosanthus crucifer, Hyptis armillata,* and *Pectis cubensis,* etc. Recently, more than 75% of this area is a managed or cultivated land. Its original vegetation may be reconstructed only from relicts of some fragmental stands. The native vegetation survived in the mountains, on the coast, keys and the less fertile serpentine areas.

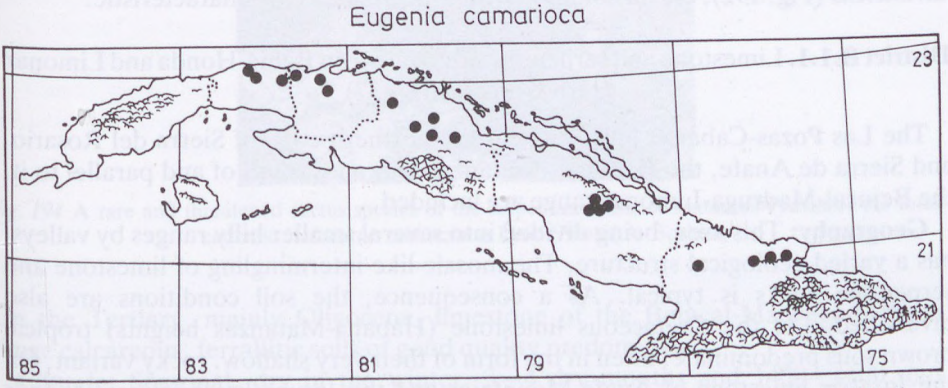


Fig. 191 Geographical distribution of *Eugenia camarioca* Wr. in Sauv. (Klotz 1978, modified)

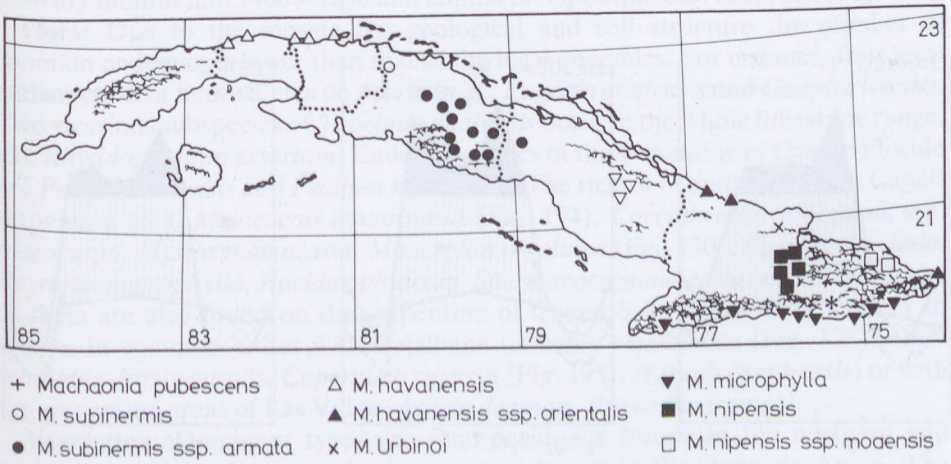


Fig. 192 Geographical distribution of some Central and East Cuban species of the genus *Machaonia* (Fernandez and Borhidi 1984)

Sector B.1. Western Central Cuba (Havanicum) (Fig. 187)

This area ranges from Bahia Honda and Artemisa to Cardenas, Cienfuegos and, on the southern coast, as far as Casilda. Coastal zones with rich flora, mountainous and hilly regions of varied bedrocks and diverse plant communities and flatland with monotonous vegetation are included. The plains have been cultivated for centuries. In addition to the few local endemic species, endemic genera (e.g., *Amphiolanthus, Acunaeanthus, Phania* – and species (*Eriochloa setosa, Coccothrinax litoralis* (Fig. 179), *Zephyranthes rosea, Crinum oliganthum, Bombacopsis cubensis, Coccoloba pallida, Harpalyce cubensis, Phyllanthus discolor, Hyeronima havanensis, Callitriche occidentalis, Comocladia mollifolia, Terminalia intermedia, Eugenia farameoides, Rauvolfia cubana, Cordia angiocarpa, Brunfelsia nitida, Rhytidophyllum wrightianum, Oplonia nannophylla* (Fig. 116), *Machaonia havanensis* (Fig. 192), etc. in common with western Cuba are characteristic.

District B.1.1. Limestone and serpentine areas between Bahia-Honda and Limonar (Jarucoënse) (Fig. 187)

The Las Pozas-Cabanas hilly range at the northern edge of Sierra del Rosario, and Sierra de Anafe, the Habana—Matanzas hills and, south of and parallel to it, the Bejucal-Madruga-Limonar range are included.

Geography: This area, being divided into several smaller hilly ranges by valleys, has a varied geological structure. The mosaic-like intermingling of limestone and serpentine rocks is typical. As a consequence, the soil conditions are also diversified. On the Cretaceous limestone (Habana-Matanzas heights) tropical brown soils predominate, often in the form of their very shallow, rocky variant. On the Jurassic limestone of Anafe Mountains and the Jaruco karst calcareous soils have developed. Red latosolic, nutrient poor soils cover the serpentine outcrops.

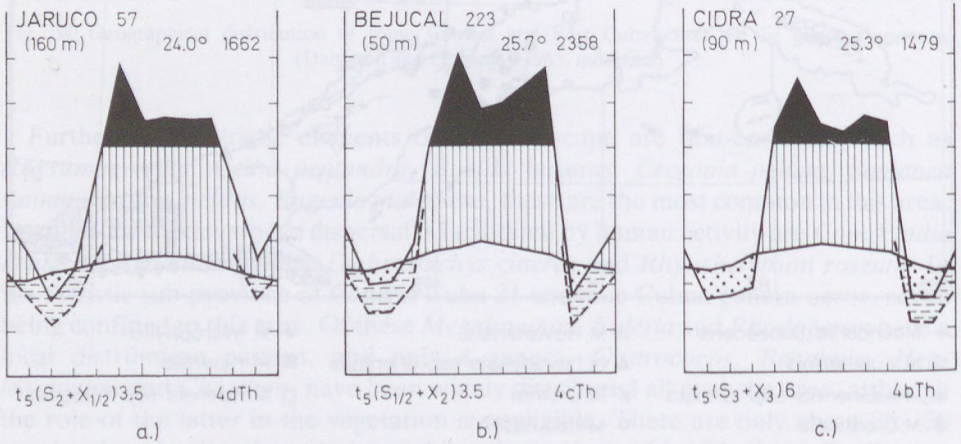


Fig. 193 Characteristic climate types of the Habana-Matanzas ranges (phytogeographical district Jarucoënse) at a) Jaruco, b) Bejucal and c) Cidra



Fig. 194 A rare and threatened cactus species of the serpentine areas of Matanzas Province: the local endemic *Melocactus matanzanus* León (Photo: A. Borhidi)

On the Tertiary, mainly Oligocene, limestone of the Bejucal-Madruga-Coliseo range calcareous, ferrallitic soils of good quality predominate.

Climate: Seasonal, dry in the winter. 3—4 dry months and 1400—1600 mm annual precipitation in the western part of the district, 1—2 dry months and an average precipitation up to 1100—2300 mm to the south–south-east of Havana, and 5—6 dry months and 1400—1800 mm annual precipitation east of Jaruco (Fig. 193).

Flora: Due to the mosaic-like geological and soil structure the number of common endemics is lower than that of the local endemics. For instance, four local endemics occur in the Sierra de Anafe (e.g., *Eugenia anafensis* and *Guapira leonis*). Two vicarious subspecies of *Tabebuia anafensis* occur in the whole limestone range, like *Rhytidophyllum exsertum*. Endemic species of the serpentine of Campo Florido are *Pectis havanensis* and *Psidium havanense*. The richest in endemics is the Canasi serpentine area; *Melocactus matanzanus* (Fig. 194), *Coccothrinax miraguana* ssp. *roseocarpa, Myrtus matanzasia, Moacroton revolutus* (Fig. 130), *Buxus gonoclada, Reynosia microphylla, Bucida ophiticola, Spermacoce matanzasia* occur here. Some of them are also found on the serpentine of Camarioca. There are a number of species in common either with Cajalbana (*Anemia cajalbanica* (Fig. 128), *Ottoschmidtia dorsiventralis, Copernicia curtissii* (Fig. 195), *Harpalyce cubensis*) or with the serpentine areas of Las Villas (*Acacia daemon, Buxus flaviramea*).

Vegetation: Dominant types are semi-deciduous forests in the northern and middle part of the district and dry evergreen forests in the Sierra de Anafe. The species-poor variant of the karstic forests of the Sierra de los Organos predominates on the Jaruco mogotes and other karstic hills, with *Thrinax morrisii* as dominant

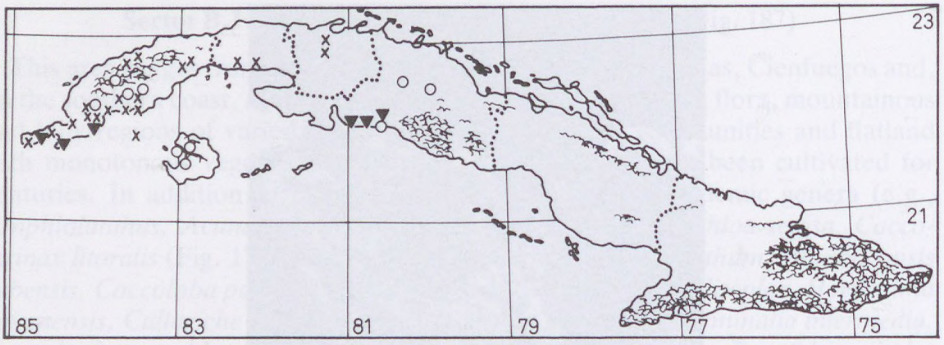


Fig. 195 Geographical distribution of the West Cuban taxa of the genus *Copernicia* (Dahlgren and Glassman 1963, modified)

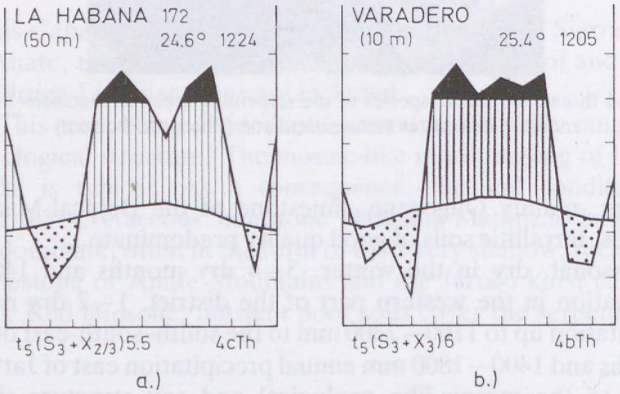


Fig. 196 Characteristic climate types of the phytogeographical district Havanense between Bahia Honda and Varadero at a) Habana and b) Varadero

species. The foothills and the valleys are covered by fragments of semi-deciduous forests and derived savannas of seasonal evergreen forests. Dry evergreen forests grow on the sperpentine areas, whereas at Canasi evergreen shrubwoods with dwarf palms are found.

District B.1.2. Seashore of the Bahia Honda-Hicacos zone (Havanense) (Fig. 187)

Geography: The coast ranging from Bahia-Honda to Varadero consists mainly of Pliocene limestone which is seldom broken by muddy or sandy beaches. Flat karsts and cliffs (Seboruco) are most usual but rocky hills may also be seen. Mainly shallow, rocky, humic-carbonated soils cover the area.

Climate: Seasonal with dry winter, the annual precipitation is 1000—1400 with a

distribution similar to that in the preceding district. The dry season gets longer eastward, reaching a duration up to 5—6 months (Fig. 196).

Flora: The area abounds in drought-tolerant endemic species. *Coccothrinax borhidiana* (Figs 88, 179, 197), *Piper cojimaranum, Gochnatia sagraeana, Croton litoralis,* ssp. *rugelianus, Pilosocereus robinii, Leptocereus wrightii, Eugenia mollifolia, Rhytidophyllum crenulatum, Borrichia cubana, Rondeletia rugelii* and *Guettarda undulata* (Fig. 89) worth mentioning.

Vegetation: Coastal thickets (Fig. 197), dry evergreen forests and shrubwoods, fragments of semi-deciduous forests on the slopes, small stands of mangrove.

District B.1.3. The plain Artemisa-Colón (Güinense) (Fig. 187)

Geography: Gently rolling denuded plain. Fertile, calcareous red ferrallitic soils predominate.

Climate: Seasonal with dry winter. Usually 5—6 dry months, 1200—1800 mm annual precipitation (Fig. 198).

Flora: Monotonous, no local endemics occur. The influence of the human impact of centuries is obvious.



Fig. 197 Dry littoral scrub on the northern limestone coastal belt between Habana and Matanzas, with *Opuntia dillenii* Ker. Gawl. and *Coccothrinax borhidiana* Muñiz (Photo: A. Borhidi)

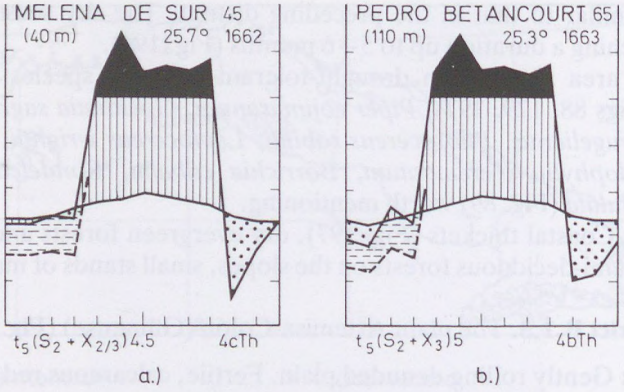


Fig. 198 Characteristic climate types of the fertile lowland area between San Cristóbal and Colón at a) Melena de Sur and b) Pedro Betancourt

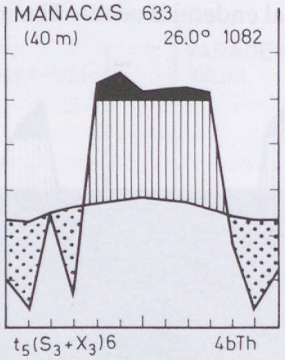


Fig. 199 Characteristic climate type of the mocarrero-area Cascajal-Manacas (phytogeographical district: Cascajalense) at Manacas

Vegetation: Originally, this is the zone of seasonal evergreen and semi-deciduous forests which have been replaced by secondary savannas and agricultural fields. Native vegetation occurs only in the mangrove and gallery forest belt on the seashore.

District B.1.4. Yaguaramas-Cascajal plain (Cascajalense) (Fig. 187)

Geography: On the border of Matanzas and the old Las Villas province this completely flat area lies at an altitude of about 100 m. The soil is mocarrero having an impermeable layer close to the surface.

Climate: Seasonal with 5—6 dry months in the winter. The annual precipitation is 1200—1400 mm (Fig. 199).

Flora: A single endemic monospecific genus *(Rhodogeron coronopifolius)* and nearly 10 endemic species (e.g., *Bucida subinermis, Brunfelsia clarensis, Eriocaulon echinospermum, Lachnocaulon cubense* and three *Cheilophyllum* species) characterize the flora. The eastern limit of the distribution of western "savanna" plants may

be drawn here. Eastward the flora becomes completely different: on the mocarrero soil shrublands and secondary savannas with *Copernicia* palms exist.

Vegetation: Thorny shrublands and savannas with *Sabal* palms on poorly drained hardpan soils. This is one of the largest edaphic savanna areas in Cuba. It may have turned to marshes several times during the Quaternary, and then dried up.

District B.1.5. Coastal area between Cienfuegos–Casilda (Casildense) (Fig. 187)

Geography: This zone begins at Juragua, east of Playa Giron and extends to the Casilda peninsula. Flat karsts consisting mainly of coastal coral limestone alternate occasionally with sand beaches. It is the ecological equivalent of floristic district B.1.2. on the southern coast, with shallow, humic-carbonated soils.

Climate: In the western part seasonal with dry winter of 5—6 months duration. In the east two arid seasons occur and the annual precipitation is 1000—1200 mm (Fig. 200).

Flora: Strongly xerotherm flora containing large succulents, for example, *Dendrocereus nudiflorus, Leptocereus silvestris, Rhodocactus cubensis* and *Pilosocereus brooksianus*. Widespread endemics are *Pavonia calcicola, Acalypha hutchinsoni, Rondeletia pedicellaris, Pectis ritlandi* and *Cassia clarensis*. A local endemic at Cienfuegos *(Acacia polypyrogenes)* and nearly ten further ones at Casilda (e.g., *Cordia intricata, Ipomoea flavopurpurea, Hyptis rivularis, Myrtus crenulata, Chrysophyllum clarense, Casearia formosa, Crossopetalum ekmanii,* etc.).

Vegetation: Rocky and sandy coastal communities, evergreen scrubs on the flat karsts, dry evergreen forests and semi-deciduous forests on deeper soils (Figs 201—202).

Sector B.2. The Guamuhaya Massif of Escambray (Trinidadicum) (Fig. 187)

Isolated mountains above the southern coastal zone of central Cuba, divided into two smaller mountains: the more elevated Trinidad Mountains and the lower Sancti

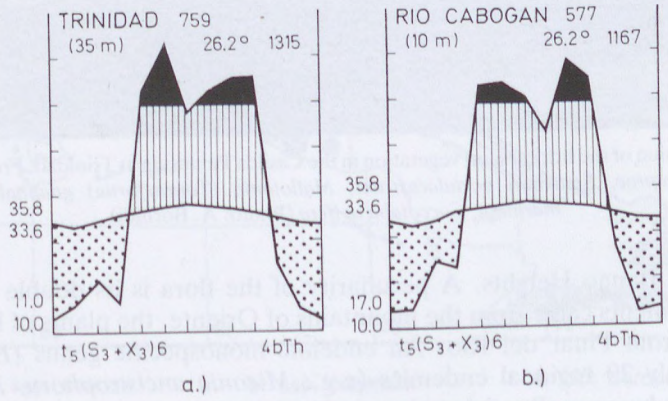


Fig. 200 Characteristic climate type of the phytogeographical district: Casildense at a) Trinidad and b) Rio Cabogan

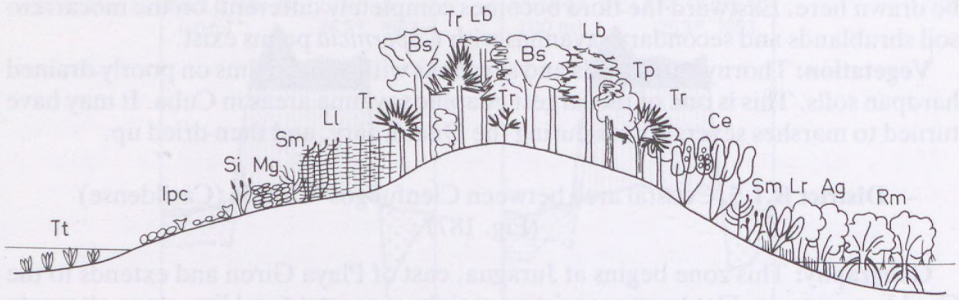


Fig. 201 Vegetation transect of the Casilda Peninsula (Photo: A. Borhidi) Tt=*Thalassia testudinum*, Ipc=*Ipomoea pes-caprae*, Si=*Sporobolus indicus*, Mg=*Mallotonia gnaphaloides*, Sm=*Suriana maritima*, Ll=*Leucaena leucocephala*, Tr=*Thrinax radiata*, Bs=*Bursera simaruba*, Lb=*Lysiloma bahamense*, Tp=*Thespesia populnea*, Ce=*Conocarpus erecta*, Lr=*Laguncularia racemosa*, Ag=*Avicennia germinans*, Rm=*Rhizophora mangle*



Fig. 202 Zonation of the littoral sand vegetation in the Casilda Peninsula at Trinidad. From right to left: *Ipomoea pes-caprae, Sesuvium portulacastrum, Mallotonia (Tournefortia) gnaphaloides, Suriana maritima, Coccoloba uvifera* (Photo: A. Borhidi)

Spiritus and Banao Heights. A peculiarity of the flora is its double origin. The montane elements came from the mountains of Oriente, the plants of karsts partly originated from Pinar del Rio. An endemic monospecific genus *(Euleria)* and approximately 20 regional endemics (e.g., *Miconia ancistrophora, M. wilsonii, Pachyanthus lunanus, Rondeletia leonis, R. pedicellaris, Tabebuia Rimaoensis, T. glaucescens, Neobracea howardii* (Fig. 117), *Lunania elongata, three Calyptranthes*

species, *Pithecellobium trinitense, Guettarda urbaniana* and *Gesneria clarensis* ssp. *clarensis)* characterize the area. Noted endemics in common with the mountains of Oriente are *Magnolia cubensis* s.l. (Fig. 203), *Hedyosmum grisebachii* (Fig. 138), *Coccoloba wrightii, Ossaea ottoschmidtii, Clidemia wrightii, C. capituliflora, Meliosma oppositifolia, Ocotea ekmanii,* etc. Also, many Caribbean—Neotropical elements of montane rainforests occur, e.g., *Ocotea cuneata, O. wrightii, Guatteria blainii, Oxandra laurifolia, Garrya fadyeni,* etc. Some elements of the limestone forest communitites of western Cuba reaching this sector eastward are *Tabebuia sauvallei, Sapium leucogynum, Rhytidophyllum wrightianum, Karwinskia rocana, Rondeletia odorata* and *Miconia cubensis.*

District B.2.1. Trinidad Heights (Trinidadense) (Fig. 187)

Geography: Steeply inclined mountains with the highest point at 1156 m and a central plateau at 700 m. The parental rocks are mainly limestone or crystalline slate. Extensive limestone and dolomite karsts in the central and south-eastern part, and a granodiorite zone with scattered serpentine outcrops (San Blas) in the west. Humic carbonated soils on the southern slopes, tropical brown soils on the northern sides, acidic yellowish-red soils in the montane zone.

Climate: Seasonal with dry winter 3—4 months duration up to an altitude about 400 m. One or two dry months up to 700 m and moist rainforest climate further up. The annual precipitation is 1200—2300 mm (Fig. 204).

Flora: In addition to the regional endemics mentioned above, a number of local endemics occur, particularly in the montane rainforests, e.g., *Calyptronoma microcarpa, Pilea clarana, P. cacuminum, Rhytidophyllum lomense, Calyptranthes lomensis,* and *Spaniopappus iodostylus.* The montane karsts of Pico Potrerillo — the contact area of montane rainforests, semi-deciduous forests and karstic forests — are especially rich in local endemics (*Vernonia potrerilloana, Rondeletia*

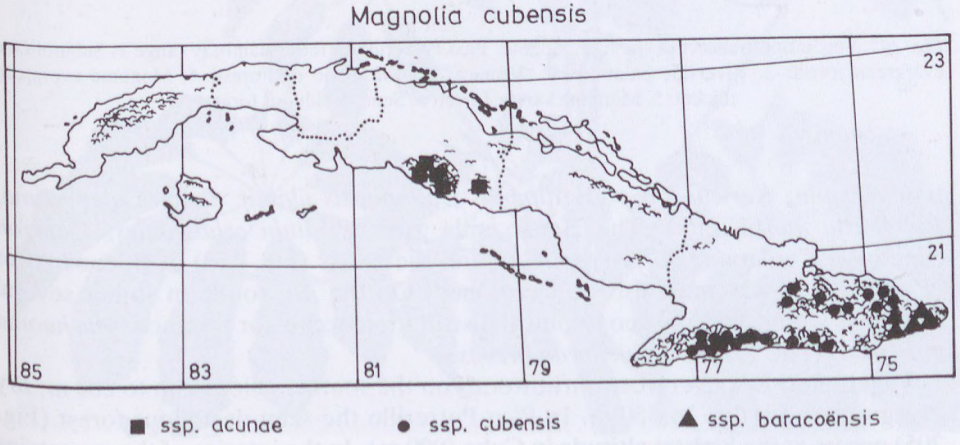


Fig. 203 Geographical distribution of *Magnolia cubensis* Urb. dots: ssp. *cubensis,* squares: ssp. *acunae,* tringles: ssp. *baracoënsis.* (Imchanitskaya 1975, Klotz 1978 and personal observations)

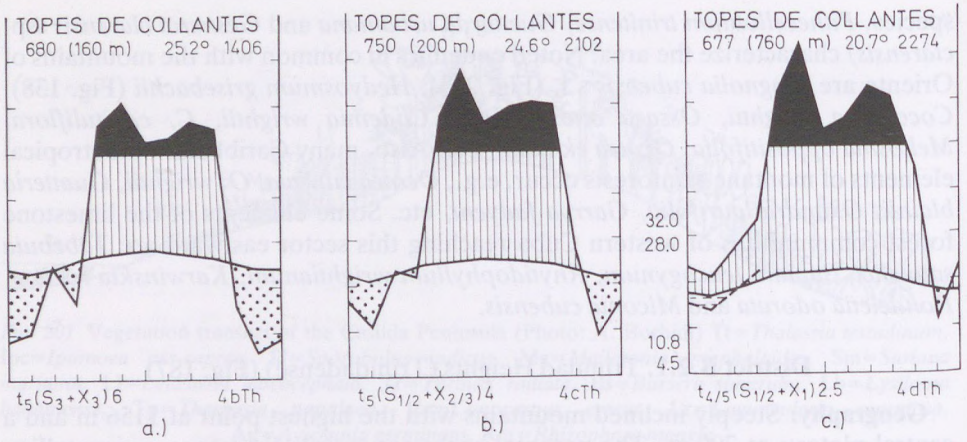


Fig. 204 Characteristic climate types of the Escambray Mountains in the surroundings of Topes de Collantes. (phytogeographical region: Trinidadicum)

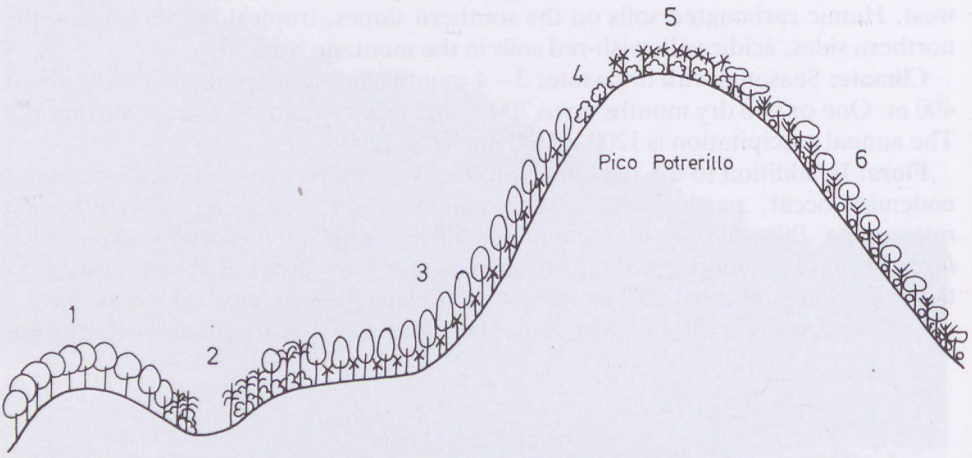


Fig. 205 Vegetation transect of the high mogote: Pico Potrerillo in the Escambray range 1. Submontane evergreen forest; 2. Riverside palm forest "Manacal"; 3. Montane rainforest; 4. Montane evergreen thicket; 5. Montane karstic forest; 6. Semi-deciduous forest

potrerilloana, Karwinskia potrerilloana, Daphnopsis alainii, Banara glaberrima, Psychotria martii, etc.). The Hanabanilla area (*Psidium celastroides, Erigeron capillipes, Cardamine porphyrophylla)* and the karsts (Fig. 156) of Buenos Aires *(Pinguicula jackii)* may also be mentioned. On the dry southern slopes several endemics with point-like geographical distribution occur, for instance, *Machaonia pubescens* (Fig. 192) and *Guettarda nervosa.*

Vegetation: Dry evergreen shrubwoods on the southern slopes up to 200 m, dry evergreen forests up to 550 m. In Pico Potrerillo the semi-deciduous forest (Fig. 205) occurs at the highest altitude in Cuba (900 m). In the interior of the mountains and on the northern slopes the seasonal evergreen forest belt occurs at an elevation

as low as 400 m. At about 800 m the vegetation turns into montane rainforests. In the high parts of the valleys montane rainforests may occur downwards to 5—600 m. Some montane elements may descend along the watercourses even to the plains (e.g., *Calyptronoma dulcis, Didymopanax morototoni* (Fig. 206). In many valleys secondary forests of the introduced *Syzygium jambos* predominate.

District B.2.2. Sancti Spiritus Heights (Spirituënse) (Fig. 187)

Geography: Mountainous area east of the Agabama river, similar to the preceding district in geology, although much fewer karstic formations occur. The highest point is 843 m at the Banao Peak. Humic-carbonated soils predominate.

Climate: Seasonal with dry winter: 3—4, or at the higher altitude 1—2 dry months. The annual precipitation is 1600—1800 mm.

Flora: Due to the drier climate and lower altitude the montane rainforest belt is lacking although some montane elements occur, as *Meriania leucantha* ssp. *nana, Torralbasia cuneifolia.* Yet, this area possesses about ten local endemics, such as *Tetrazygia aurea, Pachyanthus clementis, Rondeletia bicolor, R. convoluta, Hyperbaena acutifolia, Pilea clementis, Dorstenia rocana,* and *Psychotria banaoana.*

Vegetation: Less diverse than the vegetation of the preceding district. Semi-deciduous forests and, at a higher altitude, seasonal evergreen forests represent the dominant types.



Fig. 206 A semi-anthropic giant tree of submontane and montane rainforests: *Didymopanax morototoni (Araliaceae)* (Photo: A. Borhidi)

Sector B.3. Eastern Central Cuba (Camagüeyicum) (Fig. 207)

Mainly young plains formed at the end of the Tertiary and in the Quaternary. Emergent, strongly eroded Cretaceous block mountains (Cubitas, Chorrillo, Jatibonico) and denuded serpentine ridges make the geology of this area more diverse. The limestone flora is originated mainly from the southern slopes of the Baracoa Mountains via the karsts of Sierra Maestra and Sierra de Nipe. The serpentine elements came directly from Nipe and reached the serpentine hills around Holguin. An evidence of this is the recent distribution of three endemic genera in common with Oriente *(Hemithrinax, Doerpfeldia* and *Henoonia*). The colonization of the plains by plants was influenced by the relatively early rise of the northern coast in central Cuba: in the north the Oriente flora migrated to the farthest whereas on the southern coasts the most intensive migration was exhibited by the western elements. This discrepancy is expressed by the well-marked recent boundary of the two sectors.

The descent of plants to the lowlands resulted in a significant change of both the serpentine flora and the xerotherm forest flora. In this regard, the secondary

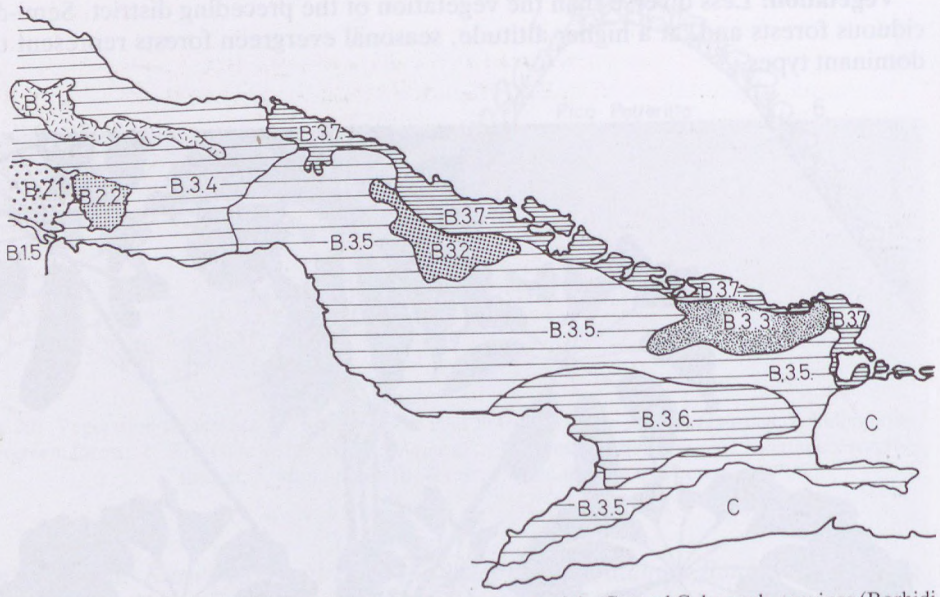


Fig. 207 The phytogeographical subdivision of the eastern part of the Central Cuban sub-province (Borhidi and Muñiz 1986)

B.2. Sector: Guamuhaya Massif (Trinidadicum)

B.2.1. District: Trinidad Heights (Trinidadense)
B.2.2. District: Sancti Spiritus Heights (Spirituënse)

B.3. Sector: Eastern Central Cuba (Camagüeyicum)

B.3.1. District: Claraënse
B.3.2. District: Camagüeyense
B.3.3. District: Holguinense
B.3.4. District: Sagüense
B.3.5. District: Guaimarense
B.3.6. District: Cautoënse
B.3.7. District: Gibarense

speciation within two young palm genera of high genetic plasticity, *Copernicia* (Figs 89, 93, 195) and *Coccothrinax*, (Fig. 179) was particularly intensive producing several taxa of hybrid origin (*Copernicia* × *textilis*, *C.* × *sueroana*, *C.* × *verpertilionum*, *C.* × *burretiana*, *C.* × *shaferi* (Fig. 190). In addition, *Copernicia gigas*, *C. hospita*, *C. rigida*, *C. yarey*, *C. molineti*, *C. curbeloi*, *Coccothrinax salvatoris* and *C. clarensis* may be mentioned. Typical are the endemic species in common with southern Oriente, e.g., *Doerpfeldia cubensis*, *Henoonia brittonii*, *Eriochloa ekmanii*, *Mimosa fagaracantha*, *Jatropha tupifolia*, *Sarcomphalus acutifolius*, *Croton myricifolius*, *Ravenia clementiana*, *Pictetia marginata*, *Tabebuia trachycarpa*, *Brya chrysogonii*, *Polygala guantanamana* and *Antirhea aristata*.

Sub-sector B.3/a Isolated serpentine areas of Motembo—Holguin (Eu-Camagüeyicum) (Fig. 207)

Four serpentine outcrops of different area 100—200 kilometres apart from one another. The smallest one is Motembo having an area of about 50 km², the others are of 500—800 km² area each. Despite the isolation, the flora is unexpectedly uniform. The presence of Pan-Cuban endemics and the absence of *Anemia coriacea* and the *Moacroton* aggregate (Figs 128 and 130) characterize all areas. Some exclusively local endemics also occur, e.g., *Jacaranda cowellii*, *Zanthoxylum nannophyllum*, *Myrtus anomala*, and *Coccoloba geniculata* (Fig. 131).

Numerous serpentinophilous species occur only in two neighbouring areas. For instance, common endemics of the Las Villas and Camagüey serpentines are: *Croton nephrophyllus*, *C. camagüeyensis*, *C. heteropleurus*, *Daphnopsis oblongifolia*, *Machaonia subinermis* (Figs 89, 192), *Gochnatia cowellii*, *Thymopsis thymoides*. The number of Camagüey—Holguin endemics is much larger, e.g., *Platygyne parvifolia* (Fig. 115), *Jacquinia shaferi*, *Stenandrium crenatum*, *Cordia grisebachii*, *Myrtus cabanasensis*, *Karwinskia orbiculata*, *Ginoria microphylla*, *Polygala ambigua*, *Notodon savannarum*, and *Coccoloba cowellii*.

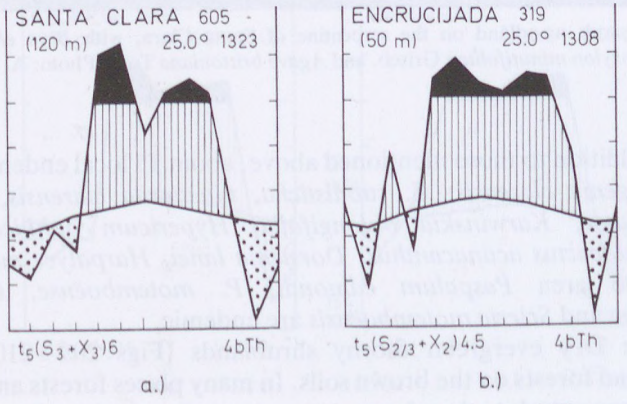


Fig. 208 Characteristic climate types of the serpentine district of the Las Villas province at a) Santa Clara and b) Encrucijada

District B.3.1. The serpentine of Santa Clara (Claraënse) (Fig. 207)

Geography: Hilly serpentine area with emergent ridges, in Sierra de Agabama up to 450 m, with gabbro and limestone outcrops. Red ferrallitic soils, occasionally with pseudoglei character, and brown soils cover the first, humic carbonated soils the second. The isolated serpentine area around Motembo also belongs to this district.

Climate: Seasonal with 5—6 (or 3—4 in the north) dry months in the winter. The annual precipitation is 1100—1600 mm (Fig. 208).



Fig. 209 Thorn scrub woodland on the serpentine of Santa Clara, with *Brya ebenus* auct. cub. *Erythroxylon minutifolium* Griseb. and *Agave brittoniana* Trel. (Photo: A. Borhidi)

Flora: In addition to those mentioned above, about 15 local endemics occur. For example, *Eugenia clarensis, E. subdisticha, Guettarda clarensis, G. roigiana, Xylosma acunae, Karwinskia oblongifolia, Hypericum ophiticola, Xylosma claraënse, Melocactus actinacanthus, Dorstenia lanei, Harpalyce macrocarpa.* To the Motembo area *Paspalum edmondi, P. motemboënse, Cheilophyllum sphaerocarpum* and *Scleria motemboënsis* are endemic.

Vegetation: Dry evergreen thorny shrublands (Figs 209—210). Evergreen shrubwoods and forests on the brown soils. In many places forests and shrubwoods are replaced by secondary dwarf grass savannas and secondary *Brya* and *Dichrostachys* scrubs.

District B.3.2. The serpentine of northern Camagüey (Camagüeyense) (Fig. 207)

Geography: Low, gently rolling flatland. Different allite-ferritic soils derived from serpentine, magnesium humic-carbonate soils, in the northwest ferritic latosols. Here and there granite, porphyrite and diorite intrusions occur.

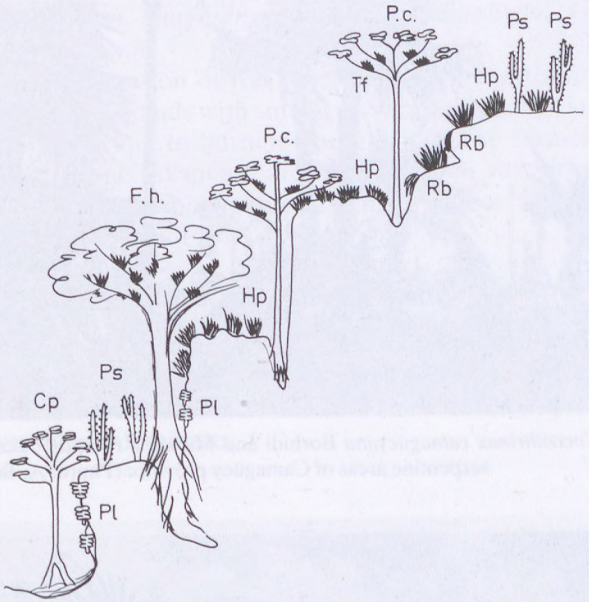


Fig. 210 Transect of the chasmophytic vegetation of Cerro Pelo Malo on isolated limestone rock. (Borhidi and Muñiz) Cp=*Cecropia peltata*, Pl=*Philodendron lacerum*, Ps=*Pilosocereus* sp. Fh=*Ficus havanensis*, Hp=*Hohenbergia penduliflora*, Pc=*Plumeria cubensis*, Rb=*Rhipsalis baccifer*

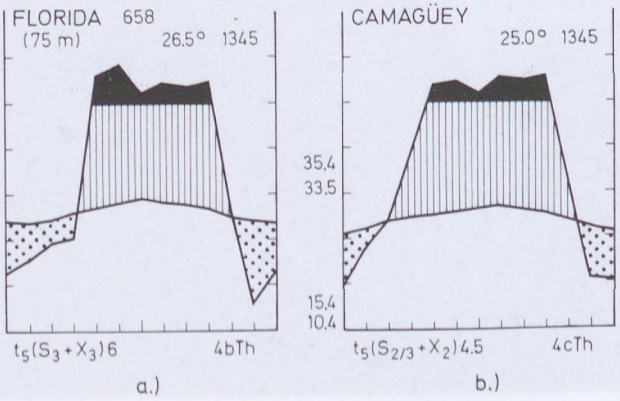


Fig. 211 Characteristic climate types of the serpentine area of the Camagüey Province at a) east of Florida and at b) Camagüey



Fig. 212 Coccothrinax camagüeyana Borhidi and Muñiz, a recently discovered endemic palm of the serpentine areas of Camagüey province (Photo: A. Borhidi)

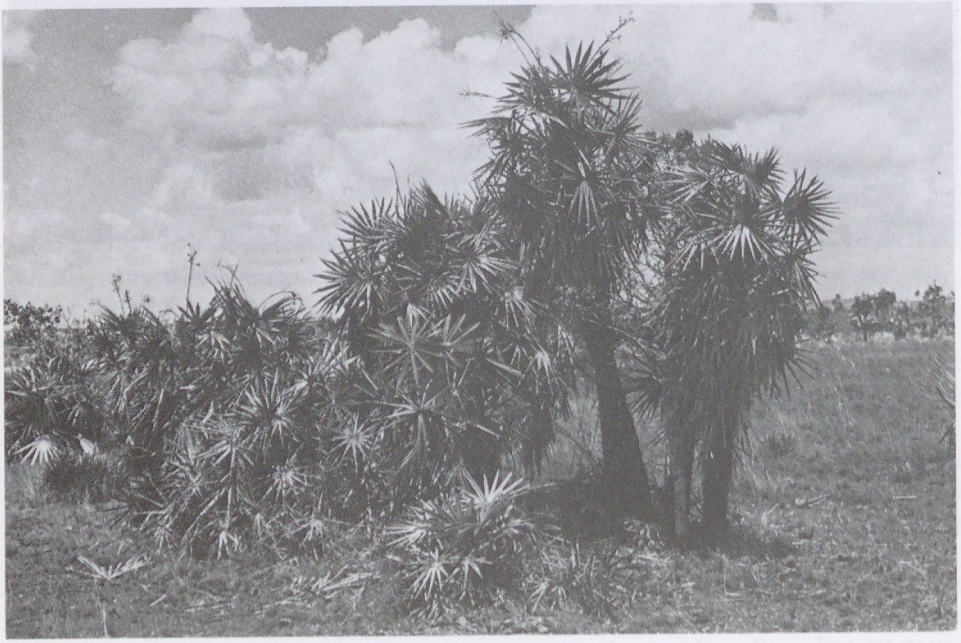


Fig. 213 Coccothrinax pseudorigida León, a dwarf serpentine palm, endemic to Camagüey (Photo: A. Borhidi)

Climate: Seasonal with dry winter of 5—6 months duration and 1200—1400 mm annual precipitation (Fig. 211).

Flora: In addition to the common serpentinophilous endemics listed above, this district has 15 local endemic species. In particular, the palms (*Copernicia cowellii*, *Coccothrinax camagüeyana* (Fig. 212), *C. pseudorigida* (Fig. 213) are famous. Further endemics are *Reynosia camagüeyensis*, *Randia acunae*, *Waltheria ovalifolia*, *Eugenia shaferi*, *E. malanadenia* ssp. *santayana*, *Cameraria microphylla*, *Nashia varifolia*, *Cheilophyllum macranthum*, *Justicia stenophylla*, *Guettarda camagüeyensis*, and *Wedelia urbanii*.

Vegetation: The primary vegetation of this district is evergreen thorny shrub-woods with dwarf palms and shrublands with small grassy clearings. The latter type became gradually predominant due to burning and grazing. The formerly wide-spread views that the "serpentine savannas" are original is not supported by the comparative taxonomic-phytogeographic-phytosociologic studies of the author (see Borhidi and Herrera 1977, Borhidi 1973, 1974, 1976).

District B.3.3. The serpentine of Holguin (Holguinense) (Fig. 207)

Geography: A diversified hilly landscape with wide ridges and inclined conical serpentine hills (Fig. 214) with isolated limestone terraces and cliffs. On the SW and NE border of the area there are red allitic-ferritic soils. Elsewhere tropical brown soils derived from serpentine predominate.



Fig. 214 Cerro de Fraile, a conical serpentine hill above Holguin covered by secondary grasslands and original sclerophyllous evergreen scrub (Photo: A. Borhidi)

Climate: Seasonal with two dry seasons. 5—6 dry months, 800—1200 mm annual precipitation (Fig. 215)

Flora: Rich in endemics. The flora, especially in Cerro Galano, is closely related to that of Sierra de Nipe and Sierra del Cristal with several endemics in common, for example, *Spirotecoma holguinensis, Piper holguinianum, Ateramnus revolutus, Moacroton lanceolatus* (Fig. 130), *Jacquinia robusta, Brya hirsuta, Leucocroton*

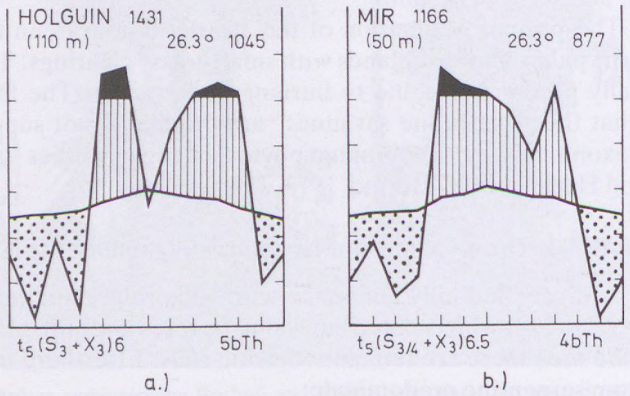


Fig. 215 Characteristic climate types of the phytogeographical district Holguinense at a) Holguin and b) Mir



Fig. 216 Euphorbia podocarpifolia Urb. a common endemic shrub of the serpentine scrubs of the Nipe and Cristal ranges and the serpentine area of Holguin (Photo: A. Borhidi)



Fig. 217 Guettarda shaferi Standl. a common shrub of the dry evergreen serpentine scrubs of North-Oriente (Photo: A. Borhidi)

saxicola, Salacia nipensis, Antirhea ophiticola, Euphorbia podocarpifolia (Fig. 216), *Antirhea minutifolia, Coccoloba nipensis, Guettarda shaferi* (Fig. 217). Approximately 20 local endemics have been indicated, e.g., *Agave anomala, Coccothrinax garciana, Acacia belairioides, Pithecellobium savannarum, Caesalpinia hermeliae, Acidocroton trichophyllus, Chamaesyce filicaulis, Buxus heterophylla, Neobesseya cubensis, Justicia tomentulosa, Rondeletia savannarum, R. shaferi, Gochnatia parvifolia, Cassia holguinensis, Croton acunae, C. holguinensis, Melocactus holguinensis, Machaonia urbinoi* (Fig. 192). *Oplonia multigemma* (Fig. 116).

Vegetation: The conical serpentine mountains, the rocky ridges and the plains were formerly covered by thorny sclerophyllous evergreen shrubwoods containing dwarf palms. These have been replaced by secondary savannas with short grasses and palms. The microphyllous semi-deciduous forests in the valleys were cleared and then turned to agricultural lands.

Sub-sector B.3/b The lowlands, limestone hills, south-coastal zones and keys of eastern Central Cuba (Guaimaricum) (Fig. 207)

Mainly farmland with unvaried vegetation. The points made in B.1. and B.3. are relevant here, too. The flora is characterized by relatively few endemics, in particular, *Copernicia hospita, C. gigas, C. vespertilionum, C.* × *textilis, C.* × *sueroana, C. baileyana* (Fig. 190) and *Hildegardia cubensis* (reaching to the northern coasts and keys too and the xerotherm endemics in common with the southern arid zone of Oriente. Its phytogeographic division is based primarily on the characteristics of lands because the phytogeographical boundaries have been obscured as a result of human impact. Many important elements of the Neotropical xerotherm flora, such as *Phyllostylon brasiliense* and *Prosopis juliflora* have reached this sub-sector from the east.

District B.3.4. The hilly and flat areas and the northern coastal zone in Las Villas (Sagüense) (Fig. 207)

Geography: Diversified landscape. The coastal zone is covered by peaty and meadow soils developed on Quaternary sediments. On the Jurassic limestone of the north-western heights and the Cretaceous limestone of the north-eastern heights (including Sierra de Jatibonico) there are humic-carbonated soils. In the valleys ferrallitic soils are predominant. In the lowlands and hills of the west and south-west the tropical brown soils derived from young Tertiary sediments cover extensive areas.

Climate: Seasonal bixeric with two dry season (3—4 dry months) on the northern coast. Elsewhere monoxeric seasonal with dry winter (5—6 dry months). At the north-eastern heights only 3—4 dry months. Annual precipitation is 1200—1600 mm on the average (Figs 218, 219).

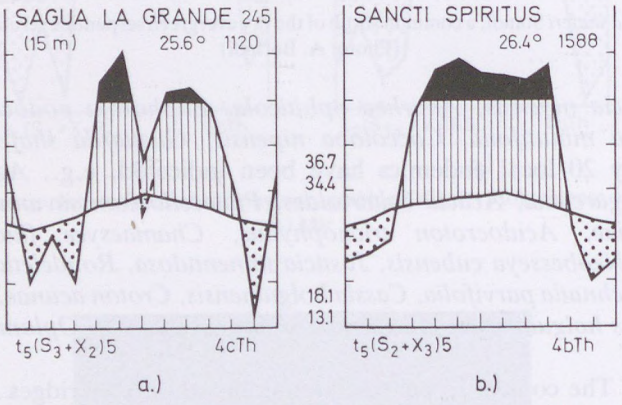


Fig. 218 Characteristic climate type of the Central Cuban lowland areas (phytogeographical district Sagüense) at a) Sagua la Grande and b) Sancti Spiritus

Flora: It is characterized by the forest elements of limestone rocks, these are in fact typical of the whole country. The Caguaguas mogotes at Sagua la Grande possess a special flora, including the representatives of two rare endemic genera, (*Thrinax ekmaniana* (Fig. 114), *Megalopanax rex*). Endemic palms of the savannas are *Copernicia burretiana, C.* × *textilis, C. molineti* (Fig. 190), *Caesalpinia savannarum* and *C. glaucophylla* are also endemic species of the savannas.

Vegetation: The coastal zone is lined with a broad mangrove belt. On the meadow soils moist and treeless secondary savannas predominate taking the place of the former woodlands. In the hills some fragments of semi-deciduous forests represent the natural climax vegetation. Most part of this area is agricultural land, all the tropical brown and red ferrallitic soils are utilized for agricultural purposes. On the mocarrero soils in the south-east semi-anthropogenic savannas with *Copernicia* palms occur, probably in the place of microphyllous semi-deciduous forests.

District B.3.5. The Ciego de Avila-Alto Cedro-La Maya Plains (Guaimarense) (Fig. 207)

The central and southern parts of Camagüey and the western lowlands in Oriente, except the northern coastal zone and the low Cauto Basin are included.

Geography: Mainly denuded plains with a gentle inclination towards the southern coast. Along the shore a wide swamp belt occurs. In western Camagüey, on the plain of Ciego de Avila-Morón, mainly calcareous and fertile red ferrallitic soils are found. On the Camagüey-Tunas-Holguin denuded plains in the interior of the island except the area of districts B.3.3—B.3.4. tropical brown soils predominate. The karstic limestone mountains (Sierra de Najasa) are covered with humic-carbonated soils. In the lowlands parallel to the coast alluvial soils are the most common. Tropical brown soils with mocarrero mosaics are also found here. The only sandy area of Central Cuba is located south of Victoria de las Tunas with a peculiar flora and fauna.

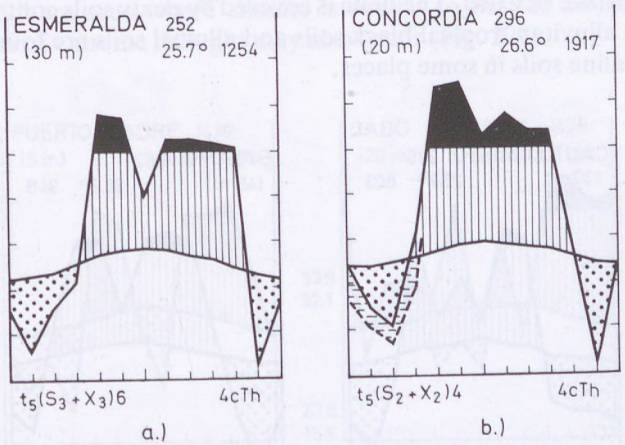


Fig. 219 Characteristic climate types of the East Cuban lowland areas (phytogeographical district Guaimarense at a) Esmeralda and b) Concordia

Climate: Seasonal tropical which is dry in the winter; 5—6 dry months occur per year. In southern Camagüey a more humid climate persists with 3—4 dry months in the winter. East of Holguin and in the northern foothills of Sierra Maestra there are two dry seasons of 5—6 months duration. The annual precipitation is 1800 mm in the west and gradually decreases eastward to a level of 800 mm/year (Fig. 219).

Flora: Similar to that of the preceding district. Strongly affected by human impact and quite uniform. Some local endemics occurring in certain places, e.g., *Cleome tenuifolia* (Galbis), *Caesalpinia hornei* (Ciego de Avila), *Rondeletia gamboana, Catesbaea gamboana, Cleome gamboensis* (Gamboa). *Copernicia longiglossa* is found on the sands at Victoria de las Tunas and also at Dumañuecos (!). At the edge of the Cauto valley *Ateleia parvifoliola* (Mir), *Crotalaria urbaniana* and *Bergia*

sessiliflora (Bayamo), *Coccothrinax savannarum* and *C. pauciflora* (Miranda) occur.

Vegetation: The natural vegetation of the ferrallitic soils on the central Cuban denuded plains are seasonal evergreen forests, semi-deciduous forests and gallery forests along the rivers on alluvial soils and black tropical soils. In the brown soil zone of the Camagüey—Tunas—Holguin plains extensive semi-deciduous forests with *Swietenia mahagoni* were found even at the turn of this century. This species is still present as a standard tree in the recent deciduous tree-savannas. On sand and mocarrero microphyllous semi-deciduous forests with *Copernicia* palms, remnants of open forests with loose canopy layer (forêt claire) and their derived savannas are found. The shoreline is covered by broad mangrove vegetation. On the rocks of Sierra de Najasa the eastern versions of karstic forests occur in which *Coccothrinax* palms and columnar cacti are typical.

District B.3.6. The Cauto Basin (Cautoënse) (Fig. 207)

Geography: The alluvial area and the delta of Rió Cauto are among the youngest areas on the surface of Cuba. The delta is covered by peaty soils containing brackish water. On the alluvium tropical black soils and alluvial soils are found. These tend to become alkaline soils in some places.

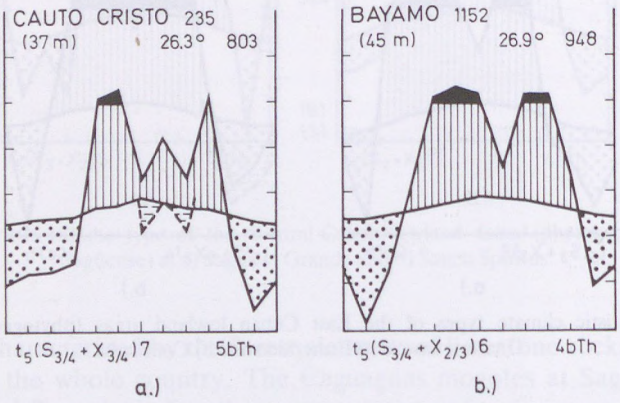


Fig. 220 Characteristic climate types of the Cauto valley (phytogeographical district Cautoënse) at a) Cauto Cristo and b) Bayamo

Climate: Seasonal with dry winter in the west. Two dry seasons in the eastern part of the area with a total of 5—6 dry months. The annual precipitation is about 700—1200 mm (Fig. 220).

Flora: Impoverished through human influence, monotonous, species poor. *Chamaesyce biramensis* is an endemic of the marshes in the delta area.

Vegetation: Only a few degraded stands of the extensive rainforest-like gallery forests remained. The natural vegetation is replaced by treeless marshy meadows and moist savannas. As a result of deforestation, erosion is intensive.

District B.3.7. Littoral terraces and islands of the northern coastal area; the Cayo Frances-Turiguano-Cebolla zone (Gibarense) (Fig. 207)

Geography: The flat coastal area and the archipelago are composed of young Tertiary and Quaternary limestone sediments and subfossil peat layers. There are also some small limestone outcrops (Turiguano, Cayo Romano). For phytogeographic reasons, the higher limestone hills and karstic mountains, Loma Cunagua, the upper Cretaceous-Eocene blocks of the Sierra de Cubitas and the limestone mountains of the Mariabón group at Gibara and Banes are also assigned to this district. Salt marshes and flat karsts covered by shallow humic-carbonated soils alternate in this area. Occasionally, smaller serpentine, gabbro and diabase outcrops increase the geological variability (Puerto Padre, Bahia de Naranjo). The hills and mountains are covered by tropical brown soils and brown carbonated soils. In the valleys of Sierra de Cubitas red ferrallitic soils occur.

Climate: Seasonal bixeric climate with two dry seasons. In general, 5—6 dry months occur, 7—8 in the islands and only 3—4 in the east at Banes. The annual precipitation is 700—1100 mm on the average. The precipitation is very low in the Puerto Padre-Gibara area where climate is similar to that of South Oriente and sometimes years of extreme drought may also occur (Fig. 221).

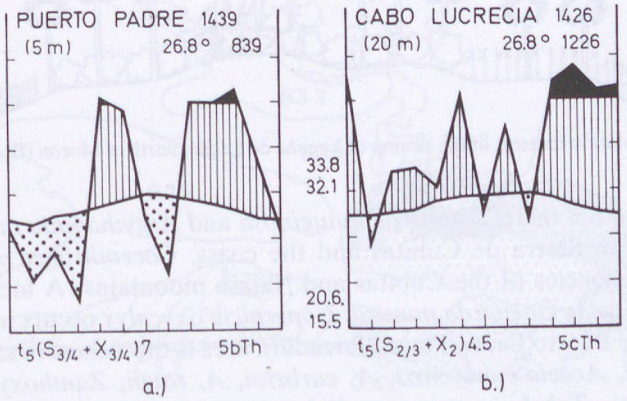


Fig. 221 Characteristic climate type of the north-east coastal zone of CENTRAL Cuba (phytogeographical district Gibarense) at a) Puerto Padre and b) Cabo Lucrecia

Flora: Local xerotherm endemics. The close relationship to the flora of Bahamas is indicated by many species shared by the two regions, e.g., *Guapira bracei, Pithecellobium millspaughii, Eugenia lucayana, Cordia bahamensis, Auerodendron northropianum* and *Phialanthus myrtilloides.* Relatively few indigenous species are typical of the whole district, for example, *Coccothrinax salvatoris, Trichilia pungens* (Fig. 222), *Sarcomphalus obovatus.* In contrast many local endemics are found in the islands and peninsulas e. g., *Chamaesyce paredonensis, Heliotropium myriophyllum* (Cayo Paredon Grande), *Selenicereus brevispinus, Nashia cayensis, Isocarpha glabrata, Notodon cayensis (Cayo Guayaba), Crescentia*

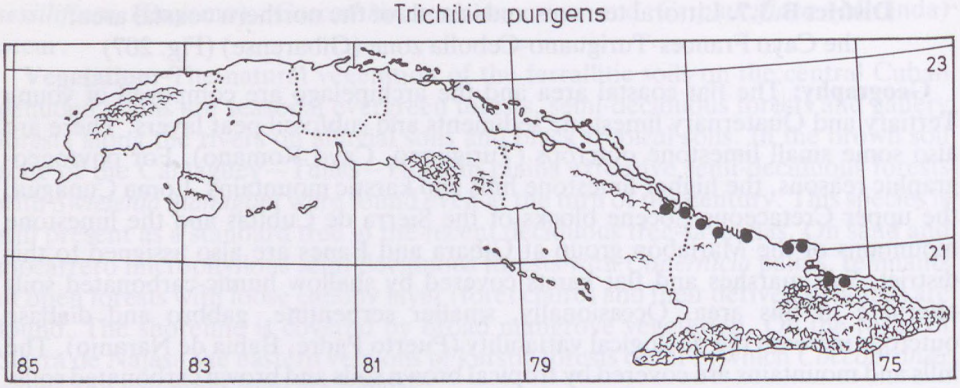


Fig. 222 Geographical distribution of *Trichilia pungens* Urb.

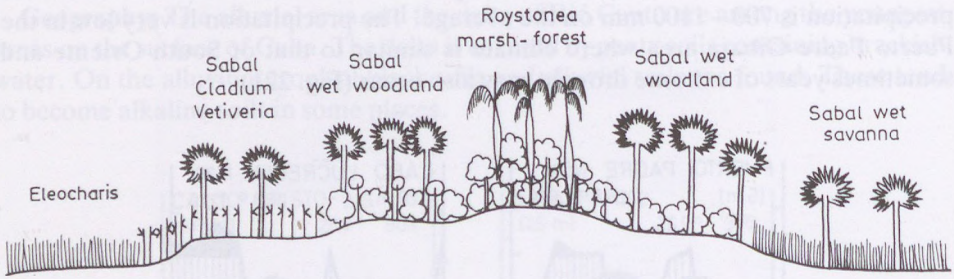


Fig. 223 Vegetation transect of the swamp of Laguna de Leche, north of Morón (Borhidi and Muñiz)

mirabilis (Cayo Sabinal). *Guettarda lanuginosa* and *Argythamnia microphylla* are in common with Sierra de Cubitas and the coast. *Coccothrinax muricata* in an endemic palm species of the Cubitas and Najasa mountains. A local endemic of Sierra de Cubitas is *Guettarda munizii. Copernicia oxycalyx* occurs in the savannas of Manati. The Puerto Padre-Playa Herradura area is the richest in endemics, e.g., *Ximenia roigii, Acacia cupeyensis, A. curbeloi, A. roigii, Zanthoxylum curbeloi, Banara wilsoni, Tabebuia truncata, Xylosma roigii, Randia costata, Baccharis orientalis* ssp. *orientalis, Galactia rotundata* and *Casasia clusiifolia* var. *hirsuta* are endemic to Gibara and surroundings, whereas *Pictetia arborescens* is endemic to Playa Pesquero Nuevo. *Eugenia pteroclada* is an endemic species of Banes. In the very dry coastal area between Puerto Padre and Banes some elements of the southern Oriente semi-desert zone also occur, for instance, *Ritterocereus hystrix, Bonania microphylla, Amyris diatrypa, Samyda ramosissima, Cordia curbeloi, Eupatorium littorale, Thouinia pseudopunctata, Pseudocarpidium avicennioides, Oplonia polyece*, and *Doerpfeldia cubensis.*

Vegetation: Besides the extensive mangroves and swamps north of Morón (Fig. 223), the most attractive types are the dry evergreen forests and the xerotherm evergreen scrubs of flat karsts. The former gallery forests grown on alluvial soils have been replaced by secondary savannas. The natural vegetation on brown soils is

the semi-deciduous forest as seen in Loma Cunagua and the valleys of Sierra de Cubitas. The eastern Cuban karstic mogotes with *Coccothrinax* palms have been even less intensively studied.

SUB-PROVINCE C. EASTERN CUBA (Oriento-Cubanicum) (Fig. 224)

This phytogeographic unit includes two big massifs in Oriente, the Sierra Maestra and the Nipe-Baracoa range, the basin in between and the adjacent coastal lowlands. This area is considered to be the cradle of the Cuban flora and, together with western Hispaniola, the most prominent centre of speciation in the Antilles. In addition to the 13 Pan-Cuban and 5 central-eastern Cuban endemic genera, there are 24 genera and more than 1500 species exclusively endemic to this sub-province. Approximately 1950 endemic taxa, including western and Pan-Cuban elements, occur in this area of about 18 000 km^2. The close relationship to Hispaniola is indicated by ten other endemic genera (*Plethadenia, Spirotecoma, Bellonia, Barleriola, Picardaea, Isidorea, Margaritopsis, Peratanthe, Fuertesiella,* and *Victorinia*) and 103 species present on both islands. Furthermore, this sub-province is

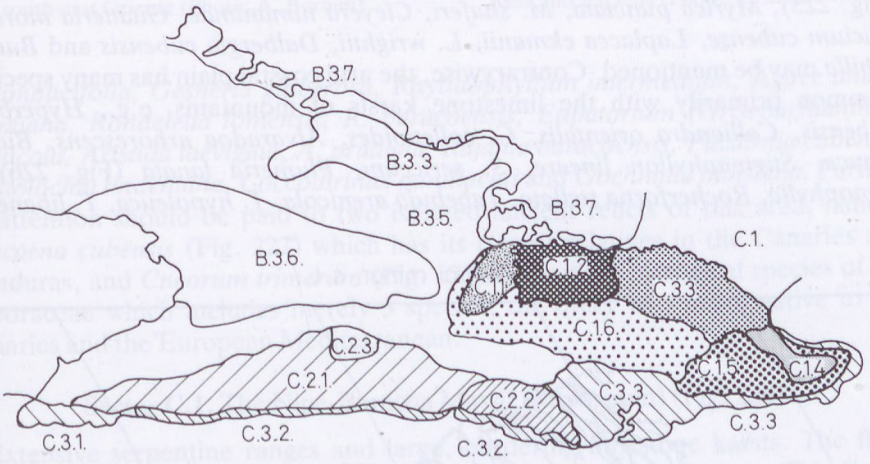


Fig. 224 The geographical subdivision of the east Cuban sub-province (Borhidi and Muñiz 1986)

C.1. Sector: Nipe-Baracoa Massif (Moanicum)

C.1.1. District: Sierra de Nipe (Nipense)
C.1.2. District: Sierras del Cristal and Micara (Cristalense)
C.1.3. District: Sierras de Moa and Toa (Moaënse)
C.1.4. District: Serpentines of Baracoa and Jauco (Baracoënse)
C.1.5. District: Purialense
C.1.6. District: Yaterense

C.2. Sector: Sierra Maestra (Maestricum)

C.2.1. District: Western and central Maestra (Turquinense)
C.2.2. District: Eastern Sierra Maestra (Piedraënse)
C.2.3. District: Mogotes of the Maestra (Bairense)

C.3. Sector: South-eastern coasts (Santiagicum)

C.3.1. District: Pilonense
C.3.2. District: Uveroënse
C.3.3. District: Guantanamense

the evolutionary centre of 22 Caribbean genera, such as *Roystonea, Spathelia, Leucocroton, Bonania, Reynosia, Auerodendron, Neobracea, Pseudocarpidium, Gesneria, Rhytidophyllum* and *Acrosynanthus,* and the largest or one of the largest evolutionary centres for additional 32 Neotropical and Pantropical flowering plant genera, e.g., *Coccothrinax, Lepanthes, Metopium, Buxus, Purdiaea, Calyptranthes, Pimenta, Eugenia, Pachyanthus, Ossaea, Lyonia, Tabebuia, Dorstenia, Coccoloba, Schoepfia, Pilea* (shared with Hispaniola), *Harpalyce, Amyris, Rondeletia* and *Gochnatia.* It may be concluded from this list that this area is in fact one of the richest gene reserves of the world. Its exploration, however, is by no means complete.

Two humid mountainous areas (Sierra Maestra and Nipe-Baracoa) and an arid coastal plain is included in this phytogeographical category. The mountains have three endemic genera (*Synapsis, Zonanthus, Triscenia)* and more than 325 endemic species, mainly orchids (e.g., *Pleurothallis, Lepanthes, Epidendrum, Maxillaria species*). Furthermore, many species of *Lyonia, Coccoloba, Clusia, Pilea, Peperomia, Ossaea, Miconia, Calycogonium, Eupatorium* and *Vernonia;* and several montane species, such as *Clathra cubensis, Magnolia cubensis* (Fig. 203), *Purdiaea nipensis, Euphorbia, helenae, Calyptronoma clementis, Talauma minor* (Fig. 225), *Myrica punctata, M. shaferi, Cleyera nimanimae, Guatteria moralesi, Illicium cubense, Laplacea ekmanii, L. wrightii, Dalbergia cubensis* and *Bumelia jubilla* may be mentioned. Contrarywise, the arid coastal plain has many species in common primarily with the limestone karsts of mountains, e.g., *Hyperbaena cubensis, Calliandra orientalis, C. colletioides, Alvaradoa arborescens, Bursera glauca, Stigmaphyllon lineare, S. sericeum, Plumeria lanata* (Fig. 226), *P. stenophylla, Rocherfortia stellata, Tabebuia arenicola, T. hypoleuca, T. libanensis,*

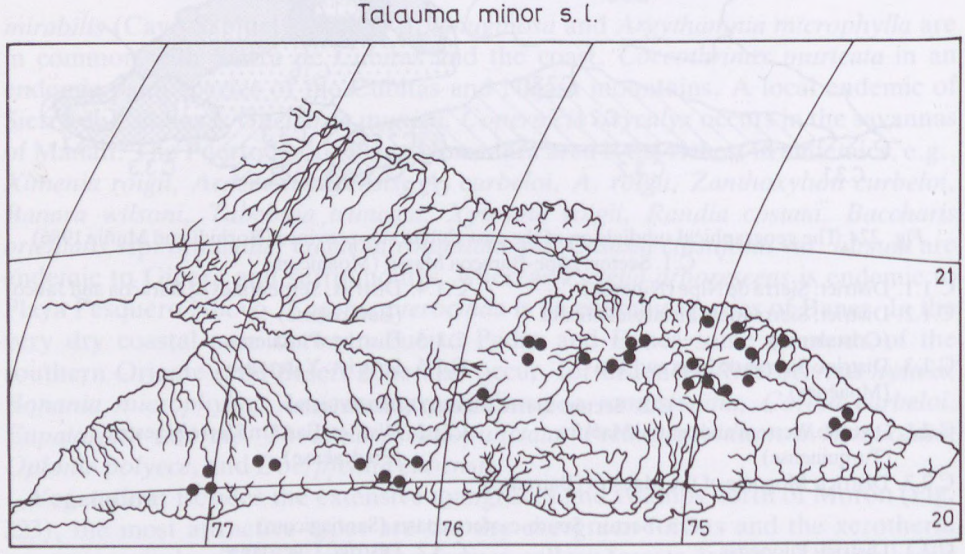


Fig. 225 Geographical distribution of *Talauma minor* Urb. (after Imchanitskaya 1975 and personal observations)



Fig. 226 Plumeria lanata Britt., a little deciduous pachycaul tree of the dry thorn scrub vegetation of south-east Oriente (Photo: A. Borhidi)



Fig. 227 A living fossil monocot of the flora of Cuba: *Dracaena cubensis* M. Vict. endemic to Moa and Baracoa (Photo: A. Borhidi)

T. simplicifolia, Gesneria gibberosa, Rhytidophyllum intermedium, Agave underwoodiana, Rondeletia lomensis, R. baracoënsis, Eupatorium (Grisebachianthus) carsticola, Aristida laevigata, A. pradana, Rajania baracoënsis, Pitcairnia cubensis, Aristolochia lindeniana, Coccothrinax gundlachii and *Gochnatia maisiana*. Particular attention should be paid to two isolated ancient relicts of this area, namely *Dracaena cubensis* (Fig. 227) which has its closest relatives in the Canaries and Honduras, and *Cneorum trimerum* (Fig. 125), the only Neotropical species of the Cneoraceae which includes merely 3 species, the other two being native to the Canaries and the European Mediterranean.

Sector C.1. The Nipe-Baracoa Massif (Moanicum) (Fig. 224)

Extensive serpentine ranges and large, bordering limestone karsts. The flora development of this area has been continuous since the upper Eocene. This region is characterized by high relief energy and diversified edaphic, macro- and microclimatic conditions. The richest flora of the Caribbean, and one of the richest floras of the World is found here and this area is also the most significant evolutionary centre of the Cuban flora and a starting point for the dispersal of species groups with different ecological requirements (serpentinophilous, montane and karstic elements). Eighteen endemic genera occur, five confined to this sector, namely *Tetralix, Phidiasia* (Fig. 228), *Schmidtottia* (16 species!), *Ariadne* and *Ekmanochloa*. The majority of species belonging to highly polymorphic genera, such as *Podocarpus, Gochnatia, Vernonia, Guettarda, Rondeletia, Purdiaea, Phyllanthus, Moacroton* (Fig. 130), *Coccoloba, Casearia, Spathelia* (Fig. 109), *Siphocampylus* and *Thrinax* (Fig. 114), etc., have a limited geographical range restricted to this sector. The number of regional endemic species is about 200.

However, if the local endemics are also considered this number reaches 725. Some typical species are *Podocarpus ekmanii, Pinus cubensis (Fig. 229), Dracaena cubensis* (Fig. 227), *Guettarda ferruginea, Phyllanthus myrtilloides, Cyrilla cubensis*, *Rauvolfia salicifolia* and *Clerodendron nipense, Bactris cubensis* (Fig. 230)

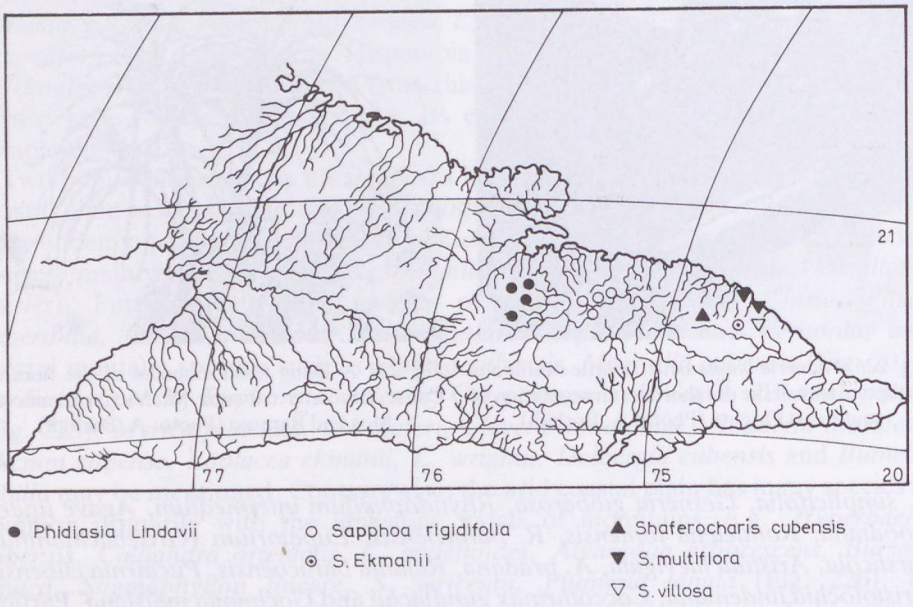


Fig. 228 Geographical distribution of the endemic genera *Phidiasia, Sapphoa* and *Shaferocharis* (Borhidi 1981, modified 1986)

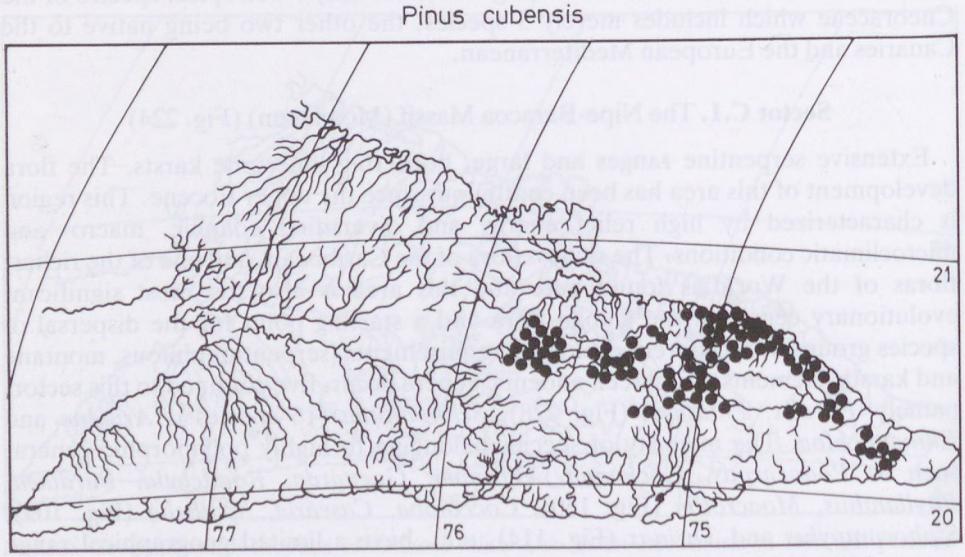


Fig. 229 Geographical distribution of *Pinus cubensis* Griseb. (Bisse 1957, modified)

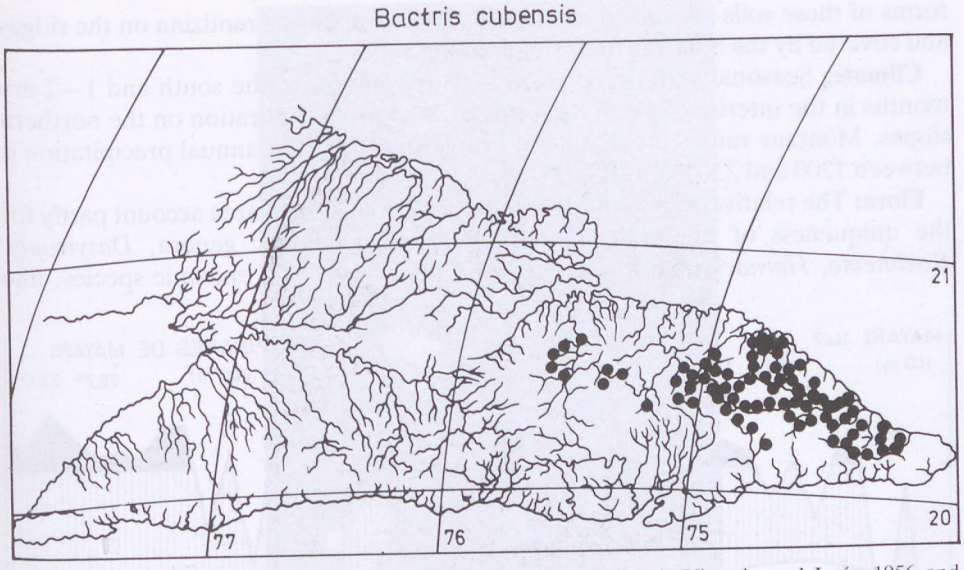


Fig. 230 Geographical distribution of *Bactris cubensis* Burret (Marie-Victorin and León 1956 and personal observations)

Sub-sector C.1/a. The serpentine mountains of the Nipe-Baracoa Massif (Eu-Moanicum) (Fig. 224)

Four mountains or mountain groups have been distinguished from a phytogeographic point of view. These are the Nipe, Cristal, Moa and the Baracoa-Jauco zone. The first two, just as the second two, represent more closely related units. Nipe and Cristal are separated only by a narrow limestone strip, the valley of Rió Mayari. The boundary between Moa and Baracoa is a narrow gabbro zone. However, Cristal and Moa are widely separated by the Sagua de Tanamo depression covered by Tertiary limestone. This area, with its mesophilous tropical forest, must have acted as an important barrier of migration for the serpentine floras. Within the east Cuban sub-province, this area has the richest flora. Of its eighteen endemic genera sixteen are confined to this sub-sector, including all regional endemic genera and the majority of the 725 endemic species. The number of vicarious species in the mountains is large. Also, many vicarious subspecies occur providing evidence for speciation in more recent times. The *Calycogonium rosmarinifolium,* (Fig. 121), *Casasia nigrescens,* (Fig. 120), *Moacroton lanceolatus* (Fig. 130), *Anemia coriacea* (Fig. 128), and *Phyllanthus myrtilloides* aggregates are examples. All developmental stages of serpentine soils are found in this area and, as a result of the different ecological conditions of serpentine habitats, the floristic and vegetational variability ranges from the arid evergreen shrublands to the submontane rainforests.

District C.1.1. Sierra de Nipe (Nipense) (Fig. 224)

Geography: A serpentine plateau at 600 m elevation, relieved by narrow and deep canyons and covered by old fossil ferrallitic and ferritic soils. The eroded

forms of these soils are mixed with more recent serpentine rendzina on the ridges and covered by the humic drift of slopes in the valleys.

Climate: Seasonal with dry winter, 3—4 dry months in the south and 1—2 dry months in the interior. Two dry seasons of 3—4 months duration on the northern slopes. Montane rainforest climate at Loma Mensura. The annual precipitation is between 1200 and 2300 mm (Fig. 231).

Flora: The relatively wide climatic conditions of this small area account partly for the uniqueness of the flora. Four monospecific endemic genera, *Dasytropis, Koehneola, Harnackia* and *Ciceronia,* and about 140 local endemic species, like

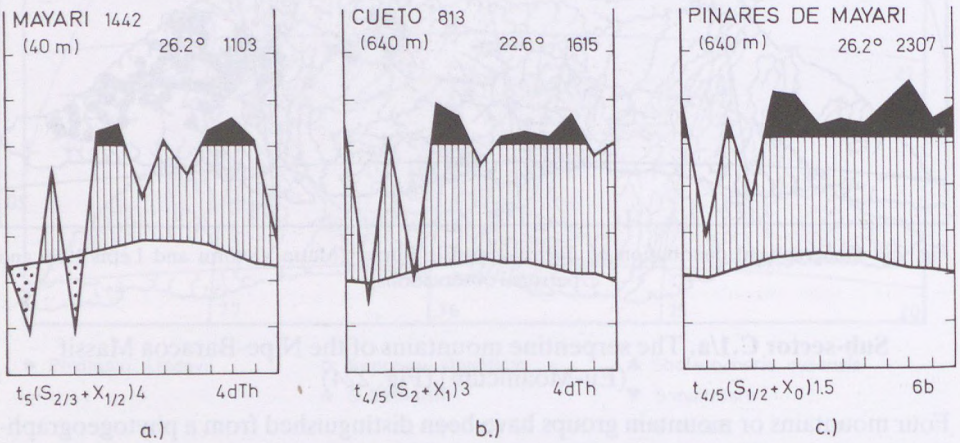


Fig. 231 Characteristic climate types of the Sierra de Nipe (phytogeographical district Nipense) at a) Mayari, b) Cueto and c) Pinares de Mayari

Clusia nipensis (Fig. 232) and *Gesneria nipensis* and especially from (Fig. 233), the genera of *Tabebuia, Leucocroton, Chaptalia, Brunfelsia, Callicarpa, Eugenia, Calyptranthes, Phyllanthus* and *Rhynchospora* also occur. Further 21 species are common to this district and the Cristal Mountains, examples are *Euphorbia podocarpifolia, Eugenia piedraensis, Schmidtottia cubensis, Rondeletia canellaefolia, Senecio subsquarrosus, Vernonia desiliens,* and *Gochnatia cubensis,* etc. Some species are exclusively found here and in Moa, being absent from the Cristal Mountains in between. These are *Pithecellobium nipense, Ravenia simplicifolia, Phyllanthus phlebocarpus, Ph. estrellensis, Buxus aneura, Phidiasia lindavii* (Fig. 228), *Matelea nipensis, Exostema stenophyllum* and *Psychotria lopezii.* The richness of certain valleys (e.g., Rio Piloto) or peaks and ridges (Loma Mensura, Loma Bandera, Loma Winch) in local endemics is also of particular interest.

Vegetation: Semi-arid evergreen shrubwoods on the sharp ridges. Various natural and secondary *Pinus cubensis* forest communities on the slopes and the plateau. Semi-arid montane rainforests predominate along the watercourses. Semi-arid montane shrubwoods occur on the western and eastern slopes of Loma Mensura. The "montane serpentine savannas" of Carabia (1945b) have resulted from the deforestation of relict pinewoods.



Fig. 232 Clusia nipensis Borhidi a characteristic tree of the open rocky pine woodland on the serpentine of the Nipe Mountain (Photo: A. Borhidi)



Fig. 233 Gesneria nipensis Britt. et Wils. an endemic shrub of the evergreen montane serpentine scrub of the Nipe Mountain (Photo: A. Borhidi)

District C.1.2. Sierras del Cristal and Micara (Cristalense) (Fig. 224)

Geography: Massif consisting of deeply inclined conical hills and sharp ridges. The lower sections are covered by ferralitic soils. Over 700 m these are replaced by yellowish-red montane clays.

Climate: More uniform than the climate of the preceding district. The dry season is in the winter with 1—2 dry months at the margin of the mountains. Humid rainforest climate in the interior. Annual precipitation between 1600—2300 mm (Fig. 234).

Flora: Strikingly poor and monotonous when compared to the flora of the neighbouring Nipe and Moa Mountains. This is indicated by breaks in the distribution of numerous species mentioned in the discussion of the preceding district. This situation may be partially accounted for by the deficiency of these mountains in extreme, dry rocky habitats. Another reason is that this area is not thoroughly explored. Thus, only one (!) endemic monospecific genera *(Eosanthe cubensis* (Fig. 88)) and about 50 endemic species are known. Most of these species

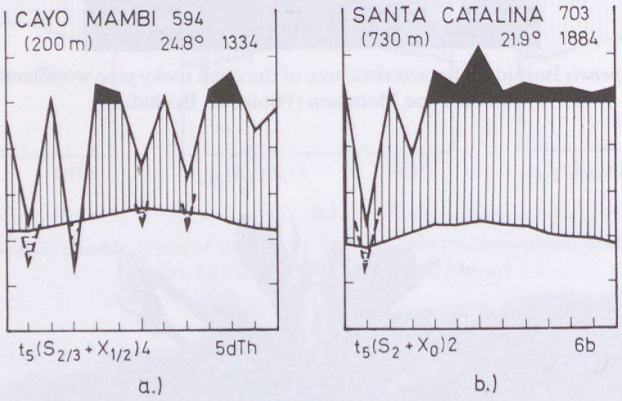


Fig. 234 Characteristic climate types of the Sierra del Cristal (phytogeographical district: Cristalense) at a) Cayo Mambi and b) Santa Catalina

are markedly different from their relatives, for example, *Lagenocarpus cubensis, Freziera conocarpa, Moacroton cristalensis* (Fig. 130), *Buxus imbricata, B. olivacea, Erythrina leptopoda, Croton pachyrachis, Ilex cristalensis, I. eoa, I. paucinervis, I. subavenia, Chaetocarpus cordifolius, Leucocroton obovatus, Pachyanthus monocephalus, Jacquinia sessiliflora, Senecio ekmanii, Sapphoa rigidifolia* (Fig. 228), *Acrosynanthus ovatus, Gesneria pachyclada, Dendropanax nervosus, Ossaea cristalensis,* etc. Whereas the Cristal Mountains are poor only in comparison with the neighbouring districts, the coniferous forests of Sierra de Micara are monotonous by any standard with an only exception of the dry rocky ridge of Saca La Lengua: as few as 6—8 endemics, such as *Annona cirstalensis, Erythroxylon flavicans, Ossaea micarensis, O. pinetorum, Myrtus micarensis* and *M. del-riscoi* have been known.

Vegetation: The coniferous zone is much narrower than in Nipe. Seasonal

evergreen forests extend up to an altitude of 600 m with moist rainforest mosaics. Between 600 and 1100 m pine forests of *Pinus cubensis* are dominant. From 1100 to 1230 m semi-dry montane shrubwood, variant of cloud forest on serpentine, is found. On the southern serpentine cliffs of Pico del Cristal the existence of a peculiar vegetation, namely dry montane evergreen shrubwoods, may be assumed.

District C.1.3. Sierras de Moa and Toa (Moaënse, Fig. 224)

The most extensive floristic district on serpentine. Its flora probably has the longest history in Cuba, as this area is considered to be the evolutionary centre of the flora and vegetation in these mountains.

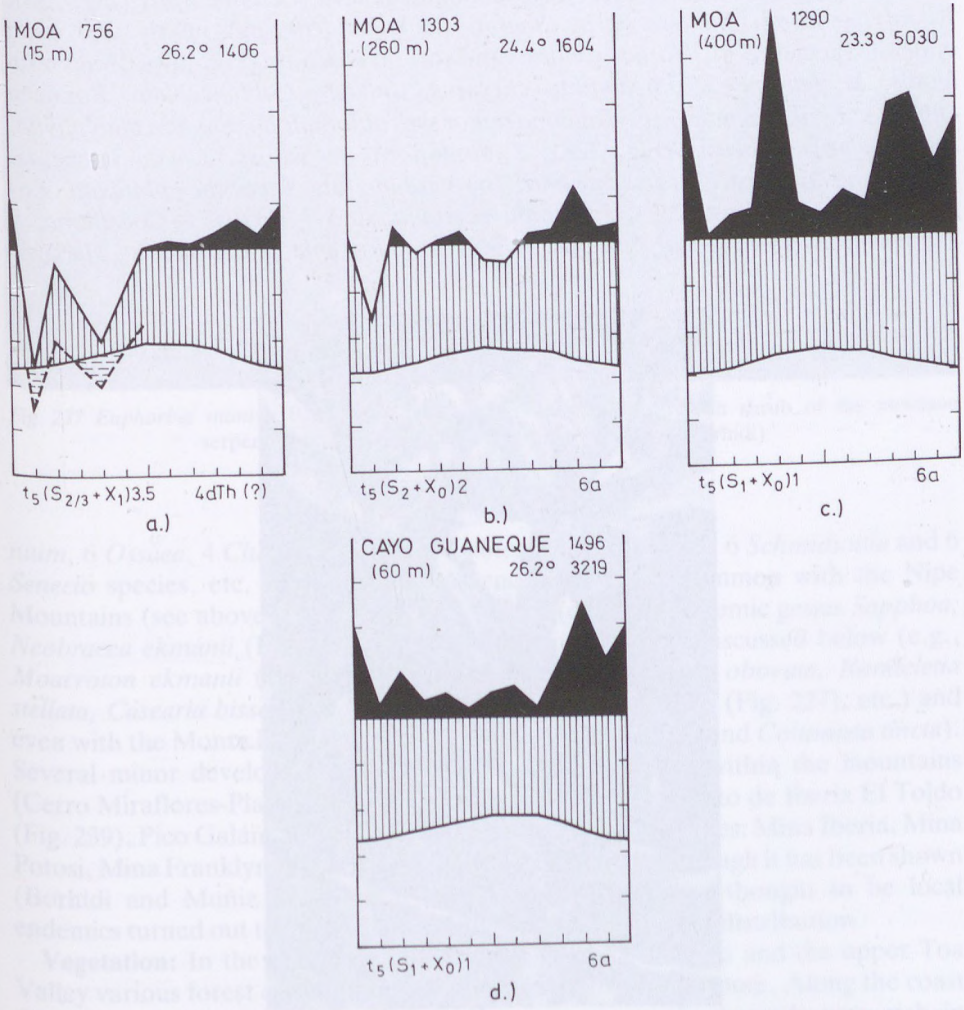


Fig. 235 Characteristic climate types of the Sierra de Moa, (phytogeographical district Moaënse) at a—c) Moa and d) Cayo Guaneque

Geography: In general, wide and flat ridges and plateaux are typical (Cupeyal, El Toldo, Altos de Iberia) although the Cuchillas de Toa range between the Jaguani and Toa rivers consists of conical and pyramidal mounts. Very old, red ferritic soils predominate. In zones close to the coast (Cerro Miraflores, Yamanigüey) younger ferrallitic serpentine soils are found. The middle and upper section of the Toa Valley is mainly covered by yellowish-red montane soils derived from serpentine.

Climate: The most humid area in Cuba. At the northern, western and southern boundary there are two dry seasons of 1—2 dry months duration. In the interior the climate is warm and moist throughout the year. At about 7—800 m altitude it is replaced by moist montane rainforest climate. Annual precipitation ranges between 1400—3000 mm, occasionally near to 5000 mm in certain localities (Fig. 235).

Flora: Very rich and diverse. Five endemic genera, *Ceuthocarpus* (Fig. 236), *Kodalyodendron, Shaferocharis, Shafera* and *Feddea,* and nearly 200 local endemic species, e.g., *Thrinax rivularis* and var. *savannarum* (Fig. 114), *Moacroton leonis, M. tetramerus, Phyllanthus chryseus, Callicarpa oblanceolata, Bonnetia cubensis, Laplacea moaënsis, Talauma minor* ssp. *oblongifolia, Shafera platyphylla, Shaferocharis cubensis* (Fig. 228), *S. multiflora, S. villosa, Cassia bucherae, Byrsonima bucherae, Acacia bucheri, Brya subinermis, Casearia ophiticola, Euphorbia munizii* (Fig. 237), *Jacquinia acunana,* and 7 *Buxus,* 4 *Coccoloba,* 5 *Leucocroton,* 4 *Ilex,* 5 *Calyptranthes,* 4 *Myrcia,* 6 *Eugenia,* 6 *Miconia,* 5 *Calycogo-*



Fig. 236 Ceuthocarpus involucratus (Vernh.) Aiello, an endemic genus and species of the coastal area of Moa (Photo: A. Borhidi)



Fig. 237 Euphorbia munizii Borhidi an endemic leptophyllous evergreen shrub of the montane serpentine scrub of El Toldo, Moa range (Photo: A. Borhidi)

nium, 6 *Ossaea*, 4 *Clusia*, 8 *Cordia*, 3 *Callicarpa*, 6 *Tabebuia*, 6 *Schmidtottia* and 6 *Senecio* species, etc. occur. Numerous endemics are in common with the Nipe Mountains (see above), with Sierra del Cristal (e.g., the endemic genus *Sapphoa*, *Neobracea ekmanii* (Fig. 117), the Baracoa-Jauco district discussed below (e.g., *Moacroton ekmanii* (Fig. 130)), *Cordia duartei*, *Platygyne obovata*, *Rondeletia stellata*, *Casearia bissei*, *Feddea cubensis*, *Dracaena cubensis* (Fig. 227), etc.) and even with the Monte Libano group (e.g., *Gesneria cubensis*, and *Columnea tincta*). Several minor developmental centres may be recognized within the mountains (Cerro Miraflores-Playa la Vaca, Yamanigüey (Fig. 238), Alto de Iberia El Toldo (Fig. 239), Pico Galán, and the sorroundings of old nickel mines: Mina Iberia, Mina Potosi, Mina Franklyn, Mina Cayo Guam, Mina Delta), although it has been shown (Borhidi and Muñiz 1973b) that many species had been thought to be local endemics turned out to be, in fact regional endemics of wider distribution.

Vegetation: In the northern foothills, the Cupeyal Plateau and the upper Toa Valley various forest communities of *Pinus cubensis* predominate. Along the coast these forests alternate with microphyllous evergreen shrubwoods very rich in species, including strongly isolated endemics such as *Kodalyodendron cubense*,

Shaferocharis multiflora (Fig. 238), *Tabebuia linearis, Acrosynanthus minor, Miconia javorkaeana, Forchhammeria emarginata, Coccoloba acuna, Phyllanthus comosus, Eupatorium minutifolium.* Over 400 m and up to 6—700 m semi-arid montane rainforests occur (Fig. 239). At higher altitude semi-arid montane shrubwoods correspond to the climax vegetation type. On the dry tops of some serpentine plateaux (e.g. El Toldo, Fig. 240) a dwarf pine woodland of *Pinus*

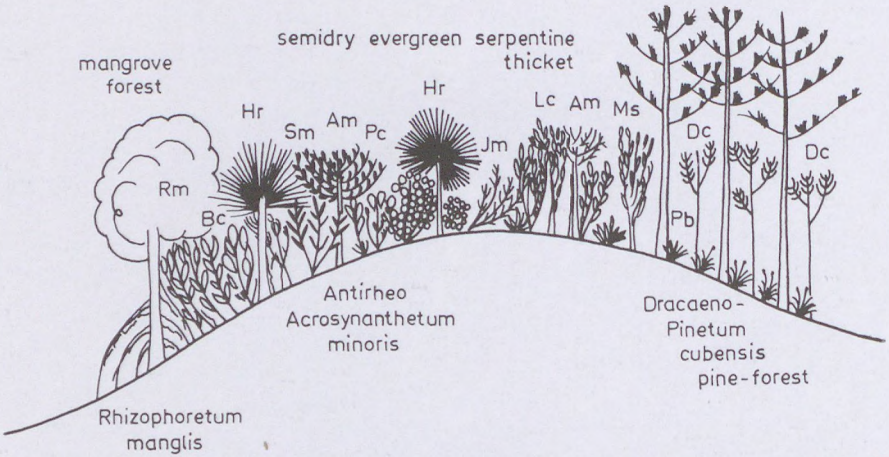


Fig. 238 Vegetation transect of the Cerro Yamanigüey in the coastal range of the Sierra de Moa

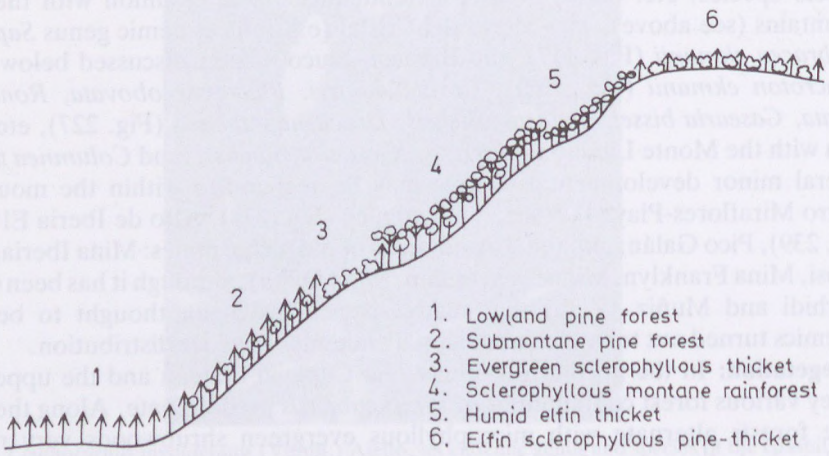


Fig. 239 Vegetation transect of the Meseta El Toldo, Sierra de Moa (Borhidi and Pócs)



Fig. 240 Inner view of the Sierra de Moa at La Melba with Loma Redonda (left) and El Toldo with Camp of Glory (right) type locality of many species discovered by Shafer (Photo: A. Borhidi)

cubensis has developed (Pócs, pers. comm). In the valleys of the Jaguani and Toa rivers the *Carapa guianensis* forests, are found representing the only submontane tropical rainforest zone in Cuba.

District C.1.4. The serpentine areas of Baracoa and Jauco (Baracoënse) (Fig. 224)

Geography: This area, situated east of the Quibiján and Toa rivers, is younger, lower and also poorer in species than the preceding districts. Yellowish red montane soils and ferritic soils occur in the west, ferrallitic red serpentine soils in the east.

Climate: Humid rainforest climate with no seasons. Annual precipitation between 1600 and 2900 mm.

Flora: Most species are in common with Moa. Approximately fifty local endemic species are found here, for example: *Melocactus radoczii, Buxus baracoënsis, Cordia baracoënsis, Siphocampylus baracoënsis, Schmidtottia multiflora, Ossaea elliptica, Henriettea cuabae, Exostema shaferi, Xylopia ekmanii, Spathelia leonis* (Fig. 109), *Leucocroton ekmanii, Rhamnidium pruinosum, Ternstroemia baracoënsis* etc.

Vegetation: Submontane rainforests in the west, pinewoods on ferritic soils, and mainly microphyllous evergreen shrubwoods in the Peladeros de Jauco zone in the east.

Sub-sector C.1/b. The limestone karsts and other not serpentine ranges of the Nipe-Baracoa Massif (Yatericum) (Fig. 224)

This sub-sector includes the mogotes of the south-western Sierra de Nipe, the partially eroded limestone blocks folded at the margin of serpentine mountains, in the Monte Libano–Monte Cristo–Monte Verde group, the sandstone hills mingled with the limestone blocks, and the Sierra del Purial range with the Sierra de Imias which continues as a limestone plateau towards the end of the island. The endemics are not evenly distributed over the area. The deciduous forests occurring on sandstone have very few floristic specialities, whereas the limestone cliffs are very rich in endemics due to geographical isolation. In spite of this heterogeneity, the sub-sector played a significant role in the flora evolution of Cuba for two fundamental reasons:

1. Via this area the montane flora migrated from the north (Moa, Cristal) southward (Sierra Maestra).
2. The limestone cliffs are considered to be the cradle of the southern Oriente xerotherm flora which, in the Quaternary, moved both to the west and towards the terraced coastal area. The existence of these floristic relationships is best shown by the distribution of the vicarious species of *Gesneria, Eupatorium* and *Siphocampylus*.

District C.1.5. Sierra del Purial, Yunque de Baracoa and the Gran Tierra Plateau (Purialense) (Fig. 224)

Geography: Diversified mountainous area. Sierra del Purial is a deeply inclined range up to 1100 m altitude, Gran Tierra is a "meseta" area. Quite different are the mogotes west of the Yumuri Valley and the anvil-shaped Yunque de Baracoa monadnock (Fig. 241) consisting of limestone and dolomite. Tropical brown soils predominate in the Sierra del Purial and Yunque. In some elevated places yellowish red montane soils occur. In the limestone area of Gran Tierra and Yumuri humic-carbonated soils are the most common.

Climate: Characterized by sudden changes along the gradient. There is hardly any transition between the bixeric climate of two dry seasons (3—4 dry months), the wet tropical and the montane rainforest climate. In the northeast a particular tropical seasonal climate occurs which is dry in the summer. Annual precipitation 1000—2200 mm (Fig. 242).

Flora: The flora of Sierra del Purial and Sierra de Imias is little investigated so that only few endemics have been known (*Senecio saugetii, Croton tropidophyllus, Scolosanthus wrightianus, Phialanthus parvifolius, Ph. macrostemon, Ardisia baracoënsis* and *Platygyne leonis*) but the discovery of others is expected. A single endemic genus, *Bembicidium,* and several endemic species, e.g., *Callicarpa areolata, Gesneria gibberosa, G. yumuriensis* (Fig. 243), *G. purpurascens, Victorinia regina, Siphocampylus yumuriensis* (Fig. 244), *Spathelia yumuriensis* (Fig.

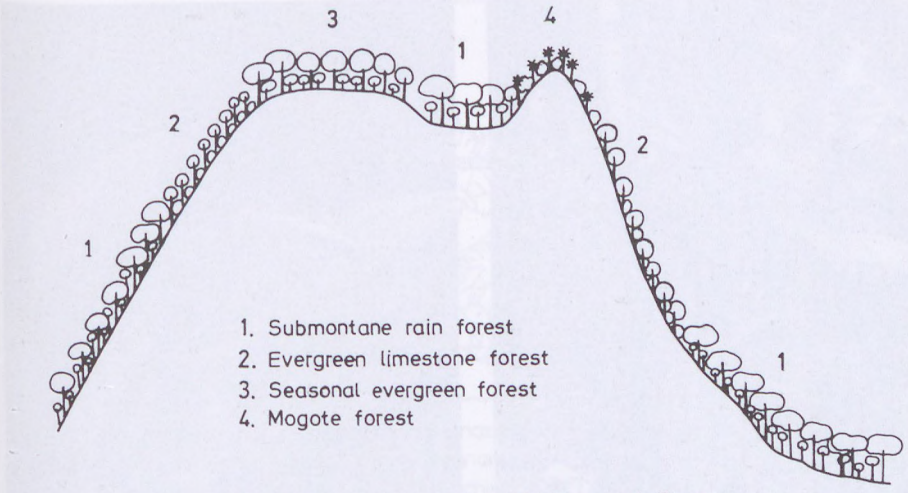


Fig. 241 Vegetation transect of the Yunque de Baracoa

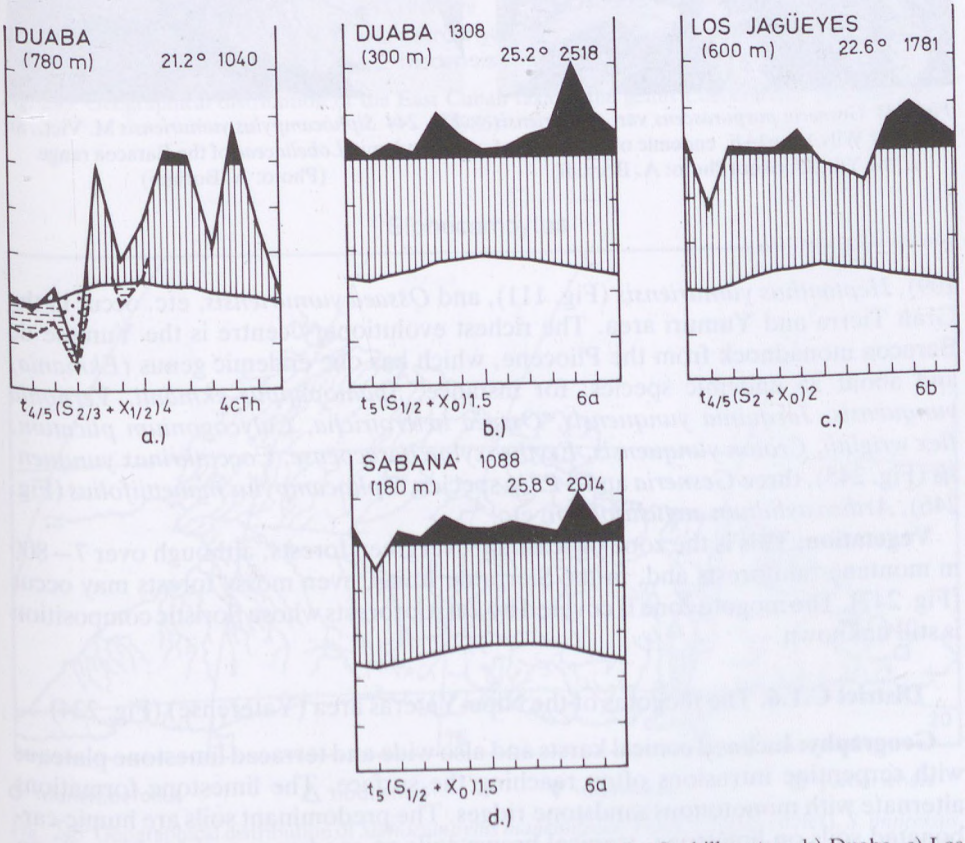


Fig. 242 Characteristic climate types of the Sierra de Imias and the Cuchillas at a—b) Duaba, c) Los Jagüeyes and d) Sabana



Fig. 243 Gesneria purpurascens var. *yumuriensis* (Britt. et Wils.) Borhidi, endemic of the gorge of the Yumuri river (Photo: A. Borhidi)



Fig. 244 Siphocampylus yumuriensis M. Vict., an endemic *Lobeliaceae* of the Baracoa range (Photo: A. Borhidi)

109), *Heptanthus yumuriensis* (Fig. 111), and *Ossaea yumuriensis,* etc. occur in the Gran Tierra and Yumuri area. The richest evolutionary centre is the Yunque de Baracoa monadnock from the Pliocene, which has one endemic genus *(Ekmania)* and about 25 endemic species, for instance, *Spaniopappus ekmanii, Vernonia yunquensis, Jacquinia yunquensis, Ossaea heterotricha, Calycogonium plicatum, Ilex wrightii, Croton yunquensis, Erythroxylon baracoënse, Coccothrinax yunquensis* (Fig. 245), three *Gesneria* and 5 *Pilea* species, *Siphocampylus manettiifolius* (Fig. 246), *Arthrostylidium angustifolium,* etc.

Vegetation: This is the zone of seasonal evergreen forests, although over 7—800 m montane rainforests and, in the Sierra de Imias, even mossy forests may occur (Fig. 247). The mogote zone is covered by karstic forests whose floristic composition is still unknown.

District C.1.6. The mogotes of the Nipe-Yateras area (Yaterense) (Fig. 224)

Geography: Inclined conical karsts and also wide and terraced limestone plateaus with serpentine intrusions often reaching the surface. The limestone formations alternate with monotonous sandstone ridges. The predominant soils are humic-carbonated soils on limestone, tropical brown soils on sandstone and ferritic soils on serpentine.

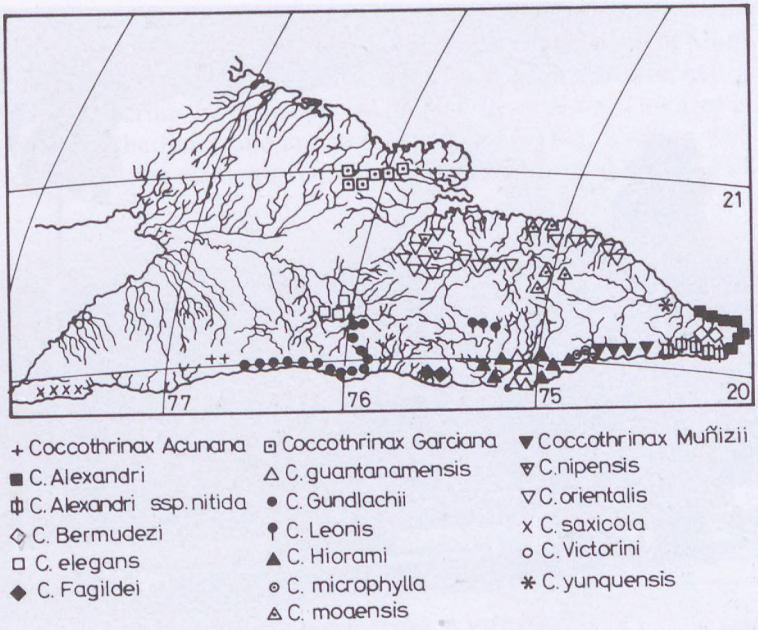


Fig. 245 Geographical distribution of the East Cuban taxa of the genus *Coccothrinax* (Borhidi 1973, 1986)

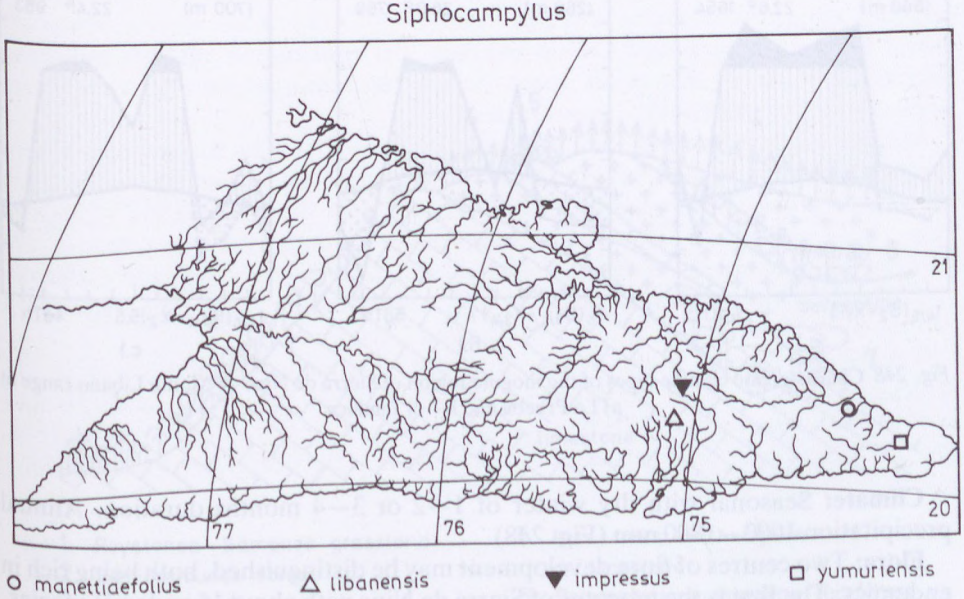


Fig. 246 Geographical distribution of *Siphocampylus manettiifolius* Hook.f. (open circles), *S. impressus* Urb. (full triangle) and *S. libanensis* Urb. (triangles) and *S. yumuriensis* (squares) (Marie-Victorin 1942, modified)



Fig. 247 The Sierra de Imias covered by clouds above 800 m a.s.l. (Photo: A. Borhidi)

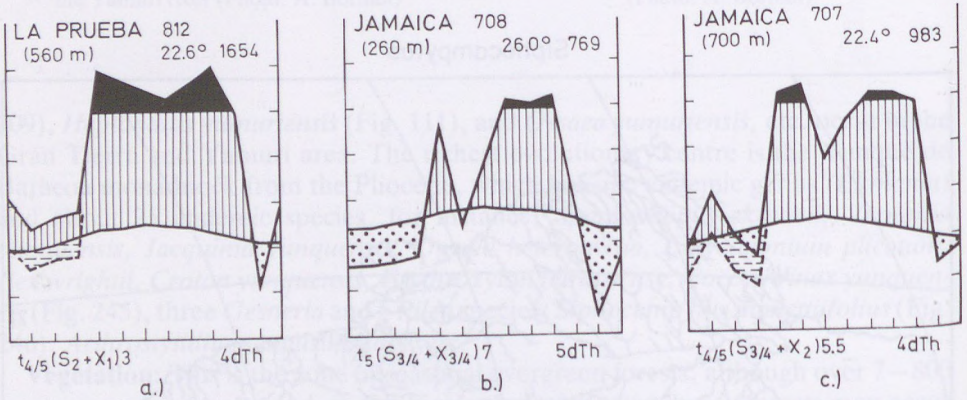


Fig. 248 Characteristic climate types of the mogote region of Sierra de Nipe — Monte Libano range at a) La Prueba and b—c) Jamaica

Climate: Seasonal with dry winter of 1—2 or 3—4 months duration. Annual precipitation 1000—1800 mm (Fig. 248).

Flora: Two centres of flora development may be distinguished, both being rich in endemics. The first is the mogotes of Sierra de Nipe with about 15 endemic species, such as *Thrinax compacta* (Fig. 114), *Spathelia lobulata* (Fig. 109), *Plinia ramosissima, Calyptranthes paradoxa, Eugenia bayatensis, E. excisa, Hydrocotyle*

oligantha, Matelea bayatensis, Tabebuia picotensis, T. mogotensis, Gesneria lopezii (Fig. 249) and *Isidorea polyneura*. The other centre is the group of Monte Libano, Monte Verde and Monte Cristo which must have been the principal junction of migratory routes during the development of the Oriente flora. This area is still a rich meeting point of the limestone and serpentine floras (Fig. 250), as well as of the semi-desert xerotherm elements. On the soils derived from serpentine the range of

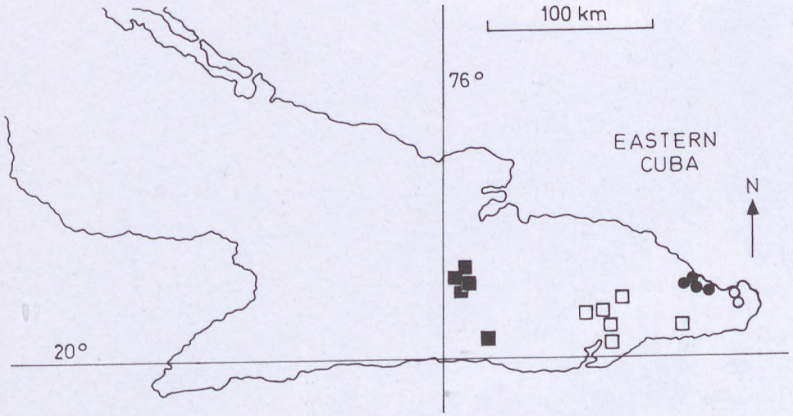
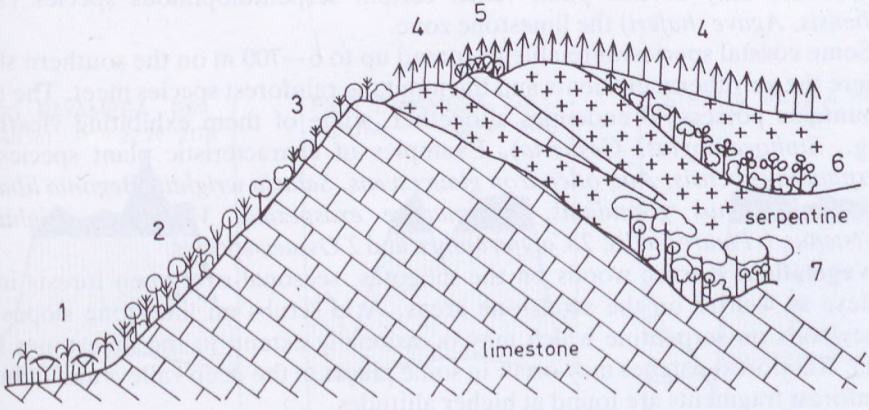


Fig. 249 Geographical distribution of *Gesneria purpurascens* Urb. full circles: var. *purpurascens*, open circles: var. *yumuriensis* and *Gesneria libanensis* Linden, — open squares: ssp. *libanensis*, full squares: ssp. *lopezii* (Morton) Borhidi (Skog 1976, modified)



1. Roystonea - Samanea grassland
2. Semideciduous forest
3. Mogote - forest
4. Pine - forest on serpentine
5. Pine - forest with Agave on limestone
6. Sclerophyllous montane rainforest
7. Submontane rainforest

Fig. 250 Vegetation transect of the Montane Libano



Fig. 251 The montane pine woodland of the Monte Libano above Guantanamo (Photo: A. Borhidi)

many species of Nipe and Cristal overlaps the distribution of Moa elements. Moreover, only at this point reach certain serpentinophilous species *(Pinus cubensis, Agave shaferi)* the limestone zone.

Some coastal species were able to spread up to 6—700 m on the southern slopes where the xerotherm elements and the montane rainforest species meet. The three mountains possess 40 endemics altogether, some of them exhibiting vicariance (e.g., *Siphocampylus, Gesneria*). Examples of characteristic plant species are *Hernandia cubensis, Auerodendron glaucescens, Salacia wrightii, Begonia libanensis, Scolosanthus granulatus, Spermacoce exasperata, Verbesina wrightii,* 3 *Dorstenia,* 6 *Pleurothallis,* 2 *Calyptranthes* and 2 *Ossaea* species.

Vegetation: Karstic woods on the mogotes, seasonal evergreen forests in the valleys as well as on the sandstone areas. Arid scrubs on limestone slopes and pinewoods on serpentine which may occasionally extend to the limestones (Fig. 251). Rainforest patches may occur in some places in the deep valleys and montane rainforest fragments are found at higher altitudes.

Sector C.2. Sierra Maestra (Maestricum) (Fig. 224)

The 250 km long and 15—20 km vide Sierra maestra is almost 750 m higher than the ancient Sagua-Baracoa Massif from which its flora originated. As a result of this altitude difference and of the presence of rocks more effectively enhancing the

moist climate (limestone, sandstone, granite, grano-diorite and diorite), a wide montane rainforest and cloud forest belt developed, in which the ancient Sagua-Baracoa flora enriched in Jamaican and Hispaniolan elements, may have become a new evolutionary centre. This spontaneously formed secondary centre is characterized by two endemic genera (*Solonia* and *Cubacroton*) and 155 endemic species, for example, *Cneorum trimerum* (Fig. 125), (ancient relict!), *Pinus maestrensis* (Fig. 89), *Laplacea urbani, Cleyera ekmanii, Persea anomala, Pithecellobium maestrense, Platygyne dentata* (Fig. 115), *Pera microcarpa, Sapium maestrense, Cubacroton maestrensis, Maytenus saxicola, Crossopetalum spathulifolium, Karwinskia bicolor, Cinnamodendron cubense, Talauma orbiculata, T. truncata, Scolosanthus maestrensis, Cordia longipedunculata, Solanum maestrense, Tabebuia oligolepis, T. hypoleuca, Justicia maestrensis, Peratanthe cubensis, Schradera cubensis,* 9 *Eugenia,* 6 *Miconia,* 6 *Ossaea,* 5 *Gesneria,* 5 *Eupatorium* and 6 *Rondeletia* species. The boundary of this sector runs at 300—400 m on the slopes in the south, and at the margin of the Cauto Basin in the north.

District C.2.1. The western and central Maestra (Turquinense) (Fig. 224)

Geography: This area extends from Pilón to the Santiago Valley and includes two higher mountainous groups (Turquino and La Bayamesa), whose highest points are over 1500 m. These mountains comprise, deeply inclined sharp ridges and conical formations so that the superficial drainage ratio is high (35—50 l/sec. km^{-2}) and the erosion is intensive. Tropical brown soils occur at medium elevation, up to 600 m and then yellowish red montane soils are found up to 1300 m. Next, up to 1750 m yellowish brown montane soils become predominant, these are replaced by brown montane soils on the peaks. The northern slopes are covered by yellow montane soils over 1300 m.

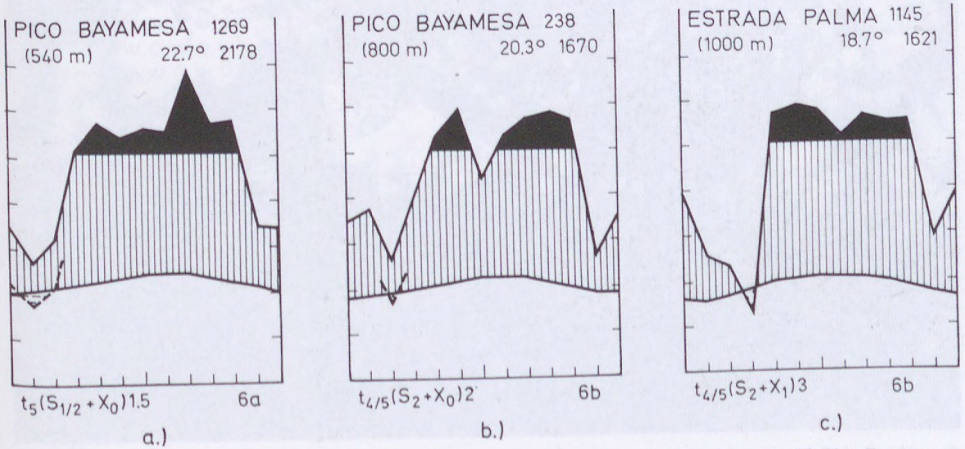


Fig. 252 Characteristic climate types of the western range of the Sierra Maestra at a—b) Pico Bayamesa and c) Estrada Palma

Climate: Seasonal with dry winter. 3—4 dry months at the foothills, 1—2 dry months up to 800 m. Further up there is a moist montane rainforest climate which is replaced by a humid, high-altitude temperate rainforest climate at 1700 m. The annual precipitation ranges from 800 to 3000 mm (Fig. 252).

Flora: Besides the characteristic endemics listed in section C.2., there are numerous regional endemic species of mossy forests in this district. For example, *Myrsine microphylla, Nectandra reticularis, Eupatorium paucibracteatum, E. praestans, Henriettea ekmanii, Hedyosmum cubense* (Fig. 138), *Ossaea turquinensis, Rondeletia naguensis, Myrica cacuminis, Rubus turquinensis* (Fig. 253), *Symplocos leonis, Sapium erythrococcum, Eugenia maestrensis,* and *E. laeteviridis,* etc. In addition, local endemics have been found in several mountain groups and valleys: Nagua has 4 endemics *Citharexylum ternatum, Tabebuia elongata, Eugenia naguana* and *Polygala rhynchosperma*, Pico Caracas is famous for the remarkable palaeoendemism *Cneorum trimerum* and the *Podocarpus* woods; (Rio Guamá, Hacienda Sevilla, Nima-nima, El Cuero, Rio Yara, Yao Arriba, Pico Joaquin, and Loma Regino possess one-two endemics each, whereas in Pico Bayamesa 4 local endemics



Fig. 253 A local endemic of the highest summits of the Maestra range: *Rubus turquinensis* Rydb. (Photo: A. Borhidi)

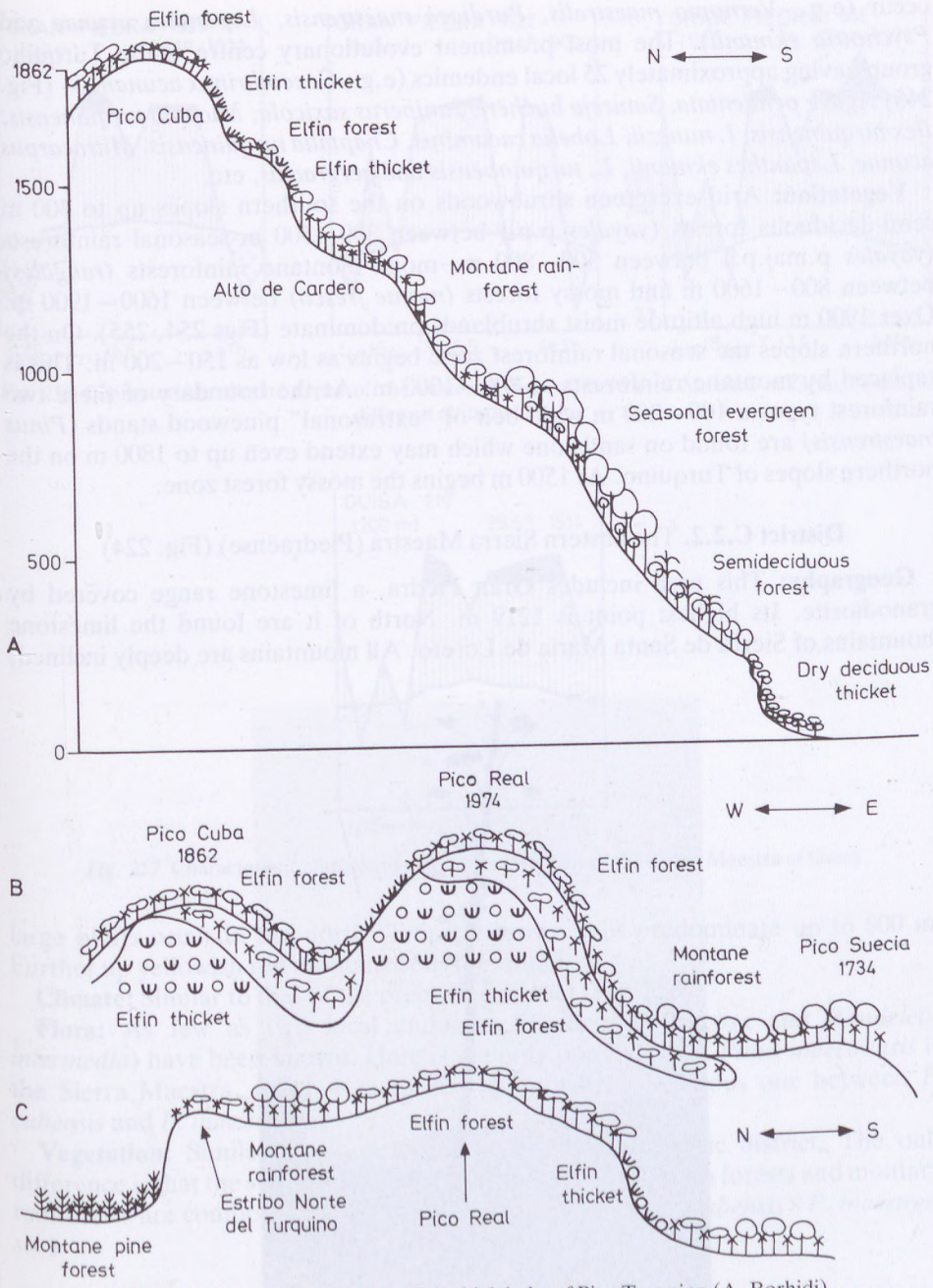


Fig. 254 Vegetation transects of the high belts of Pico Turquino (A. Borhidi)

occur (e.g., *Vernonia maestralis, Purdiaea maestrensis, Lepanthes acunae* and *Psychotria ekmanii*). The most prominent evolutionary centre is the Turquino group having approximately 25 local endemics (e.g., *Coccothrinax acunana* – (Fig. 245) *Agave pendentata, Satureja bucheri, Juniperus saxicola, Miconia turquinensis, Ilex turquinensis, I. nunezii, Lobelia cacuminis, Chaptalia turquinensis, Mitracarpus acunae, Lepanthes ekmanii, L. turquinoënsis* and *pergracilis*, etc.

Vegetation: Arid evergreen shrubwoods on the southern slopes up to 300 m semi-deciduous forests (*yayales* p.p.) between 300—500 m seasonal rainforests (*yayales* p.maj.p.) between 500—800 m. moist montane rainforests *(rangales)* between 800—1600 m and mossy forests *(monte fresco)* between 1600—1900 m. Over 1900 m high altitude moist shrublands predominate (Figs 254, 255). On the northern slopes the seasonal rainforest zone begins as low as 150—200 m. This is replaced by montane rainforests at 800—1000 m. At the boundary of these two rainforest types a 100—200 m wide belt of "extrazonal" pinewood stands *(Pinus maestrensis)* are found on sandstone which may extend even up to 1800 m on the northern slopes of Turquino. At 1500 m begins the mossy forest zone.

District C.2.2. The eastern Sierra Maestra (Piedraënse) (Fig. 224)

Geography: This area includes Gran Piedra, a limestone range covered by granodiorite. Its highest point is 1219 m. North of it are found the limestone mountains of Sierra de Santa Maria de Loreto. All mountains are deeply inclined,



Fig. 255 Agave pendentata, Lyonia leonis, Ilex turquinensis Miconia turquinensis Chusquea abietifolia and *Mitracarpus acunae* are the characteristic elements of the elfin thicket of the Turquino Peak at 1990 m a.s.l. (Photo: A. Borhidi)

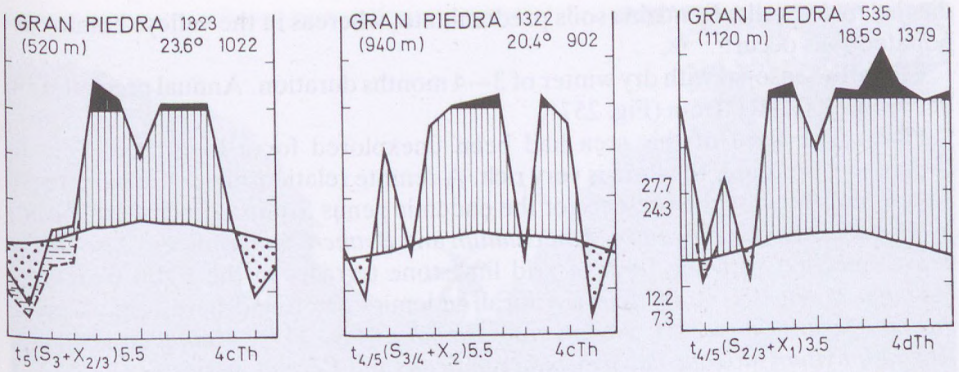


Fig. 256 Characteristic climate types of the eastern range of the Sierra Maestra at Gran Piedra in different altitudinal belts

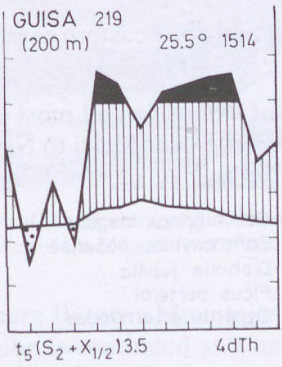


Fig. 257 Characteristic climate type of the mogote belt of the Sierra Maestra at Guisa

large bluffs occur in the north. Tropical brown soils predominate up to 800 m. Further up yellowish red montane soils are found.

Climate: Similar to that of the preceding district (Fig. 256).

Flora: As few as two local endemics (*Callicarpa floccosa* and *Rondeletia intermedia*) have been known. Here is the only population of *Pinus maestrensis* in the Sierra Maestra, which is supposed to be a hybridogenous one between *P. cubensis* and *P. maestrensis*.

Vegetation: Similar zonation as in the preceding floristic district. The only difference is that the stands enclosed by the seasonal evergreen forests and montane rainforests are composed of *Pinus maestrensis* (or rather *P. cubensis*×*P. maestrensis*.)

District C.2.3. The mogotes of Baire, northern Sierra Maestra (Bairense) (Fig. 224)

Geography: These karsts are found within the Charco Redondo–Los Monos–Matias–Los Negros quadrangle. Conical hills of 400—600 m height with perpen-

dicular rocky walls. Rendzina soils predominate, whereas in the valleys humic-carbonated soils occur.

Climate: Seasonal with dry winter of 3—4 months duration. Annual precipitation between 1200—1600 mm (Fig. 257).

Flora: The flora of this area had been unexplored for a long time. Due to geographic isolation, the flora is very rich. A remote relationship to the mogotes of Nipe is indicated by the presence of the endemic genus *Synapsis* and of *Siphocampylus undulatus, Clerodendron denticulatum* and *Byttneria microphylla.* Also, there is a connection with the flora of arid limestone terraces in the Cabo Cruz area (*Catalpa brevipes*). More than ten local endemics are found here, e.g., *Coccothrinax elegans (Fig. 245), Neobracea susannina* (Fig. 117), *Malpighia acunana, Rhytidophyllum mogoticola, Tabebuia candicans* and *Pilea uninervis.*

Vegetation: Semi-deciduous forests with Coccothrinax palms, cacti and agaves predominating in the mogotes. Seasonal evergreen forests occur in the valleys. (Figs 258—260)

Sector: C.3. The southern and northeastern coasts of Oriente (Santiagicum) (Fig. 224)

This sector includes the most extensive and most extremely arid zone of Cuba: the area extending from Cabo Cruz over Maisi to Navas in the rain shadow of the

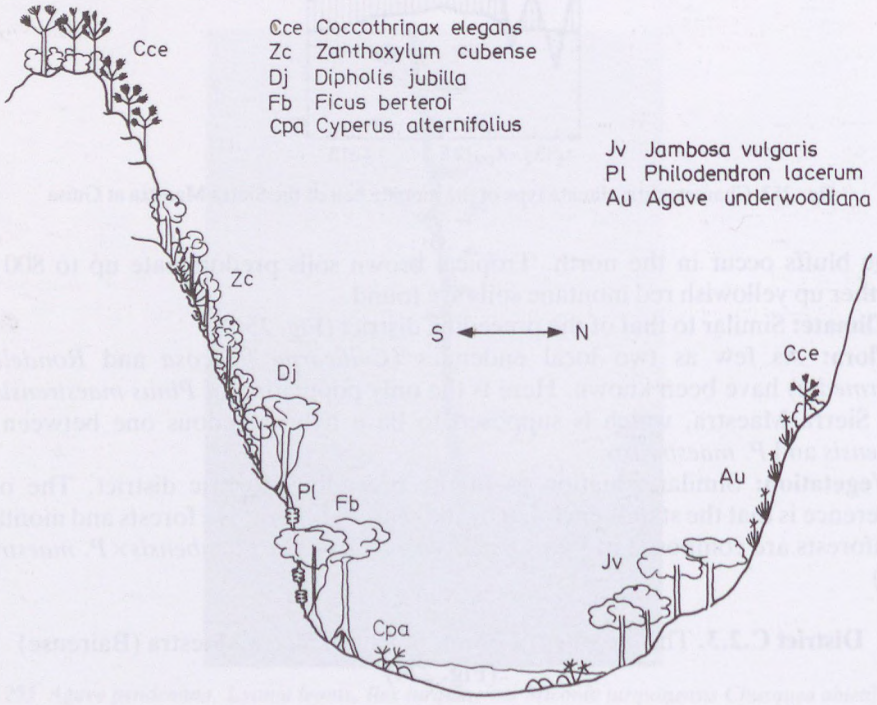


Fig. 258 Vegetation transect of the mogote formation in the valley of Rio Mogote at Matias (Borhidi and Muñiz)



Fig. 259 An almost unknown sector of the Maestra range: the mogote-region between Baire and La Tabla; the valley of the Mogote river (Photo: A. Borhidi)

Sierra Maestra and the southern Baracoa Mountains which are mainly responsible for the dry climate. This region is continued as a narrow strip along the northern coast to Navas. The Sierra Canasta, the Guantanamo Basin, the southern slopes of Sierra Maestra up to about 200 m, and the terraces of southern Baracoa up to 300—400 m are also included. In the Monte Libano group some coastal elements managed to reach 700 m altitude. This area is an old coastal land with an eventful geological past. During millions of years sections of this land rose and sunk, became separated and joined again at different points of time, resulting in several evolutionary centres of the flora. Therefore, the common species of this sector are mostly widely distributed xerophilous species, such as *Dendrocereus nudiflorus* (Fig. 261), *Lemairocereus hystrix, Cordia taylori, Pseudocarpidium avicennioides, Croton rosmarinoides, C. myricifolius* and *C. litoralis.* There is one monospecific endemic genus: *Caribaea,* and about 110 endemic species, most of them being confined to a given locality or a floristic district. The number of endemics found throughout the sector is relatively small (e.g., *Guettarda cueroensis, G. coxiana, Galactia cuneata, Consolea macracantha, Myrtus conophylla, Cordia leucosebestena, C. leptoclada, Lantana parvifolia, Callicarpa grisebachii, C. bucheri, Pseudocarpidium multidens, Spirotecoma spiralis, Eupatorium helianthemoides, Vernonia complicata, Gochnatia calcicola, Bonania elliptica, Croton micradenus, C. munizii* etc. The vicarious *Melocactus* species and *Coccothrinax* palms (Fig 245) are also typical.



Fig. 260 Semi-deciduous and deciduous forest complex on the limestone karstic area of the Sierra Maestra, with *Swietenia, Zanthoxylum cubense, Tabebuia bibracteolata,* many climber, xerophytic epiphytes, *Agaves* and *Cactaceae* (Photo: A. Borhidi)



Fig. 261 Dendrocereus nudiflorus (Engelm.) Britt. et Rose a giant endemic tree-shaped cactus of Cuba up to 12 m high, occurring in the semi-desert thorn scrub vegetation of South East Oriente, near Jauco (Photo: A. Borhidi)

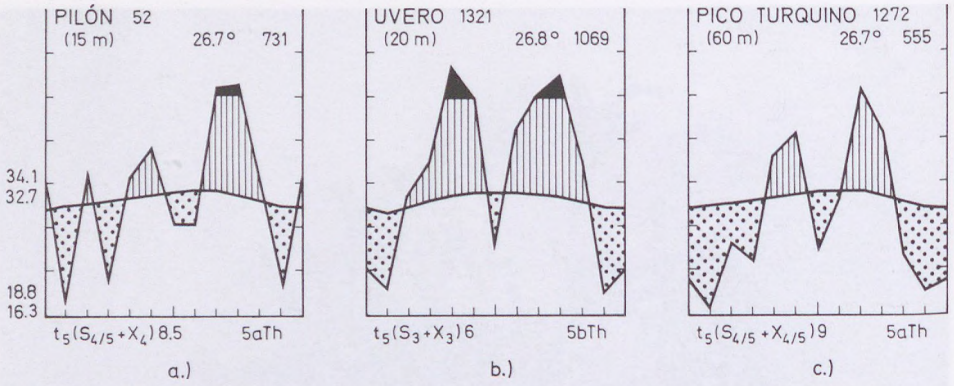


Fig. 262 Characteristic climate types of the coastal phytogeographical district Pilonense at a) Pilón and the western range of the Sierra Maestra, at b) Uvero and c) Pico Turquino

District C.3.1. The coastal and terraced land between Belic and Pilón (Pilonense) (Fig 224)

Geography: The Pliocene limestone cliffs, sometimes reaching 50 m height, the western end of Sierra Maestra having several terraced levels, and the plain at Pilón Bay with sedimentary origin from the Quaternary are included. Limestone rendzina and humic-carbonated soils predominate in the first two. The plain is covered by tropical alluvial soils.

Climate: Seasonal bixeric with two dry seasons of 7—8 or 5—6 months duration. Annual precipitation is 700—1200 mm. At higher altitudes 3—4 dry months, all in the winter, and 1000—1400 mm annual precipitation (Fig. 262).

Flora: Fairly isolated from that of the other districts in the sector. It is characterized by the low number of regional endemics and by many local endemic species with several centres of flora development. For example, Media Luna (*Coccothrinax victorini* (Fig. 245)), Niquero *(Copernicia humicola, Cassia niqueroensis, Chamaesyce niqueroana),* Cabo Cruz (*Cordia corallicola, C. dumosa, Eugenia peninsularis, E. aceitillo, Amyris polymorpha, Croton corallicola, Rondeletia peninsularis, Coccothrinax saxicola* (Fig. 245) and *Portulaca tuberculata*) and Pilón *(Chaptalia comptonioides, Justicia agria, Belairia parvifolia, Pilea cowellii, P. carnosa, Begonia cowelli, Leptocereus sylvestris).* There is a certain relationship to the flora of the mogotes of Baire as shown by the occurrence of *Catalpa brevipes.*

Vegetation: Arid evergreen shrublands in the coastal zone, dry evergreen forests in the lower terraces, and semi-deciduous forests higher up. The original vegetation of the plain was a tropical humid woodland.

District C.3.2. The coastal area between Marea del Portillo and Nima-nima (Uveroënse Fig. 224)

Geography: Narrow and mostly rocky coasts along the western part of Sierra Maestra. Gravely and sandy beaches at the estuaries, and the lower parts of the

slopes exposed to the south. Rendzina and humic carbonated soils are usual, whereas tropical brown soils occur in the valleys.

Climate: Evenly warm bixeric climate with two dry seasons of a total of 5—6 months duration. Annual rainfall 800—1200 mm (Fig. 262b—c).

Flora: Very little studied. Probably several evolutionary centres could be detected here. *Rhytidophyllum minus* is an endemic in common with the preceding district, and some local endemic species, e.g. *Tabebuia acunana, Rondeletia sevillensis, Erigeron taylori, Pilea sevillensis, Melocactus nagyii* (Fig. 265) characterize the area. There is also an endemic palm, common with the Sierra Maestra, is *Coccothrinax gundlachii* (Fig. 245).

Vegetation: Microphyllous evergreen shrublands, dry evergreen forests with deciduous elements, and locally, mangroves in the estuaries and the gravelly coastal depressions.

District C.3.3. Coastal belt and terraces between Santiago de Cuba-Guantánamo-Maisi and Baracoa (Guantanamense) (Fig. 224)

Geography: High cliffs and low limestone terraces with small inlets and coastal plains. Rendzina and cinnamon-coloured humic carbonated soils predominate. Also the plain in the Guantánamo Basin covered partly by brown humic carbonated soils. The district includes the southern coasts at the foots of the Gran Piedra range, the Gauntánamo Basin with Sierra de Canasta, the coasts and terraces from



Fig. 263 The famous series of the limestone terraces consisting of seven in the southern slopes of Monte Cristo, near Jauco, south-east Oriente (Photo: A. Borhidi)

Guantánamo to Maisi up to an elevation of 400 m, and the northern Baracoa shores between Maisi and Navas (Fig. 263).

Climate: Evenly warm seasonal bixeric climate with two dry seasons (5—8 dry months) and annual precipitation totalling 600—1100 mm. Semi-desert climate with 9—10 dry months and 300—600 mm annual rainfall appears in the rain shadow of the Sierra de Puriales and Sierra de Imias, south and east of Guantánamo ranging eastward to Jauco. Between Maisi and Baracoa seasonal climate with short summer dry period is characteristic (Figs 264).

Flora: Very rich and diverse xerothermophilous flora, with several small areas characterized by local endemics. A single monospecific endemic genus is *Caribaea* (Nyctaginaceae), a particular littoral cushion plant with very restricted area. A great number of regional endemic species occur also, as *Coccothrinax alexandri* s.l. *C. hiorami, C. munizii* (Fig. 245), *Rhytidophyllum acunae, Melocactus acunai* (Fig. 265—266), *Caesalpinia pinnata, Passiflora santiagana, Castela victorini, Consolea macracantha, Rondeletia apiculata, Tabebuia libanensis* (Fig. 267), *Reynosia mucronata* ssp. *azulensis* (Fig. 119), *Maytenus buxifolia* ssp. *cochlearifolia* (Fig. 118). The area abounds in very important local evolutionary centres wuth 80 endemic taxa altogether. Local endemic species are at Santiago de Cuba: *Rondeletia*

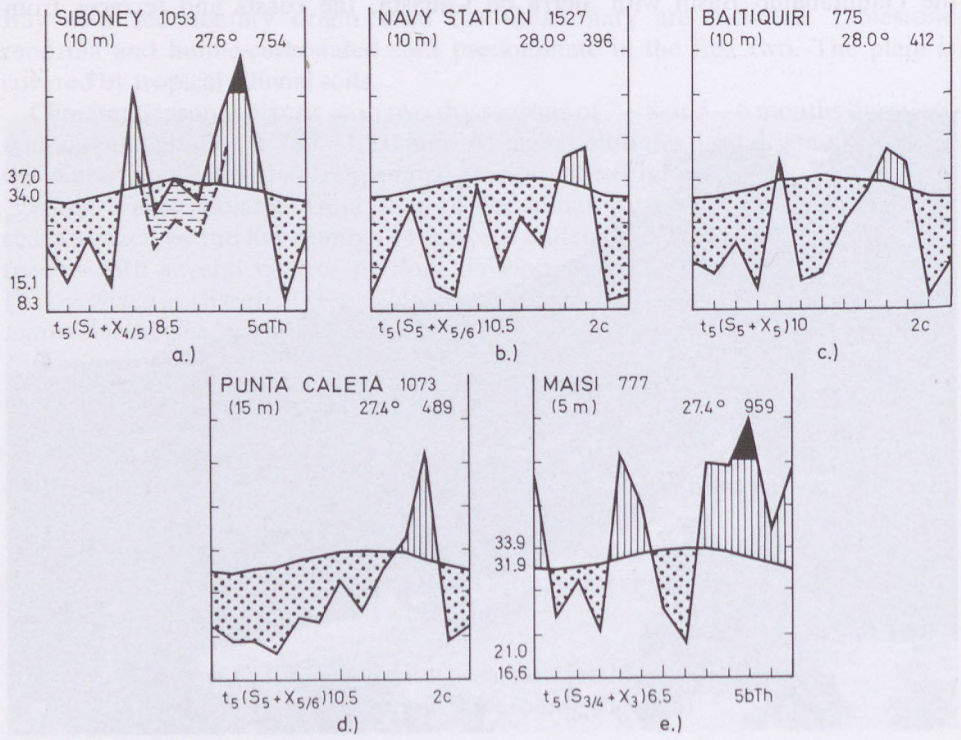


Fig. 264 Characteristic climate types of the coastal phytogeographic district Guantanamense between Santiago and Maisi at a) Siboney, b) Navy Station, c) Baitiquiri, d) Punta Caleta and e) Maisi

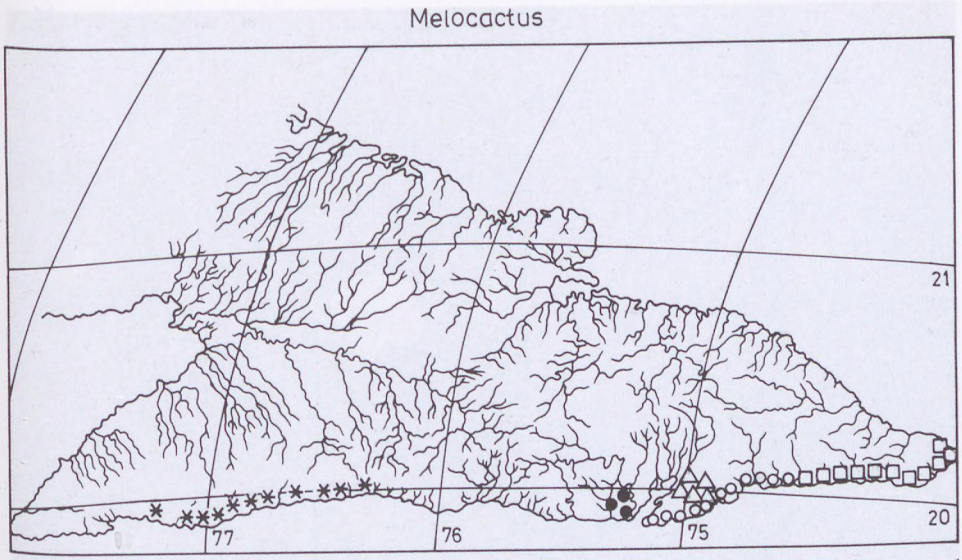


Fig. 265 Geographical distribution of *Melocactus evae* Mészáros (full circles), *M. harlowii* Britton and Rose (open circles), *M. borhidii* Mészáros (triangles) *M. acunai* León (squares) and *M. nagyii* (asterisks) (Mészáros, 1977)

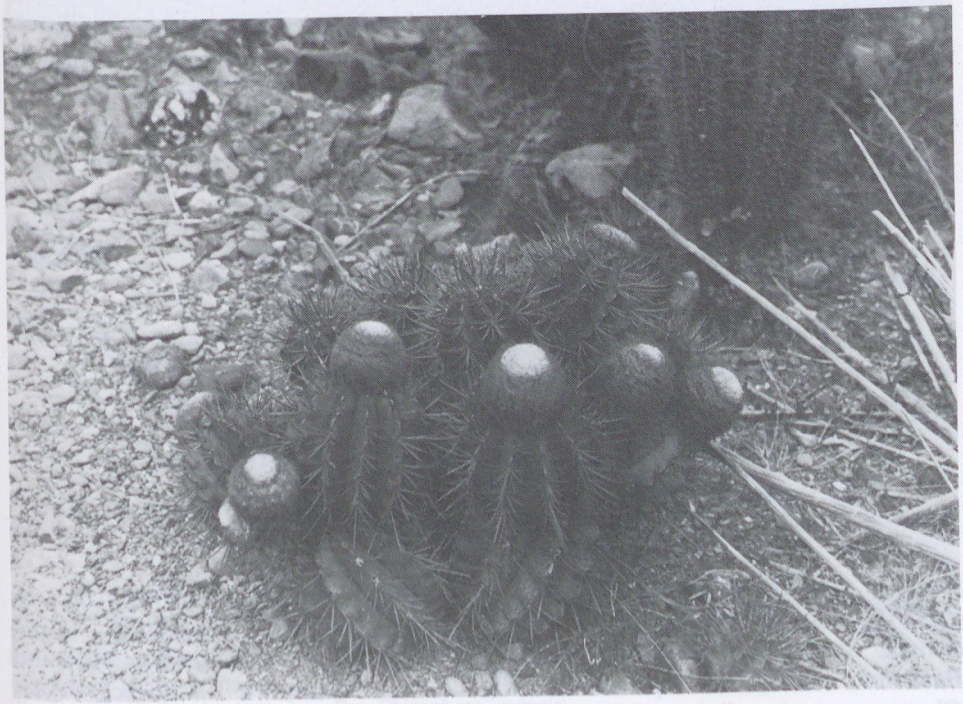


Fig. 266 A well-developed example of *Melocactus acunai* León, a species endemic to the coastal limestone karsts between San Antonio del Sur and Maisi (Photo: A. Borhidi)



Fig. 267 Tabebuia libanensis Urb. a leptophyllous dwarf shrub of the dry limestone areas from the mogotes of the Nipe Mountains to the southern subcoastal karstic terraces of Maisi (Photo: A. Borhidi)

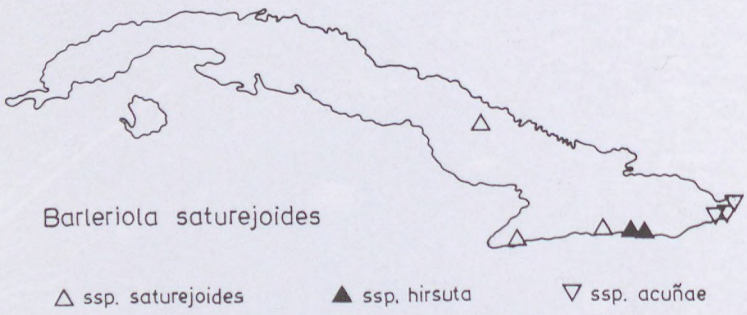


Fig. 268 Geographical distribution of *Barleriola saturejoides* (Acanthaceae) (Borhidi 1973)

norlindii, Acacia cowellii, Caesalpinia subglauca, Eugenia amblyophylla, E. itephylla, Lasiocroton gracilis and *Tephrosia clementis;* at Aguadores: *Nashia armata, Rochefortia oblongata,* at Siboney: *Neobracea martiana* (Fig. 117) and *Barleriola saturejoides* ssp. *hirsuta* (Fig. 268): at Daiquiri: *Cassia scleroxyla, Chamaesyce microclada* and *Coccothrinax fagildei* (Fig. 245); at Baconao: *Justicia maestrensis, Jacquinia verticillaris* and *Machaonia urbaniana* (Fig. 192) occur.

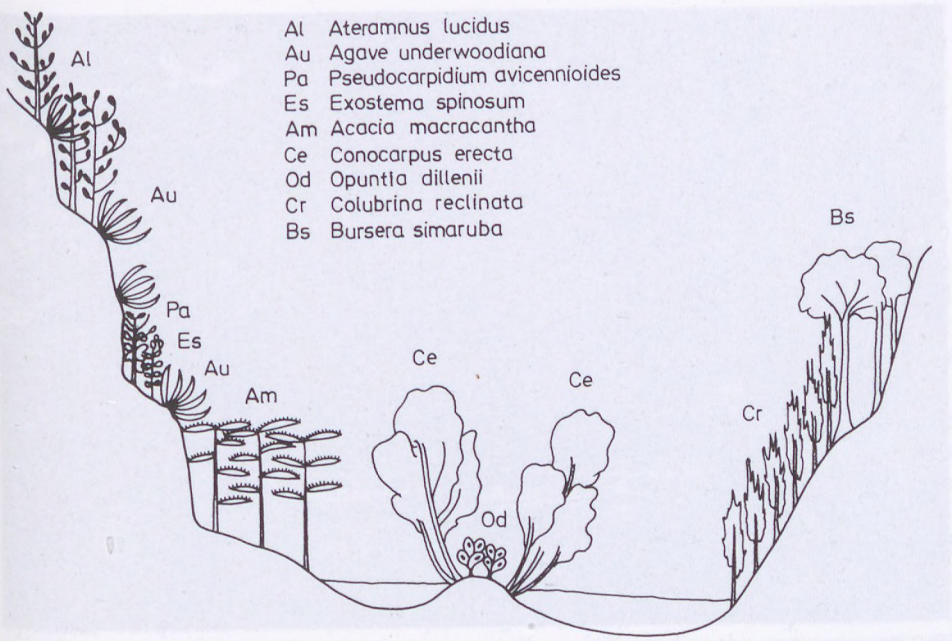


Fig. 269 Vegetation transect of the limestone terraces in the mouth of Rio Juan at Aguadores (Borhidi and Muñiz)

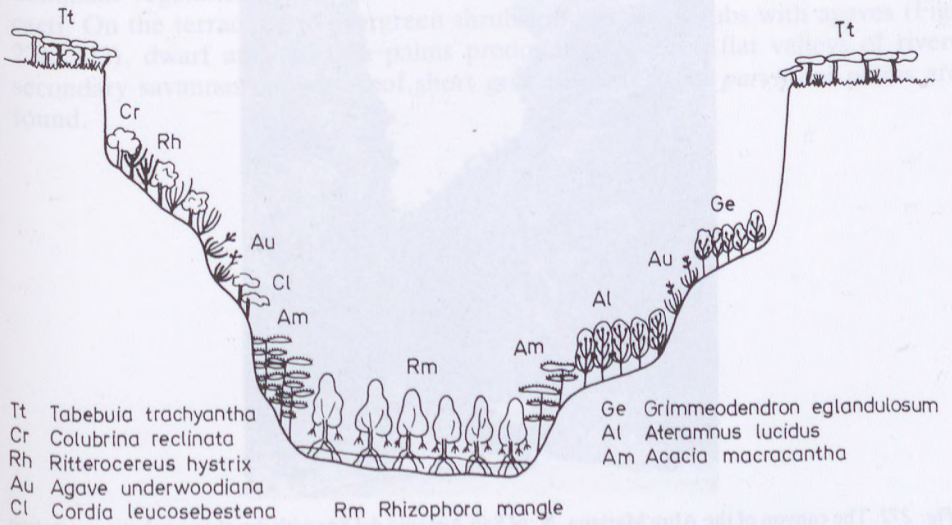


Fig. 270 Vegetation transect of the limestone terraces at Siboney (Borhidi and Muñiz)



Fig. 271 Sclerophyllous scrub forest on the limestone terraces of the mouth of San Juan river at Aguadores, Santiago de Cuba (Photo: A. Borhidi)



Fig. 272 The canyon of the Abra Mariana, N. of San Antonio del Sur with dry chasmophytic vegetation dominated by *Agave albescens* Trel. (Photo: A. Borhidi)

Fifteen local endemics live around Guantánamo, e.g. *Coccothrinax guantanamensis* (Fig. 245), *Andrachne brittonii, Croton excisus, Colubrina obtusata, Opuntia militaris, Melocactus evae* (Fig. 265), *Myrtus nummularioides* and *Geophila multiflora.* Between Guantánamo and Macambo *Agave albescens, Casearia comocladifolia, Thouinia leonis, Stigmaphyllum coccolobaefolium, Coccothrinax microphylla* (Fig. 245), *Scolosanthus strictus* occur; at Macambo *Caribaea littoralis, Drymaria glandulosa,* and *Apassalus parvulus* are local endemics, whereas between Cajobabo and Jauco, *Pheidonocarpa cubensis, Gyminda orbicularis, Isidorea rheedioides, Tabebuia jaucoensis, Micromeria suborbicularis, Barleriola saturejoides* ssp. *acunae* (Fig. 268), *Scolosanthus hirsutus* are found. Additional 15—20 endemics are known from the Maisi Plain and the surrounding terraces, for example, *Isidorea leonis, Pseudocarpidium shaferi, Cnidoscolus matosii, Acacia seifriziana, Tabebuia leonis, Duranta arida, Harpalyce maisiana, Galactia maisiana, Jacquinia maisiana, Scolosanthus hispidus* and *S. maisianus.* On the young serpentine outcrops around the langune of the Jojó Valley some local neoendemics such as *Rondeletia ingrata* and *Melocactus acunai* ssp. *lagunaënsis* (Fig. 265) are to be found.

The role of xerotherm elements that are also found in Hispaniola is increased (e.g. *Coccothrinax fragrans* (Fig. 245), *Pithecellobium oppositifolium, Bellonia spinosa, Jacquinia berterii, Caesalpinia glandulosa, Exostema spinosum* etc.) Floristic relations with Hispaniola is especially manifested at the easternmost part of the south-east coast of Oriente around Maisi, where some common species of Cuba and Hispaniola with very districted areas occur, as *Omphalea commutata, Petitia urbanii,* (Fig. 135) *Victorinia regina* etc.

Vegetation: Microphyllous evergreen and deciduous shrubwoods and shrublands (Figs 269, 270). Open shrublands with cacti in the understorey and semi-desert scrubs with columnar cacti occur in many areas. Eastward of Guantánamo the dominant vegetation type is the semi-desert scrub with tree-shaped or columnar cacti. On the terraces arid evergreen shrubwoods, open scrubs with agaves (Figs 271, 272), dwarf and tall thin palms predominate. In the flat valleys of rivers secondary savannas composed of short grasses, with *Sabal parviflora* palms are found.

PART V
THE VEGETATION MAP OF CUBA

PART V

THE VEGETATION MAP OF CUBA

22. The main vegetation types of Cuba

The vegetation map of Cuba has been prepared at a scale of 1 : 1 250 000. 37 different vegetational units are shown, these are primarily distinguished on physiognomic criteria, although floristic composition was also considered in case of karstic forests and pinewoods. Data for 267 relevés taken in 40 different cenological noda representing 22 of the 37 units shown in the map are given in Table 25a and b. (see Appendix) In the sequel the principal structural, floristic, ecological and chorological features of the mapped units will be discussed in brief.

22.1. Rainforests

22.1.1 Submontane rainforests *(Calophyllo–Carapetum guianensis)* (Table 25, col. 19)

Forests with three canopy layers occurring on yellowish red mountain soils in the Moa Mts. and in the Toa, Jaguani and Duaba Basins where precipitation is more than 2500 mm and is evenly distributed over the year. The upper canopy layer is 30—35 m high, almost completely closed. As in the Mora forests of Trinidad (Beard 1946*b*), this layer is composed of a single species, which in Cuba is *Carapa guianensis* (Fig. 273). It is very rarely mingled with some exceptionally tall specimens of second level constituents. The plank buttresses of *Carapa guianensis* are frequently entwined by the aerial roots of the strangler *Clusia rosea.* (Fig. 274). The fully closed middle layer is 20—25 m high, and is composed of numerous tree species, whose leaves are mostly mesophylls. Permanent elements are *Calophyllum utile, Sloanea curatellifolia, Dipholis jubilla, Guarea guidonia, Cupania americana, Buchenavia capitata, Ficus wrightii,* and *Roystonea regia.* Of the montane elements *Ocotea leucoxylon* and *Phoebe montana* are mentioned. *Cecropia peltata, Didymopanax morototoni* and *Ochroma pyramidalis* occur in the cleared habitats. Palms are commonly found between the second and third layers along creeks, e.g., *Bactris cubensis, Prestoea montana* and *Calyptronoma clementis* ssp. *orientensis.*

Such stands rich in palms are popularly referred to as "Manacales" (see León 1946: 61). The third canopy layer is 6—15 m high, and is only up to 50—60% closed.



Fig. 273 Structure profile of a submontane rainforest *(Calophyllo-Carapetum guianensis)* association in the valley of the Rió Jaguani, Sierra de Moa (Borhidi and Muñiz) Cg=*Carapa guianensis;* Cgl=*Cupania glabra;* Ca=*Cupania americana;* Cu=*Calophyllum utile;* Dm=*Didymopanax morototoni;* Cm=*Cedrela mexicana;* Fb=*Ficus berteroi;* Cs=*Cordia sulcata;* Me=*Miconia elata;* Gg=*Guarea guidonia;* Op=*Ochroma pyramidalis* Bc=*Buchenarvia capitata;* Bj=*Bumelia jubilla;* Car=*Cyathea araneosa;* Cr=*Clusia rosea;* Hc=*Heliconia caribaea;* Hh=*Hemitelia horrida;* Md=*Miconia dodecandra;* O=*Oxandra lanceolata;* Ol=*Oxandra laurifolia:* Rr=*Roystonea regia;* Sc=*Sloanea curatellifolia*

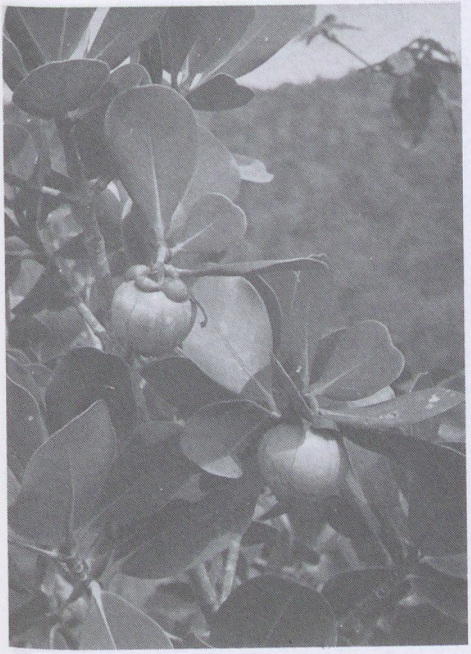


Fig. 274 Clusia rosea L. is one of the most common stranglers in all forest types of Cuba (Photo: A. Borhidi)



Fig. 275 Columnea tincta Griseb (Acanthaceae) a beautiful endemic epiphyte of the Moa range (Photo: A. Borhidi)

It is very rich in species, some characteristic elements being *Oxandra lanceolata, O. laurifolia,* and the large-leaved *Cordia sulcata, Miconia elata, M. dodecandra,* and tree ferns, such as *Cyathea araneosa* and *Hemitelia horrida.* The tree-sized herbaceous life-form is also typical *(Heliconia caribaea).* In the sparser shrub layer *Cassipourea elliptica,* Myrtaceae and Melastomataceae species are abundant. The herb layer is dominated by ferns, *Ichnanthus pallens, Scleria pilosissima* and *S. secans* in the moister places. Few macrophyllous lianes occur, e.g., *Omphalea diandra* and *Marcgravia evenia.* The double epiphyte layer is rich, the upper being dominated by flowering plants *Columnea tincta* (Fig. 275), *Psychotria guadelupensis, Hillia parasitica* (Fig. 276) *Maxillaria* species, *Laelia lyonsii, Reichenbachianthus emarginatus, Aechmea nudicaulis, Hohenbergia penduliflora, Guzmania monostachya* and *G. lingulata.* The lower epiphyte layer is composed primarily of ferns, e.g., *Elaphoglossum crinitum, Rhipidopteris peltata, Polypodium, Asplenium* and *Trichomanes* species, and *Lycopodium funiculum.* Forest communities with similar structure are the *Sloanea berteriana – Ormosia krugii* association described by Ciferri (1936) from Hispaniola, the *Dacryodes–Sloanea* community in Dominica (Beard 1949), also reported from Puerto Rico (Dansereau 1966) and Guadeloupe (Stehlé 1945) and the *Psidium montanum–Calophyllum jacquinii* community described from Jamaica by Asprey and Robbins (1953). Everywhere often transformed into coffee-plantages (Fig. 277)



Fig. 276 Hillia parasitica Jacq. *(Rubiaceae)* a common dicot epiphyte of the rainforest communities (Photo: A. Borhidi)

22.1.2 Wet montane rainforests *(Ocoteo–Magnolietalia)* (Table 25, cols 20—21)

This is the climax vegetation zone over 800 m altitude in Sierra Maestra, Escambray Mts and Sierra del Purial, and also in some mesoclimatic spots in Moa, Sierra del Cristal and Baracoa. Annual precipitation is 1700—3000 mm, distributed evenly over the year, the average temperature is 14—22 °C. Yellowish red ferrallitic soils and montane yellow allit-ferritic soils predominate. Two canopy layers can be recognized. These rainforests correspond to the „fangales" (León 1946) the "high open forests" (Seifriz 1943) and are called the "montane mist forests" in Jamaica (Asprey and Robbins 1953). They are 20—25 m high and have a closed upper layer consisting of microphylls and notophylls, e.g., *Magnolia cubensis, Ocotea cuneata, O. leucoxylon, O. floribunda, Myrsine coriacea,* and *Cyrilla racemiflora.* (Fig. 278) Characteristic trees in the second layer are *Clusia tetrastigma, Gomidesia lindeniana, Alchornea latifolia, Garrya fadyenii, Miconia punctata,* and *Ossaea ottoschmidtii,* and tree ferns, such as *Cyathea arborea, C. balanocarpa* and *C. cubensis.* The two epiphyte layers are very rich, having orchids and bromelias (e.g., *Pleurothallis* species, *Guzmania lingulata, G. monostachya* (Fig. 279) *G. erythrolepis, Tillandsia* species, *Vriesea* species *Catopsis* species, and *Dilomilis mon-*



Fig. 277 The last coffee-plantation at the border of the rainforest–virgin forest belt of the Jaguani Reserve (Photo: A. Borhidi)

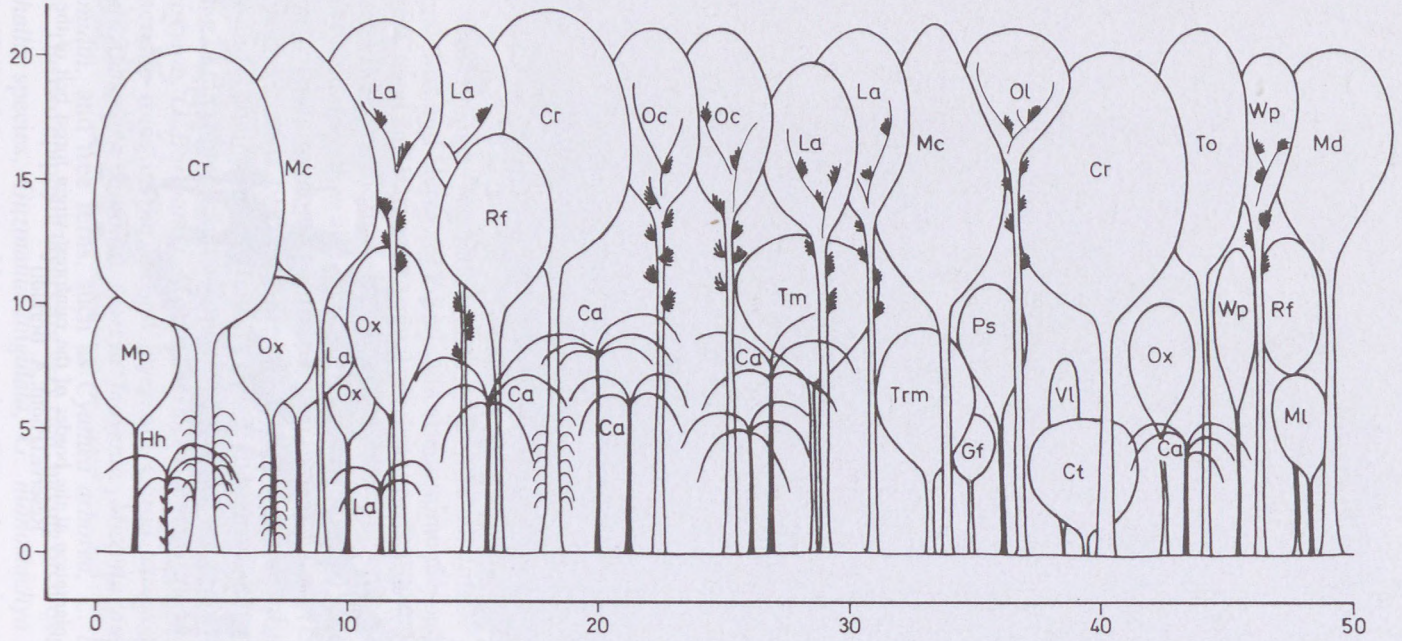


Fig. 278 Structure profile of a montane humid rainforest *(Magnolio-Laplaceetum angustifoliae)* association in Alto de Cardero, Sierra Maestra, at 1350 m a.s.l. Ca=*Cyathea arborea* and *C.* spp.; Cr=*Cyrilla racemiflora;* Ct=*Clusia tetrasperma;* Gf=*Garrya fadyenii;* Hh=*Hemitelia horrida;* La=Laplacea angustifolia; Lq=*Lophosoria quadriradiata;* Mc=*Magnolia cubensis;* Md=*Matayba domingensis;* Ml=*Meriania leucantha* ssp. *nana;* Mp=*Miconia punctata;* Oc=*Ocotea cuneata;* Ox=*Oxandra laurifolia;* Ps=*Persea similis;* Rf=*Rapanea ferruginea;* Tm=*Talauma minor;* To=*Tabebuia oligolepis;* Trm=*Ternstroemia monticola;* Vl=*Vaccinium leonis;* Wp=*Weinmannia pinnata*



Fig. 279 Guzmania monostachya (L.) Rusby ex Mez *(Bromeliaceae)* a frequent hygrophilous epiphyte of the submontane and montane rainforest belts (Photo: A. Borhidi)

tana) in the upper, and in the lower epiphyte ferns (*Polypodium, Elaphoglossum, Hymenophyllum* and *Trichomanes* species), epiphyllous mosses and liverworts. Terrestrial orchids (*Prescottia, Ponthieva, Malaxis* and *Phaius*) and shade-tolerant lianes (*Odontosoria, Gleichenia, Peperomia,* and *Schradera* species) are characteristic of the herb layer. The *Magnolio—Laplaceetum angustifoliae* community developed in Sierra Maestra between 800—1600 m (Column 20 in Table 25) represents a relatively rich rainforest type characterized by *Torralbasia cuneifolia, Solonia reflexa, Ditta maestrensis, Brunellia comocladifolia, Weinmannia pinnata, Lasianthus lanceolatus, Cleyera nimanimae, Graffenrieda rufescens,* and *Ilex macfadyenii;* it has very diverse epiphyte layers (Fig. 280). Secondary communities with *Prestoea montana* and ferns dominating the herb layer, are typical following deforestation or wind damage between 800—1200 m (e.g., Gran Piedra). A poorer community with a less montane character is the *Magnolio—Cyrilletum racemiflorae* (col. 21) developed in the Escambray Mountains between 800 and 1100 m, it often occurs as extrazonal stands. Submontane elements and some endemics of the herb and shrub layers, such as *Pilea clarana, P. cellulosa, P. clementis,* and *Psychotria martii,* are typical.



Fig. 280 Structure profile of a montane rainforest of the Cuba Peak of the Turquino group, Maestra range, with two densely closed canopies at 1700 m a.s.l. (Photo: A. Borhidi)

22.1.3 Semi-arid montane serpentine rainforests *(Podocarpo—Sloanetalia)* (Table, 25, cols 14—15)

These forests represent the climax vegetation type in the Cristal and Moa Mountains between 400 and 900 m elevation. Extrazonal stands are found in the valleys of Nipe Mts. Climatic requirements are: annual precipitation 1800—3200 mm, with rainfall all year round, and a mean temperature of 18—24 °C. Two canopy layers are recognized, the constituents being sclerophyllous and lauraceous trees and shrubs. The open, 15—22 m (Fig. 281) high upper canopy layer is composed of *Calophyllum utile, Podocarpus ekmanii, Hyeronima nipensis, Dipholis jubilla, Cyrilla cubensis* ssp. *nipensis, Pera ekmanii, Ocotea leucoxylon, O. bucheri, Tabebuia dubia, Byrsonima coriacea* and *B. orientensis, Matayba domingensis, Bonnetia cubensis, Talauma minor* ssp. *oblongifolia,* and *Magnolia cubensis,* often mingled with *Pinus cubensis.* The lower stratum is 5—12 m high and more closed. Abundant species are *Chionanthus (Linociera) domingensis, Tetrazygia cristalensis, Spathelia pinetorum, Tapura cubensis, Byrsonima biflora,* and *Ilex berteroi.* A constant elements are *Bactris cubensis,* and the tree fern *Alsophila aquilina.* In the shrub layer *Psychotria moaënsis, Myrcia gundlachii, Rauvolfia salicifolia, Moacroton ekmanii, Baccharis shaferi, Shafera platyphylla,* and *Eugenia, Lyonia, Ossaea, Calycogonium, Eupatorium,* and *Vernonia* species are typical. Due to the openness

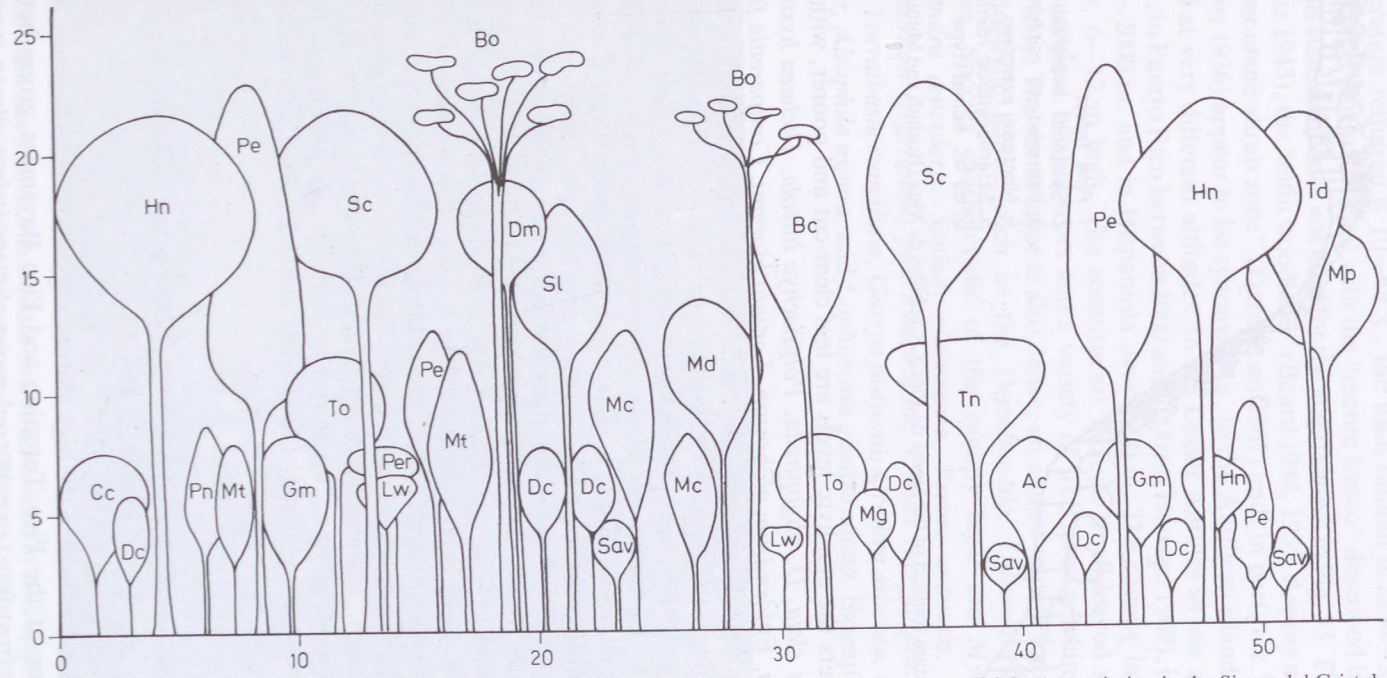


Fig. 281 Structure profile of a montane semi-dry serpentine rainforest *(Hyeronimo-Sloanetum curatellifoliae)* association in the Sierra del Cristal, Cayo Verde, at 800 m a.s.l. Ac=*Annona cristalensis*, Bc=*Byrsonima coriacea*, Bo=*Byrsonima orientensis*, Cc=*Coccoloba costata*, Dc=*Dipholis cubensis*, Dm=*Didymopanax morototoni*, Gm=*Guatteria moralesii*, Hn=*Hyeronima nipensis*, Lw=*Leucocroton wrightii*, Mc=*Myrsine coriacea*, Md=*Matayba domingensis*, Mg=*Mozartia gundlachii*, Mp=*Micropholis polita*, Mt=*Miconia tetrandra*, Pe=*Podocarpus ekmanii*, Per=*Pera ekmanii*, Pn=*Pachyanthus neglectus*, Sav=*Savia cuneifolia*, Sc=*Sloanea curatellifolia*, Sl=*Simaruba laevis*, Td=*Tabebuia dubia*, Tn=*Terminalia nipensis*, To=*Talauma minor* ssp. *oblongifolia*

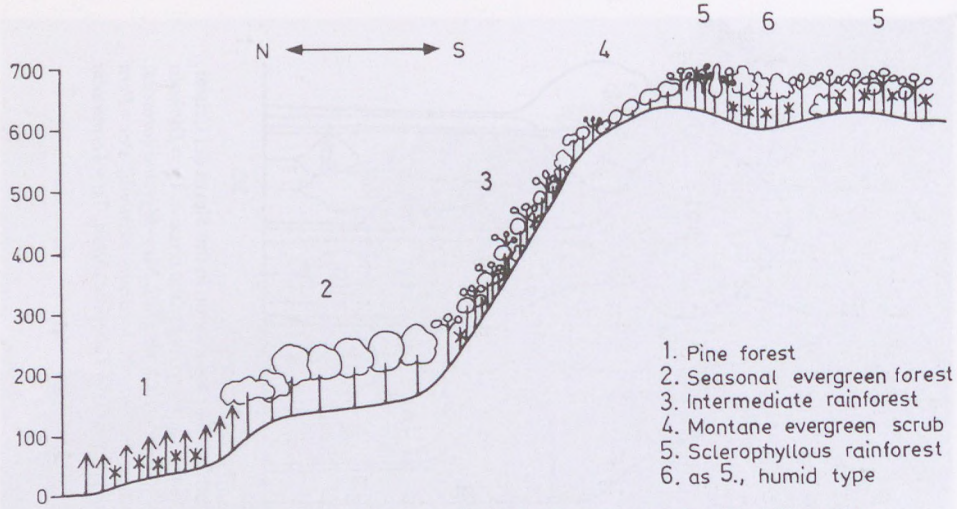


Fig. 282 Vegetation transect of the Sierra de Iberia, Cuchillas de Moa (Borhidi and Muñiz)

of the canopy layers the epiphyte levels are less clear-cut and poorer, with small orchids (*Dilomilis elata, D. oligophylla, Polystachya luteola, Dichaea hystricina, Dinema cubincola, Epidendrum globosum, Lanium hiorami, Comparettia falcata, Elleanthus linifolius*) predominating. The shade-tolerant epiphytes and epiphyllous bryophytes are absent, the number of ferns is much reduced. By contrast, many lianes grow in these forests, e.g., *Morinda moaensis, Vanilla wrightii, Gleichenia flexuosa, G. leonis, Chusquea abietifolia, Arthrostylidium* species, *Odontosoria* species, *Schradera cubensis, Marcgravia evenia, Rajania baracoënsis, Eupatorium rhexioides, Lygodium volubile,* and *Platygyne obovata,* etc. The forests of this vegetation belt (Fig. 282) have been classified into two cenological noda. The broad-leaved climax forests belong to the *Podocarpo—Byrsonimion orientensis* nodum (col. 15) with several associations. The non-climax woodlands, in which pines are dominant, have been assigned to the *Cyrillo—Pinion cubensis* alliance (col. 14). The latter one is a more humid community having luxuriant herb and moss strata and relatively rich epiphyte layer. Noted discriminating species are: *Senecio rivalis, S. polyphlebius, Hedyosmum crassifolium, Cladium restioides, Rhynchospora marisculus, Scleria secans, Calyptronoma clementis* ssp. *orientensis, Isachne leersioides, Rondeletia pachyphylla, Gundlachia cubensis, Brya subinermis,* and *Pilea* species.

22.1.4 Cloudforests or mossy forests *(Weinmannio—Cyrilletalia)* (Table 25, col. 22)

In Cuba this type is confined to the high altitude regions of Sierra Maestra, and to the high mountains of the Pico Turquino and Pico Bayamesa group between 1600—1900 m. In frost-free, evenly cool moist climate it is a climax type, but

extrazonal stands on moist gravel slides may also occur. The annual mean temperature required is 10—14 °C, the total rainfall is 2800—3200 mm per year. This type is partly identical with the "monte fresco" described by León (1946:63), but this statement does not hold for the stand shown in Fig. 33. The "alpine thicket" (Seifriz 1943), the "elfin woodland" (Beard 1944, 1955, Asprey and Robbins 1953), the "montane shrub zone" (Dansereau 1967) and, in part, the "foresta montana" (Ciferri 1936) appear to be synonymous. In the Antillean islands mossy forests are found at very different altitudes: in the Lesser Antilles as low as at 300 m (Beard 1949), in Puerto Rico between 1000 and 1200 m (Howard 1969), in Jamaica between 1600—2000 m, and in Hispaniola over 2000 m. The canopy layer is closed, very dense, 6—12 m high. The constituents include small-leaved sclerophyllous and leaf-succulent twisted trees and a variety of tree ferns reaching the canopy level (Fig. 283). The shrub layer is also dense, an almost impenetrable bush tangled by pteridophytic lianes, such as the *Dennstaedtia, Odontosoria* and *Gleichenia,* species. Species characteristic of the canopy layer are *Myrsine microphylla, Nectandra reticularis, Sapium maestrense, Persea anomala, Symplocos leonis, Eupatorium* (*Ageratina*) *paucibracteatum, Cyrilla racemiflora, Weinmannia pinnata, Torralbasia cuneifolia, Garrya fadyenii, Cyathea arborea, C. balanocarpa, C. minor, Alsophila aspera,* and *Lophosoria quadriradiata.* Examples of the abundant



Fig. 283 Elfin mossy forest with crowded dwarf trees covered by thick epiphytic mossy carpet on the Real Peak of the Turquino group at 1900 m a.s.l. (Photo: A. Borhidi)

shrub layer plants are *Vaccinium leonis* — sometimes tree-sized individuals — *Lyonia calycosa, Ternstroemia monticola* and *T. leonis, Miconia turquinensis, M. nystroemii, Duranta fletcheriana, Cordia longipedunculata, Tabebuia turquinensis, Hedyosmum cubense, Henriettea ekmanii,* and *Scolosanthus maestrensis*. Ferns and lycopods, such as *Cheilanthes harrisii, Diplazium urbanii, Blechnum tuerckheimii, Danaea* species, *Lycopodium clavatum, L. serrulatum, L. taxifolium,* and *L. montanum,* are dominant in the herb layer. The simple epiphyte stratum is very rich in small endemic orchids (e.g., *Lepanthes ekmanii, L. blepharantha, L. fractiflexa, L. fulva, L. acunae, Stelis cubensis, Pleurothallis* spp.), in Hymenophyllaceae species (six *Trichomanes* and four *Hymenophyllum* species occur), and *Polypodium* and *Elaphoglossum* species. The soil surface, the branches and the lower foliage of trees are covered by an unbroken stretch of bryophytes, including nearly 40 mosses, such as *Meteoriopsis patula, Mettenothamnium reptans, Macromitrium harrisii, M. jamaicense, M. schwaneckeanum, Hypnum polypterum, Phyllogonium fulgens, Pilotrichella flexilis, Prionodon densus, Rhizogonium spiniforme,* and *Fissidens weizii,* etc. Only one community type in Cuba may be assigned to this cenological category, namely the *Myrsino (microphyllae)—Nectandretum reticularis* association, which is extremely rich in endemics (they account for 41.15% of the non-zero scores in the data).

22.1.5 Semi-arid montane serpentine shrubwoods *(Clusio—Ilicetalia)* (Table 25, cols 16 and 18)

Microphyllous evergreen montane shrubwoods have been reported to be present on young lava soils of Central American volcanoes (Lötschert 1959) and on the slopes of the Blue Mountains in Jamaica, in a mesoclimatically arid zone (Asprey and Robbins 1953). These two noda, under the respective names *Myrico—Baccharidetalia vaccinioidis* and *Myrico—Lyonietalia jamaicensis,* have been amalgamated into the class *Myrico—Baccharidetea* (Knapp 1965, see also Knapp 1965:297). However, the montane serpentine shrubwoods of Cuba, often called "charrascals", are completely different from these in floristic composition and seral position. The Cuban shrubwoods are not pioneer communities, unlike those in Central America, and not subclimax types of arid regions, unlike the sclerophyllous montane shrubwoods of Jamaica. The montane shrubwoods in the Nipe, Cristal and Moa Mountanins are edaphic climax communities developed under a humid tropical rainforest climate. Their sclerophyllous character is a mere consequence of the ferritic soils derived from serpentine bedrocks (see Part II chapter 13 for more details). The overwhelming majority of species are endemic so that a separate class, *Clusio—Ilicetea,* was created to include these communities. It consists of a dense bush of microphyllous and nanophyllous sclerophyll shrubs and stunted trees up to 4—6 m height, with an open layer of emergent trees reaching 7—10 m height. In Moa this community has high species diversity between 600 and 1000 m in altitude. The more moist association group of Moa *(Ilici—Laplaceion)* is characterized by the following trees and shrubs: *Ilex berteroi, I. victorini, I. hypaneura, I. shaferi, Laplacea moaënsis, L. benitoënsis, Clusia moaënsis, C. callosa, C. monocarpa,*



Fig. 284 Cyrilla cubensis P. Wils. an endemic shrub of North Oriente, characteristic of the evergreen serpentine scrub communities (Photo: A. Borhidi)

Acrosynanthus trachyphyllus, Rauvolfia salicifolia, Byrsonima biflora, Lyonia glandulosa, Cyrilla cubensis (Fig. 284), *Tapura cubensis, Myrica shaferi, Antirhea abbreviata, Alsophila aquilina, Jacaranda arborea, Illicium cubense,* and *Rheedia polyneura,* etc. Only a few epiphytes occur *(Dilomilis oligophylla, Polypodium duale, Hymenophyllum abruptum).* Conversely, the sclerophyllous lianes are numerous (e.g., *Arthrostylidium fimbriatum, A. pinifolium, Feddea cubensis, Rajania baracoënsis, Symphyisia alainii, Morinda moaensis,* etc.). *Ekmanochloa aristata, Paepalanthus pungens, P. riparius, Rhynchospora cernua, R. pruinosa,* and *R. shaferi* are characteristic of the herb stratum in cleared areas. The contribution of endemic taxa to the total of all scores is 77 (cf. Table 25, col. 16). In Nipe and Loma Mensura at 650—1000 m the *Myrcio—Bourrerietum* association is found, which is similar in appearance but more xeromorphic, having many spinose elements (here the contribution of endemics to the total is 70%, also very high!). Characteristic species are *Bourreria pauciflora, Myrcia retivenia, Coccoloba reflexa, Spathelia cubensis, Callicarpa lancifolia, Ariadne shaferi* ssp. *shaferi, Clusia nipensis, Annona sclerophylla* (Fig. 285), *Calycogonium rosmarinifolium, Euphorbia podocarpifolia, Jacaranda arborea, Eugenia mensuraensis,* and *Baccharis shaferi.* There are few lianes, the endemic *Harnackia bisecta* is characteristic. In the herb layer some drought-resistant terrestrial orchids *(Bletia purpurea, B. florida, Encyclia atropurpurea)* and many cyperaceous species are found.



Fig. 285 Annona sclerophylla Safford, a common shrub of the evergreen montane serpentine scrub communities of North Oriente (Photo: A. Borhidi)

22.1.6 Elfin thickets *(Ilici—Myricion cacuminis)* (Table 25, col. 23)

This vegetation type is represented by extrazonal stands on the southern and eastern bluffs between 1800 and 1970 m in Pico Turquino, the highest mountains of Sierra Maestra (Fig. 286). It corresponds to the "alpine thicket" described by Beard (1944, 1955), the "alpine woodland" of Howard (1969) and is on a par with the Central American alpine shrublands that are rich in *Ericaceae* species (Knapp 1965:300), the latter being a climax vegetation belt between cloudforests and paramós. Léon's (1946) "monte fresco" term includes this type too (in elfin thicket is illustrated by the photograph in Fig. 33 as "monte fresco"). This vegetation type is much drier than the shrubwoods of the cloudy zone, partly because it is above the condensation belt and partly because water is rapidly drained from the steep rocky surface. This is why many herbaceous leaf-succulents and spinose shrubs are found here. Within this nodum two associations may be recognized. The first is a dense bush composed of 1.5—2 m high microphyllous and nanophyllous evergreen shrubs *(Illici—Myricetum cacuminis)* and is characterized by *Ilex turquinensis, I. nunezii, Peratanthe cubensis, Myrica cacuminis, Lobelia cacuminis, Eupatorum* (*Ageratina*) *paucibracteatum, Vernonia parvuliceps, V. praestans* ssp. *cacuminis, Weinmannia pinnata, Persea similis, Lyonia calycosa, Torralbasia cuneifolia,* and *Viburnum vil-*



Fig. 286 Elfin thicket of the main ridge of the Real Peak of the Turquino group at 1950 m a.s.l. with the local endemic *Agave pendentata* Trel. (Photo: A. Borhidi)

losum, etc. The other association, *Agavo–Mitracarpetum acunae*, is a 50–100 cm high evergreen thicket on steep rocky slopes. This is rich in lianes, subshrubs and orchids rooted in the moss carpet. Prominent characteristic species are emergent agaves *(Agave pendentata* Fig. 255) and many small epiphytic orchids living on the ground here *(Pleurothallis gelida, P. obliquipetala, P. wrightii, P. testifolia, P. parvula. P. velaticaulis, Lepanthes turquinoënsis, L. pergracilis, L. blepharantha, Lepanthopsis microlepanthes)*. Typical members of the shrub layer are the dominant *Ilex turquinensis, I. nannophylla, Mitracarpus acunae, Cassia turquinae, Micromeria bucheri, Juniperus saxicola, Schoepfia stenophylla, Vernonia praestans* ssp. *cacuminis, Eugenia maestrensis*, and *E. lomensis*. Of the herbs *Chaptalia turquinensis, Pilea micromeriifolia, Peperomia galioides, P. grisebachiana*, and *Begonia lomensis* are to be mentioned. *Chusquea abietifolia* and *Arthrostylidium multispicatum* are dominant lianes densely entangling the vegetation.

22.2 Seasonal evergreen forests or seasonal rainforests

Many authors do not make a distinction between the important tropical seasonal forests and the true rainforests. For example, the *Spondias–Oreodoxa* association of Ciferri (1936:222), thought to be true tropical rainforest, is in fact a seasonal lowland rainforest. The "forêt ombrophile tropicale" category used by many French researchers comprises seasonal forest formation. Others, e.g., Walter (1962) disagree only with the adjective "seasonal". Our vegetation type is indentical with the "seasonal evergreen forest" of Beard (1944), although that type may be more broadly interpreted. The Jamaican equivalent is the "wet limestone forest" (Asprey and Robbins 1953). In Puerto Rico seasonal evergreen forest is called "lowland rainforest" by Dansereau (1966:20). He uses "seasonal evergreen forest" for a drier formation than Beard's community of the same name. Dansereau's seasonal evergreen forest should be called a semi-deciduous forest. Knapp (1965) uses the term "semi-deciduous moist forest", which is obviously unacceptable as these forests are actually evergreen. The reason for this nomenclatural confusion is that these forests are transitional between the rainforests and semi-deciduous forests. They are closer to the rainforests in structure (number of strata, richness in epiphytes). However, the presence of deciduous emergents, the highly developed liane stratum and the absence of shade-tolerant epiphytes and epiphylls emphasize their similarity to the semi-deciduous forests. In the Antilles this formation, the climax type in extensive areas, can be clearly distinguished from both the rainforests and the semi-deciduous forests.

22.2.1 Lowland seasonal rainforests

This vegetational zone formerly occupied the most extensive areas in the island and is still widespread in Cuba. It is a climax formation in tropical seasonal climate with 3–5 dry months and 1200–1600 mm annual precipitation, it occurs on calcareous, ferrallitic, and deep red ferrallitic soils. On shallower ferrallitic soils it

may develop only if there are not more than one or two dry months a year, as longer dry seasons are more favourable for semi-deciduous forests. This forest zone is the most suitable for tropical agriculture. Consequently, undisturbed stands are hardly found anywhere in Cuba. Their probable physiognomy is reconstructed from semi-cultivated fragments, and from studying standard trees of agricultural savannas and the shade trees of abandoned lowland coffee plantations. Two canopy levels, both evergreen, are recognized. The upper is more open and 20—25 m high, the lower is closed and 8—15 m high. Typically there are emergent specimens of the deciduous *Ceiba pentandra* which may be as tall as 30—40 m. Elements of the upper canopy layer are *Roystonia regia, Guazuma ulmifolia, Bucida buceras, Mastichodendron foetidissimum, Lonchocarpus domingensis, L. latifolius, Luehea speciosa, Chlorophora tinctoria, Cecropia peltata, Cordia collococca, C. gerascanthus,* and *Ficus* species, and many microphyllous trees, such as *Pithecellobium cubense, Samanea saman,* and *Peltophorum adnatum.* In the lower stratum *Oxandra lanceolata, Andira inermis, Ateramnus lucidus, Crescentia cujete* are characteristic species. Drought-tolerant epiphytes *(Tillandsia fasciculata, T. recurvata, T. valenzuelana, T. polystachya, T. tenuifolia)* and lianes *(Philodendron lacerum, Ph. krebsii, Ph. clementis, Hylocereus undatus, Pithecoctenium echinatum)* are commonly found on tall trees. The royal palm—cotton tree—samanea agricultural savannas widespread in the northern Caribbean are derived from these forests by logging, burning and grazing.

22.2.2 Submontane seasonal rainforests *(Oxandro—Dipholietum)* (Table 25, col. 24)

These are forest formations in the submontane zone from 200 m to 800 m in altitude. They have a seasonal climate with one to three dry months and an annual rainfall averaging 1400—1800 mm. These forests correspond to León's (1946) "yayales" formation. They are similar to the lowland seasonal rainforests in structure but the megatherm trees differ. *Ceiba pentandra, Samanea saman, Guazuma ulmifolia,* and *Zanthoxylum elephantiasis* are absent. Of the emergents *Dipholis jubilla* occurs in the Oriente whereas *Dipholis salicifolia* or *Cedrela mexicana* specimens are found elsewhere. These forests have different composition in the different mountains. In the stands sampled in Sierra Maestra (Table 25, col. 24) *Dipholis jubilla* is the only buttressed emergent tree (Fig. 287). *Calophyllum antillanum, Zizyphus rhodoxylon, Ficus berteroi, Zanthoxylum martinicense, Z. cubense, Didymopanax morototoni, Sapium jamaicense, Faramea occidentalis, Cedrela mexicana, Guarea guidonia, Cupania glabra, C. americana,* and *Roystonea regia* are characteristic of the closed upper canopy, and *Oxandra lanceolata, O. laurifolia, Chrysophyllum argenteum, Dendropanax arboreus, Lonchocarpus latifolius, Sloanea amygdalina, Wallenia laurifolia* and *Ateramnus lucidus,* etc., occur in the lower stratum. The herb layer is dominated by terrestrial ferns from the genera *Dryopteris, Asplenium, Adiantum, Tectaria, Diplazium,* and *Dennstaedtia.* These ferns, the mesophytic orchids of the epiphyte layer (mostly *Epidendrum, Encyclia* and *Oncidium* species) and the mesophilous lianes allow a clear distinction

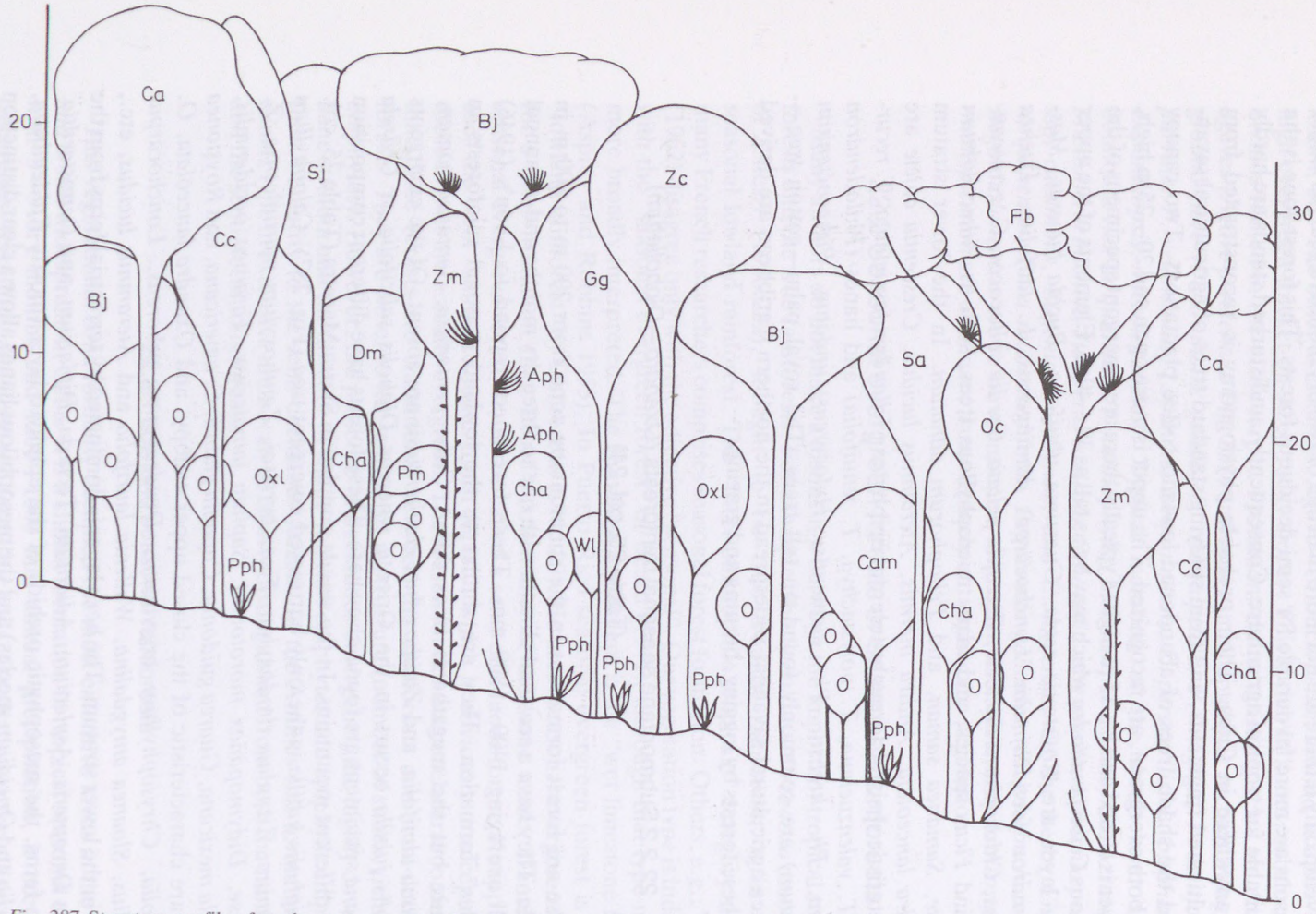


Fig. 287 Structure profile of a submontane seasonal evergreen forest *(Oxandro-Bumelietum jubillae)* associations in the Sierra Maestra, at 400 m a.s.l. next to Guisa (Borhidi and Muñiz) Aph=*Asplenium phyllitidis*, Bj=*Bumelia jubilla*, Ca=*Calophyllum antillanum*, Cam=*Cupania americana*, Cc=*Calycophyllum candidissimum*, Cha=*Chrysophyllum argenteum*, Dm=*Didymopanax morototoni*, Fb=*Ficus berteroi*, Gg=*Guarea guidonia*, O=*Oxandra lanceolata*, Oc=*Ocotea cuneata*, Oxl=*Oxandra laurifolia*, Pm=*Protium maestrense*, Pph=*Polypodium phyllitidis*, Sa=*Sloanea amygdalina*, Sj=Sapium jamaicense, Wl=Wallenia laurifolia, Zc=Zanthoxylum cubense, Zm=Zanthoxylum martinicense

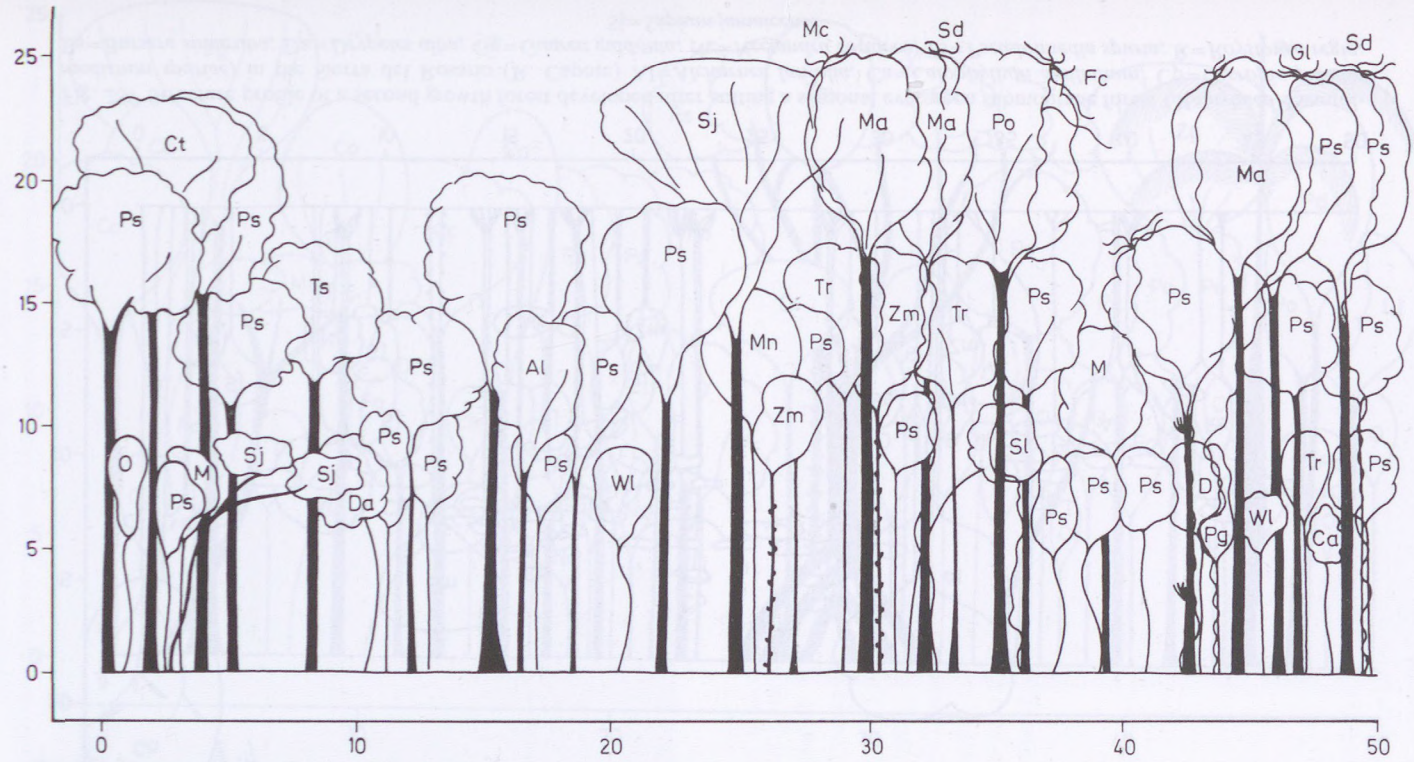


Fig. 288 Structure profile of a submontane seasonal evergreen forest *(Mataybaeo-Pseudolmedietum spuriae)* association of the Sierra del Rosario, Pinar del Rió province, in the Loma El Salon at 470 m a.s.l. (Borhidi, Capote and Del Risco) Al=*Alchornea latifolia,* Ca=*Calophyllum antillanum,* Ct=*Cinnamomum triplinerve,* D=*Drypetes alba,* Da=*Dendropanax arboreus,* Fc=*Forsteronia corymbosa,* Gl=*Gouania lupuloides,* Ma=*Matayba apetala,* M=*Mastichodendron foetidissimum,* Mc=*Merremia cissoides,* Mn=*Margaritaria nobilis,* O=*Oxandra lanceolata,* Pg=*Psychotria grandis,* Po=*Prunus occidentalis,* Ps=*Pseudolmedia spuria,* Sd=*Smilax domingensis,* Sj=*Sapium jamaicense,* Tr=*Trophis racemosa,* Ts=*Tabebuia shaferi,* Wl=*Wallenia laurifolia,* Zm=*Zanthoxylum martinicense*

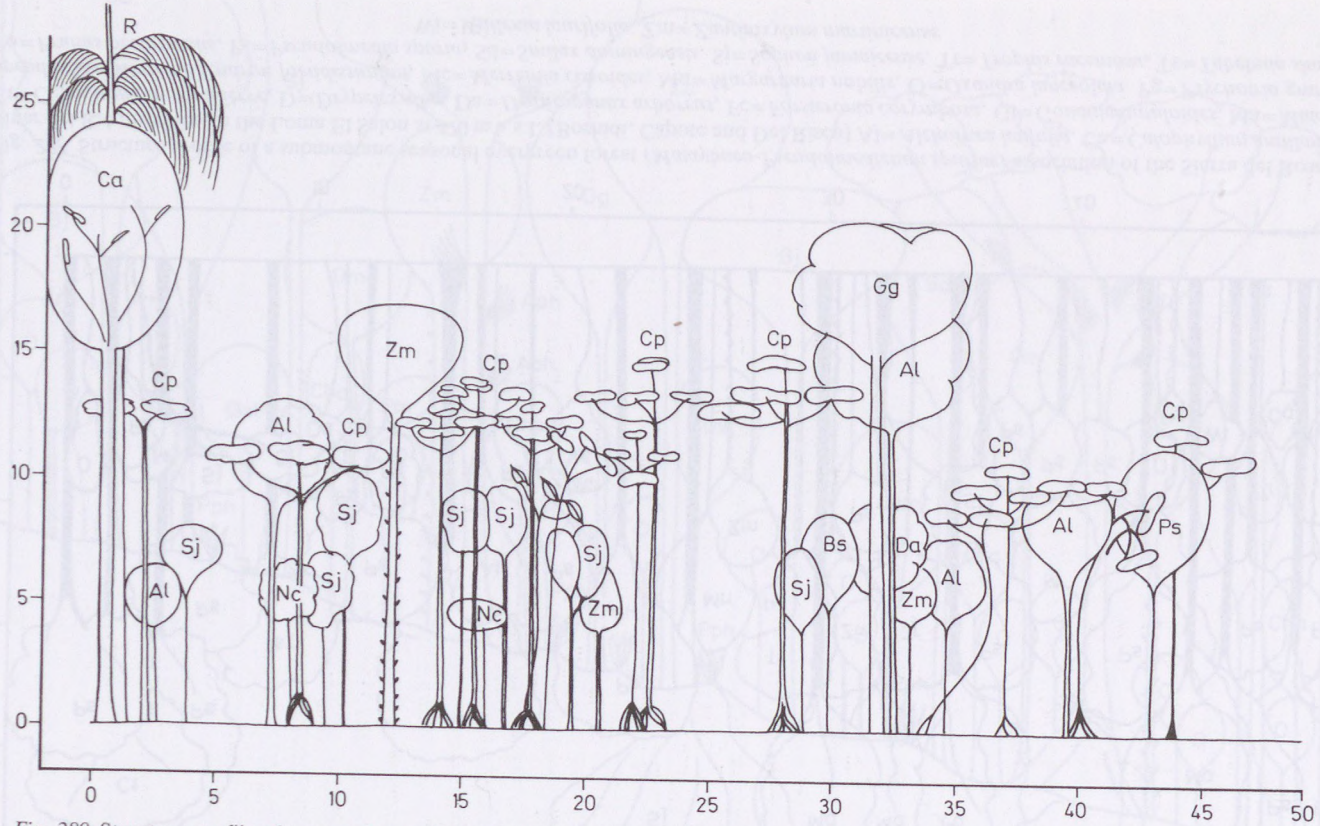


Fig. 289 Structure profile of a second growth forest developed after cutting a seasonal evergreen submontane forest *(Mataybaeo-Pseudolmedietum spuriae)* in the Sierra del Rosario (R. Capote) Al=*Alchornea latifolia;* Ca=*Calophyllum antillanum;* Cp=*Cecropia peltata;* Bs=*Bursera simaruba;* Da=*Drypetes alba;* Gg=*Guarea guidonia;* Nc=*Nectandra coriacea;* Ps=*Pseudolmedia spuria;* R=*Roystonea regia;* Sj=*Sapium jamaicense*

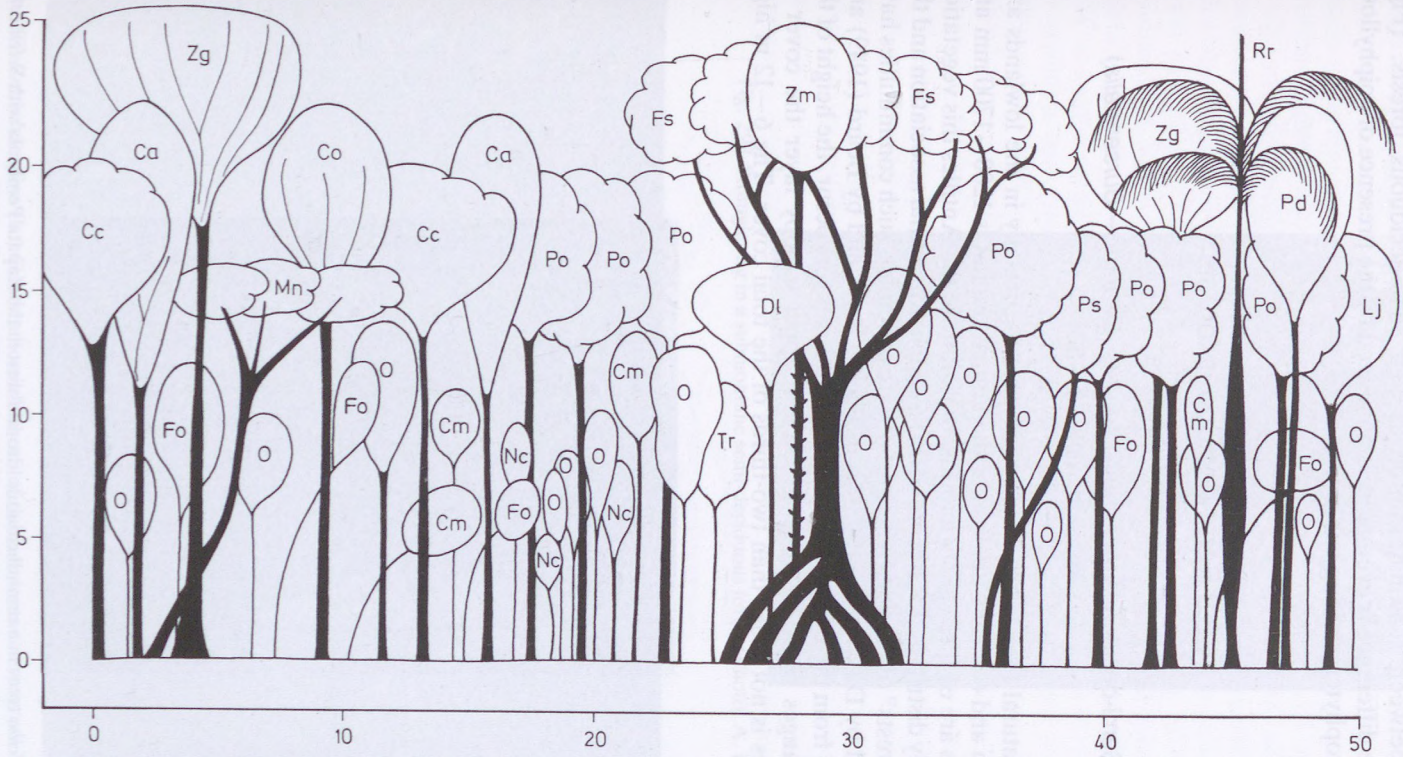


Fig. 290 Structure profile of a dry variant of the submontane evergreen forest at the foothill of a mogote in the Sierra del Faustino, next to San Diego de Los Baños, Pinar del Rio Province, at 200 m a.s.l. (R. Capote and Borhidi) Ca=*Calophyllum antillanum;* Cc=*Cordia collococca;* Co=*Cedrela odorata;* Cm=*Cupania macrophylla;* Dl=*Drypetes lateriflora;* Fo=*Faramea occidentalis;* Fs=*Ficus subscabrida;* Lj=*Licaria jamaicensis;* Mn=*Margaritaria nobilis;* Nc=*Nectandra coriacea;* O=*Oxandra lanceolata;* Pd=*Pouteria dictyoneura;* Po=*Prunus occidentalis;* Ps=*Pseudolmedia spuria;* R=*Ryostonea regia;* Tr=*Trophis racemosa;* Zg=*Zuelania guidonia;* Zm=*Zanthoxylum martinicense*

to be made between seasonal rainforests and semi-deciduous forests. (Figs 288—290). The difference is even more emphasized by the presence of epiphyllous lichens and bryophytes growing on trunks.

22.3 Semi-deciduous forests

22.3.1 Semi-deciduous mesophytic forests *(Oxandro—Burseretalia)* Table 25, cols 28—30)

These are natural forests which are widespread especially in the lowlands and hills of western and central Cuba where the annual rainfall is 1200—1700 mm and the dry seasons are of three to six months' duration. In the Antilles this vegetation type is generally distributed. Ciferri's (1935) *Catalpa—Swietenia* association and the "Hammock forests" of Florida (Knapp 1965) are examples, such communities have been described by Dansereau (1967) from Puerto Rico, and by Beard (1949) and Stoffers (1956) from the Lesser Antilles. Two canopy layers occur, the height of the tallest trees ranges from 18 to 25 m. In the upper canopy layer the cover of deciduous trees is not more than two-thirds of the total cover. The 6—12 m high



Fig. 291 Giant *Ceiba* trees in a semi-deciduous littoral forest in the Zapata Peninsula with *Selenicereus boeckelmannii* climber on the trunks (Photo: A. Borhidi)

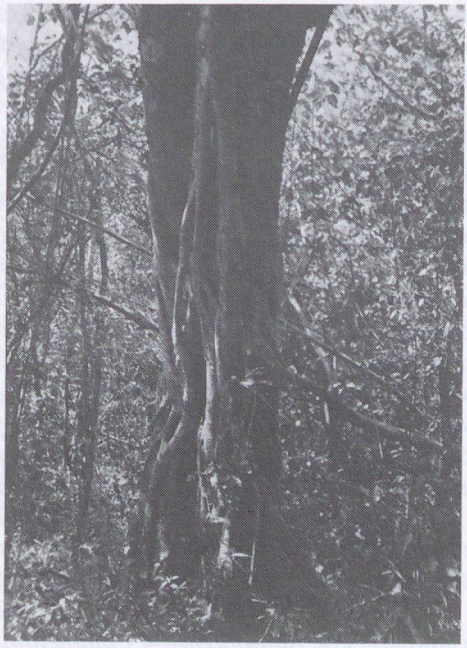


Fig. 292 Strangler fig in a submontane semi-deciduous forest (Photo: A. Borhidi)



Fig. 293 *Urera baccifera* (L.) Gaud. a horrible shrub of the submontane evergreen forests (Photo: A. Borhidi)

second stratum is composed exclusively of evergreens, partly of sclerophyllous ones. Deciduous giant trees (*Ceiba pentandra Fig. 291, Bombacopsis cubensis*) may also be present but are sparsely distributed in any case. Prominent elements of the upper canopy layer are *Ficus crassinervis* (Fig. 292), *Cedrela mexicana, Andira inermis, Bursera simaruba, Mastichodendron foetidissimum, Pithecellobium cubense, Zanthoxylum elephantiasis, Catalpa punctata, Tabebuia shaferi, Zuelania guidonia, Casasia calophylla,* and *Casearia hirsuta.* In the second layer *Amyris balsamifera A. elemifera, Trichilia hirta, Picramnia pentandra, Adelia ricinella, Diospyros crassinervis, Krugiodendron ferreum, Ateleia cubensis, Eugenia axillaris, E. rhombea, E. maleolens, Canella winterana, Allophylus cominia, Savia sessiliflora, Cordia gerascanthus, Urera baccifera* (Fig. 293), and *Ateramnus lucidus* are common. The epiphyte level is fragmented, only the emergent trees possess vast numbers of epiphytic plants, especially drought-resistant *Tillandsia* species. Many lianes, with xerophytic microphylls occur, e.g., *Pisonia aculeata, Celtis iguanea, Solandra longiflora, Chiococca alba, Cissus sicyoides, C. formosa, Canavalia ekmanii, Dalechampia scandens, Serjania diversifolia, Abrus precatorius, Securidaca elliptica, Clematis dioica, Passiflora suberosa, P. multiflora, Bauhinia divaricata,* (Fig. 294), *Pithecoctenium echinatum, Stegnosperma scandens, Platygyne hexandra,* and *Smilax havanensis,* etc. The herb layer is poor or even completely lacking, so are the shade-tolerant ferns. Three closely related associations coming from three different regions of Cuba were studied. The *Bombacopsi– Catalpetum* (Fig. 295), communi-



Fig. 294 The semi-deciduous forest is rich in climbers; one of them is *Bauhinia divaricata* L. in the Zapata Peninsula (Photo: A. Borhidi)

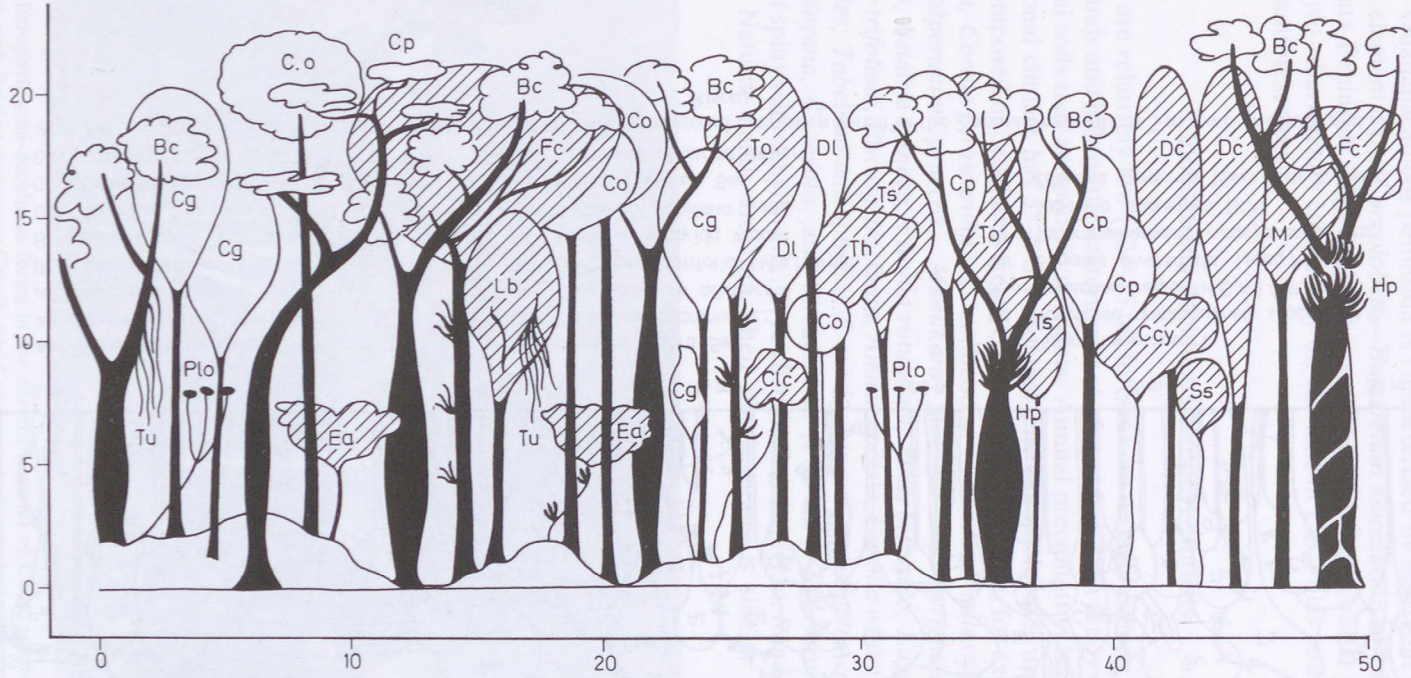
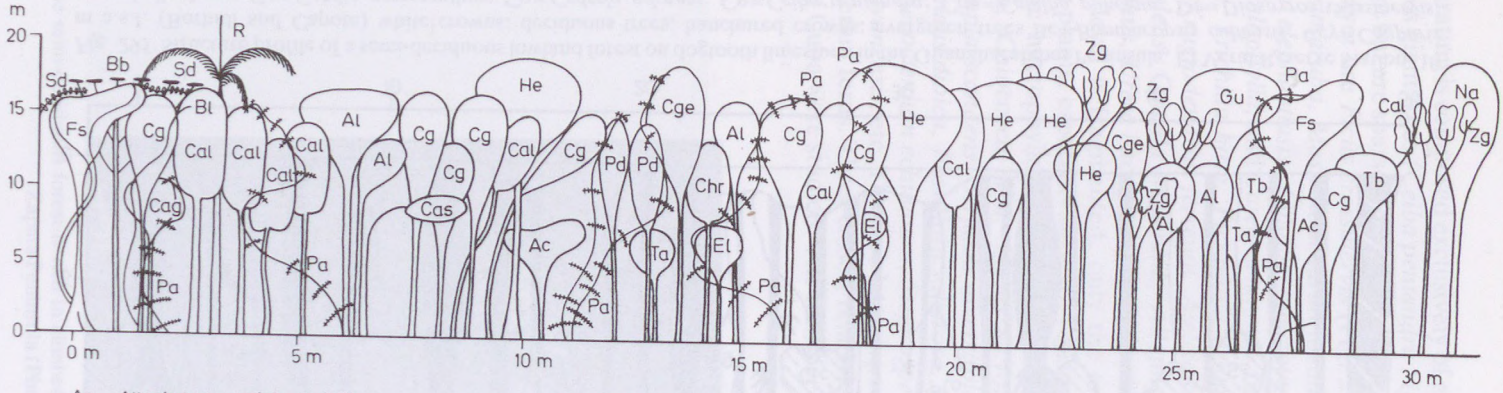


Fig. 295 Structure profile of a semi-deciduous lowland forest on dogtooth limestone in the Guanahacabibes Peninsula, El Veral Reserve Station, 10 m a.s.l. (Borhidi and Capote) white crowns: deciduous trees; hanchured crowns: evergreen trees Bc=*Bombacopsis cubensis;* Ccy=*Capparis cynophallophora;* Cg=*Cordia gerascanthus;* Co=*Cedrela odorata;* Cp=*Ceiba pentandra;* Cpu=*Catalpa punctata;* Dc=*Diospyros crassinervis;* Dl=*Drypetes lateriflora;* Ea=*Eugenia axillaris;* Fc=*Ficus crassinervis;* Lb=*Linociera bumelioides;* Plo=*Plumeria obtusa;* Th=*Trichilia hirta;* To=*Torrubia* (Guapira) *obtusata;* Ts=*Tabebuia shaferi;* Clc=*Clerodenrum calcicola;* Hp=*Hohenbergia penduliflora;* Tu=*Tillandsia usneoides*



Ac Allophylus cominia (L.) Sw.
Ai Andira inermis (Sw) H.B.K.
Al Alchornea latifolia Sw.
Bb Bucida buceras L.
Bl Banisteriopsis pauciflora (H.B.K.) C.B. Robinson.
Cag Casearia guianensis (Aubl.) Urb.
Cal Calophyllum antillanum Britt.
Cas Casasia calophylla A. Rich.
Cg Cupania glabra Sw.
Cge Cordia gerascanthus L.
Chr Chrysophyllum oliviforme L.
El Enallagma latifolia (Mill.) Small.
Fs Ficus subscabrida Warb.
Gu Guazuma ulmifolia Lam.
He Hibiscus elatus Sw.
Na Nectandra antillana Meisn.
Pa Pisonia aculeata L.
Pd Palicourea dominguensis (Jacqui) D.C.
R Roystonea regia (H.B.K.) O.F. Cook.
Sd Serjania diversifolia (Jacq.) Radik.
Ta Tabernaemontana amblyocarpa Urb.
Tb Tabebuia angustata Britt.
Zg Zuelania guidonia (Sw.) Britt. & Millsp.

Fig. 296 Structure profile of an anthropically influenced lowland seasonal evergreen forest in the Zapata Peninsula at 5 m a.s.l. (Borhidi and Del Risco)

ty in the Guanahacabibes peninsula is characterized by emergent giant trees and Mexican elements, the *Coccolobeto–Burseretum* association of Isla de Pinos and the Zapata Peninsula (Fig. 296) has many microphyllous coastal plants, and the *Zanthoxylo–Burseretum* community on the hills in Las Villas and Camagüey has several rainforest trees.

22.3.2 Semi-deciduous xerophytic forests

These are relatively low (12–15 m) forests with a single canopy layer, found in the lowlands and hills of the eastern part of central Cuba, on sandy or rocky, acidic or neutral soils that are poor in nutrients. Annual precipitation is 800–1200 mm, the seasonal climate has 5–6 dry months. The canopy level is up to 80% and is partly composed of deciduous trees. Characteristic trees are, for example, *Bursera simaruba, Cordia gerascanthus, C. collococca, C. nitida, Phyllostylon brasiliensis, Gossypiospermum praecox, Manilkara jaimiqui* ssp. *wrightiana, Maytenus buxifolia, Belairia spinosa, Pisonia rotundata, Ficus laevigata, Eugenia maleolens, Hypelate trifoliata, Piscidia piscipula, Ateleia apetala, Canella winterana, Diospyros halesioides, Tabebuia anisophylla, T. trachycarpa, Carpodiptera cubensis, Copernicia baileyana, C. textilis,* and *C. sueroana* (Fig. 297). The shrub layer consists mainly of spiny sclerophylls, e.g., *Brya ebenus* s.l., *Malpighia, Randia,* and *Oplonia* species. Natural stands are rare, their physiognomy is similar to the cerrado



Fig. 297 Microphyll semi-deciduous forest in the eastern lowland of Cuba, south of Victoria de las Tunas, with *Belairia mucronata* Griseb. and *Copernicia baileyana* León (Photo: A. Borhidi)

vegetation of the cerrado forest zone in Brazil, as described by Eiten (1972). As a result of burning and grazing most stands have been replaced by secondary savannas dominated by either *Copernicia* or deciduous trees.

22.4 Tropical karstic forests

These are extremely diverse forests on shallow humic-carbonated rendzina or bare rocks of deeply eroded mountains and solitary cliffs consisting mainly of hard Jurassic and Triassic limestone. Usually a single, 5—10 m high open canopy layer composed mainly of deciduous trees occurs. In Cuba this formation is most similar to the dry deciduous forests. Thanks to the favourable light conditions, the usually epiphytic plants live on the ground forming a closed herb layer on rocks where water balance is just as poor as on the trunk or at canopy level. In extreme habitats which become dry and hot very quickly, succulent agaves, epiphytic, columnar or liane-like cacti *(Rhipsalis, Leptocereus, Selenicerus, Pilosocereus),* and trees with barrel-like trunks capable of water storing *(Gaussia, Bombacopsis (Fig. 174))* are found. The thickness of soils, if any, is extremely uneven due to erosion and soil accumulation caused by geomorphological formations. Therefore, the vegetation itself is also of mosaic structure. Lötschert (1958) takes the view that no associations can be distinguished in the mogotes. Of course, associations in the sense applied to

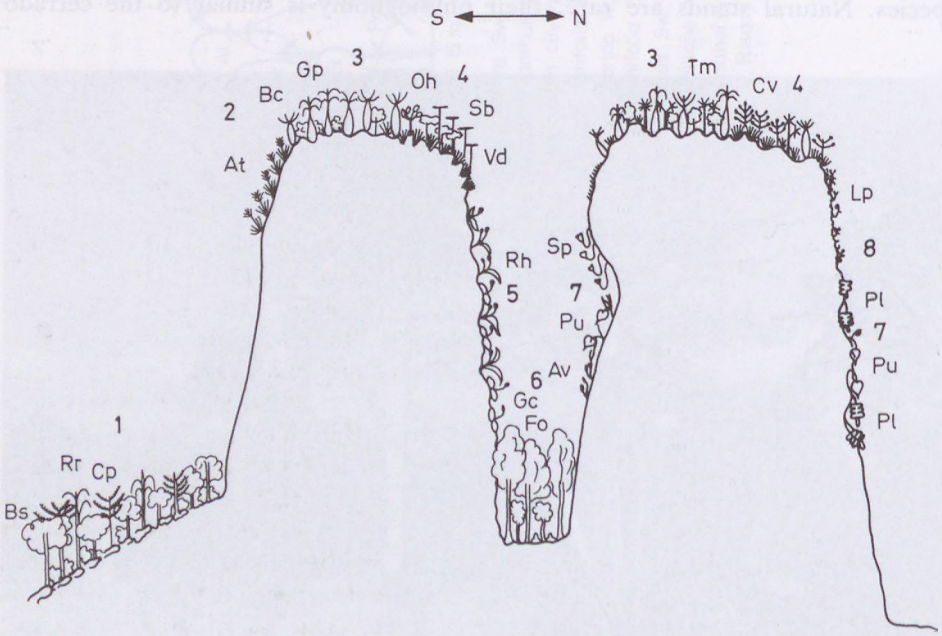


Fig. 298 General scheme of the vegetation types of a "mogote complex" Bs=*Bursera simaruba;* At=*Agave tubulata;* Av=*Anthurium venosum;* Bc=*Bombacopsis cubensis;* Cv=*Ceratopyxis verbenacea;* Cp=*Ceiba pentandra;* Gp=*Gaussia princeps;* Gc=*Gesneria celsioides;* Fo=*Faramea occidentalis;* Lp=*Leptocereus prostratus;* Oh=*Omphalea hypoleuca;* Pl=*Philodendron lacerum;* Pu=*Philodendron urbanianum;* Rh=*Rhytidophyllum rupincola;* Rr=*Roystonea regia;* Sp=*Siemensia pendula;* Tm=*Thrinax morrisii*

the temperate zone, especially to Central Europe, cannot be recognized in the tropical vegetation if characterized by a multitude of dominant species (tropical coniferous forests, mangroves, littoral communities and savannas are usually exceptions), but it is possible to define associations. Under favourable conditions seven well-defined vegetational noda may be distinguished in the mogotes: herbaceous communities of the insolated (1) and those of shaded (2) crevices, shrub dominated (3) and bromeliad dominated (4) mogote forests, semi-deciduous forests on rocks (5) and at the foot of hills (6), and seasonal rainforests in the gorges (7) (Fig. 298). The first four communities comprise the "mogote complex" in the wider sense. This complex is hard to subdivide for technical reasons. The shrub and bromeliad dominated mogote forests can be treated as "mogote forests" in a narrower sense. Their composition is shown in Table 25., (col. 26). The mogote forests of the bromeliad type are absent from the soft limestone formations (e.g., Las Villas, Oriente) where only the shrubby variant may develop (cols 25 and 27). The mogote forests have two evolutionary centres with completely different floras, the older in western Cuba *(Bombacopsi—Thrinacetalia)*, another in the central and eastern part of the island *(Tabebuio—Coccothrinacetalia)*. Both vegetation types served as a basis for the flora development on the rocky coasts. Most of the mogotes of eastern Cuba were themselves located on the coastal zone in the Tertiary. Therefore, the connection between the flora of these mogotes and the recent coastal zone had been stronger than that between the coast and the mogotes of Sierra de los Organos that were separated from each other by slatey outcrops.

22.4.1 Species rich karstic forests of western Cuba *(Spathelio—Gaussion)* (Table 25, col. 26)

These are open forests composed of 5—8 m high, mostly deciduous trees on the steep slopes and the top of the karstic mountains in Sierra de los Organos. Characteristic are *Bombacopsis cubensis* and *Gaussia princeps* with barrel-like trunks, and the tree fern-shaped *Spathelia brittonii, Thrinax punctulata, Ekmanianthe actinophylla, Omphalea hypoleuca, Bourreria polyneura, Microcycas calocoma, Plumeria emarginata, Colubrina elliptica, Citharexylum caudatum, Erythrina cubensis, Sapium leucogynum, Trichilia havanensis,* and *Zanthoxylum pimponelloides*. In the bromeliad dominated variant *(Vrieseo—Bombacopsidetum) Hohenbergia penduliflora, Vriesea dissitiflora* and twelve *Tillandsia* species are typical. Dominant species of the shrubby variant are *Ceratopyxis verticillata, Eugenia galeata, Psidium vicentinum, Oplonia purpurascens, Annona cascarilloides, Malphighia roigiana, Guettarda calcicola,* etc. Of the succulents *Agave tubulata, Leptocereus assurgens,* and *Selenicereus grandiflorus* are worth mentioning. Lianes, such as *Siemensia pendula, Philodendron urbanianum,* and *Cuervea integrifolia,* and chasmophytes, e.g., *Gesneria celsioides, Rhytidophyllum rupincola, Anthurium venosum,* and *Peperomia verticillata* are also common. The endemic taxa account for 40% of the total of the presence scores in the data, suggesting that among the limestone formations of Cuba these forests are the richest in endemics.

22.4.2 Species poor karstic forests of western Cuba *(Thrinacion punctulatae)*

These forests are found in the limestone karsts originated from the Cretaceous and the Eocene in the provinces of Habana and Matanzas, between 200 and 300 m altitude, in a seasonal climate of one to four dry months and 1200—1600 mm rainfall per year. In these rocks that are softer than the Jurassic limestone of Sierra de los Organos, the biologically induced karstification process is intensive so these karstic forests are poorer in chasmophytes, most of those being replaced by mesophytic and grophilous elements of canyon forests *(Peperomia, Pilea, Rhytidophyllum* and fern species). Most typical of these forests is the *Bombacopsi—Thrinacetum morrisii* association, which was studied in the mogotes of Jaruco. *Thrinax morrisi* is dominant, its 5—6 m high canopy layer is barley broken by emergent individuals of *Bombacopsis cubensis.* An additional element characteristic of the Viñales mogotes but also present here, is *Agave tubulata.* The others are replaced by more common calciphilous species, such as *Celtis trinervia, Erythroxylum areolatum, Ficus jacquinifolia, F. aurea, Casearia guianensis, C. hirsuta, Hamelia patens, Bocconia frutescens, Piper umbellatum, Trichilia havanensis,* and *Cordia globosa.* The occurrence of the spiny shrub *Leucocroton microphyllus* is typical of dry habitats. *Rhytidophyllum exsertum* occurs in shaded crevices in rocks. The community is strikingly poor in epiphytes.

22.4.3 Karstic forests of eastern Cuba *(Tabebuio—Coccothrinacion)*

Isolated stands of different size extend from the limestone cliffs of Las Villas as far as the Baracoa area, including the karstic block mountains of Camagüey and the extensive mogote zone of Nipe and Sierra Maestra. They are different from the western mogotes in four respects:

1. Trees with barrel-like trunks are absent,
2. Thrinax palm is replaced by *Hemithrinax* and *Coccothrinax* species,
3. Columnar cacti are customarily found, and
4. Deciduous elements are less abundant, being replaced by evergreen sclerophyllous trees and shrubs. The floristic composition differs with various mountain areas.

The isolated mogote floras of Las Villas and Camagüey are poor in species. The most developed stands, that are repeatedly found are representatives of the association *Coccothrinaci—Tabebuietum albicantis.* They were examined in the northern karstic area of Sierra Maestra (Table 25, col. 25). This is in fact a shrubwood with loose canopy layer and dominated by microphyllous evergreen trees, epiphytes and lianes. On the rims columnar cacti *Pilosocereus brooksianus)* and *Agave* occur. Characteristic trees are *Coccothrinax elegans, Tabebuia albicans, Alvaradoa arborescens, Ficus jacquinifolia, Plumeria ekmanii* and *P. filifolia, Swietenia mahagoni, Pithecellobium cubense, Zanthoxylum spinosum, Colubrina elliptica, Catalpa brevipes, Hyperbaena cubensis, Helietta glaucescens, Thouinia trifoliata, Cordia alliodora, Dendropanax arboreus, Savia erythroxyloides,* and

Strempeliopsis strempelioides. In the shrub layer *Bernardia dichotoma, Eugenia maleolens* and *Forsteronia corymbosa* are dominant. Additional species are several local endemics *(Neobracea susannina, Malpighia acunana, Rhytidophyllum mogoticola, Lunania cubensis)*, and more than 20 lianes (e.g., *Marcgravia rectiflora, Byttneria microphylla, Tournefortia volubilis, Selenicereus grandiflorus, S. urbanianus, Serjania diversifolia, S. crassinervis, Philodendron lacerum, Ph. krebsii, Cissampelos pareira,* and *Anguria pedata)*.

22.4.4 Montane karstic forests *(Tabebuio—Garryetum)* (Table 25, col. 27)

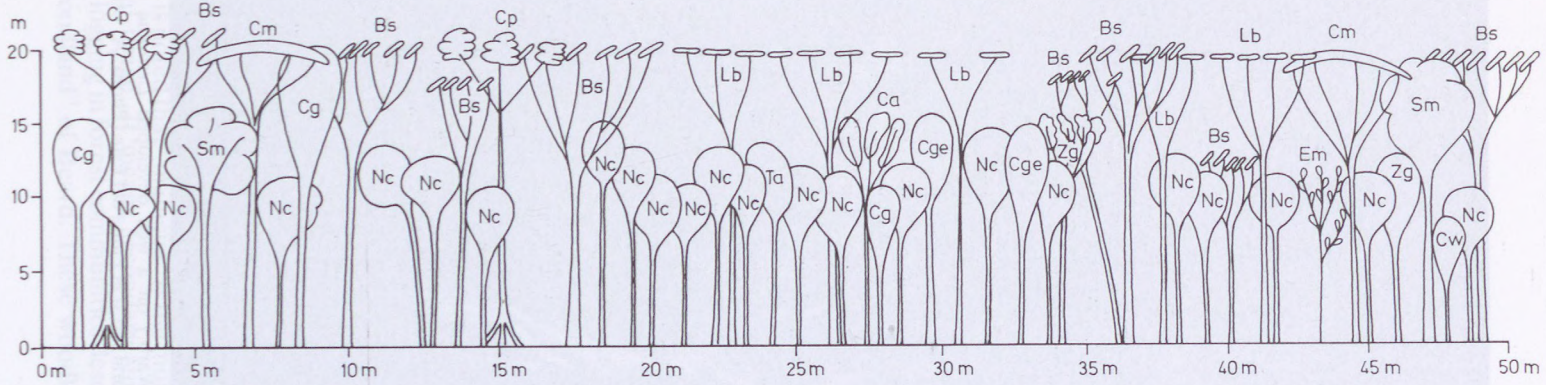
These occur in the karsts situated in the montane rainforest zone or at its margin. Annual mean temperature is 19—21 °C, average annual precipitation is 2000 mm, and evenly distributed. A single stand was examined in Pico Potrerillo, Sierra Escambray, at an elevation between 850 and 930 m. It is characterized by a 6—8 m high loose canopy layer composed of drought-tolerant deciduous trees. A highly dense, 2—3 m high shrub layer containing many montane rainforest elements occurs beneath the trees. The rocks, logs and trunks are covered with rich moss assemblages, many rainforest epiphytes *(Pleurothallis* spp., *Lepanthes* spp., *Guzmania monostachya, G. lingulata, Catopsis nitida)*, and hygrophilous herbs *(Begonia, Peperomia, Pilea,* ferns). Characteristic elements are *Thouinia clarensis, Garrya fadyenii, Berberis tenuifolia, Dendropanax arboreus, Coccothrinax trinitensis, Terminalia neglecta,* and *Ocotea floribunda* in the canopy layer, and *Ilex clementis, Tabebuia sauvallei, Bernardia dichotoma, Savia sessiliflora, Citharexylum matheanum, Erythroxylon clarense, Karwinskia potrerilloana, Sapium leucogynum,* and *Psychotria martii* in the shrub layer.

22.5 Dry forests and shrubwoods

These are the forest communities of arid zones, but are also found elsewhere if edaphic conditions are poor (shallow soils). In the arid zones the climate is seasonal with one dry season in the winter or with two dry seasons; the number of dry months is five to nine, annual precipitations may also develop on serpentines or in the coastal zone even though climate is more humid in these places. Dominant are the microphyllous and nanophyllous trees and shrubs, most of them being sclerophyllous evergreens or having compound leaves (e.g., *Mimosaceae* and *Caesalpiniaceae*). Spinose elements are common, reaching as much as 33% of the presence scores, especially on serpentine. Epiphytes, mosses and cacti are very poorly represented. The liane flora, however, is rich with drought-resistant herbaceous life-forms predominating.

22.5.1 Dry evergreen forests *(Eugenio—Metopietalia toxiferi)* (Table 25, cols 37—38)

10—18 m high forest with one or two canopy layers. They occur on limestone rendzina and humic carbonate soils or shallow red ferrallitic soils, usually close to the coasts. These forests correspond to the "dry evergreen forests" and "littoral forests" described by Beard (1944), and to the "dry limestone scrub forests" of Asprey and Robbins (op. cit.). Ciferri's (1936) "foresta subxerofitica" associations also belong to this group. The dry evergreen forests are widespread along the rocky coasts of Cuba and even in the higher terraces looking on to the sea in Oriente, especially at Cabo Cruz and Maisi. The height of trees is 15—18 m if two canopy strata occur, or 8—12 m in a single layered canopy. Characteristic constituents are the Mimosaceae and Caesalpiniaceae which dominate the canopy layer, and other sclerophyllous trees. The most widespread community is the 12—18 m high *Lysilomo—Burseretum simarubae* (Table 25, col. 37) association, the climax stage of the successional sere on littoral rocks. In structure, dry evergreen forest is similar to the semi-deciduous forests. (Fig. 299) Depending on soil depth and human impact the structure and floristic composition of the stands are highly variable. Constant and common species of the canopy layer are *Bursera simaruba, Lysiloma bahamense, Thrinax radiata, Ficus aurea* (Fig. 300), *Capparis cynophallophora, C. flexuosa, Coccoloba diversifolia, Chrysophyllum oliviforme, Tabernaemontana amblyocarpa, Caesalpinia vesicaria, C. bahamensis, Ateleia gummifera, Pithecellobium lentiscifolium, Carpodiptera cubensis, Hypelate trifoliata,* and *Hippomane mancinella.* Prominent elements of the shrub layer and the lower canopy level are *Amyris balsamifera, Ateramnus lucidus, Eugenia maleolens, E. axillaris, Bourreria succulenta, Croton lucidus, Cordia globosa* ssp. *humilis, Plumeria emarginata, Lantana involucrata, Exostema caribaeum, Erythroxylon areolatum, E. rotundifolium, Caesalpinia pauciflora, Solanum bahamense, Adelia ricinella,* and *Schaefferia frutescens.* Of the 25 liane species *Caesalpinia crista, Pisonia aculeata, Morinda royoc, Solandra longiflora, Smilax havanensis,* and *Jacquemontia jamaicensis* are shallow and rocky soils, the forest canopy is uneven rather open and 6—10 m high. (Fig. 301) An example is the *Krugiodendro-Drypetetum* association described by Ciferri (1936) from Hispaniola, which is similar to the communities found at Maisi and in the Guanahacabibes Peninsula. The *Swietenio-Metopietum brownei* association (Table 25, col. 38) is of similar distribution to the former community and it is found in the southern part of Isla de Pinos, in the Zapata Peninsula and the nearby southern coasts. Characteristic trees are *Swietenia mahagoni, Metopium brownei, Picrodendron macrocarpum, Krugiodendron ferreum, Pithecellobium cubense, Terminalia neglecta, Bucida spinosa, Nectandra coriacea, Elaeodendron attenuatum* s.l., *Acacia farnesiana, Peltophorum adnatum, Linociera ligustrina, Belairia ternata, Pseudocarpidium wrightii. Manilkara jaimiqui, Capparis* and *Erythroxylon* species, *Gyminda latifolia, Chrysobalanus icaco,* and *Canella winterana.* Of the palms *Coccothrinax litoralis* and *Sabal parviflora* are common, the latter occurring in habitats with stagnant water in the summer. The shrub layer is rich in species, the commonest plants being spiny shrubs and lianes, such as *Coccoloba armata, Jacquinia aculeata* and *J. stenophylla, Malpighia cubensis, Zanthoxylum fagara,*



Bs Bursera simaruba (L.) Sargent.
Ca Colubrina arborescens (Mill) Sarg.
Cg Cupania glabra Sw.
Cge Cordia gerascanthus L.
Cm Cedrela mexicana M. J. Roem.
Cp Cecropia peltata L.
Cw Canella winterana (L.) Gaertn.
Em Eugenia maleolens Poir.
Lb Lysiloma bahamensis Benth.
Nc Nectandra coriacea (Sw.) Griseb.
Ta Tabernaemontana amblyocarpa Urb.
Zg Zuelania guidonia (Sw.) Britt. & Millsp.

Fig. 299 Structure profile of an anthropically influenced dry variant of a deciduous lowland forest on limestone, (*Lysilomo-Burseretum simarubae* association) at 10—12 m a.s.l. the Zapata Peninsula, near Soplillar (Borhidi, Del Risco and Ovideo)



Fig. 300 Strangler fig (*Ficus aurea* Warb.) on a well developed *Lysiloma bahamense* tree in a semi-deciduous sublittoral forest at Punta del Este (Photo: A. Borhidi)



Fig. 301 Semi-deciduous sublittoral limestone forest in the Zapata Peninsula near Playa Girón (Photo: A. Borhidi)

Caesalpinia crista, C. bonduc, Leucocroton microphyllus, Comocladia dentata, Randia aculeata, Brya ebenus, etc. The dry coastal forests of northern and southern Oriente may also be assigned to this vegetation type. These are rich in Acacia species (*A. roigii, A. curbeloi* and *A. cupeyensis* between Puerto Padre and Banes; *A. lutea* and *A. seifriziana* at Maisi, and *A. cowellii* at Santiago de Cuba). The floristic composition of these communitites is not known exactly, but there is an obvious similarity to the *Phyllostylon-Acacia* and *Acacia-Krugiodendron* associations reported from Hispaniola by Ciferri. The 'thorn scrub' of Asprey and Robbins also overlaps the dry evergreen forests *(Acacia–Prosopis).*

22.5.2 Dry, thorny limestone shrubwoods *(Lantano—Cordietalia)* (Table 25, col. 39)

This is the dense vegetation composed of thorny, sclerophyllous, small-leaved trees and shrubs occurring on bare rocks of dry limestone terraces and the lowland karstic "dogtooth" formations. The 2—3 m high shrubs and the emergent individuals or groups of 5—6 m high "rod like" trees form an unpenetrable vegetation mosaic described under various names in the literature. In Cuba these are usually called the "manigua" or "manigua costera", the latter used for coastal shrubwoods. (It is noted that "manigua" is the more correct term in the sylvicultural and geographical usage. It means secondary shrubwood, mainly degraded ones developed after logging in forest communities described in 22.1.5. This corresponds to the "thorn woodland" of Beard. These woodlands are best developed under a



Fig. 302 Deciduous thorn scrub forest in the littoral limestone belt of Daiquiri (Photo: A. Borhidi)

climate of two dry seasons which together are 7—8 dry months and an average annual precipitation of 600—800 mm. Columnar or tree-shaped cacti may also occur under a loose canopy layer or intermingled with shrubs in some closed fragments of the community. Cacti, however, are never dominant in this vegetation. Smaller stands of this vegetation type are found in the northern coastal zone of Habana and Matanzas and is southern Matanzas and Las Villas. Extensive unbroken stands occur in Oriente between Puerto Padre and Gibara, and in the southern terraced coast between Cabo Cruz and Maisi. The latter was examined at several localities, the relevés taken are summarized in col. 39 of Table 25. This formation is very rich in species. A number of noda, one gradually transformed to the other, may be defined (Fig. 302). Characteristic trees are *Picrodendron macrocarpum, Cordia leucosebestena, Colubrina elliptica, Maytenus buxifolia, Polygala cuneata, Auerodendron cubense, Erithalis fruticosa, Cassia emarginata, Ateramnus lucidus, Pseudocarpidium wrightii, P. avicennioides, P. multidens, Diospyros grisebachii, Spirotecoma spiralis,* and *Thouinia pseudopunctata.* Main elements of the shrub layer are *Croton lucidus, C. rosmarinoides, C. myricifolius, Jacquinia berteroi, J. maisiana, Eugenia cowellii, Exostema spinosum, Grimmeodendron eglandulosum, Polygala guantanamana, Erythroxylon minutifolium, Bellonia spinosa, Pithecellobium hystrix, Calliandra colletioides, Randia spinifex, Oplonia polyece, Tabebuia myrtifolia, T. polymorpha, Cordia globosa, C. pulverulenta, C. brittonii, C. leptoclada, Bunchosia linearifolia, Plumeria* and *Savia species, Coccothrinax fragrans, C. munizii, C. microphylla,* and *Lantana involucrata.* Of the succulents *Agave underwoodii, Melocactus harlowii, M. borhidii, Harrisia fernowii,* and in some places *Dendrocereus nudiflorus* and *Ritterocereus*

hystrix occur. The number of herbs and drought-tolerant epiphytes (e.g., *Tillandsia circinnata, T. balbisiana, T. recurvata, T. flexuosa, T. pruinosa*) is low. Of the 30 lianes more common are *Mesechites rosea, Aristolochia clementis, Helicteres semitriloba, Stigmaphyllon* spp., *Passiflora santiagana, P. cuprea, P. suberosa, P. multiflora, Distictis rhynchocarpa, D. gnaphalantha, D. lactiflora, Gayoides crispum, Jacquemontia jamaicensis,* and *Morinda royoc* etc.

22.5.3 Dry lowland serpentine shrubwoods *(Phyllantho—Neobracetalia)* (Table 25, cols 31—34)

These communities occur on red ferrallitic soils derived from serpentine in several isolated spots from the Cajalbana Hills to the Holguin serpentine area in Oriente. The climate is characterized by a single dry season (or two in the east) with 1—2 to 5—6 dry months and annual precipitation averaging 1000—1600 mm a year. Aridity tends to increase towards the east. This vegetation type, called the 'cuabales' in Cuba, corresponds to Beard's 'dry evergreen scrub forest' or 'scrub woodland', which is a zonal community on limestone with an annual precipitation of 600—1000 mm. It is characterized by a dense, 2—4 m high, closed shrub layer, smaller emergent palms, dwarf palms and 4—6 m high microphyllous evergreen trees. Contrary to the limestone shrubwoods, the physiognomy of serpentine scrub woodlands is quite uniform despite the great differences in climate, soil and floristic composition. The proportion of microphylls and spiny elements is even higher than in the limestone formation. The only major difference is the absence of cacti (except of *Melocactus* species) that usually cannot tolerate the high water retention power (osmotic pressure) of soils derived from serpentine. Another structural characteristic of serpentine scrubs is that the stands alternate with small grassy clearings, these can be transformed into dwarf-grass savannas later by human interference and grazing. Common characteristic species of the lowland serpentine scrubs are *Neobracea valenzuelana, Phyllanthus orbicularis, Annona bullata, Rondeletia camarioca, Eugenia camarioca, Zanthoxylum dumosum* s.l., *Cynanchum ophiticola, Passiflora cubensis, Ipomoea carolina* ssp. *ophiticola, Tabebuia lepidota, Coccothrinax miraguama,* and *Malpighia nummulariifolia,* etc. Two vegetational noda, differing in their past flora development, may be distinguished. The serpentine scrubs of western Central Cuba are included in the *Coccothrinaci-Tabebuion lepidotae* alliance (Table 25, col. 31) containing *Coccothrinax miraguama* ssp. *roseocarpa, Ottoschmidtia dorsiventralis, Leucocroton havanensis, Anemia cajalbanica,* and *Eugenia sauvallei,* etc. (see also phytogeographic district B.1.1.). Those of the eastern part of Central Cuba belong to the *Guettardo—Jacarandion* cowellii nodum which includes three local associations, *Rondeletio-Guettardetum clarensis* (col. 32) in Las Villas, *Copernicio-Tabebuietum trachycarpae* (col. 33) in Camagüey, and *Acacio belairioidi—Spirotecometum holguinensis* and related communities, (col. 34) at Holguin, all these occur solely in sites not disturbed by grazing. (Most of the common and vicarious character species have been listed in the discussion of phytogeographic subsector B.3/a and districts B.3.1—B.3.3.).

22.5.4 Semi-dry lowland serpentine shrublands *(Ariadno—Phyllanthetalia)* (Table 25, col. 17)

Evergreen shrublands developed almost exclusively on the ferritic latosols of the coastal zone north of the Moa Mts, and on the semi-humid serpentine rendzinas in the hilly and lower montane zones of the Sagua-Baracoa range. Precipitation averages 1400—1900 mm a year, one or two dry months occur in the spring or early summer. These communities are rather similar to the dry lowland serpentine shrubwoods in physiognomy. However, while the latter are characterized by equal proportions of microphylls and nanophylls, more than 30% of spiny plants, and the occurrence of grassy clearings, in the semi-dry lowland serpentine shrubwoodland microphylls are dominant, the percentage of spiny species is hardly over 10%, and no clearings are present. The ancient endemic flora has originated from Moa, and moved along the coast in both direction. In the dry vegetation type the proportion of endemics reaches 35—40%, in the semi-dry type endemics account for as much as 75—85% of the flora. In Cuba this formation is the richest in endemics. Main constituents are several species of small trees and shrubs (Fig. 303). Common or abundant elements are *Hemithrinax savannarum H. rivularis, Acrosynanthus minor, Tabebuia linearis, Antirhea abbreviata, A. orbicularis, Phyllanthus comosus, P. chryseus, Purdiaea velutina, Shaferocharis multiflora, S. villosa, Kodalyoden-*



Fig. 303 Evergreen sclerophyllous shrub on the serpentine of Yamanigüey river, with *Thrinax rivularis* (León) Borhidi palms (Photo: A. Borhidi)

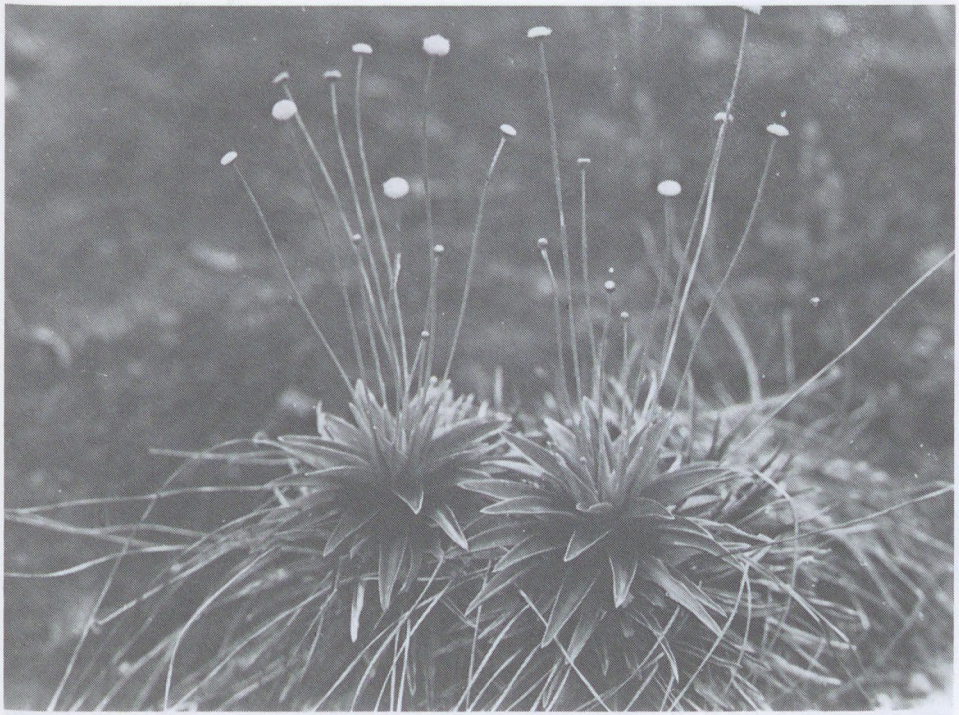


Fig. 304 Paepalanthus brittonii Mold. an endemic herbaceous plant of the coastal pine forests of the Yamanigüey river (Photo: A. Borhidi)

dron cubense, Ceuthocarpus involucratus, Exostema purpureum, Neobracea valenzuelana, Spirotecoma apiculata, Jacaranda arborea, Coccoloba shaferi, C. nipensis, C. acuna, Cassia bucherae, Byrsonima bucheri, Suberanthus stellatus, Casasia jacquinioides, C. nigrescens ssp. *moaënsis, Dipholis cubensis, Moacroton leonis, Pachyanthus moaënsis,* and *Miconia javorkaeana (Graffenrieda cordifolia).* In the herb layer *Paepalanthus brittonii* (Fig. 304), *Machaerina cubensis* and *Rhynchospora* species are found. A special feature of this plant community is that only very few lianes and epiphytes are present. This fact also emphasizes the difference between the dry and semi-dry lowland serpentine shrubwoods.

22.6 Semi-desert cactus scrubs *(Consoleo—Ritterecereion hystricis)* (Table 25, col. 40)

The cactus scrubs form an unbroken stretch along the coast from the Guantánamo Bay to Imias. From Imias to Maisi smaller fragments occur, especially on the sand deposits of the coastal areas. The small trees and shrubs constitute an open vegetation. Succulents, mainly cacti, are co-dominant or even dominant in both the shrub and canopy layers. This vegetation type is identical with Beard's 'cactus



Fig. 305 Dry cactus scrub at Baitiquiri, with old individuals of *Ritterocereus hystrix* (Haw) Britt. and Rose (Photo: A. Borhidi)



Fig. 306 Guayacum officinale L., a characteristic tree of the dry thorn scrubs and forests in the southern coastal belt of Baracoa (Photo: A. Borhidi)

scrub', the 'cactus-thorn scrub' described by Asprey and Robbins, and partly with Ciferri's 'foresta iperxerofitica'. According to Knapp (1964, 1965) and Hueck (1966) Hueck and Seibert (1972) these scrubs belong to the semi-desert formations and constitute an integral part of coastal semi-deserts in the Caribbean. Several geographically separated associations occur depending on whether the soil is rocky or sandy and on the duration of dry periods. On sandy soils *Rittereocereus hystrix,* (Fig. 305), *Opuntia dillenii, O. militaris, Cylindropuntia histrix* and *Rhodocactus cubensis* are dominant, the sparse herb layer is composed of grasses. Most of the sporadically distributed trees and shrubs are members of the families Caesalpiniaceae and Capparidaceae, e.g., *Caesalpinia pinnata, C. pauciflora, Capparis flexuosa, C. cynophallophora,* and also *Guajacum officinale* (Fig. 306). Dominant species of rocky habitats are *Consolea macracantha* (Fig. 307) *Dendrocereus nudiflorus, Pilosocereus brooksianus, Harrisia fernowii, Agave albescens,* and *Melocactus acunae,* the latter two in the herb layer. The shrub flora is very rich, in addition to those mentioned above the *Jacquinia, Gochnatia, Cordia, Guettarda,* and *Lantana* species, and emergent *Coccothrinax* palms *(C. hiorami, C. munizii, C. alexandri)* are abundant.



Fig. 307 Consolea macracantha (Griseb.) Berger, a tree shaped endemic cactus of the cactus-scrub communities of Cuba (Photo: A. Borhidi)

22.7 Coniferous forests

The primary production and complexity of coniferous forests is lower than those of the climax forests expected under the given climatic conditions. They occur only on nutrient-poor acidic soils, either on quartz sands, slates and sandstones as subclimax communities, or as paraclimax communitites on ferritic soils. The geographical range of coniferous forests is bipolar, being restricted to the eastern and western ends of the island, where, at the same time, they are the dominant vegetation type.

22.7.1 *Pinus tropicalis* forests on sand *(Acoelorrapho—Pinion tropicalis)* (Table 25, col. 1)

This type is found in the western coast of Isla de Pinos, in a narrow strip north of the Lanier Swamp, in the Guanahacabibes Peninsula and the southern plains of Pinar del Rio. The soil is light gray quartz sand with low nutrient content and marked seasonal fluctuation of moisture. The natural pine forests, 'clear pine forests', had a loose canopy layer. As a result of logging they have been replaced by 'pine woodlands' with an even looser canopy (less than 30%), or by srub and savannas. Contrary to the general view, expressed in Beard (1953) following the soil surveys of Bennett and Allison (1928) and other sources, the original vegetation was by no means a sort of pine savanna (cf. Samek, 1969). Samek distinguishes between two vicarious associations: the *Eragrosti cubensi—Pinetum tropicalis* community (ined.) in Pinar del Rio, and the *Paepalantho seslerioidi—Pinetum* association (see col. 1) in Isla de Pinos. Characteristic elements of the canopy layer of both types are *Pinus tropicalis, Colpothrinax wrightii, Acoelorraphe wrightii, Tabebuia lepidophylla, Chaetolepis cubensis, Byrsonima crassifolia, B. wirghtiana.* In the latter association *Syngonanthus insularis, Cladium jamaicense, Panicum longiligulatum, Kalmiella aggregata, K. simulata, Pachyanthus longifolius, Xyris longibracteata,* and *Lyonia vaccinioides* are typical. The canopy layer of both associations is closed up to 10—30%, the cover of shrubs is similar. The herbs may cover as much as 40—100% of the ground, and some sparse lichen assemblages also occur.

22.7.2 *Pinus caribaea* and mixed oak-pine forests on slatey rocks *(Pachyantho—Pinion caribaeae)* (Table 25, cols 2—37)

These are lowland and hill forests on yellow, quartz—allitic soils derived from slatey rocks. The canopy is 60—70% closed, some palms and evergreen trees are intermingled with the pines. The cover of the rich shrub layer may be as much as 50%. The cover of herbs is close to 100% in the drier, convex orographical formations. The Isla de Pinos representative of this vegetation type is the *Pinetum cariba etropicalis* association (Samek 1969). Characteristic species are *Pinus tropicalis, Pinus caribaea, Acoelorraphe wrightii, Coccothrinax miraguama,*



Fig. 308 Purdiaea cubensis (A. Rich.) Planch. a characteristic endemic element of the West Cuban pine woodland (Photo: A. Borhidi)

Curatella americana, Byrsonima crassifolia, Tetrazygia delicatula, Roigella correifolia, Croton craspedotrichus, Chamaesyce pinariona, Clitoria laurifolia, Evolvulus sericeus, Phyllanthus junceus, Zamia silicea, Panicum aciculare, Lyonia myrtilloides, Xylopia aromatica, Desmodium barbatum, Eriosema crinitum, Herpyza grandiflora, Trachypogon filifolius, and *Leptocoryphium lanatum.* In Pinar del Rio this community is replaced by mixed oak-pinewoods, *Querco sagraenae–Pinetum* (Table 25, col. 3), that become oak gallery forests in the moist habitats of valleys. Typical species are *Pinus tropicalis, P. caribaea, Quercus sagraeana, Rhus copallina* ssp. *leucantha, Xylopia aromatica, Roigella correifolia, Tabebuia lepidophylla, Befaria cubensis, Vaccinium cubense* ssp. *ramonii, Tetrazygia delicatula, Miconia ibaguensis, Conostegia xalapensis, Byrsonima crassifolia, B. pinetorum, Davilla rugosa, Psidium salutare, Clidemia neglecta, Hypericum styphelioides* s. str., *Lygodium cubense, Pachyanthus poiretii, Chrysobalanus pellocarpus,* and *Odontosoria wrightiana.*

22.7.3 *Pinus caribaea* forests on ferritic soils *(Neomazaeo—Pinetum caribaeae)* (Table 25, cols 4—5)

This is the original paraclimax coniferous forests in the Cajalbana Hills. The canopy layer is fairly closed, a 70—80% cover is usual. Some degraded stands are of a loose 'woodland' character. On ridges and slopes the shrub layer is usually poor, the herb layer is dominated by grasses. On flat areas a vegetation type with shrubs and tall grasses develops. In the valleys the shrub layer is very dense and many fern species occur. All these are variants of the *Neomazaeo—Pinetum caribaeae* climax association (Table 25, col. 4). Its characteristic species are *Pinus caribaea, Coccothrinax yuraguana, Purdiaea cubensis* (Fig. 308), *Eugenia rosariensis, Vaccinium cubense* ssp. *ramonii* (Fig. 309), *Sauvallella immarginata, Neomazaea phialanthoides, Acunaeanthus tinifolius, Psidium cymosum, Tabebuia leptopoda, Anemia cajalbanica, Mitracarpus glabrescens, Phania cajalbanica, Tetrazygia coriacea, Rondeletia longibracteata, Lescaillea equisetiformis, Andropogon gracilis, Aristida refracta,* and *Rhynchospora tenuis,* etc. On steep rocky slopes the more open *Agavo cajalbanensi—Pinetum caribaeae* community (Table 25, col. 5) is found. This is rich in agaves, palms and spiny shrubs. Of the many serpentine endemics *Agave cajalbanensis, Eugenia rigidifolia, Brya ebenus, Jacquinia brunnescens, Malpighia horrida, Buxus wrightii, Zanthoxylum dumosum* s. str., *Plinia dermatodes, Machaonia dumosa,* and *Rheedia fruticosa* are characteristic here.



Fig. 309 Vaccinium cubense (A. Rich.) Griseb. ssp. *ramonii* (Griseb.) Borhidi a frequent shrub of the West Cuban pine woodlands and pine forests (Photo: A. Borhidi)



Fig. 310 Pine forest of *Pinus cubensis* Griseb. with *Coccothrinax orientalis* (León) Muñiz and Borhidi in the Nipe mountains *Anemio–Pinetum cubensis* (Photo: A. Borhidi)

22.7.4 Xerothermic *Pinus cubensis* forests *(Guettardo—Pinion cubensis)* (Table 25, cols 6, 9, 11, 13)

These are xerothermic coniferous forests on the ferritic soils of lowland and hilly serpentine areas and the more elevated, open rocky places of Sagua-Baracoa. These communitites are very rich in endemics (67.74% of the presence scores). The ratio of regional and Cuban endemics is high: RE/CE=4.2. The Greater Antillean species outnumber the Neotropical elements, their ratio being GA/Nt=1.4. The microclimate in the relatively open stands is xerothermic. The highly developed shrub layer is microphyllous; many more phanerophytes occur than hemicryprophytes (P/H=2.6). The percentage of spiny elements is over 10 %. Four associations are distinguished. *Anemio—Pinetum cubensis* (Fig. 310) includes the climax pinewoods in the foothills and submontane belt of Nipe and Cristal. Characteristic species are *Pinus cubensis, Anemia coriacea, A. nipensis, Coccothrinax orientalis, Casearia crassinervis, Rondeletia myrtacea* (Fig. 311), *Ouratea striata, Clerodendron nipense* (Fig. 312), *Lyonia macrophylla, L. nipensis, Vernonia urbaniana, Guettarda monocarpa, G. calyptrata, Bletia purpurea, B. floribunda, Plumeria clusioides, Pachyanthus reticulatus, Paepalanthus brittonii, Tabebuia shaferi, Vaccinium cubense* ssp. *cubense, Andropogon* spp., *Rhynchospora* spp., *Galactia rudolphioides, Rajania howardii,* and *Heptanthus cordifolius.* The foothills north of Moa and the hill-country of Baracoa are covered by very rich *Dracaeno—Pinetum*



Fig. 311 Rondeletia myrtacea Standl., a characteristic element of the pine forest and serpentine scrub communities of the Sagua–Baracoa (Photo: A. Borhidi)



Fig. 312 Characteristic endemic species of the *Pinus cubensis* forests: *Clerodendron nipense* Urb. (Photo: A. Borhidi)

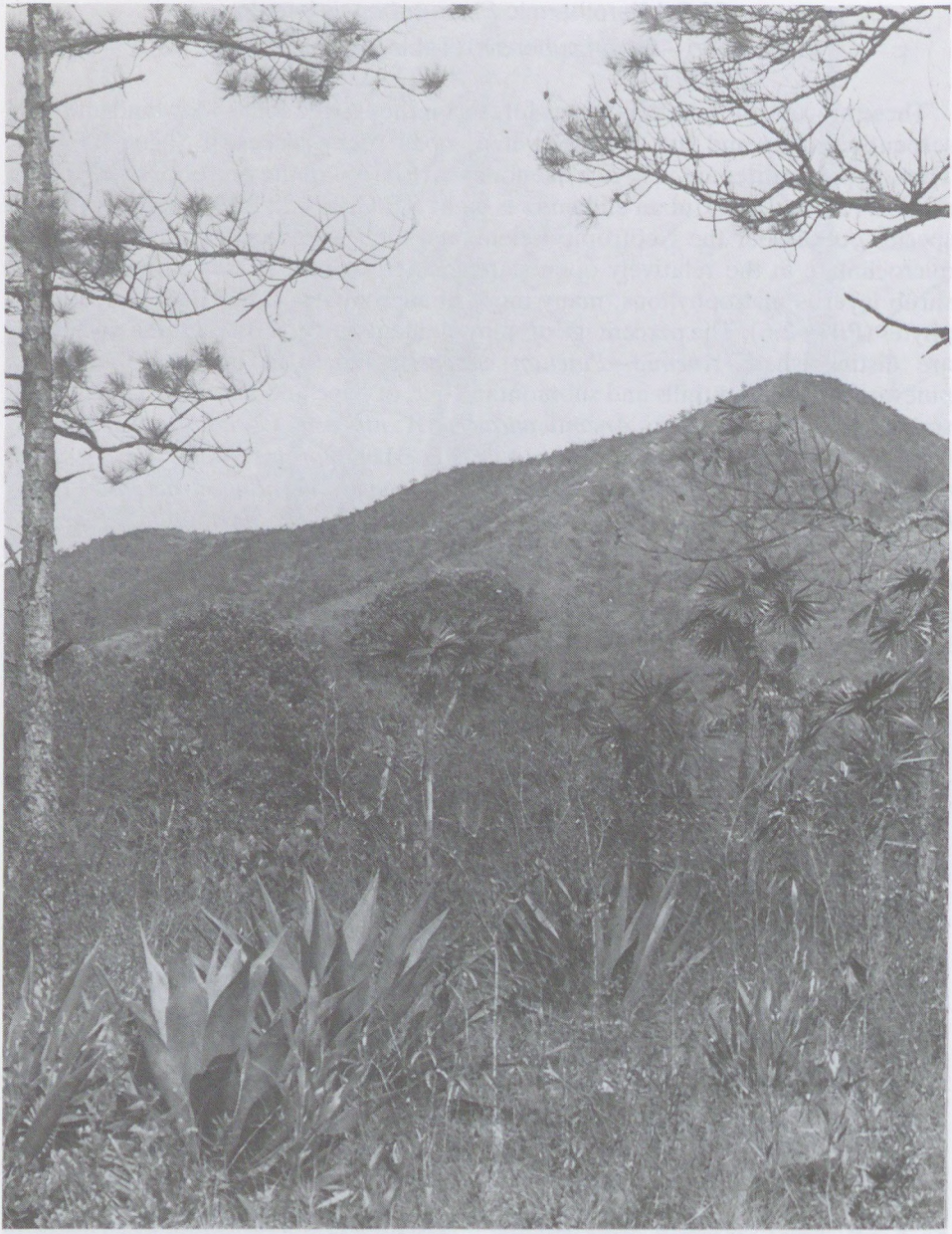


Fig. 313 Open rocky pine woodland on the serpentine of the Nipe Mountains *(Agavo shaferi–Pinetum* association), with the Loma Mensura in the background (Photo: A. Borhidi)

cubensis forests to about 400 m in altitude. The 72.4% of endemism is higher than all other Cuban coniferous forest communitites. Beneath the closed canopy there is a dense shrub layer of 40—50% cover, and a usually tall herb layer. Characteristic species are *Pinus cubensis, Dracaena cubensis, Schmidtottia, sessiliflora, Psidium parvifolium, Casearia bissei, C. moaënsis, Guettarda crassipes, Cyrilla cubensis, Ossaea pauciflora, Phyllanthus myrtilloides* ssp. *erythrinus, Jacquinia roigii, Myrtus ophiticola, Bumelia cubensis, Suberanthus stellatus, Rhynchospora lindeniana, Eugenia pinetorum, Guettarda ferruginea, Callicarpa oblanceolata,* and *Anemia coriacea* ssp. *moaensis.*

Two of the rocky coniferous forest communities (Fig. 313) may be classified into the group of the xerothermic pine forests. The *Agavo shaferi—Pinetum* association develops on the cliffs and even on the eroded mocarrero surfaces of the Nipe and Cristal mountains. Its canopy layer is loose (30—50%), the cover of shrubs is between 30 and 60%. Characteristic species are *Pinus cubensis, Coccothrinax orientalis, Agave shaferi, Ariadne shaferi, Aristida laevigata, Oplonia cubensis, Clusia nipensis, Cyrilla nipensis, Callicarpa nipensis, C. lancifolia, Eupatorium nipense, Euphorbia podocarpifolia, Gesneria nipensis, Ossaea acunae, Paspalum breve,* and *Platygyne triandra,* etc. On the eroded rocky ridges of Moa occur the *Euphorbio helenae—Pinetum cubensis* forests with dwarf palms, sometimes loose canopy, and a shrub layer of 70—80% cover. The characteristic species of this type are *Pinus cubensis, Coccothrinax yuraguana* ssp. *moaënsis, Euphorbia helenae* (Fig. 314), *Scaevola wrightii* (Fig. 315), *Croton monogynus, Coccoloba oligantha,*



Fig. 314 Euphorbia helenae Urb., a beautiful shrub of the serpentine scrubs of the Sagua–Baracoa range, with bright scarlet bracts (Photo: A. Borhidi)



Fig. 315 Scaevola wrightii (Griseb.) Maza *(Goodeniaceae),* an isolated endemic shrub of the East Cuban serpentine mountains, characteristic of the rocky pine woodland and scrub communities (Photo: A. Borhidi)



Fig. 316 Hypericum styphelioides ssp. *styphelioides,* a characteristic element of the West Cuban grasslands (Photo: A. Borhidi)

Eupatorium lantanifolium, Guettarda ferruginea, Gochnatia recurva, Hypericum styphelioides ssp. *moaënsis* (Fig. 316), *Linodendron aronifolium, Malpighia cnide, Neobracea valenzuelana, Rheedia ophiticola, Senecio trichotomus, Tabebuia pinetorum, Byrsonima minutifolia, Vaccinium alainii,* and *Vernonia wrightii.*

22.7.5 Mesophilous and montane *Pinus cubensis* forests *(Andropogono—Pinion cubensis)* (Table 25, cols 7, 8, 10 and 12)

These are natural and semi-cultured stands of the paraclimax coniferous belt between 600—900 m on the ferritic latosols of the Sagua–Baracoa serpentine mountains. The proportion of endemics (52.4% of the total of presence scores) and the ratios of regional and Cuban endemics (RE/CE=2.9) are lower than in the xerothermic *Pinus cubensis* forests. The Neotropical elements outnumber the Greater Antillean species (GA/Nt=0.8). The natural stands are more closed than those abandonned by agriculturalists and, furthermore, the herb layer is tall and dense, the phanerophyte hemicryptophyte ratio is low (P/H=1.3), the spiny elements are absent in most cases (their frequency being lower than 5%). Two climax associations are distinguished. The *Rhynchosporo—Pinetum* association includes the montane pinewoods of the Nipe and Cristal mountains. It is characterized by eight *Rhynchospora* species and the abundance of *Baccharis scoparioides, Pteridium caudatum, Andropogon reinoldii,* and *A. nashianus.* Three types are recognized within this community.



Fig. 317 General view of the Sierra de Moa from the valley of the Jiguani river, with banana plantations; pine forests in the foreground and sclerophyllous evergreen rainforest in the background (Photo: A. Borhidi)

Type *a) panicetosum* (col. 7), is found on flat and moderately sloping areas and contains *Clidemia capituliflora, Sauvagesia brownei, Panicum aciculare, P. fusiforme, P. scoparium,* and *Paspalum alainii.*

Type *b) rhynchosporetosum* (col. 8), occurs in hollows and valleys is a moister formation and has *Rhynchospora diodon, R. tenuis, R. shaferi, R. nipensis, R. lindeniana, Ternstroemia flavescens,* and *Turnera diffusa,* etc.

Type *c) euphorbietosum* (col. 10), is found on the shallow soils of mocarrero ridges, some of its species are *Euphorbia helenae, Croton borhidii, Lyonia macrophylla, Guettarda ferruginea,* and *G. calyptrata.* Type c) not recognized as a separate association, unlike the analogous situation in the Moa Mts.

In the high interior plataeux of Moa Mts (Cupeyal, upper Toa Valley) is the much richer *Shafero—Pinetum* (Fig. 317) community. The 20—25 m high closed canopy layer is a mixture of pines and many evergreen trees. A second canopy layer composed of smaller trees, such as *Bactris cubensis* and *Alsophila aquilina,* is found underneath. Characteristic species are *Pinus cubensis, Spirotecoma apiculata, Miconia cerasiflora, Shafera platyphylla, Vaccinium alainii, Lyonia glandulosa, Eupatorium ayapanoides, E. grandiceps, Clethra cubensis, Ficus wrightii, Gomidesia lindeniana, Gundlachia cubana, Hyeronima nipensis, Ilex macfadyenii, Lisianthus glandulosus, Linociera domingensis, Mettenia oblongata, Miconia* spp., *Mecranium* spp., *Ossaea navasensis, O. ferruginea, Schmidtottia multiflora, Scolosanthus lucidus,* and *Vernonia calida.*

22.7.6 Mixed tree fern-pinewoods in the montane rainforest zone *(Pinetalia occidentalis—maestrensis)*

This vegetation type has been studied only in Hispaniola Stands are formed by *Pinus occidentalis* and develops between 1500—2000 m in the rainforest zone (Urban 1923, Ekman 1930, Ciferri 1936, Marie-Victorin 1943b). Accompanying species are *Weinmannia pinnata, Garrya fadyenii* and many montane endemics. In Cuba such communities are represented by some isolated stands on the northern slopes of Sierra Maestra between 800—1300 m, on acidic yellow montane soils developed mainly on sandstone outcrops. In Pico Turquino there are stands reaching an elevation as much as 1800 m. In Grand Piedra, too, pinewoods occur in the montane rainforest zone. These have been considered *Pinus cubensis* stands, although the constituent trees may just as well be introgressive hybrids of *Pinus cubensis* and *Pinus occidentalis.* These morphologically rather diversified populations were united under the name of *Pinus maestrensis* Bisse. The variability range of its populations has been studied by A. Lopez. For the structure and composition of this vegetation type see Fig. 318 and Table 139.

22.8 Savannas and grasslands

The map shows both the original and the derived savannas and, in the latter case, indicates the original vegetation type. Based on physiognomy, two main groups of savannas can be distinguished: tall palm-tall grass savannas *(Sabalo—Roystonietea)*

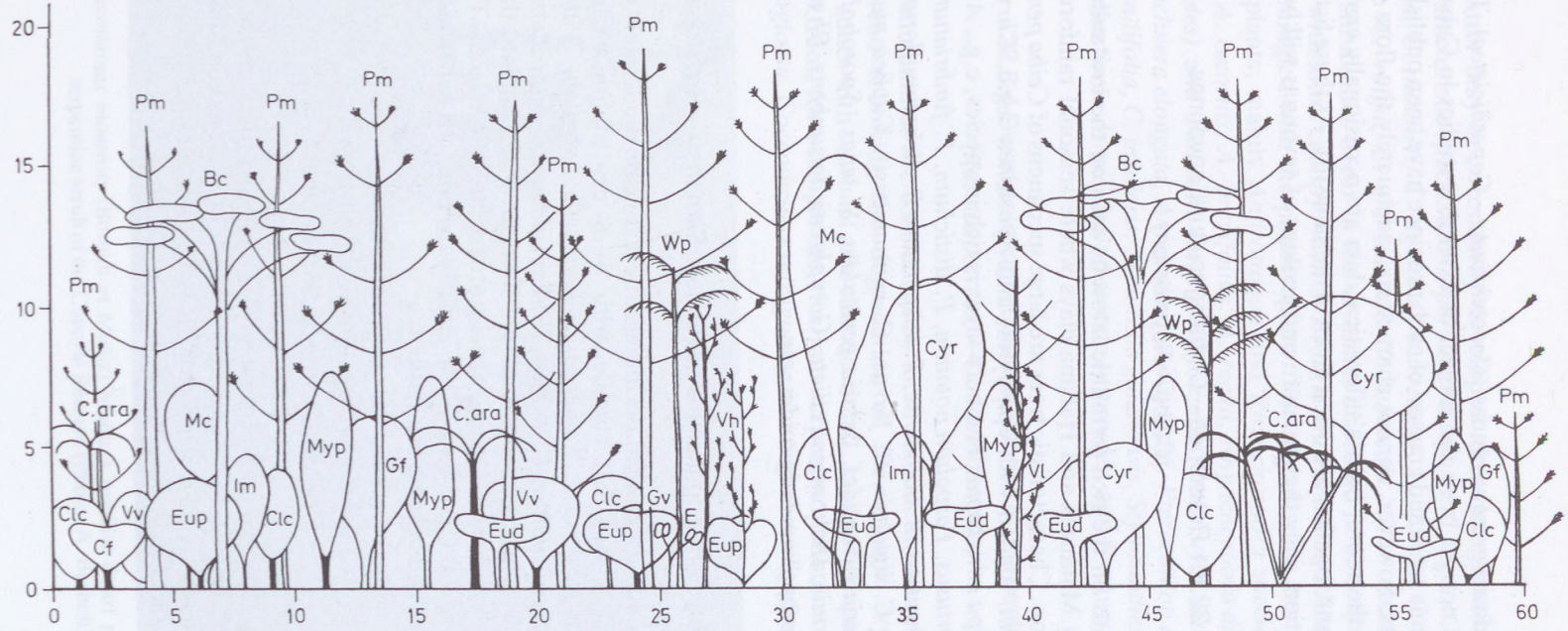


Fig. 318 Structure profile of a montane pine forest of *Pinus maestrensis* in Alto La Francia, Sierra Maestra at 1300 m a.s.l. (Borhidi 1976) C. ara=*Cyathea araneosa;* Clc=*Clethra cubensis;* Bc=*Brunellia comocladifolia;* Cyr=*Cyrilla racemiflora;* Eud=*Eupatorium dalea;* Eup=*Eupatorium paucibracteatum;* Gf=*Garrya fadyenii;* Hu=*Heterotrichum umbellatum;* Myp=*Myrica punctata;* Pm=*Pinus maestrensis;* Rf=*Rapanea ferruginea;* Vl=*Vaccinium leonis;* Wp=*Weinmannia pinnata;* Cf=*Callicarpa ferruginea;* Im=*Ilex macfadyenii;* Mc=*Myrsine coriacea;* Vv=*Viburnum villosum*

and small palm-dwarf grass savannas *(Coccothrinaci—Copernicietea)*. The floristic composition has not yet been the subject of extensive studies in Cuba, only lists containing 'savanna trees and grasses' of each province have been published (Seifriz 1943). These lists, however, cannot characterize adequately the flora of physiognomic units. Furthermore, Seifriz's floristical data are occasionally erroneous and species never found together are often given in the same list. As these lists should be treated with caution, only the structure and ecology of savannas will be described here.

22.8.1 *Roystonea—Ceiba* agricultural savannas *(Ceibo—Roystonion)*

Cultivated lands on the rich ferrallitic latosolic soils on the lowlands of central Cuba, especially Matanzas and Habana clays where seasonal rainforest was the original vegetation. Characteristic trees are large specimens of *Ceiba pentandra* and *Spondias mombin,* loaded with epiphytes, and *Ryostonea regia, Chrysophyllum oliviforme, Genipa americana.* The herb layer is rich in species, e.g., *Andropogon virginicus, A. pertusus, Paspalum notatum, P. distichum, P. fimbriatum, Panicum caespitosum, P. reptans, P. boliviense, P. adspersum, P. dichotomiflorum, Cyperus iria, C. haspan, C. ligularis, C. flavus, C. surinamensis, Cuphea melanium, C. parsonsia, Borreria ocimoides, Setaria geniculata, S. tenax, Sporobolus indicus, Reynaudia filiformis, Dichromena ciliata, Gomphrena decumbens, Rhynchelytrum roseum,* and *Macroptilium lathyroides,* etc.

22.8.2 *Roystonea* agricultural savannas *(Samaneo—Roystonion)*

These are savannas of the semi-deciduous forest zone on moderately rich siallitic lowland soils, in a seasonal climate with 4—8 dry months. Characteristic phanerogams are *Roystonea, Samanea, Peltophorum adnatum, Pithecellobium cubense, Cordia gerascanthus, C. dentata, Psidium guajava, Anacardium edule,* and *Bursera simaruba.* The components of the herb layer are mainly those of the previous type, although most *Cyperus* species are replaced by *Sclerias*. Tall savanna grasses not native to Cuba (e.g., *Panicum maximum, Hyparrhenia rufa*) are commonly planted and became established.

22.8.3 *Copernicia* agricultural savannas *(Andropogono—Copernicietalia)*

These are secondary savannas of the semi-deciduous dry forest and dry evergreen forest zone. Small fragments developed as a result of edaphic conditions, may be natural. These stands were extended by logging and burning the neighbouring forests. The secondary savannas are usually found on poor sandy or mocarrero

soils, the latter may be secondarily developed after deforestation in wet gallery forests. Characteristic species are *Copernicia baileyana, C. gigas, C. vespertilionum, C. sueroana, C. molineti, C. rigida, C. burretiana, C. textilis, C. hospita,* in some places also *C. roigii, C. clarkii,* and *C. humicola,* (The dwarf Copernicia of serpentine shrublands occur in the savannas discussed in 22.8.4). Here and there spiny trees with loose canopy, such as *Belairia mucronata* and *Acacia* species, may occur intermingled with the phanerogams. The herb layer is composed of a great variety of plants, mainly *Andropogon* and *Rhynchospora* species *(Andropogon virginicus, A. bicornis, A. brevifolius, A. reedii, Rhynchospora diodon, R. tenuis, R. cyperoides)* and *Panicum chrysopsidifolium. Fimbristylis annua, Bulbostylis setacea, Buchnera elongata, Anisantherina hispidula, Pterocaulon alopecuroideum, Cassia rotundifolia, C. insularis, Schultesia guianensis, Stylosanthes hamata, Zornia diphylla, Sebastiania corniculata, Borreria ocimoides,* and *B. thymocephala,* etc.

22.8.4 Dwarf palm agricultural savannas on serpentine *(Parvicopernicio—Coccothrinacion)*

These communitites are considered by most authors as natural savannas which rapidly spread following the degradation of the original dry shrublands of serpentine zones with seasonal arid climate. Small, 1—4 m high palms are common as standard trees, for example the vicarious serpentinophilous ecotypes of *Copernicia macroglossa, Coccothrinax miraguama* and *Copernicia glabrescens* (Fig. 195),



Fig. 319 Coccothrinax moaensis (Borhidi et Muñiz) Muñiz a peculiar dwarf palm of the montane serpentine scrub of the Cupeyal Reserve (Photo: A. Borhidi)

Matanzas, *C. hospita* ssp. *clarensis* in Las Villas, *C. yarey* in Camagüey and Oriente, *C. cowellii* and *Coccothrinax garciana C. nipensis* and *C. moaensis* (Fig. 319) in Oriente. The relatively high *Gastrococos crispa* savannas of wetter or richer serpentine soils are also included here. The herb layer is dominated by dwarf grasses, namely *Andropogon* and *Aristida* species *Andropogon hirtiflorus, A. multinervosus, Aristida neglecta, A. refracta, A. vilfifolia,* which also occur in the shrublands. Other species to be mentioned are *Imperata brasiliensis, Diodia rigida, D. teres, Solanum aculeatum, Byrsonima crassifolia, Sachsia polycephala, Ayenia euphrasifolia, Croton nummulariifolius, Leptocoryphium lanatum, Polygala saginoides, Stylosanthes hamata, Angelonia pilosella, Thymopsis thymoides, Evolvulus sericeus,* and *Zamia kickxii,* etc.

22.8.5 Pine savannas *(Pino—Aristidion neglectae)*

These secondary communities replace degraded pinewoods on yellow allite-ferritic soils on quartz and slate substrates, or on red ferrallitic soils. Scattered individuals of pine are still present, the herb layer is the same as in the previous type. (The pine savannas are not indicated as a separate category in the map, because their distinction from sandy pinewoods is less obvious and the aim is to show the potential vegetation wherever possible).

22.8.6 Natural edaphic *Sabal* savannas *(Macrocopernicio—Sabalion)*

These savannas usually develop on mocarrero soils containing an impermeable layer close to the surface and having a strong seasonal fluctuation of the water table. Most stands are found in the provinces of Pinar del Rio, Matanzas and Las Villas. The floristic composition of these formations is not sufficiently known. Characteristic elements are the dominant *Sabal parviflora,* and in the herb layer *Rhynchospora, Scleria* and *Setaria* species. Notable plants are the endemic *Cheilophyllum* species.

22.8.7 Secondary *Sabal* savannas

The wide-spread Sabal palm swamp meadows and moist pastures have been derived from the wet gallery forests of coastal zones and from the fenwood stages of the vegetational succession in boggy hollows. The floristic composition is determined by the former quality of habitats, the methods of land use and the intensity of land exploitation. Tropical black or alluvial soils, and occasionally peaty soils are typical. The secondary *Sabal* savannas are not distinguished from the gallery forests and bogs in the map.

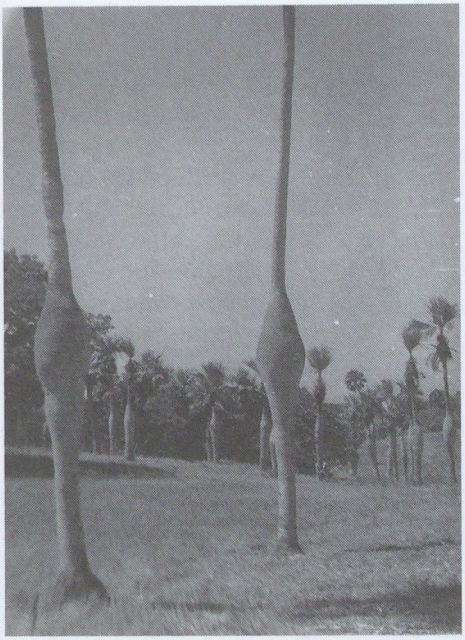


Fig. 320 Overgrazed *Colpothrinax wrightii* savanna at Consolación del Sur (Photo: A. Borhidi)

22.8.8 *Acoelorraphe wrightii* savannas

These are either degraded forms of *Acoelorrapho-Pinion* pinewoods on sands, secondary communitites derived from deforested fenwoods, or, in some cases, stages of the natural reforestation of bogs (meadows with palms and tall sedges). Being relatively small, these are included in the categories of sandy pinewoods and bogs in the map. (Fig. 320)

22.8.9 Deciduous and treeless savannas

These stands are usually the result of the complete transformation of the wet alluvial forest belt found parallel to the coasts. The origin of these savannas was revealed by the study of soils and geomorphology. Voronov (1970) describes many such areas from Camagüey and Oriente, but they are of heterogeneous origin and their separation is doubtful. These stands are shown as areas of potential alluvial forests on the map.

22.9 Freshwater vegetation formations

22.9.1 Alluvial gallery forests

These forests occur in the wide valleys of lowland rivers, especially along the Cauto, on the coastal alluvial banks of smaller rivers, and in flatlands bordered by small rivers and the coast. The soils are rich tropical black soils or tropical meadow soils (term 'meadow' refers merely to soil type and not vegetation) they are under water in the wet season and do not dry out even in the dry season. The forests, with a single canopy layer and emergent *Roystonea* palms, are 20—25 m high. In places covered by water for a longer time the height is 10—15 m and emergent *Sabal* palms occur. Most trees are partially deciduous, e.g., *Bucida subinermis, Tabebuia angustata,* and *Erythroxylon confusum.* The diverse epiphyte layer is composed mainly of drought-resistant heliophytic *Tillandsias.* Contrary to the epiphytes, the lianes are macrophyllous hygrophilous species (e.g., *Philodendron krebsii, Vanilla articulata*). Characteristic species are *Roystonea regia, Sabal parviflora, S. japa, Acoelorraphe wrightii, Bucida buceras, Hibiscus elatus, Calophyllum antillanum* ssp. *rivularis, Tabebuia angustata, Swietenia mahagoni, Guettarda combsii, Ficus subcabrida, Myrsine cubana, Tabernaemontana amblyocarpa, Crescentia cujete,* and *Conocarpus erecta.* In the herb layer *Cladium jamaicense, Acrostichum danaifolium, Nephrolepis biserrata, Enhydra sessilis, Bacopa* spp., *Hemianthus* spp., *Paspalum vaginatum, Dichromena colorata, Cyperus acicularis, C. articulatus, Fimbristylis annua, F. spathacea,* and *Aster* spp. occur. Following the removal of gallery forest trees *Roystonea* groves and savannas, second-grown *Sabal* groves and savannas, various mixed deciduous savannas (with *Bucida, Swietenia,* etc.) and tree-less savannas may develop, depending on the type of habitat and intensity of land exploitation.

22.9.2 Riverside gallery forests and derived types

The gallery forests along rivers and creeks (Fig. 321) are rich in lianes, palms and tall grasses and have only a single canopy layer. Characteristic elements are *Roystonea regia, Calyptronoma dulcis, Lonchocarpus domingensis, Lysiloma bahamense, Dalbergia ecastophyllum, Bucida buceras, Ginoria americana;* of the lianes *Arthrostylidium cubense* and *A. capillifolium,* and of the tall grasses *Gynerium sagittatum,* the latter forming dense stands like reeds. Most natural stands have been replaced by secondary vegetation, such as *Roystonea* lines, *Bambusa vulgaris* bushes, and *Arundo donax* stands. The *Calyptronoma* galleries along mountain streams have been almost completely removed. They are succeeded by dense stands of the introduced *Syzygium jambos* and by second-growth marginal stands of *Pennisetum purpureum* and *Cyperus alternifolius.*



Fig. 321 Evergreen tropical gallery forest in the valley of the Jauco river, near Baracoa (Photo: A. Borhidi)

22.9.3 Swamp vegetation complex

Just like in the temperate zone, the vegetation of bogs and swamps is a mosaic of several noda with dissimilar structure and composition which is determined by the quantity of accumulated litter. Therefore, all uliginal vegetation types are included in a single category in the map of 1 : 1 250 000. But in more detailed map swamp-mosaic may be divided into several units, as it is shown in Fig. 322. The succession starts with floating plants followed by submersed and rooted weeds of ponds. Then, *Eleocharis interstincta, E. cellulosa, Scirpus validus, S. olneyi* and later *Typha domingensis* associations follow. Skipping the Scirpus stage, *Typha domingensis* may directly form small floating stands ('marsh islets'). Along water-courses *Typha* may be replaced by *Cyperus giganteus*. The next stage of the successional sere is occupied by *Cladium jamaicensis* which grows to a height of 1.5—2 m. In sites always covered by water the *Crino—Cladietum* association is found, otherwise *Pontederio—Cladietum* develops. This is the earliest stage in which fenwood elements may be encountered, e.g., *Acoelorraphe wrightii, Chrysobalanus icaco* and *Annona glabra* (Fig. 323) and then tall *Sabal parviflora* palms *(Chrysobalano—Annonetum* Ciferri, 1936). Subsequently, high fenwoods *(Tabebuio—Bucidetum)* with *Bucida palustris, Tabebuia angustata, Hibiscus elatus, Fraxinus caroliniana* ssp. *cubensis,* and *Salix longipes* develop. In the meantime *Sabal* is gradually replaced by *Roystonea*. Logging and grazing result in boggy meadows or wet *Sabal* (or *Roystonea*) cultured savannas. On limestone substrate, bogs are succeeded by low karstic fenwoods *(Osmundo—Annonetum)* with many ferns and epiphytes. On sandy beaches of lagoons fern-palm shrubwoods *(Blechno—Acoelorraphetum* Hadač and Hadačová, 1971) represent the subsequent stage. The latter association occurs in the zone of sandy pinewoods.

22.9.4 Freshwater weed communities

Extensive stands, large enough to show in the map, are associated with the major lakes (Ariguanabo, Laguna del Tesoro). In deep water a floating layer of duckweed *(Lemno—Azolletum carolinianae, Salvietum auriculatae)* and floating mats of water-hyacinth and water-lettuce *(Eichhornietum crassipedis* and *E. azureae Pistietum stratiotidis* Ciferri, 1936) develop. Submerged floating bladderworts are also present forming communitites, of the *Aldrovando—Utricularion* alliance. In the ponds and slow streams of the Zapata Peninsula the submerged and rooted *Vallisneria* forms a community *(Vallisnerietum neotropicalis)*. Extensive aquatic communities of other localities are composed of *Cabomba piauhiensis* and *Myriophyllum sparsiflorum*. In Laguna del Tesoro *Chara* mats, submerged *Najas* populations, then *Vallisneria neotropicalis, Potamogeton nodosus* and *P. illinoënsis* are found in large multilayered stands (Fig. 324). Rooted mats of water-lily, lotus and fringed water-lily are also significant. Major constituents of freshwater weed communities are *Brasenia schreberi, Nymphaea ampla, N. odorata, Nuphar advena, Nymphoides grayanum, Nelumbo lutea, Polygonum portoricense* and *Limnocharis flava*. In the shallow coastal zone of sandy lagoons a very special floating community formed by the moss-like *Mayaca wrightii* is found.

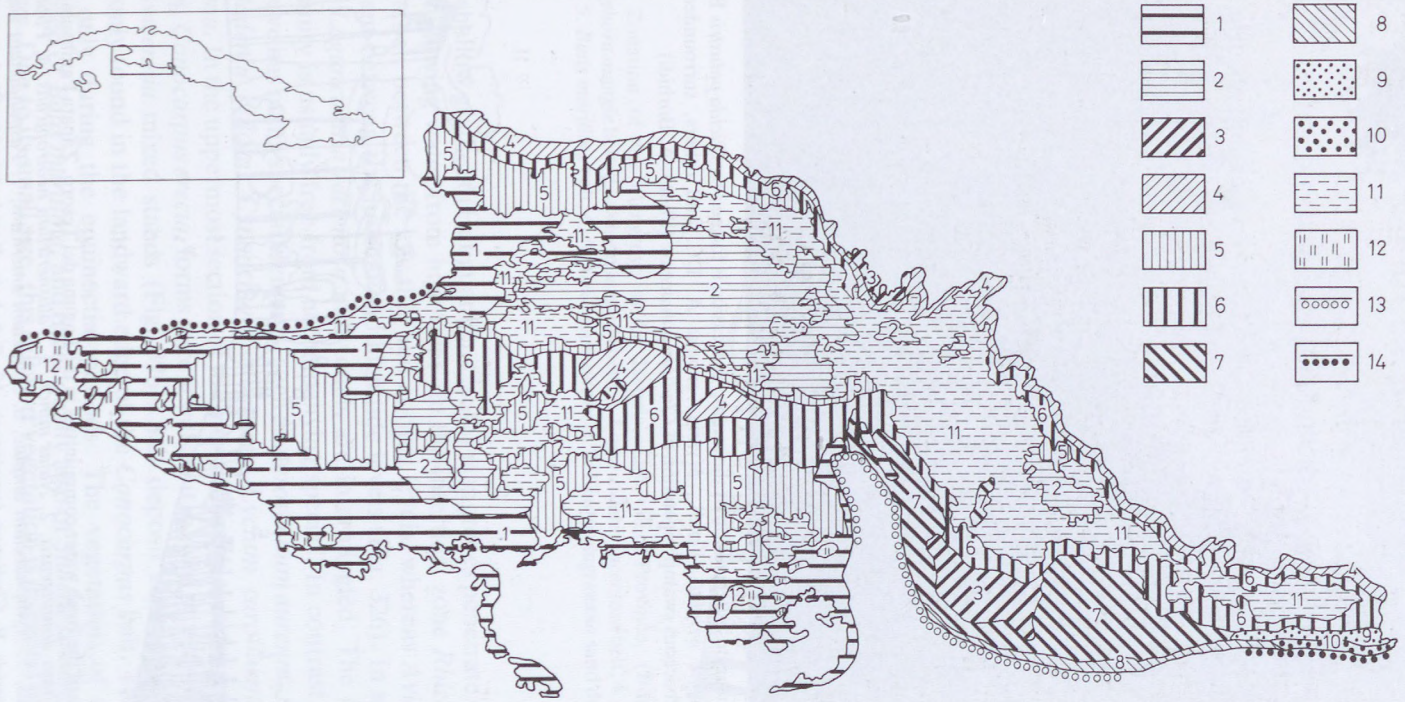


Fig. 322 The vegetation map of the Zapata-Peninsula (Del-Risco and Borhidi 1975) Legend: 1=mangroves of salt water; 2=mangroves of low salinity water; 3=tropical evergreen seasonal forest; 4=alluvial forest; 5=swamp forest on peat; 6=swamp forest on flooded limestone; 7=tropical semi-deciduous forest; 8=dry littoral forest; 9=tropical deciduous forest; 10=thorny dry limestone forest; 11=herbaceous swamp (Typha, Cladium); 12=salt marsh; 13=littoral sand vegetation; 14=littoral rock pavement vegetation. Scale: 1 : 450 000



Fig. 323 The pioneer bush vegetation of the swamp succession is formed by *Bucida palustris* Borhidi et Muñiz, *Acoelorraphe wrightii* Wendl., *Myrsine cubana* A. DC. and others, surrounded by the herbaceous swamp vegetation of *Cladium jamaicense* (Photo: A. Borhidi)

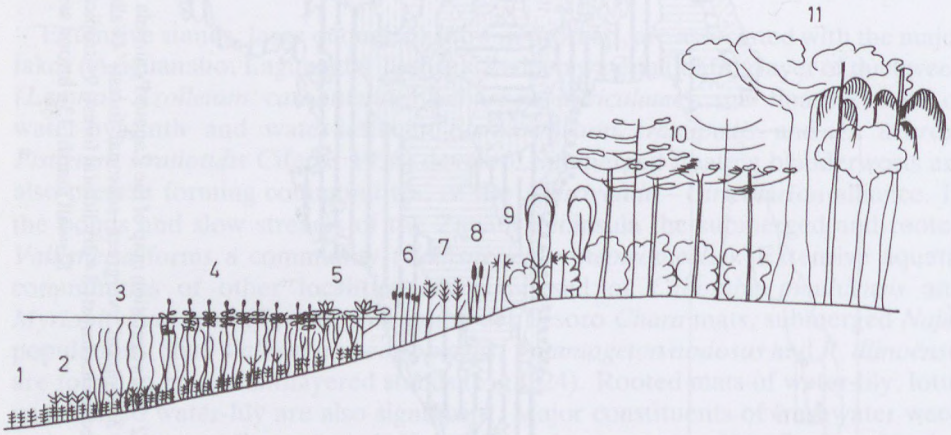


Fig. 324 Zonation of the fresh water communities in the Laguna del Tesoro, Zapata Peninsula (Borhidi and Muñiz). 1. *Chara domingensis*, 2. *Najas minor*, 3. *Vallisnerietum neotropicalis*, 4. *Potamogeton illinoësensi-nodosus*, 5. *Nymphaeetum amplae*, 6. *Scirpetum americani*, 7. *Paspalidietum vaginati*, 8. *Typhetum domingensis*, 9. *Cladietum jamaicensis*, 10. *Tabebuio–Bucidetum*, 11. *Guazumo–Ceibetum*

22.10 Coastal vegetation

22.10.1 Mangroves *(Rhizophoro—Avicennietea)*

The Caribbean mangrove vegetation, composed only of four tree species, has been studied in several localities (Ciferri 1936, Asprey and Robbins 1953, Stehlé 1945, Holdridge 1940, Dansereau 1966, Dansereau and Buell 1966, Loveless 1960, and Davis 1940, 1942). Besides floristic surveys, some reports on the growth and regeneration (Wadsworth 1959), ecology (Davis 1940) and nutrient cycling (Golley, Odum and Wilson 1962) of mangrove communities are also available. In Cuba, as elsewhere, mangrove vegetation occurs along shallow muddy beaches protected by coral reefs (Fig. 325). Here mangroves may form zones 2—3 km wide. In estuaries

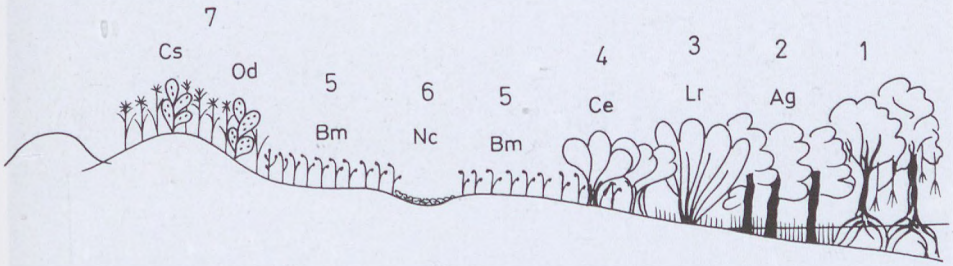


Fig. 325 Zonation of the mangrove at La Isabela, Las Villas Province, (Borhidi and Muñiz) 1. *Rhizophora mangle* belt, 2. *Avicennia nitida* belt, 3. *Laguncularia racemosa* belt, 4. *Conocarpus erecta* belt, 5. *Batis maritima* belt, 6. *Nostoc commune* belt, 7. *Chloris sagraeana* sand dune vegetation

with a shallow gradient (Hatiguanico, Cauto) mangroves penetrate deeply into the island following water from high tides. In the intertidal zone *Rhizophora mangle* forms a belt between the low tide and normal levels, whereas *Avicennia nitida* is dominant between the normal and high tide levels (Fig. 326). In some *Avicennia* stands *Laguncularia racemosa* individuals are intermingled. The *Rhizophoretum* community is usually free from accompanying species. In contrast, the *Avicennia* mangrove has many special elements, such as *Acrostichum aureum, A. danaifolium, Rhabdadenia biflora, Cynanchum salinarum, Lycium carolinianum,* and *Batis maritima.* In the uppermost section of the intertidal zone an extremely salt-resistant species, *Conocarpus erecta,* forms pure stands or it may be mixed with *Laguncularia* and *Avicennia* mixed stands (Fig. 326). Salt deposit zone up to 1 km wide is commonly found in the landward edge of the *Conocarpus* belt. This area is under water only during the equinoctial periods. The vegetation of salt deposits is composed of *Batis maritima,* and occasionally also of *Suaeda linearis* and *Salicornia perennis.* Due to its small size, this saltwort vegetation is included in the mangroves on the vegetation map.



Fig. 326 Mangrove forest of the tidal belt formed by *Avicennia germinans,* at La Isabela (North of Las Villas) (Photo: A. Borhidi)



Fig. 327 Young mangrove forest destroyed completely by sinking of water table in the Zapata Swamp. (Photo: A. Borhidi)

22.10.2 The vegetation of sandy beaches *(Ipomoeo—Mallotonietea)*

The plant communities of sandy beaches are found to be particularly well developed between Habana and Varadero, and also in the Guanahacabibes Peninsula, in the southern part of Isla de Pinos, and in several short sections of the southern coast of Cuba (Fig. 328). Two noted pioneer plants of the strand line are *Ipomoea pes-caprae* and *Canavalia maritima*. They are common in the open strand communities such as *Sesuvio—Ipomoeetum, Ipomoeo—Philoxeretum,* and *Philoxero—Unioletum virgatae*. The community type actually occurring in a site is determined by the hardness of ground, angle of slope and water supply. The next successional stage is the horse-bush scrub *(Borrichio—Mallotonietum)* with various combinations of *Borrichia arborescens, Mallotonia (Tournefortia) gnaphaloides, Spartina juncea, Turnera diffusa, Ernodea maritima, Suriana maritima, Baccharis halimifolia,* and *Sporolobus virginicus*. The primary dunes are covered by sea-grape *(Coccoloba uvifera)* scrubs. Towards the interior of the island this successional sere is terminated by dry coastal evergreen scrubs ('manigua costera'). The vegetation of sandy beaches is only shown on the map where extensive continuous stands are found.

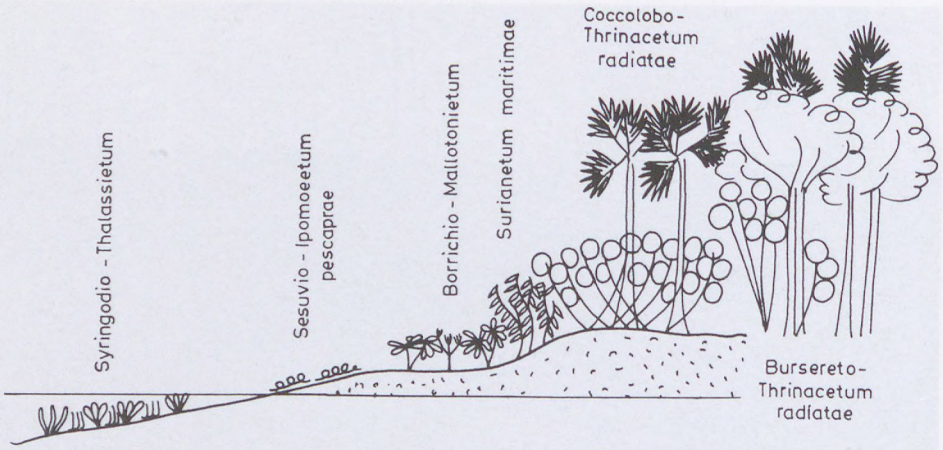


Fig. 328 Zonation of the vegetation of the sandy shores in the Casilda Peninsula, near Trinidad (Borhidi and Muñiz)

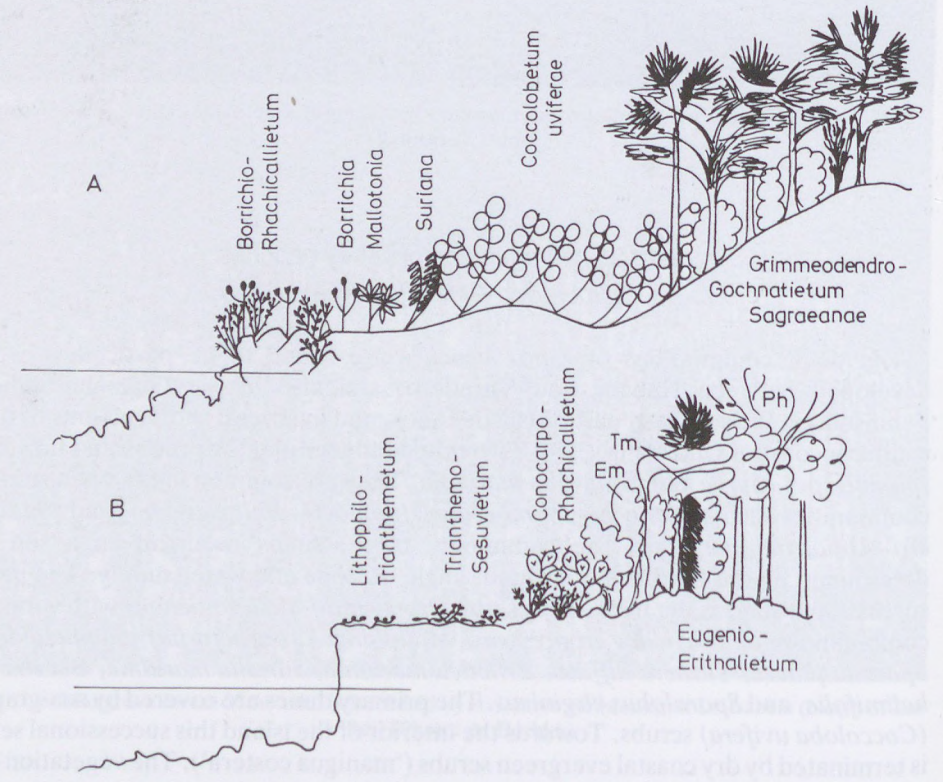


Fig. 329 Zonation of the coastal rock pavement vegetation. A: Arroyo Blanco near Jibacoa and B: Punta Guanal near Matanzas Em=*Eugenia maleolens;* Ph=*Piscidia havanensis;* Tm=*Tabebuia myrtifolia*

22.10.3 The coastal rock pavement vegetation *(Sesuvio—Rachicallietea)*

The communitites of coastal rocky slopes are especially widespread along the southern coast of eastern and Central Cuba and at Habana and Matanzas. In contrast to the sandy vegetation, which is primarily of pan-tropical character, the vegetation of coastal rock pavements is mainly of Antillean and Caribbean elements. Most constituents of the open pioneer community *(Trianthemo—Sesuvietalia)* are succulent creepers *(Lithophila muscoides, Trianthema portulacastrum, Sesuvium portulacastrum, S. maritimum)*. (Fig. 329). The next successional stage is the coastal rocky scrub *(Borrichio—Rachicallietalia)* containing *Rachicallis americana, Borrichia arborescens, Erithalis fruticosa, Strumpfia maritima, Conocarpus erecta, Flaveria linearis, Heliotropium humifusum, Pectis* spp., *Opuntia dillenii,* and *Agave legrelliana.* Many scrub associations may be distinguished. On cliffs exposed to salt-spray and winds *Rachicallis* and *Conocarpus* form a community, which is similar to some alpine creeper communities in appearance (Fig. 330). Further up these stands may reach a height of 1.5 m. Then, low sea-grape scrub follows on shallow sand. Elsewhere, e.g., in north-western and south-eastern Oriente, this sea-grape stage is skipped and thorn scrubs occur. These thorn scrubs are rich in *Mimosaceae* species.



Fig. 330 Rough dogtooth limestone area in the coastal belt of the Guanahacabibes Peninsula, near Punta del Holandés partly covered by creeping individuals of *Rachicallis americana* and *Conocarpus erecta* severely controlled by salt spray and sea winds (Photo: A. Borhidi)

23. Classification of major forest types of Cuba (with the contribution of Z. Szőcs)

23.1 The main questions of the classification

The classification of forest and shrubwood communities of Cuba, based on objective criteria, may answer several important questions:

- Is the choice of mapped vegetation units correct?
- What relationships are there between the structure and floristic composition of vegetation types?
- What conclusions may be drawn from the present day floristic composition of vegetation types about the past flora and vegetation development?

23.1.1 The vegetation categories to be classified

The based on structural features (height, number of levels, per cent closure, life forms and growth types) following the works of Davis and Richards (1933,. 1934), Richards, Tansley and Watt (1940), Richards (1952, 1959, 1961), Beard (1944, 1955), Küchler (1949), Fanshave (1954), Dansereau (1958), Webb (1959), Aubréville (1965*b*), Ellenberg and Mueller—Dombois (1966a) and Eiten (1968). Most resulting categories proved to be identical with the Neotropical forest types established and clearly characterized by Beard (1955). The semi-arid serpentine formations, was studied by Borhidi (1973, 1974, 1975, 1976; 1979, in Borhidi *et al.*, 1980, in Borhidi and Muñiz), and Berazain (1978, 1981a,b) discussed and their recognition and present description provides new phytosociological findings.

23.1.2 Problems of classifying tropical forest communities

Mapping and classifying tropical forest communities are difficult for several reasons. For example, it is doubtful if they can be characterized by any means as associations, if their objective separation is possible, and if the tropical vegetation is continuous or discontinuous (Walter 1962). The discussion of these problems is beyond the scope of this book, only a few points relevant to the topic will be made to summarize my personal experience. Ciferri's (1936) and Knapp's (1964, 1965) work seemed to suggest that a cenological approach to the analysis of tropical vegetation might be plausible. I also made an effort not only to study the structure of formations but also to reveal principles determining floristic composition and to recognize and describe associations. Such a treatment of aquatic and uliginal vegetation, coastal sandy and rocky communities, mangroves, salt prairies and most coniferous forests presents no difficulties. The situation is completely different, however, in case of tropical forests and shrubwoods dominated by a multitude of species. The floristic richness of these communities causes high diversity, making the determination of minimum areas and the recognition of

characteristic species combinations extremely difficult. As far as classification is concerned, the richness in local endemics is also a disadvantage. Having the large number of exclusive 'characteristic species' in mind, one tends to establish too many categories with a result overemphasizing geographic differences. Furthermore, the presence of many local endemics conflicts with the final goal of classification, i.e., the recognition of relationships and common features.

23.1.3 Continuity or discontinuity of Cuban vegetation

In Cuba there are relatively few synbotanical objects supporting the continuity theory of vegetation. The recognition of vegetation types and associations is usually facilitated by the great variety of reliefs, substrates and soils. For example, a sharp vegetational boundary results wherever limestone and serpentine substrates meet. However, the delimitation of associations in zonal stands of semi-arid rainforests, semi-arid serpentine shrubwoods and xeric limestone scrubs is always difficult. In these formations only higher phytosociological categories were established since results of more detailed surveys were not available.

23.2 Material of the numerical analysis

In order to answer the questions raised in 23.1. data from 267 relevés taken in 40 lignosa noda (forest and shrubwood communities) usually dominated by many species were summarized in the matrix of the Table 25. (in the Appendix.) Accidental species have been omitted from this list. The frequency or constancy values of all other species, the life-form and growth type of each taxon (38 categories altogether) and 36 chorological types are indicated. The data matrix contains nearly 85 000 entries in more than 2 000 rows (taxa) and 40 columns (communities). This matrix was analyzed from three aspects:

- Floristic composition,
- Life-form spectrum, and
- Chorological spectrum.

First, traditional tabular sorting was done and then, to avoid the problems mentioned in 23.1.2. computer techniques were used. The ordination of the 40 vegetation units was obtained by principal components analysis (PCA) with VARIMAX rotation (Lawley and Maxwell 1963, Harman 1967) using floristic data. The classification of the same set of data was based on physiognomic and chorological variables. The method was sum of squares agglomeration clustering (SSA, Orlóci 1967). The computations were performed on a CDC 3300 computer using the clustering program developed by Goldstein and Grigal (1972a).

The numerical analysis was not operational in a sense that its purposes were to justify or reject the hypothesized classification and to indicate possible corrections to be made. The results, with an exception, support the hypotheses. The only major discrepancy arises in the case of Oriente pinewoods, possibly as a result of sampling error. The hypothesized classification was corrected accordingly, and the interpretation of modified results proved fairly easy.

23.3 Results

23.3.1 Component analysis based on floristic composition data

The first five components account for 45% of the total variance. The ordination in the first three dimensions is shown by Figs 331—333. The ecological and phytosociological interpretation of these components is as follows:

a) On PCI the communities of the montane serpentine zone in Oriente, being characterized by ferritic soils and the most unique flora, are separated from the others.

b) On PCII the broad-leaved forests growing mainly on limestone or neutral soils form a separate group.

c) The lowland serpentine shrubwoods and pinewoods, i.e., communities with few strata and many hemicryptophytes, have high positive loadings on PCIII. At the opposite end of this axis relevés from extremely xeric limestone thorn scrubs are located. These communitites have also few layers and are very poor in terrestrial herbs.

d) The ordination results suggest that the floristic diversity of the vegetation of Cuba is primarily due to edaphic factors.

These are:

- Latosols, rich in heavy metals, in old serpentine areas,
- Limestone karsts and connected young limestone flatlands and coastal rocky formations,
- Younger lowland areas, poor in nutrients, on serpentines, slates and quartz sands.

It is noted that rainforests determined merely by climate (19—23) are not affected by these edaphic factors.

23.3.2 Relationships in floristic composition depicted by PCA

Relationships depicted by PCA are summarized as follows:

a) In the plane of PCI and PCII (Fig. 331) the pinewoods and serpentine shrubwoods occur in quarter I; the montane rainforests (with semi-arid and wet types clearly separated) in quarter II; the submontane rainforests in quarter III; and the broad-leaved forests of lowlands and hills of the seasonal climatic zone in quarter IV.

b) In the plane of PCI and PCIII (Fig. 332) the coniferous forests of lowlands and hills and the serpentine shrublands are found in quarter I; the montane communities in quarter II, and the forests and scrubs of the seasonal climate belt in quarter III.

c) In dimensions II and III (Fig. 333) the first quarter contains the same communities as in case b) The rainforests occur in quarter III, while the others are grouped in quarter II.

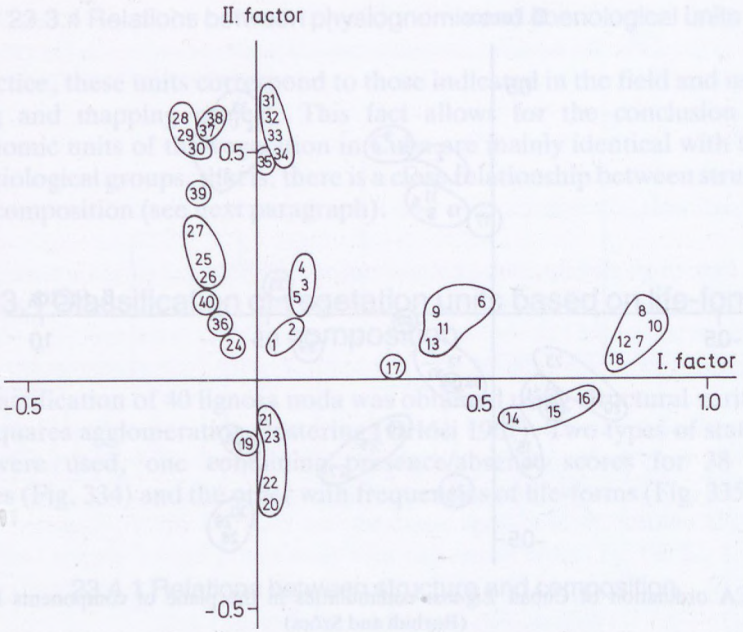


Fig. 331 PCA ordination of Cuban *Lignosa*-communities in the plane of components I and II (Borhidi and Szőcs)

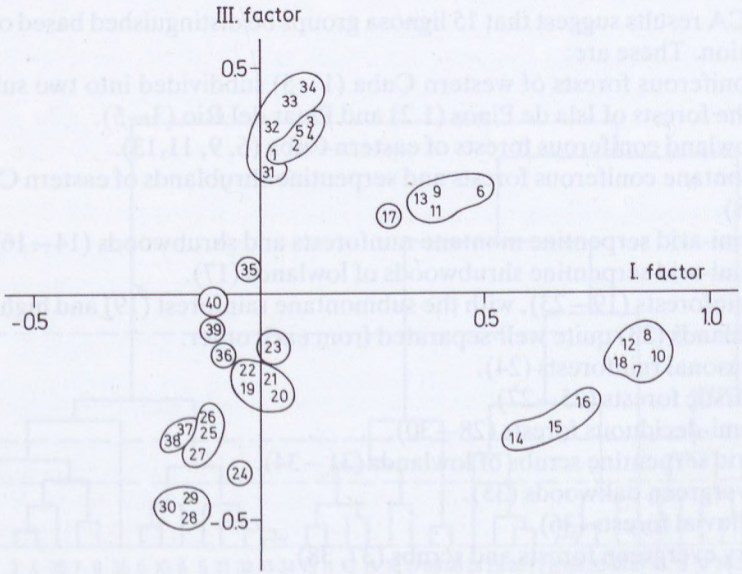


Fig. 332 PCA ordination of Cuban *Lignosa*-communities in the plane of components I and III. (Borhidi and Szőcs)

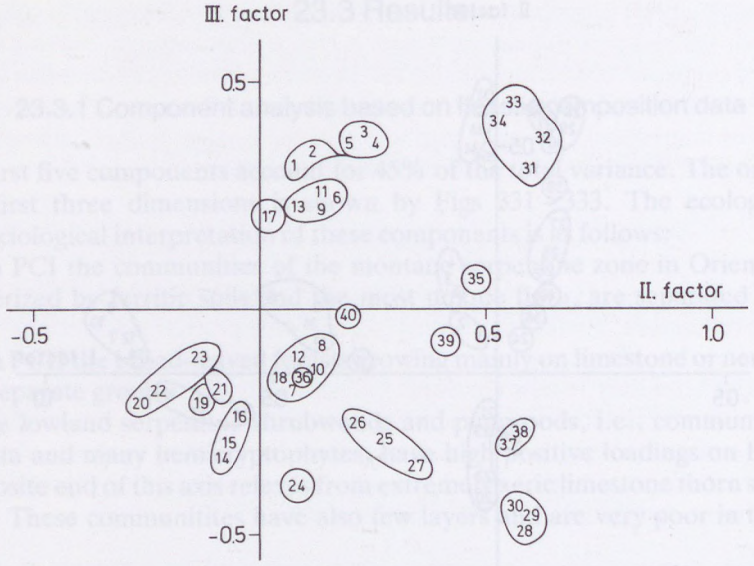


Fig. 333 PCA ordination of Cuban *Lignosa*-communities in the plane of components II and III. (Borhidi and Szőcs)

23.3.3 Grouping of the communities by PCA

The PCA results suggest that 15 lignosa groups be distinguished based on floristic composition. These are:

1. Coniferous forests of western Cuba (1—5) subdivided into two sub-groups, namely the forests of Isla de Pinos (1.2) and Pinar del Rio (3—5).
2. Lowland coniferous forests of eastern Cuba (6, 9, 11,13).
3. Montane coniferous forests and serpentine shrublands of eastern Cuba (7, 8, 10, 12, 18).
4. Semi-arid serpentine montane rainforests and shrubwoods (14—16).
5. Semi-arid serpentine shrubwoods of lowlands (17).
6. Rainforests (19—23), with the submontane rainforest (19) and high montane wet shrublands (23) quite well-separated from each other.
7. Seasonal rainforests (24).
8. Karstic forests (25—27).
9. Semi-deciduous forests (28—30).
10. Arid serpentine scrubs of lowlands (31—34).
11. Evergreen oakwoods (35).
12. Alluvial forests (36).
13. Dry evergreen forests and scrubs (37, 38).
14. Arid limestone thorn scrubs (39).
15. Semi-desert scrubs (40).

23.3.4 Relations between physiognomic and coenological units

In practice, these units correspond to those indicated in the field and used in the sampling and mapping project. This fact allows for the conclusion that the physiognomic units of the vegetation in Cuba are mainly identical with the major phytosociological groups, that is, there is a close relationship between structure and floristic composition (see next paragraph).

23.4 Classification of vegetation units based on life-form composition

The classification of 40 lignosa noda was obtained using structural variables and sum of squares agglomeration clustering (Orlóci 1967). Two types of starting data matrix were used, one containing presence/absence scores for 38 life-form categories (Fig. 334) and the other with frequencies of life-forms (Fig. 335).

23.4.1 Relations between structure and composition

The cluster analysis results suggest the following:

a) The presence and frequency of life-forms, i.e., the structural attributes of vegetation, and the floristic data yielded quite similar classifications of the lignosa noda. It also means that the different formations are composed of dissimilar floras developed as a result of long isolation and long periods of adaptation and speciation.

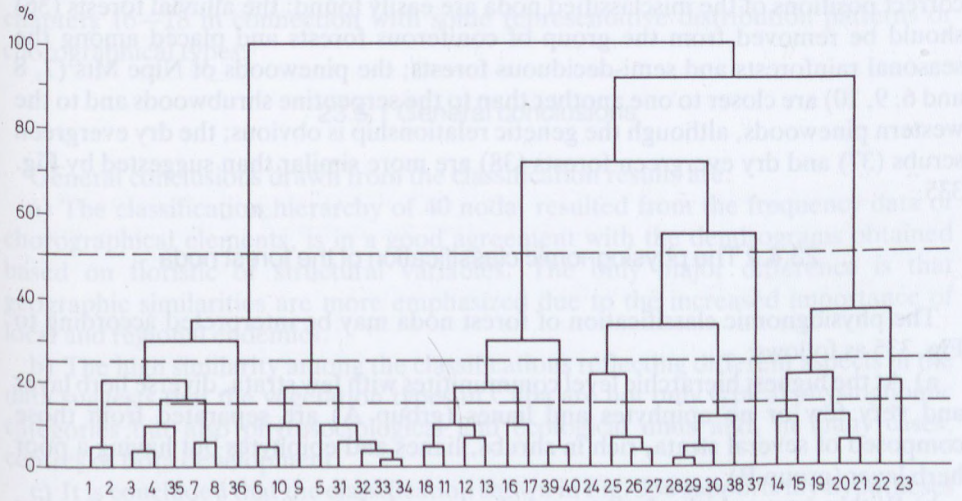


Fig. 334 Classification of Cuban *Lignosa*-communities obtained by Orlóci's sum of squares agglomeration method using the presence scores of the life-form types (Borhidi and Szőcs)

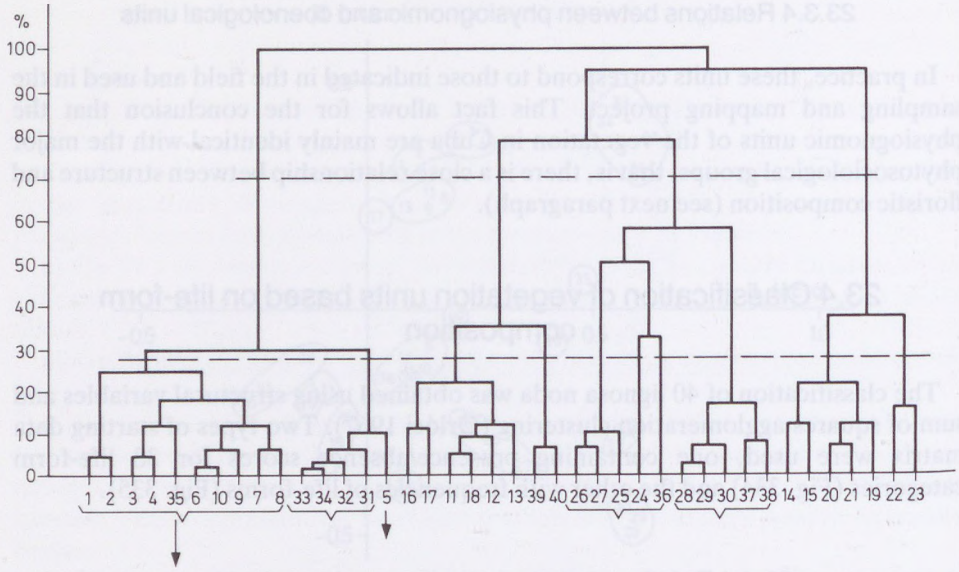


Fig. 335 Classification of Cuban *Lignosa*-communities with sum of squares agglomeration based on the frequency of life-form types (Borhidi and Szőcs)

b) The results of cluster analysis are more straightforward, more informative and easier to interpret than the PCA ordination.

c) The structural relationships of tropical forests are better reflected in life-form frequencies than in the presence/absence data. Nevertheless, the alternative classifications differ only in the positions of three noda. The clustering based on life-form frequencies is in the best agreement with the field observations, so the correct positions of the misclassified noda are easily found: the alluvial forests (36) should be removed from the group of coniferous forests and placed among the seasonal rainforests and semi-deciduous forests; the pinewoods of Nipe Mts (7, 8 and 6, 9, 10) are closer to one another than to the serpentine shrubwoods and to the western pinewoods, although the genetic relationship is obvious; the dry evergreen scrubs (37) and dry evergreen forests (38) are more similar than suggested by Fig. 335.

23.4.2 The physiognomic classification of the forest noda

The physiognomic classification of forest noda may be interpreted according to Fig. 335 as follows:

a) At the highest hierarchic level communitites with few strata, diverse herb layer and very few or no epiphytes and lianes (group A) are separated from those composed of several strata, rich in shrubs, lianes and epiphytes but having a poor herb layer (group B).

b) Within group A the forests and shrubwoods form distinct clusters. Smaller forest groups are the pinewoods of Isla de Pinos and the adjacent evergreen

oakwoods, and the pinewoods of Nipe. In the shrubwood group the presumed evolutionary relationship between the pine-mixed shrubwoods of Cajalbana (5) and the xeric evergreen serpentine shrubwoods of lowlands in Central Cuba (31—34) is justified.

c) In group B first the rainforests (14—15, 19—23) separate from the others: the semi-arid serpentine rainforests (14, 15), the submontane and montane wet rainforests (19—21) and the mossy forests and elfin thicket (22, 23) form smaller clusters.

d) At lower lever in group B the broad-leaved seasonal forests form a separate group. Four smaller physiognomic categories are distinguished within this: karstic forests (25—27), seasonal rainforests (24), alluvial forests (36) and semi-deciduous and xeric evergreen forests (28—30) and (37, 38, respectively). The latter two are separated at an even lower level.

e) The last subcluster of group B is very heterogeneous floristically. All communities included are characterized by few strata, rich shrub layer and reduced or missing herb and epiphyte strata. This cluster is subdivided into three fairly homogeneous groups, the lowland and montane semi-arid serpentine shrubwoods (16, 17), the Oriente latosol pinewoods with rich shrub layer (11, 18, 12, 13) and the limestone thorn scrubs and semi-desert scrubs (39—40).

23.5. Classification of the forest noda based on chorographical patterns

The 40 lignosa noda were also classified based on the frequency of flora according its different chorographical patterns. However, instead of creating a new syntaxonomical system, the goal of this analysis was to gain ideas, free from subjectivity, regarding the hypotheses on flora evolution and migration outlined in chapters 16—18 in connection with some representative distribution patterns or chorographical types.

23.5.1 General conclusions

General conclusions drawn from the classification results are:

a) The classification hierarchy of 40 noda, resulted from the frequency data of chorographical elements, is in a good agreement with the dendrograms obtained based on floristic or structural variables. The only major difference is that geographic similarities are more emphasized due to the increased importance of local and regional endemics.

b) The high similarity among the classifications reflecting different aspects in the data suggests that the vegetation types in Cuba are not only typical physiognomic categories but also phytosociological and ecological units and, in many cases, centres of flora development.

c) It is concluded that the classification shown in Fig. 336 supports my hypotheses on the development and migration of endemic flora, (see chapters 19—20).

23.5.2 The chorographical relationships among the floras of forest noda

The relationships among the floras of forest noda are summarized using Fig. 336 as follows:

a) The serpentine forests on latosol of northern Oriente have an old and unique flora if compared to other parts of the country. Within these the pinewoods and shrubwoods of Nipe (with a flora containing 45—70% endemics), and the pinewoods, shrubwoods and semi-arid rainforests of Moa (with the percentage of endemics up to 50—80% represent distinct types. It is an important point that all vegetational formations of Moa are primarily characterized by endemics. In Nipe only the pinewoods and shrubwoods can be mentioned in this regard, since the extrazonal montane rainforests are identical with the forests of Moa.

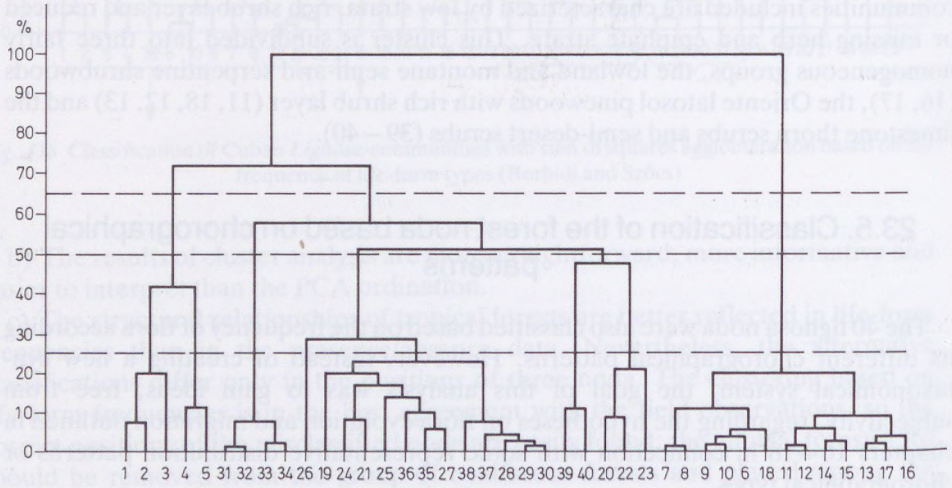


Fig. 336 Classification of Cuban Lignosa communities with sum of squares agglomeration based on the frequency of phytogeographic elements (Borhidi and Szőcs)

b) The flora history of all other noda is largely independent of northern Oriente, Most links to the flora of northern Oriente are indicated in the pinewoods of western Cuba (1—5), which are subdivided into three groups of flora development. Isla de Pinos, Pinar del Rio and the Cajalbana forests.

c) Regarding flora development, the serpentine shrubwoods of Central Cuba (31—34) are closely related to the pinewoods of western Cuba and even to the Oriente latosol zone.

d) There are weaker relationships between the montane rainforest noda of Sierra Maestra (20, 22, 23) and the forest noda of northern Oriente. Nevertheless, definite floristic relationships exist between the fairly dissimilar vegetation of the mountains and the coastal arid zone in Oriente.

e) Most different from the serpentine vegetation are the forest noda of limestone

areas, whose flora is usually much younger. Due to the relatively low number of local endemics, the geographic differences among these noda are less pronounced. Within this group the species rich karstic forests of the mogotes in western Cuba form a fairly distinct class. The others are divided to two groups. The first (19—27) is rather heterogeneous phytosociologically and floristically, being constituted by submontane and seasonal rainforests, karstic forests and gallery forests. These are all characterized by a young, somewhat uninteresting flora containing few endemics and many species of Neotropical and Caribbean distribution pattern. The relatively wetter habitat and the more heterogeneous flora distinguish these noda from the similarly characterless semi-deciduous and xeric evergreen forests, which are also composed of widely spread species.

PART VI
SYSTEMATIC SURVEY OF PLANT COMMUNITIES

PART VI

SYSTEMATIC SURVEY OF PLANT COMMUNITIES

This systematic review is a more detailed and elaborated version of the classification of the vegetation of Cuba, published by Borhidi, Muñiz and Del Risco (1979). It is based mainly on the original phytosociological relevés made by Borhidi, Borhidi and Muñiz, Borhidi and Del-Risco, Borhidi and R. Capote between 1969 and 1979, with a consideration of the vegetation studies and results of Knapp (1964, 1965), Cuatrecasas, Chapman, Ciferri, Gómez-Pompa, Hadač, Dansereau, Moncada, G. Mueller, Balátová, Berazain, Gutte, Samek, Schubert and collaborators, Stehlé, Stoffers, Smith, van Donselaar, etc. The review contains the first description and original type relevés of many Cuban and Antillean plant communities.

1. Class: **SALVINIO–EICHHORNIETEA** Borhidi and Del-Risco in Borhidi et al. (1979) 1983

(Syn.: *Cabombo–Eichhornietea* Knapp 1964)

The free-floating phanerogamic vegetation of the Neotropical freshwaters, especially in the Caribbean area.

Characteristic species: *Salvinia auriculata, S. rotundifolia, Azolla caroliniana, Lemna minima, L. perpusilla, Eichhornia crassipes, E. azurea, E. heterosperma, E. diversifolia, Pistia stratiotes, Aldrovanda vesiculosa, Utricularia* spp.

1.1 Order: SALVINIO–EICHHORNIETALIA Borhidi in Borhidi et al. (1979) 1983

Free-floating phanerogamic plant communities of the Neotropical areas, formed by unrooted plants floating on the surface of mainly eutrophic freshwater tables.

Characteristic species: *Salvinia auriculata, S. rotundifolia, Azolla caroliniana, Lemna* spp., *Eichhornia* spp., *Pistia stratiotes.*

1.1.1 Alliance: ***Azollaeo–Salvinion***
Borhidi and Muñiz in Borhidi et al. (1979) 1983

Free-floating freshwater vegetation formed by small water-pteridophytes and Lemnaceae, covering the surface of lakes, ponds, and slow streams.

Associations studied in Cuba:

Lemno–Azolletum carolinianae Borhidi and Muñiz in Borhidi et al. 1983

Association composed of *Lemna perpusilla* and *Azolla caroliniana,* represented in 10 relevés (Table 43) made by Borhidi and Muñiz, in the ponds and streams of the Batabano Swamp, S. of Havanna (Dec. 1969) and in the Lake Ariguanabo, SE of Guanajay, La Habana Province (Jan. 1970). Type: Relevé no. 2. E. of Batabanó.

Table 43 Lemno-Azolletum carolinianae Borhidi and Muñiz 1983

	1	2	3	4	5	6	7	8	9	10
Cover (%)	60	75	40	50	45	65	60	70	60	55
Lemna perpusilla Torr.	3	3–4	3	2–3	2	2	2–3	4	3	2
Lemna trinervis (Austin) Small	–	+	–	1	+	–	–	1	–	–
Azolla caroliniana Willd.	2	2	1	2	2	3	3	1–2	2	3
Spirodela polyrrhiza (L.) Schleid.	+	–	–	–	–	+–1	–	–	+	–

Table 44 Spirodelo-Salvinietum auriculatae Borhidi and Muñiz in Borhidi et al. 1983

	1	2	3	4	5	6	7	8	9	10
Cover (%)	70	75	65	80	70	55	70	75	65	60
Salvinia auriculata Aubl.	4.4	4.4	3.4	4.4	4.4	3.3	4.5	4.5	4.4	4.5
Spirodela polyrrhiza (L.) Schleid.	1.2	2.2	2.2	2.3	2.2	2.2	1.1	–	+.1	–
Salvinia rotundifolia	–	–	–	–	–	–	–	–	–	+.1
Lemna perpusilla Torr.	–	+	–	+.1	–	–	+.1	+.1	–	–
Pistia stratiotes L.	+	–	–	–	–	–	–	+	–	–

Spirodelo–Salvinietum auriculatae Borhidi and Muñiz in Borhidi et al. 1983

Community composed of *Salvinia* and *Lemnaceae* species, represented in 10 relevés (Table 44) made by A. Borhidi and O. Muñiz in the ponds and streams of the Batabanó Swamp, in the Lake Ariguanabo and in the Zapata Swamp (Matanzas Province), 1969–1970. Type: Relevé no. 7. Zapata Swamp.

1.1.2 Alliance: ***Eichhornion azureae***
Borhidi and Muñiz in Borhidi et al. (1979) 1983

Free-floating freshwater vegetation formed by large unrooted, usually emergent aquatic plants on the surface of eutrophic and oligotrophic lakes and ponds and on that of the slow streaming rivers and creeks.

Association studied in Cuba:

Eichhornietum crassipedis Samek and Moncada 1971

Water-hyacinth mat community usually monodominant and nearly monotypic plant community of extreme by rush growth and population dynamics. It is represented in eight relevés; three of them made by Samek and Moncada in the white sand area of Cortés (Pinar del Rio Province) one by Borhidi in the Rio Hondo (Pinar del Rio Province), and four by Borhidi and Muñiz in Laguna de Ariguanabo. Type relevé no. 1 (Table 45).

Pistietum stratiotidis (Ciferri 1936) Borhidi in Borhidi et al. 1983

The name of the *Pistia stratiotes* association was used by Ciferri (1936:146) for a special aquatic plant zone in the zonation of a lake with muddy bottom. In his interpretation, *Pistia stratiotes* forms a slightly rooted population, but the water-lettuce association is usually a free-floating aquatic community, characterized by the species listed in the Table 46. The association is represented in 10 phytosociological relevés made by Borhidi, Borhidi and Muñiz in the swamp area of Batabanó, Lake Ariguanabo, 1969—1970. Type relevés no. 7. Lake Ariguanabo.

Eichhornietum azureae Borhidi in Borhidi et al. 1983

This water-hyacinth association differs from *Eichhornietum crassipedis* in preferring more oligotrophic and/or dystrophic shallow freshwaters, swamp-lakes, etc. The community is represented in 5 relevés made by Borhidi in the Zapata Swamp near Santo Tomas and Laguna del Tesoro, May, 1970. Type: Relevé no. 3. (Table 47).

Table 45 Eichhornietum crassipedis Samek and Moncada 1971

	1	2	3	4	5	6	7	8
Cover %:	100	100	95	95	100	100	100	100
Eichhornia crassipes (Mart.) Solms.	5.5	3.4	5.5	5.5	5.5	5.5	5.5	5.5
Paspalidium geminatum (L.) Stapf.	+.1	2.2	+.1	+	+	—	+	—
Vigna sp.	+.1	+.1	—	—	—	—	—	—
Ludwigia repens Forst. var. *repens*	+.1	—	—	+.1	+.1	+	+	—
Pistia stratiotes L.	—	—	—	—	+	—	—	—
Spirodela polyrrhiza (L.) Schleid.	—	—	—	+.1	+	1.1	+.1	+.1
Azolla caroliniana Willd.	—	—	2.2	—	—	+	—	—
Salvinia auriculata Aubl.	—	—	—	+.1	—	—	—	+.1

1.1.3 Alliance: ***Ceratophyllo–Cabombion*** piauhyensis Samek and Moncada 1971

Neotropical aquatic vegetation formed by submerged and partly emerged plants of palmate- and pinnatifid leaves in eutrophic or moderately oligotrophic lakes.

Associations studied in Cuba:

Cabombetum piauhyensis Borhidi and Muñiz in Borhidi et al. 1983

The monodominant submerged plant community of the *Cabomba piauhyensis* only with some accident companions. It is represented with 5 relevés made by A. Borhidi and O. Muñiz in the Laguna Ariguanabo near Guanajay (Habana Province) in January, 1970. Type relevé: no. 1. (Table 48).

Nymphaeo–Cabombetum piauhyensis Samek and Moncada 1971

This community is formed by two layers: the submerged layer of Cabomba and the emergent layer of the water-lilies with large, entire floating leaves. It is represented with 5 relevés, all made in the white sand wetlands of West Cuba, two

Table 46 Pistietum stratiotidis (Ciferri 1936) Borhidi in Borhidi et al. 1983

	1	2	3	4	5	6	7	8	9	10
Cover %:	100	90	95	80	75	95	70	75	80	95
Pistia stratiotes L.	5.5	5.5	5.5	5.5	4.4	5.5	4.5	4.5	5.5	5.5
Salvinia auriculata Aubl.	1.1	+.1	+.1	–	–	1.1	1.1	–	+.1	–
Spirodela polyrrhiza (L.) Schleid.	+.1	–	–	+.1	–	+.1	–	–	+	–
Azolla caroliniana Willd.	+	–	–	–	1.1	–	+.1	+.1	–	+.1
Proserpinaca palustris L.	–	–	–	+.1	–	–	–	+.1	–	–
Ludwigia peduncularis (Wr. ex Griseb.) Maza	–	–	–	–	–	–	+	–	+	–

Table 47 Eichhornietum azureae Borhidi in Borhidi et al. 1983

	1	2	3	4	5
Cover %:	100	100	95	90	95
Eichhornia azurea (Sw.) Kunth	5.5	5.5	5.5	5.5	5.5
Pistia stratiotes L.	+.1	1.1	–	+.1	1.1
Salvinia auriculata Aubl.	–	–	+.1	–	1.1
Panicum aquaticum Poir.	1.1	+.1	+	+.1	–
Polygonum hispidum HBK.	+.1	+	+	+	+.1
Polygonum hydropiperoides Michx.	–	+.1	+.1	–	–
Azolla caroliniana Willd.	+	–	–	+	–

Table 48 Cabombetum piauhyensis Borhidi and Muñiz in Borhidi et al. 1983

	1	2	3	4	5
Cover %:	70	75	80	70	65
Cabomba piauhyensis Aubl.	4.4	4.4	4.5	4.5	4.4
Proserpinaca plaustris L.	1.1	—	+.1	—	—
Potamogeton nodosus Poir.	—	—	+.1	+.1	—
Myriophyllum sparsiflorum C. Wr. ex Sauv.	+.1	—	—	—	—
Ludwigia inclinata (L.f.) H. Hara	—	+.1	—	—	+.1
Ludwigia erecta (L.) H. Hara	+.1	—	+.1	—	—
Utricularia mixta Barnh.	—	+.1	+.1	—	—

Table 49 Nymphaeo-Cabombetum piauhyensis Samek and Moncada 1971

	1	2	3	4	5
Cover %:	90	75	80	75	85
Cabomba piauhyensis Aubl.	3.3	3.3	3.3	4.4	4.5
Nymphaea odorata Dryand	4.5	3.2	2.3	1.3	2.2
Nymphoides aureum (Britt.) Britt. et Millsp.	—	+.1	+.1	1.1	1.1
Ludwigia inclinata (L.f.) H. Hara	—	—	+.1	+.1	—
Salvinia auriculata Aubl.	—	—	—	+.1	+.1
Hymenachne amplexicaulis (Rudge) Nees.	—	—	+.1	—	—

by Samek and Moncada in Santa Lucia, the other three by A. Borhidi and Ramona Oviedo in the Laguna Alcatraz Mayor (3—4—5). The type relevé is no. 1. (Table 49).

1.2 Order: ALDROVANDO–UTRICULARIETALIA Borhidi in Borhidi et al. (1979) 1983

Aquatic plant communities formed by free-float submerged, mainly carnivorous hydatophytes. Some of the plant species live only slightly submerged under the surface of the water table, whereas the reproductive organs are usually emergent. They occur preferably in the eutrophic, or more frequently, in the dystrophic water of the swamp-lakes, bogs and swamp-currents.

Characteristic species: *Aldrovanda vesiculosa, Utricularia foliosa, U. juncea, U. brevifolia, U. sclerocarpa, U. stellaris, U. cornuta, U. resupinata, U. olivacea, U. incisa, U. purpurea, U. virgatula,* etc.

1.2.1 Alliance: ***Aldrovando–Utricularion***
Borhidi in Borhidi et al. (1979) 1983

Characteristics are those of the order. Communities studied in Cuba:

Utricularietum foliosae Borhidi in Borhidi et al. 1983

Free-floating submerged water plant community formed by large carnivorous plants living mostly in deeper dystrophic or eutrophic swamp-lakes of neutral or basic freshwater. The association is represented in 5 relevés made by A. Borhidi in the Lake Ariguanabo and in the Zapata Swamp area. Type: Relevé no. 2. Lake Ariguanabo, 1970. (Table 50).

Utricularietum junceae Borhidi in Borhidi et al. 1983

Free-floating submerged water plant community formed by carnivorous plants of medium or small size living mostly in shallow dystrophic or oligotrophic freshwaters of neutral or slightly acidic chemical reaction. The association is represented in 5 relevés made by A. Borhidi in the West Cuban white sand lake area. Type: relevé no. 2. Laguna Santa Maria (Pinar del Rio Province) March, 1976. (Table 51).

Utricularietum resupinatae Borhidi in Borhidi et al. 1983

Free-floating or partly rooted aquatic weed community formed by small carnivorous plants living in the shallow sublittoral sandy shore of the lakes of

Table 50 Utricularietum foliosae Borhidi in Borhidi et al. 1983

	1	2	3	4	5
Cover %:	45	50	60	40	55
Utricularia foliosa L.	3.4	3.3	4.5	2.3	3.4
Utricularia mixta Barnh.	+.1	2.2	–	1.1	1.2
Ludwigia erecta (L.) H. Hara	–	–	+1.1	1.1	–
Spirodela polyrrhiza (L.) Schleid.	–	+.1	1.1	–	–
Salvinia auriculata Aubl.	–	+.1	–	–	1.1

Table 51 Utricularietum junceae Borhidi in Borhidi et al. 1983

	1	2	3	4	5
Cover %:	50	55	45	60	50
Utricularia juncea Vahl.	3.2	3.3	3.3	3.3	3.3
Utricularia virgulata Barnh.	+.1	–	–	–	–
Utricularia pusilla Vahl.	–	–	1.1	+.1	–
Utricularia pumila Walt.	–	+.1	–	–	–
Bulbostylis tenuifolia McBr.	1.2	+.1	–	1.2	1.1
Bulbostylis capillaris (L.) C. B. Clarke	+.1	–	1.1	–	–

Table 52 Utricularietum resupinatae Borhidi in Borhidi et al. 1983

	1	2	3	4	5
Cover %:	45	55	60	40	55
Utricularia resupinata B. D. Greene	3.2	3.3	4.3	3.2	3.3
Utricularia pumila Walt.	+.1	1.1	1.1	—	+.1
Utricularia sclerocarpa Wr. in Sauv.	+.1	+.1	—	—	—
Bulbostylis tenuifolia McBr.	1.2	1.1	2.2	+.2	1.1
Bulbostylis arenaria Lindm.	—	—	+.1	+.1	—
Caperonia cubana Pax. et Hoffm.	—	+.1	—	—	—

oligotrophic and usually acidic freshwater. The association is distributed all over the West Cuban wetland of the Isthmus of Guanahacabibes, and it is represented with 5 relevés made by A. Borhidi and Ramona Oviedo, March. 1976. The association is characterized by a community of minor *Utricularia* and *Bulbostylis* species. Type: relevé no. 2., Laguna del Jovero, cerca de Sandino (Pinar del Rió Province, Table 52).

1.3 Order: MAYACETALIA FLUVIATILIS Borhidi in Borhidi et al. (1979) 1983

Aquatic submerged, occasionally amphibious plant communities formed by the dense sward of moss-shaped rooted phanerophytes living in the transitional littoral zone of montane, rapid creeks and oligotrophic lowland lakes. The communities are distributed throughout the Neotropical region.

Characteristic species: *Mayaca fluviatilis, M. fluviatilis* ssp. *wrightii, Utricularia sclerocarpa, U. cornuta, U. cleistogama,* etc.

1.3.1 Alliance: ***Mayacion fluviatilis*** Borhidi in Borhidi et al. (1979) 1983

Characteristics are those of the order. Associations studied in Cuba:

Mayacetum fluviatilis Borhidi in Borhidi et al. 1983

Submerged rock pavement vegetation along the montane creek-sides and river-sides in the mountains of Oriente, especially on serpentine rocks. *Mayaca fluviatilis* is monodominant, among the accompanying species several endemics are found. The association is represented in 5 relevés made by A. Borhidi in the Sierra de Nipe (Rio Piloto, Rio del Medio, Rio Guaro); type relevé is no. 1. (Table 53) from the Rio Piloto, 19. July, 1970.

Mayacetum wrightii Borhidi in Borhidi et al. 1983

Dense, permanently or seasonally submerged littoral sward on the shore of the oligotrophic lakes in the wetlands of the white sand areas of West Cuba and Isle of

Table 53 Mayacetum fluviatilis Borhidi in Borhidi et al. 1983

	1	2	3	4	5
Cover %:	90	100	90	95	100
Mayaca fluviatilis Aubl.	5.5	5.5	5.5	5.5	5.5
Fimbristylis annua (All.) R. et S.	+.2	1.1	+.1	+.1	—
Eleocharis elegans (HBK.) R. et S.	+.1	—	+.1	—	+.1
Anemia nipensis Benedict.	+.1	—	+.1	—	—
Utricularia pusilla Vahl.	+.1	+.1	—	+.1	—
Heptanthus lobatus Britt.	—	+.1	—	—	+.1
Koehneola repens (Griseb. ex Urb.) Urb.	—	—	+.1	+.1	—

Table 54 Mayacetum wrightii Borhidi in Borhidi et al. 1983

	1	2	3	4	5
Cover %:	100	100	90	100	100
Mayaca fluviatilis ssp. wrightii (Griseb.) Borhidi	5.5	5.5	5.5	5.5	5.5
Eleocharis interstincta (Vahl) R. et S.	1.1	+.1	—	1.1	1.2
Eleocharis capillacea Kük.	—	+.1	1.1	+.1	—
Eleocharis minima Kunth	+.1	+.1	—	—	—
Eriocaulon lacustre Ruhl.	—	+.1	+.1	—	—
Pinguicula filifolia Wr. ex Griseb.	—	+.2	—	+.2	—
Rhynchospora cyperoides (Sw.) Mart.	+.2	+.1	1.1	+.2	+.1
Scirpus confervoides Poir.	+.2	+.2	+.1	1.2	—
Rhynchospora tracei Britt.	—	—	—	+.2	+.1
Utricularia juncea Vahl.	+.2	+.2	+.1	1.2	—
Andropogon sp.	—	—	—	+.2	—

Pine. *Mayaca fluviatilis* ssp. *wrightii* is a characteristic morphologically distinct ecotype of the white sand areas. The type relevé is no. 2. (Table 54) from the Laguna de la Máquina Pinar del Rio Province, made by A. Borhidi and Ramona Oviedo, March, 1976.

2 Class: **CABOMBO–NYMPHAEETEA** Borhidi and Del-Risco in Borhidi et al. (1979) 1983

(Syn.: *Cabombo-Eichhornietea* Knapp 1964 p.p.)

Aquatic vegetation of the Neotropical freshwaters, formed by rooted hydatophytes submerged or emerged, in the different ecological types (eutrophical, oligotrophical and dystrophical) of freshwaters.

Characteristic species: *Brasenia peltata, B. schreberi, Cabomba aquatica, C. piauhyensis, Hydrocotyle umbellata, nymphaea* spp., *Potamogeton* spp., *Myriophyllum sparsiflorum, M. verticillatum, Nymphoides* spp., etc.

2.1 Order: CABOMBO-NAJADETALIA Borhidi and Del-Risco in Borhidi et al. (1979) 1983

(Syn: *Utriculario-Najadetalia* Knapp 1964 p.p.)

Neotropical aquatic vegetation formed by submerged and rooted plants in the standing or slowly streaming freshwaters, sometimes also in slightly saline brackish waters.

Characteristic species: *Cabomba* spp., *Ceratophyllum demersum, Myriophyllum pinnatum, M. sparsiflorum, Najas marina, N. microdon, Vallisneria americana, V. neotropicalis.*

2.1.1 Alliance: ***Vallisnerion americanae*** Borhidi and Del-Risco in Borhidi et al. (1979) 1983

Subaquatic freshwater swards formed by rooted submerged aquatic weeds with ribbon-like leaves mostly in eutrophic or slightly dystrophic lakes, rarely also in slightly saline waters.

Associations studied in Cuba:

Vallisnerietum americanae Borhidi and Muñiz in Borhidi et al. 1983

Submerged aquatic, monodominant dense sward of *Vallisneria americana* with very few accompanying species. The association is also known from Florida and the SE. United States. It is represented in 5 relevés made by A. Borhidi and O. Muñiz in the Rio Zaza (Sancti Spiritus province), July 1970. Type relevé: No. 3. (Table 55).

Vallisnerietum neotropicalis Borhidi and Del-Risco in Borhidi et al. 1983

Subaquatic dense sward formed almost exclusively by *Vallisneria neotropicalis.* This community is widely distributed and common in the Laguna del Tesoro (Zapata Peninsule, Matanzas Province). It is represented with 5 relevés made by A. Borhidi and E. Del-Risco, October, 1974. Type relevé: no. 2. (Table 56).

Table 55 Vallisnerietum americanae Borhidi and Muñiz in Borhidi et al. 1983

	1	2	3	4	5
Cover %:	100	100	100	100	100
Vallisneria americana Michx.	5.5	5.5	5.5	5.5	5.5
Hydrocotyle umbellata L.	+.1	+.1	+.1	—	+.1
Potamogeton nodosus Poir.	—	—	+.1	+.1	—

Table 56 Vallisnerietum neotropicalis Borhidi and Del-Risco in Borhidi et al. 1983

	1	2	3	4	5
Cover %:	100	100	100	100	100
Vallisneria neotropicalis M. Vict.	5.5	5.5	5.5	5.5	5.5
Utricularia foliosa L.	+.1	+.1	+.1	1.1	–
Hydrocotyle umbellata L.	–	1.1	–	–	+.1
Panicum geminatum Forsk.	–	–	–	–	+.1
Potamogeton nodosus Poir.	–	–	+.1	+.1	–

2.2 Order: NYMPHAEETALIA AMPLAE Knapp 1964 ex Borhidi et al. (1979) 1983

Aquatic vegetation formed mostly by rooted large emergent hydatophytes with floating leaves. The communities belonging to this phytosociological unit live in shallow eutrophic, oligotrophic and dystrophic freshwaters.

Characteristic species: *Brasenia schreberi, Nymphaea ampla, N. blanda, Nuphar luteum* ssp. *macrophyllum, Hydrocotyle umbellata, Nelumbo lutea, Nymphoides humboldtiana, N. grayana, Potamogeton* spp.

2.2.1 Alliance: ***Potamion illinoensis*** Borhidi in Borhidi et al. (1979) 1983

Slightly emergent, densely closed aquatic swards mostly in eutrophic, slowly streaming freshwaters.

Associations studied in Cuba:

Potametum illinoensi-nodosi Borhidi and Muñiz in Borhidi et al (1979) 1983

A fairly dense aquatic plant community formed by two mostly co-dominant Potamogeton species. It is found mainly in the sublittoral zone of the slowly flowing lowland rivers and drainage ditches of wetlands and swamp areas. The 5 representative relevés (Table 57) were made by A. Borhidi and O. Muñiz in the Zapata Swamp, May, 1970. Type relevés: no. 2. Laguna del Tesoro.

Nymphaeo-Potametum nodosi Borhidi in Borhidi et al. 1983

An aquatic plant community, similar to the former one. It occurs frequently in contact with *Potametum illinoensi-nodosi* in shallower freshwater, on muddier bottom, replacing the former mostly toward the shore in the hydrosere. The representative 5 relevés were made by A. Borhidi and O. Muñiz at the same localities and date. Type relevé: no. 1. Zapata Swamp near Buenaventura. (Table 58).

Hydrocotyletum umbellati Del-Risco in Borhidi et al. 1983

A very common plant community of *Hydrocotyle umbellata,* formed usually in the transitional zone between water-lily mat and littoral sedge marsh or reed-grass marsh communities. It is usually composed of two layers, a submerged and an emergent one. The submerged dominant are *Vallisneria, Najas, Potamogeton, Ceratophyllum* and others. Five representative relevés (Table 59). were made by E. Del Risco and A. Borhidi in the Laguna del Tesoro, near Guama (Zapata Swamp), in October and November. 1974. Type relevé: no. 4.

Table 57 Potametum illinoensi-nodosi Borhidi and Muñiz in Borhidi et al. 1983 (*Potametum nodosi-malaini* Borhidi and Muñiz 1979 nom. nud.)

	1	2	3	4	5
Cover %:	70	75	80	60	70
Potamogeton illinoisensis Morong	3.3	3.4	5.5	3.3	3.4
Potamogeton nodosus Poir.	3.4	3.2	—	1.3	2.3
Utricularia foliosa L.	—	+.1	1.1	—	—
Hydrocotyle umbellata L.	+.1	+.1	—	—	—
Vallisneria neotropicalis M. Vict.	—	—	1.1	2.2	—
Paspalidium paludivagum (L.) Stapf.	+.1	—	—	—	—

Table 58 Nymphaeo-Potametum nodosi Borhidi in Borhidi et al. 1983

	1	2	3	4	5
Cover %:	100	90	95	80	100
Potamogeton nodosus Poir.	5.5	5.5	5.5	5.5	5.5
Nymphaea ampla (Salisb.) DC.	2.2	2.2	1.3	2.2	—
Sagittaria lancifolia L.	1.2	—	+.1	—	+.1
Utricularia foliosa L.	1.2	+.1	—	1.1	—
Utricularia mixta Barnh.	—	—	—	—	+.1
Proserpinacea palustris L.	—	—	—	+	—

Table 59 Hydrocotyletum umbellati Del-Risco in Borhidi et al. 1983

	1	2	3	4	5
Cover %:	60	70	75	80	70
Hydrocotyle umbellata L.	3.3	3.4	4.4	4.5	3.3
Utricularia foliosa L.	+.1	+.r	—	—	—
Vallisneria neotropicalis M. Vict.	1.1	2.2	2.2	4.4	+.1
Scirpus validus (Vahl) T. Koyama	—	+.1	—	1.1	1.1
Paspalidium paludivagum (L.) Stapf	—	—	+.1	+.r	—
Polygonum punctatum Ell.	1.1	—	—	—	—

Myriophylletum sparsiflori Borhidi in Borhidi et al. 1983

This association is a very characteristic plant community of the little, shallow white sand lakes, forming the inner belt of the rooted aquatic vegetation. In can be found in slightly oligotrophic, shallow freshwaters on sandy bottom. The representative relevés (Table 60) were made by A. Borhidi and Ramona Oviedo in the white sand wetland of West Cuba, March, 1976. Type relevé: no. 4. Laguna Alcatraz Chiquito, near Cortés (Pinar del Rio Province).

2.2.2 Alliance: ***Nelumbio-Nymphaeion amplae*** Samek and Moncada 1971

Emergent freshwater vegetation formed by water-lily mats and by other large, rooted aquatic plants with large-floating or emergent leaves and showy flowers. The communities belonging to this alliance grow in all types of freshwaters, but more frequently in dystrophic and oligotrophic ones.

Associations studied in Cuba:

Brasenietum schreberi Borhidi in Borhidi et al. 1983

Emergent, rooted freshwater plant community living mostly in the inner side of the water-lily mats, in somewhat deeper water and on muddy substrate. Brasenia is monodominant, the companions are the dominant species of the neighbouring communities of the zonation. Five representative relevés were made by A. Borhidi in the Ariguanabo Lake, January, 1975. Type relevé: no. 3. (Table 61).

Nymphaeetum amplae Borhidi and Muñiz in Borhidi et al. 1983

This is the association of the very common water-lily mats of the Antilles and tropical America, mentioned but not analyzed by Ciferri (1936) and Dansereau (1966). This community is widely distributed in eutrophical and dystrophical lakes, ponds, dead arms of rivers, etc. Five representative relevés were made by Borhidi and Muñiz in the Lake Ariguanabo near Guanajay, January, 1970. Type relevé: no. 3. (Table 62).

Table 60 Myriophylletum sparsiflori Borhidi in Borhidi et al. 1983

	1	2	3	4	5
Cover %:	70	80	90	85	95
Myriophyllum sparsiflorum Wr. ex Sauv.	3.4	4.4	4.5	4.4	4.5
Proserpinaca palustris L.	1.2	2.2	+.1	1.1	–
Cabomba piauhyensis Aubl.	1.1	–	–	–	1.2
Utricularia foliosa L.	2.2	–	1.1	–	–
Utricularia mixta Barnh.	–	1.1	–	–	–
Mayaca fluviatilis ssp. wrightii (Griseb.) Borhidi	–	–	–	1.1	–

Table 61 Brasenietum schreberi Borhidi in Borhidi et al. 1983

	1	2	3	4	5
Cover %:	80	75	90	85	70
Brasenia schreberi Gmel.	4.5	4.5	5.5	4.5	3.3
Nymphaea ampla (Salisb.) DC.	–	+.1	–	–	1.2
Nuphar luteum (L.) Sibth. and Sm. ssp. Macrophyllum (Small) Beal.	+.1	+.1	–	+.1	–
Potamogeton nodosum, Poir.	+.1	–	–	–	–
Urticularia foliosa L.	–	–	2.2	–	1.2
Scirpus confervoides Poir.	–	–	–	–	1.2
Eleocharis interstincta (Vahl.) R. and S.	–	–	–	–	1.1

Table 62 Nymphaeetum amplae Borhidi and Muñiz 1983

	1	2	3	4	5
Cover %:	80	90	85	90	80
Nymphaea ampla (Salisb.) DC.	4.4	5.5	5.5	5.5	5.5
Brasenia schreberi Gmel.	2.2	–	–	–	–
Nuphar luteum ssp. *macrophyllum* (Small) Beal.	–	1.1	–	+.1	–
Potamogeton nodosus Poir.	–	+.1	2.2	–	2.2
Utricularia foliosa L.	2.2	–	1.1	1.1	+.2
Eleocharis interstincta (Vahl.) R. and S.	+.1	+.1	–	–	+.1
Ludwigia erecta (L.) H. Hara	–	+.1	–	–	–

Nupharetum macrophylli Borhidi and Del-Risco in Borhidi et al. 1983

This is a vicarious community of the water-lily mat in shallower, more dystrophic freshwater and muddier sites. Somewhere it is in contact shoreward with water-lily mats. Five representative relevés were made by Borhidi and Del Risco in the Zapata Swamp, E. of Buenaventura, Zanja de Jiqui, and by Borhidi in the Laguna del Tesoro, October, November 1974 and March, 1975, respectively. Type relevé: no. 1. (Table 63).

Nelumbonetum luteae Samek and Moncada 1971

This is the American lotus mat community formed by large-leaved, highly emergent, rooted water plants is rather common in the littoral zones of both eutrophic and oligotrophic freshwater lakes. It is mostly a 2- or 3-layered community, with a high emergent layer of *Nelumbo lutea*, a less emergent layer with floating leaves of *Nymphaea, Nuphar* and *Potamogeton* species and a submerged layer formed mostly by *Utricularia* species. The representative relevés can be

Table 63 Nupharetum macrophylli Borhidi and Del-Risco in Borhidi et al. 1983

	1	2	3	4	5
Cover %:	80	70	85	65	75
Nuphar luteum ssp. *macrophyllum* (Small) Beal.	4.4	3.3	5.5	4.4	4.5
Nymphaea ampla (Salisb.) DC.	2.2	2.3	1.3	2.2	1.2
Potamogeton nodosus Poir.	2.2	—	1.2	—	—
Utricularia foliosa L.	2.2	—	—	+.2	+.2
Eleocharis interstincta (Vahl.) R. and S.	—	1.1	—	1.1	—
Sagittaria lancifolia L.	—	—	+.1	—	—
Polygonum punctatum Ell.	—	—	+.1	—	—

Table 64 Nelumbonetum luteae Samek et Moncada 1971

	1	2	3	4	5	6	7	8	9	10
Cover (%):	80	50	85	70	85	80	90	85	100	95
Nelumbo lutea (Willd.) Pers.	4.4	3.3	1.3	1.2	4.4	3.4	4.5	4.4	4.4	3.3
Eleocharis interstincta (Vahl.) R. and S.	—	2.3	2.3	2.3	1.2	1.2	—	—	—	—
Nymphoides aureum (Britt.) Britt. and Millsp.	—	2.2	1.2	3.2	—	—	—	—	—	—
Nymphaea ampla (Salisb.) DC.	—	—	—	—	1.1	3.3	3.3	2.3	4.4	4.4
Utricularia foliosa L.	2.2	2.2	—	—	—	2.2	1.3	2.3	1.2	+.2
Panicum geminatum Forsk.	—	—	3.3	1.2	—	+.2	1.2	—	—	—
Panicum parvifolium Lam.	—	—	—	1.2	—	—	—	—	—	—
Rhynchospora cyperoides (Sw.) Mart.	—	—	—	1.1	—	—	—	—	—	—
Scholnoplectus validus (Vahl.) T. Koyama	—	—	—	—	—	1.1	2.2	1.2	1.1	1.2
Utricularia mixta Barnh.	—	—	—	—	—	—	+.2	—	+.2	—

divided into two subassociations; relevés nos 1—5 represent the subass. *eleocharetosum interstinctae* (relevés made by Samek and Moncada at Sabanalamar, in oligotrophic lakes); type relevé: nos 1. the relevés nos 6—10, made by Borhidi and Muñiz in the Laguna Ariguanabo, January, 1970, represent the subass. *nymphaeetosum amplae* of the more eutrophic waters (Table 64). Type relevé of the subassociation: no. 9.

Eichhornio heterospermae-Nymphoidetum aureae Samek and Moncada 1971

This is an aquatic community of the slightly oligotrophic to eutrophic shallow lakes of West Cuba, composed of rooted, floating leaved aquatic weeds *(Nymphoides, Marsilia, Nymphaea)* and of free-floating ones *(Eichhornia, Salvinia)*. Ten representative relevés were made by Samek and Moncada in the Laguna Santa Lucia, near Mantua, at the edge of the white sand area of West Cuba. The relevés 1—5 represent the subass. *marsilietosum polycarpae,* those of nos 6—7 represent

the subass, *typicum*, and 8—10 the subass. *cabombetosum*. The characteristic species of the subassociation *marsilietosum* is correctly: *Marsilia polycarpa* Hook, and Grev. rather than *M. quadrifolia* L. as suggested by the mentioned authors. Type relevé: no. 6. (Table 65).

Nymphoidetum aureae Borhidi in Borhidi et al. 1983

Monodominant formed by *Nymphoides aurea* in shallow slightly oligotrophic lakes of the white sand area. Type relevé is no. 1. (Table 66) made by Samek and Moncada in the Laguna Santa Lucia, other relevés (nos 2—5) made by Borhidi and Oviedo in Laguna La Maquina, March, 1976.

Nymphoidetum grayanae Borhidi in Borhidi et al. 1983

Freshwater plant association formed by rooted floating leaved aquatics, in shallow, eutrophic waters of limestone karstic pits in South Isle of Pine and

Table 65 Eichhornio heterospermae-Nymphoidetum aureae Samek and Moncada 1971

	marsilietosum					*cabombetosum*				
	1	2	3	4	5	6	7	8	9	10
Cover %:	95	45	75	80	90	80	40	100	60	80
Nymphoides aurea (Britt.) Britta and Millsp.	4.4	2.2	3.3	3.4	4.4	4.4	2.3	1.2	1.1	2.3
Eichhornia heterosperma Alexander	+.1	1.2	2.3	+.1	1.2	1.1	1.2	5.5	2.2	+.1
Salvinia auriculata Aubl.	+.1	+.1	+.1	+.1	1.3	+.1	+.1	—	+.1	—
Marsilea polycarpa Hook. and Grev.	3.2	2.2	1.2	3.3	3.3	—	—	—	—	—
Polygonum punctatum Ell.	+.1	+.1	+.2	+.1	—	—	—	—	—	—
Cabomba piauhyensis Aubl.	—	—	—	+.1	+.1	—	—	2.3	3.3	2.3
Nymphaea odorata Dryand.	—	—	—	—	—	—	—	—	2.2	3.3
Ludwigia inclinata (L.f.) H. Hara	1.2	—	—	—	—	+.1	—	—	+.1	—
Hymenachne amplexicaulis (Rudge) Nees.	—	+.1	+.1	—	—	—	—	—	—	—

Table 66 Nymphoidetum aureae Borhidi in Borhidi et al. 1983

	1	2	3	4	5
Cover %:	100	80	65	70	90
Nymphoides aurea (Britt.) Britt. and Millsp.	5.5	4.5	3.4	4.4	4.5
Nymphaea odorata Dryand.	—	+.1	2.2	+.2	1.2
Ludwigia inclinata (L.f.) H. Hara	1.2	—	1.2	—	+.2
Ludwigia erecta (L.) H. Hara	—	+.1	—	+.1	+.1
Hymenachne amplexicaulis (Rudge) Nees.	1.2	—	—	—	+.1
Cabomba piauhyensis Aubl.	—	—	—	+.1	1.2
Caperonia palustris (L.) St. Hill.	—	—	+.1	—	—

peninsula of Guanahacabibes. The five representative relevés were made by Borhidi, 26. December, 1969, between Cayo Piedra and Punta del Este, Isla de Pinos. Type relevé: no. 3. (Table 67).

Polygonetum densiflori Borhidi in Borhidi et al. 1983

Seasonally flooded freshwater plant community formed by aquatic and amphibious plants in the littoral zone of the shallow, muddy swamp lakes. It is a transitional community to the grass and sedge marshes. Five representative relevés were made by Borhidi in the Swamp area of Bataban, type relevé: no. 3. (Table 68).

2.2.3. Alliance: ***Crino-Limnocharion flavae***
Borhidi in Borhidi et al. (1979) 1983

Emergent aquatic vegetation of the slowly streaming shallow, slightly eutrophic freshwaters, forming dense swards along creeks and rivers.

Characteristic species: *Crinum americanum, C. oliganthum, Limnocharis flava, Fuirena umbellata, Rhynchospora* ssp.

Table 67 Nymphoidetum grayanae Borhidi in Borhidi et al. 1983

	1	2	3	4	5
Cover %:	80	70	90	75	80
Nymphoides grayana (Griseb.) Arthur	4.5	4.4	5.5	4.4	4.5
Cabomba piauhyensis Aubl.	+.1	—	1.1	—	+.2
Nymphaea ampla (Salisb.) DC.	+.2	+.1	—	—	—
Hydrocotyle umbellata L.	—	—	+.1	—	1.1
Marsilia polycarpa Hook. et Grev.	1.2	+.1	—	—	+.1
Salvinia natans L.	—	+.1	—	+.1	—

Table 68 Polygonetum densiflori Borhidi in Borhidi et al. 1983

	1	2	3	4	5
Cover %:	80	95	100	100	90
Polygonum densiflorum Meisn.	3.3	4.5	5.5	4.4	4.4
Eleocharis interstincta (Vahl.) R. et S.	+.1	—	1.2	1.1	—
Sagittaria lancifolia L.	1.1	—	—	—	—
Hydrocotyle umbellata L.	+.1	1.2	2.2	2.2	—
Nymphaea ampla (Salisb.) DC.	—	+.1	—	—	2.2
Panicum geminatum Forsk.	—	+.1	—	—	1.1
Ludwigia erecta (L.) H. Hara	+.1	—	+.1	—	—
Hymenachne amplexicaulis (Rudge) Nees.	—	—	—	1.1	—

Table 69 Limnocharietum flavae Borhidi in Borhidi et al. 1983

	1	2	3	4	5
Cover %:	100	100	100	100	100
Limnocharis flava (L.) Buchan.	5.5	5.5	5.5	5.5	5.5
Rhynchospora cyperoides (Sw.) Mart.	1.1	+.1	—	—	—
Rhynchospora stellata (Lam.) Griseb.	+.1	—	1.2	1.1	1.2
Fimbristylis ovata (Burm.f.) Kern.	—	1.1	—	1.2	—
Fuirena umbellata Rottb.	+.1	+.1	1.1	1.1	+.1
Eleocharis cellulosa Torrey	—	1.1	—	—	—
Crinum americanum L.	—	—	—	—	+.2

Associations studied in Cuba:

Limnocharietum flavae Borhidi in Borhidi et al. 1983

This is the community of swamp-lily formed in shallow beds of slowly flowing freshwater streams, especially in river bends. Five representative relevés were made by Borhidi in Rio Cristal, La Habana and Rancho Boyeros, in October, 1969. Type relevé: no. 3. (Table 69).

3 Class: **CLADIETEA JAMAICENSIS** Knapp (1964) ex Borhidi et al. (1979) 1983

Tall reed-grass, sedge-, wintersedge-, cattail-marshes and swamps, rivercane- and bamboo-brakes in the regularly flooded alluvial surfaces and littoral zones of the lowland rivers in Central America and the West Indies.

3.1 Order: GYNERIO-BAMBUSETALIA Borhidi in Borhidi et al (1979) 1983

Rivercane- and bamboo-brakes monodominant, formed by 3—10 m high, often lignified gramineaes, along the riversides (Fig. 337).

Characteristic species: *Gynerium sagittatum, Bambusa vulgaris* (naturalized), *Arundo donax,* etc.

3.1.1 Alliance: ***Gynerion sagittati*** Borhidi in Borhidi et al. 1979

With the same characteristics as the order.

Association studied in Cuba:

Gynerietum sagittati Borhidi (Fig. 337)



Fig. 337 Gynerium sagittatum reed vegetation in the valley of the Jaguani river at La Melba (Photo: A. Borhidi)

3.2 Order: CYPERO HETEROPHYLLI-PENNISETETALIA Borhidi in Borhidi et al. 1979

Secondary communities of reedgrass- and sedge-marshes conditioned by human influence along the gravelly submontane and montane creeks and riversides.

Characteristic species: *Cyperus heterophyllus, C. surinamensis, Pennisetum purpureum,* etc.

3.2.1 Alliance: **Cyperion heterophylli** Borhidi in Borhidi et al. 1979

Communities with the same characters as those of the order, represented by several secondary associations in Cuba and the other West Indian islands.

3.3 Order: SCIRPO-ELEOCHARIETALIA INTERSTINCTAE Borhidi and Muñiz in Borhidi et al. (1979) 1983

Communities of tall swamp and marsh vegetation formed by grasses and sedges in steady or seasonally flooded eutrophic, dystrophic or slightly saline wetland areas, without a continuous accumulation of peat in the soils.

Characteristic species: *Scirpus validus, Schoenoplectus americanus, Eleocharis interstincta, E. cellulosa, E. articulata, Cyperus articulatus, C. diffusus, C. swartzii, Sagittaria lancifolia, S. intermedia, Echinodorus* spp. *Pontederia lanceolata, Paspalidium paludivagum, Panicum aquaticum, P. lacustre, Rhynchospora corniculata, R. gigantea,* etc.

3.3.1 *Sagittario-Eleocharion interstinctae* Borhidi and Del-Risco in Borhidi et al. (1979) 1983

Tall spike-rush and sedge marshes in eutrophic or slightly saline freshwaters of low wetlands. Characteristic species are the same as those of the order.

Associations studied in Cuba:

Sagittario-Eleocharetum interstinctae Del-Risco in Borhidi et al. 1983

This association is found in the littoral zone of the muddy eutrophic and peaty dystrophic lakes, ponds and bogs of the swamp and wetland areas, formed by the dominant spike-rush species, sedges and with a layer of aquatic plants. Five representative relevés were made by A. Borhidi and O. Muñiz, in 1970 and later by E. Del Risco and A. Borhidi, (1974—1975) all in the Zapata Swamp. Type relevé: no. 3. (Table 70).

Paspalidietum paludivagi Del-Risco and Borhidi in Borhidi et al. 1983

This association is a monodominant community of tall, emergent grasses forming a lower vegetation zone at the inner side of the read-grass of cattail zone in the sublittoral belt of the eutrophic or dystrophic lakes. In typical form it is a one-layered community, but in deeper water it develops a two-layered form, with a dense second herb layer formed by submerged aquatic plants. In our five relevés, all made by E. Del-Risco and A. Borhidi in the Zapata Swamp area, nos 1—3 represent the two layered subass, *vallisnerietosum,* and nos 4—5 the subass. *typicum.* Type relevé no. 4. (Table 71).

Eleocharetum cellulosae Borhidi in Borhidi et al. 1983

Tall spike-rush marsh with two herb layers formed in the eutrophic wetlands and the dystrophic to slightly halotrophic seaside swamps and marshes. (Fig. 338) The tall herb layer is composed of the monodominant *Eleocharis cellulosa, Pontederia*

Table 70 Sagittario-Eleocharetum interstinctae Del-Risco in Borhidi et al. 1983

	1	2	3	4	5
Cover %:	100	100	90	90	100
Eleocharis interstincta (Vahl.) R. and S.	4.5	5.5	5.5	4.5	5.5
Pontederia lanceolata Nutt.	2.4	—	1.2	—	—
Sagittaria lancifolia L.	1.1	2.3	2.3	2.2	+.2
Nuphar luteum ssp. *macrophyllum* (Small) Beal.	2.2	+.r	—	—	—
Nymphaea ampla (Salisb.) DC.	—	+.r	1.2	2.3	2.2
Polygonum punctatum Ell.	+.r	—	—	1.1	—
Typha domingensis (Pers.) Kunth	—	1.1	—	—	—
Cyperus ligularis L.	—	1.1	+.1	—	—
Potamogeton nodosus Poir.	—	+.1	—	+.1	1.1
Proserpinaca palustris L.	—	+.1	+.1	—	—
Rhynchospora stellata Griseb.	—	1.2	—	+.1	—
Hymenachne amplexicaulis (Rudge) Nees	—	—	—	—	+.1
Phyla stoechadifolia (L.) Small	—	+.r	—	—	—
Mikania hastata (L.) Willd.	—	+.r	—	—	—
Scirpus cubensis Poepp. and Kunth	2.3	—	1.2	+.1	—

Table 71 Paspalidietum paludivagi Del-Risco and Borhidi in Borhidi et al. 1983

	1	2	3	4	5
Cover %:	100	100	95	100	90
Paspalidium paludivagum (L.) Stapf	5.5	4.5	4.5	5.5	4.5
Vallisneria neotropicalis M. Vict.	5.5	2.3	2.2	—	—
Typha domingensis (Pers.) Kunth	+.1	—	—	+.1	—
Hydrocotyle umbellata L.	—	—	—	1.2	2.2
Schoenoplectus validus (L.) T. Koyama	—	—	1.1	—	1.2
Proserpinaca palustris L.	—	+.1	—	—	—
Panicum geminatum Forsk.	—	—	+.1	—	—
Aeschynomene villosa Poir. in Lam.	—	—	—	—	+.1

lanceolata, Sagittaria lancifolia, Fimbristylis spp., the lower one is formed by *Rhynchospora stellata, Cynodon, Hydrocotyle* and *Echinodorus* spp. Five representative relevés were made by Borhidi in the marshes of Rancho Boyeros and the seaside swamps of Batabanó, in October and December, 1969, Type relevé: no. 1. (Table 72).

Cyperetum articulati Borhidi in Borhidi et al. 1983

This is a two-layered sedge marsh community on regularly flooded, muddy sites along slow swamp streams. The high herb layer is formed by the monodominant *Cyperus articulatus,* mixed with *Rhynchospora stellata, Eleocharis interstincta* and *Paspalum, Aster, Pluchea,* etc. species, the other herb layer is very low, formed by



Fig. 338 Plant community of the swamp areas formed by *Eleocharis cellulosa* and *Sagittaria lancifolia*, at Rancho Boyeros near Habana (Photo: A. Borhidi)

Table 72 Eleocharetum cellulosae Borhidi in Borhidi et al. 1983

	1	2	3	4	5
Cover %:	100	95	100	90	100
Eleocharis cellulosa Torrey	5.5	4.4	5.5	3.4	4.4
Sagittaria lancifolia L.	+.1	–	–	1.1	–
Sporolobus virginicus (L.) Kunth	+.1	–	–	1.1	–
Echinodorus berteroi (Spreng) Fassett	–	+.1	–	–	1.1
Fimbristylis annua (All.) R. and S.	2.2	1.2	2.2	1.2	2.2
Fimbristylis spadicea (L.) Vahl.	–	2.2	–	1.2	1.2
Rhynchospora stellata Griseb.	2.2	1.1	2.2	+.2	+.2
Rhynchospora corniculata (Lam.) A. Gray.	–	+.1	–	+.2	–
Leersia hexandra Sw.	–	–	1.2	–	–
Ludwigia suffruticosa Maza	+.1	+.1	–	–	–
Pontederia lanceolata Nutt.	+.2	+.2	+.1	–	–
Phyla stoechadifolia (L.) Small	–	–	+.1	+.1	–
Hydrocotyle verticillata Thunb.	–	–	–	+.2	1.1
Cynodon dactylon (L.) Pers.	–	–	1.2	2.2	2.2
Ipomoea nil (L.) Roth.	–	–	–	–	+.1
Ludwigia peruviana (L.) H. Hara	–	–	–	+.1	+.2

Table 73 Cypereteum articulati Borhidi in Borhidi et al. 1983

	1	2	3	4	5
Cover %:	100	100	85	95	100
Cyperus articulatus L.	4.5	5.5	4.5	4.4	5.5
Bulbostylis setacea Svens.	+.1	1.1	+.2	+.1	1.1
Rhynchospora stellata Griseb.	1.1	1.2	2.2	2.3	+.1
Limnocharis flava (L.) Buchen.	+.2	—	—	—	—
Paspalum vaginatum Sw.	—	—	1.1	1.1	—
Cyperus filiformis Sw.	—	+.2	+.1	—	1.2
Eleocharis interstincta (Vahl.) R. and S.	+.2	—	—	1.1	—
Aster exilis Ell.	+.1	1.1	2.2	1.2	—
Pluchea purpurascens (Sw.) DC.	—	—	+.1	2.2	—
Pluchea rosea Godfr.	+.1	1.1	—	—	—
Ruellia paniculata L.	—	+.1	—	—	—
Phyla stoechadifolia (L.) Small	—	—	—	2.2	1.1
Nephrolepis biserrata (Sw.) Schott	1.1	—	1.1	—	—
Bacopa monnieri (L.) Pennell	—	2.4	—	2.3	2.3
Nasturtium portoricense Spreng.	2.2	—	2.3	1.3	—
Ipomoea triloba L.	—	+.1	—	—	—
Mikania hastata (L.) Willd.	—	—	—	+.1	—
Commelina erecta L.	+.2	—	—	—	—

Bulbostylis setacea, Phyla stoechadifolia, Bacopa monnieri and *Nasturtium portoricense*. Five representative relevés were made by Borhidi, at the northern edge of the Batabanó wetland, in December, 1969; type relevé: no. 3. (Table 73).

Schoenoplectetum validi Borhidi and Muñiz in Borhidi et al. 1983

This is a tall sedge marash community in the littoral zone of the eutrophic and slightly dystrophic lakes and ponds, where it generally substitutes the lacking reed-grass- and cattail marshes. It has a seasonally flooded terrestrial form (relevés 1—5, Table 61) that consider as subass. *typicum,* characterized by helophytes as *Centella erecta, Pontederia lanceolata, Bulbostylis* and *Fimbristylis* spp. (type relevé no. 3), and a permanently flooded aquatic form (relevés nos 6—10) considered by me as subass. *vallisnerietosum,* characterized by hydrophytes, as *Vallisneria* and *Utricularia* spp. (type relevé: no. 9). Relevés (Table 74) made by Borhidi and Muñiz, in May 1970 and by Borhidi and Del Risco, in March, 1975, in the Laguna del Tesoro, Zapata Swamp.

Acrostycho-Schoenoplectetum americanae Borhidi in Borhidi et al. 1983

This is a halotrophic sedge marsh community of the seaside wetlands in the transitional zone of the eutrophic or dystrophic wetlands or swamps to the mangrove. It is characterized by the co-dominant *Schoenoplectus americanus* and *Acrostichum aureum,* accompanied by helophytes as *Typha* and *Cladium,* and by obligate and facultative halophytes as *Conocarpus erecta, Heliotropium curas-*

savicum, Baccharis halimifolia ssp. *angustior* and *Eleocharis cellulosa*. The five relevés were made by Borhidi (December, 1969) near Batabano. Type relevé: no. 4 (Table 75).

3.3.2 Alliance: ***Rhynchosporo-Eleocharion interstinctae*** Samek and Moncada 1971

Sedge marsh vegetation of the littoral zone in the oligotrophic lakes of the white sand wetland of western-Cuba. It is characterized by acidophilous, small hydro- and helophytes, many of which are endemics.

Table 74 Schoenoplectetum validi Borhidi and Muñiz in Borhidi et al. 1983

	1	2	3	4	5	6	7	8	9	10
Cover (%)	60	65	80	70	55	100	100	100	100	100
Schoenoplectus validus (Vahl.) T. Koyama	3.4	3.5	4.5	4.4	3.4	3.5	4.4	3.3	3.4	4.4
Vallisneria neotropicalis M. Vict.	—	—	—	—	—	5.5	3.5	4.5	5.5	3.4
Utricularia foliosa L.	+.1	—	—	—	1.2	1.1	+.1	1.2	+.1	+.2
Nymphaea ampla (Salisb.) DC.	+.1	—	—	1.1	—	—	—	—	—	—
Hydrocotyle umbellata L.	+.1	+.1	—	—	1.1	+.1	+.2	1.1	1.1	
Centella erecta (L.f.) Fern.	+.1	1.1	1.1	+.1	—	—	—	—	—	—
Sagittaria lancifolia L.	—	—	+.1	—	+.1	—	—	+.1	—	—
Echinodorus berteroi (Spreng.) Fassett	+.1	+.1	—	—	—	—	—	—	—	—
Pontederia lanceolata Nutt.	+.1	1.1	1.2	—	—	—	—	—	—	—
Eleocharis interstincta (Vahl.) R. and S.	1.1	—	—	1.2	2.2	—	—	—	—	—
Rhynchospora corniculata (Lam.) A. Gray.	—	+.1	+.2	1.2	—	—	—	—	—	—
Rhynchospora gigantea Link.	+.1	—	—	—	+.1	—	—	—	—	—
Bulbostylis capillaris (L.) C.B. Clarke	—	+.2	2.2	—	1.2	—	—	—	—	—
Fimbristylis ovata (Burm.f.) Kern.	1.1	+.1	1.2	1.2	2.2	—	—	—	—	—
Fimbristylis castanea (Michx.) Vahl	1.1	1.2	1.1	2.2	+.2	—	—	—	—	—
Paspalidium paludivagum (L.) Stapf	—	—	—	—	—	+.2	—	—	1.1	—

Table 75 Acrostycho-Schoenoplectetum americanae Borhidi in Borhidi et al. 1983

	1	2	3	4	5
Cover %:	100	100	100	100	100
Schoenoplectus americanus (L.) Palla	4.4	3.4	3.3	5.5	4.5
Acrostichum aureum L.	3.4	3.5	4.4	3.3	3.4
Eleocharis cellulosa Torrey	1.1	—	1.2	—	—
Fimbristylis annua (All.) R. and S.	—	1.1	—	+.2	—
Typha domingensis (Pers.) Kunth	—	—	1.1	—	+.1
Baccharis halimifolia ssp. *angustior* (DC.) Borhidi	+.1	—	+.1	+.1	—
Fimbristylis ovata (Burm.f.) Kern	—	+.2	—	—	—
Heliotropium curassavicum L.	—	—	+.1	—	—
Conocarpus erecta L.	—	—	—	+.2	—
Cladium jamaicense Crantz	—	—	—	—	+.1

Characteristic species: *Eleocharis interstincta, E. alveolata, E. minutissima, E. oligantha, Xyris grandiceps, X. fleuxosa, Rhynchospora gigantea, R. cyperoides, Panicum lacustre, P. parvifolium, P. tenerum, Mayaca wrightii.* The alliance has an intermediate position in the oligo-psammosere between *Mayacetalia fluviatilis* and *Rhynchosporeto-Xyridetalia.*

Associations studied in Cuba:

Rhynchosporeto-Eleocharetum interstinctae Samek and Moncada 1971

This association occupies the superior part of the littoral zone of the oligotrophic white sand lakes in the western Cuban wetland. It can be divided into three subassociations, each representing a little belt in the zonation. The subass. *panicetosum parvifolii* occupies the exterior part, the subass. *scirpetosum confervoidis* the central part and the subass typicum the transitional part to the inner side of the littoral zone. (Table 76).

Eleocharetum interstinctae Samek and Moncada 1971

This sedge marsh association occurs in contact with the former one. It forms the inner ring of the littoral belt by three subassociations. The subass. nymphaeetosum is permanently flooded, the subass. typicum is seasonally flooded, generally in autumn, the subass. panicetosum forms the transitional zone to the former association. (Table 77).

3.4 Order: TYPHETO-CLADIETALIA JAMAICENSIS Borhidi and Del-Risco in Borhidi et al. (1979) 1983

(Syn.: *Pontederio-Cladietalia* Knapp 1964 and *Rhynchosporo-Cladietalia* Knapp 1964 p.p.)

Reed-grass and high sedge marshes and swamps generally on permanently flooded sites, with peat accumulation in the soils.

3.4.1 Alliance: ***Typhion domingensis*** Del-Risco in Borhidi et al. (1979) 1983

Reed-grass and cattail marshes, high sedge marshes and *Maranthaceae*-swamps in eutrophic or dystrophic wetlands on peaty soils.

Characteristic species: *Typha domingensis, Phragmites australis, Cladium jamaicense, Pontederia lanceolata, Fuirena umbellata, Cyperus giganteus, Thalia geniculata, Erianthus giganteus,* etc.

Table 76 Rhynchosporeto-Elocharetum interstinctae Samek and Moncada 1971

A: panicetosum (7 rel.); B: scirpetosum (5 rel.); C: typicum (5 rel.)

	A	B	C
Eleocharis interstincta (Vahl.) R. and S.	V. +–4	V. +–3	V. 2–5
Rhynchospora cyperoides (Sw.) Mart.	V. +–2	V. +–2	V. 1–3
Xyris grandiceps p. maj. p. Griseb.	V. +–2	N. r–1	III. 1–2
Utricularia foliosa L.	III. +–2	V. +–2	III. 2–3
Panicum parvifolium Lam.	V. +–3	–	–
Panicum tenerum Beyr.	III. +–2	I. +	–
Panicum lacustre Hitchc. and Ekman	I. 2	I. +	–
Scirpus confervoides Poir.	–	V. 1–4	I. +
Utricularia purpurea Walt.	I. +	I. 1	–
Blechnum serrulatum A. Rich.	I. +	–	–
Caperonia palustris (L.) St. Hill.	–	I. +	–
Rhynchospora gigantea Link	–	–	I. +

Table 77 Eleocharetum interstinctae Samek et Moncada 1971

A: typicum (10 rel.); B: nymphaeetosum (13 rel.); C: panicetosum geminati (9 rel.)

	A	B	C
Eleocharis interstincta (Vahl.) R. and S.	V. 1–5	V. +–4	V. 2–3
Paspalum serratum Hitchc. and Chase	II. 1–3	I. +	– –
Mayaca fluviatilis ssp. *wrightii* (Griseb.) Borhidi	I. 2–3	I. 2	– –
Utricularia foliosa L.	I. 3–4	II. +–2	II. 1
Aeschynomene tuberculata Griseb.	I. r–+	– –	I. 1
Rhynchospora cyperoides (Sw.) Mart.	I. +	I. +	I. +–1
Sacciolepis striata (L.) Nash.	I. r	– –	– –
Vigna sp.	I. 1	I. 1	– –
Panicum lacustre Hitchc. and Ekman	I. 1	– –	– –
Scirpus confervoides Poir.	I. +	III. 2–4	– –
Nymphaea ampla (Salisb.) DC.	I. r	V. 1–3	II. +–2
Xyris grandiceps Griseb.	I. 1	– –	– –
Caperonia palustris (L.) St. Hill.	I. +	– –	– –
Pontederia lanceolata Nutt.	I. +	I. +	– –
Brasenia schreberi Gmel.	– –	II. +–3	– –
Utricularia purpurea Walt.	– –	I. 1–2	– –
Panicum geminatum Forsk.	– –	– –	V. +–4
Nymphoides aurea (Britt.) Britt. and Millsp.	– –	– –	II. +–3
Fuirena scirpoidea Michx.	– –	– –	I. 1
Rhynchospora gigantea Link.	– –	– –	I. +
Ludwigia repens Forst.	– –	– –	I. +
Salvinia auriculata Aubl.	– –	– –	I. +

Table 78 Typhetum domingensis Borhidi and Muñiz in Borhidi et al. 1983

	1	2	3	4	5
Cover %:	100	95	90	100	90
Typha domingensis (Pers.) Kunth	5.5	5.5	5.5	5.5	5.5
Ipomoea triloba L.	1.1	—	—	+.1	—
Mikania hastata (L.) Willd.	1.1	1.1	1.1	+.1	—
Panicum virgatum var. *cubense* Griseb.	—	1.1	1.2	+.1	—
Jussiaea suffruticosa L.	+.1	—	+.1	—	1.2
Polygonum punctatum Ell.	+.1	—	1.1	+.1	+.2
Hymenachne donacifolia (Raddi) Chase	+.1	1.1	+.1	+.1	+.1
Solidago stricta Ait.	—	+.1	—	—	—
Nymphaea blanda GFW. Meyer	1.1	—	—	—	—
Cabomba piauhyensis Aubl.	2.2	+.1	—	+.2	—
Hydrocotyle umbellata L.	+.1	1.2	+.2	1.2	2.2
Cynoctonum mitreola (L.) Britt.	—	+.1	1.2	—	—
Pluchea purpurascens (Sw.) DC.	—	+.1	1.2	—	—
Ipomoea tenuissima Choisy.	—	+.1	+.1	—	—
Centella erecta (L.f.) Fern.	—	—	+.2	—	—
Fuirena umbellata Rottb.	—	—	+.1	—	+.1
Aster exilis Ell.	—	—	—	—	+.1
Fimbristylis ovata (Burm.f.) Kern.	—	—	—	1.2	—

Typhetum domingensis Borhidi and Muñiz in Borhidi et al. 1983

Cattail marshes in eutrophic and dystrophic wetlands commonly as permanently flooded stands of the littoral zone, with a second herb layer formed by aquatic plants. Five representative relevés were made by Borhidi and Muñiz in May, 1970, and by Borhidi and Del Risco in March, 1975, in the Zapata Swamp area. Type relevé: no. 3, (Table 78).

Cyperetum gigantei Borhidi in Borhidi et al. 1983

This is a giant sedge-marsh community up to 3 m high, usually with three herb layers. The first herb layer is formed by the monodominant *Cyperus giganteus*, the second one by *Rhynchospora, Eleocharis* and *Gramineae* species, and the third one by aquatic and helophytic plants such as *Limnocharis flava, Crinum americanum, Sagittaria,* and *Ruellia* spp. Five relevés were made by Borhidi in the wet marshes of Rancho Boyeros, in October, 1969 (Table 79); type relevé: no. 1.

Polygoneto-Thalietum geniculatae Borhidi in Borhidi et al. 1983

This is a seasonally flooded broadleaved marsh association, in which *Thalia geniculata* of the Marantaceae is associated with high, helophytic grasses as *Vetiveria zizanoides, Panicum virgatum* var. *cubense,* sedges and with *Polygonum portoricense.* There is developed also a species rich, densely closed low herb layer under the protection of the broad-leaved Thalia. In the successional process this

Table 79 Cyperetum gigantei Borhidi in Borhidi et al. 1983

	1	2	3	4	5
Cover %:	90	85	95	100	100
Cyperus giganteus Vahl.	4.5	4.4	4.5	5.5	4.5
Pontederia lanceolata Nutt.	+.1	+.2	–	–	–
Limnocharis flava (L.) Buchen	2.3	2.3	1.3	1.2	2.2
Crinum americanum L.	–	–	+.2	–	+.2
Rhynchospora ligularis	1.2	–	–	2.2	–
Rhynchospora stellata Griseb.	1.3	2.2	2.3	2.3	1.2
Fuirena umbellata Rottb.	+.2	1.2	1.1	1.1	1.1
Phyla nodiflora (L.) Greene	1.2	2.2	2.2	+.1	–
Eleocharis interstincta (Vahl.) R. and S.	–	–	–	+.2	–
Panicum lancearium Trin.	+.2	–	–	–	1.1
Polygonum punctatum Ell.	–	–	+.1	–	–
Rhynchospora cyperoides (Sw.) Mart.	–	–	–	1.1	–
Sagittaria lancifolia L.	–	–	–	–	+.r
Panicum virgatum var. *cubense* Griseb.	–	1.2	–	–	–
Vetiveria zizanoides (L.) Nash.	–	+.1	1.1	–	–
Hymenachne donacifolia (Raddi) Chase	–	–	–	1.1	–
Ruellia paniculata L.	+.1	–	–	–	–

Table 80 Polygoneto-Thalietum geniculatae Borhidi in Borhidi et al. 1983

	1	2	3	4	5
Cover %:	100	100	100	100	100
Thalia geniculata L.	5.5	4.5	5.5	4.5	4.5
Vetiveria zizanoides (L.) Nash.	1.2	2.2	1.2	2.3	2.2
Panicum virgatum var. *cubense* Griseb.	1.1	1.2	1.3	2.2	2.3
Fuirena umbellata Rottb.	+.1	–	1.2	+.2	–
Pontederia lanceolata Nutt.	+.1	+.2	–	–	–
Typha domingensis (Pers.) Kunth	+.2	+.1	–	+.2	1.1
Polygonum portoricense Bert.	1.2	2.3	2.3	3.3	2.3
Baccharis halimifolia L.	+.1	–	–	–	–
Mimosa pigra L.	–	1.1	–	2.1	–
Sagittaria lancifolia L.	1.2	+.2	–	+.2	–
Rhynchospora stellata Griseb.	–	–	–	–	1.2
Nephrolepis biserrata (Sw.) Schott	2.2	–	1.2	–	–
Cyperus ligularis L.	–	–	+.1	+.1	–
Cyperus flavus (Vahl.) Nees	–	+.1	–	+.1	–
Phyla nodiflora (L.) Greene	2.3	2.3	–	+.2	–
Ludwigia repens Forst.	–	–	1.2	–	–
Centella erecta (L.f.) Fern.	–	–	–	–	1.1
Cynoctonum mitreola (L.) Britt.	–	–	+.1	–	1.2
Hydrocotyle umbellata L.	–	+.2	–	+.2	+.2
Cyperus filiformis Sw.	–	–	1.2	–	–
Bulbostylis capillaris (L.) C.B. Clarke	–	–	–	+.2	–
Mikania hastata (L.) Willd.	+.2	1.1	–	–	–
Ipomoea triloba L.	–	+.1	1.2	–	–
Aster leonis Britt.	–	–	–	+.1	–
Scleria pterota Presl.	–	–	1.1	–	–
Cassytha filiformis L.	–	–	–	1.2	1.3

community develops to a wet shrub savanna by settling of *Mimosa pigra, Paspalum secans* and others. Five relevés were made by Borhidi in the wetland area of Rancho Boyeros, in October, 1969. Type relevé: no. 1 (Table 80).

3.4.2 Alliance: ***Cladion jamaicensis***
Borhidi and Muñiz in Borhidi et al. (1979) 1983

High swamp vegetation of the winter sedge, mostly in dystrophic freshwaters and peaty soils, rarely forming wide extended swinging sedge-bogs on the surface of swamp-lakes.

Characteristic species: *Cladium jamaicense, Crinum americanum, C. oliganthum, Paspalum giganteum, Rhynchospora stellata, Panicum lancearium, P. condensum, P. virgatum, Andropogon glomeratus, Erianthus giganteus, Sacciolepis striata, Thelypteris palustris, Centella erecta, Solidago stricta,* etc.

Association studied in Cuba:

Crino-Cladietum jamaicensis Borhidi and Muñiz in Borhidi et al. 1983

It is a very common and widely distributed sedge-swamp community in the West Indies, represented with the greatest extension in the Zapata Swamp of Cuba and in the everglades of Florida (Fig. 339). The enclosed five relevés were made by Borhidi and Muñiz in May, 1970 and by Borhidi and Del Risco in March, 1975 in the Zapata Swamp. Type relevé: no. 5. (Table 81).



Fig. 339 A very extensive plant community of the swamp areas: the herbaceous swamp of the *Cladium jamaicense* Cr. (Photo: A. Borhidi)

Table 81 Crino-Cladietum jamaicensis Borhidi and Muñiz in Borhidi et al. 1983

	1	2	3	4	5
Cover %:	100	100	100	100	100
Cladium jamaicense Crantz	5.5	4.4	4.5	4.4	5.5
Andropogon glomeratus (Walt.) BSP.	+.1	+.2	1.2	1.1	+.2
Typha domingensis (Pers.) Kunth.	+.r	3.2	+.1	+.r	—
Ipomoea tenuissima Choisy	+.r	+.1	—	—	—
Cassytha filiformis L.	+.r	3.3	1.2	2.3	1.3
Conocarpus erecta L.	+.r	+.r	+.r	—	+.r
Solidago stricta Ait.	—	1.1	+.2	—	1.1
Annona glabra L.	—	+.r	—	+.r	+.r
Hydrocotyle umbellata L.	—	1.2	—	—	—
Mikania hastata (L.) Willd.	—	1.1	+.1	+.2	+.1
Cynoctonum mitreola (L.) Britt.	+.1	1.2	1.2	+.2	1.2
Panicum virgatum var. *cubense* Griseb.	+.2	1.1	1.1	1.2	1.2
Echinochloa crusgalli (L.) Beauv.	—	1.1	+.2	—	—
Rhynchospora cyperoides (Sw.) Mart.	—	1.1	+.1	+.1	—
Phyla nodiflora (L.) Greene	—	1.1	—	—	—
Sagittaria lancifolia L.	—	+.r	+.1	+.1	+.1
Pluchea purpurascens (Sw.) DC.	—	+.r	+.1	—	1.2
Sisyrinchium recurvatum Bicknell	—	+.r	—	—	—
Baccharis halimifolia L.	—	+.r	—	—	—
Chara domingensis	—	3.3	—	—	—
Bacopa monnieri (L.) Pennel	—	2.2	+.2	—	—
Crinum oliganthum Urban	—	(+)	+.2	+.1	+.1
Erianthus gigantens (Walt.) Muhl.	—	—	+.2	+.2	—
Panicum lancearium Trin.	—	—	+.1	+.1	—
Rhynchospora stellata Griseb.	—	—	+.2	+.1	—
Centella erecta (L.f.) Fern.	—	—	1.1	1.2	1.2
Sacciolepis striata (L.) Nash	—	—	1.1	+.1	+.1
Thelypteris palustris	—	—	2.3	1.3	—
Nymphaea ampla (Salisb.) DC.	—	—	—	—	+.1
Nephrolepis biserrata (Sw.) Schott	—	—	—	—	+.1
Blechnum serrulatum A. Rich.	—	+.2	—	—	—
Proserpinaca palustris L.	—	—	—	—	+.1
Ludwigia natans Ell.	—	—	1.2	—	—

4 Class: **PARVIRHYNCHOSPORO-ERIOCAULETEA** Borhidi 1979 in Bal.—Tul. and Capote 1985

Open and moderately closed short grassland vegetation on humid or at least seasonally wet, mostly oligotrophic acidic soils, poor in nutrients, most frequently on humid white sand seasonally flooded by oligotrophic shallow freshwaters. The vegetation is formed by short or dwarf cyperaceas, xyridaceas, eriocaulaceas, scrophulariaceas and rubiaceas with pygmaeous or creeping stems, accompanied by carnivorous plants as the dwarf rooted *Utricularia* species, *Pinguicula filifolia,*

Drosera intermedia and little rosette hemicryptophytes as *Hyptis pedalipes, Aster grisebachii, Lachnorrhiza, Stenandrium, Sachsia* ssp. *Chaetolepis cubensis, Eriocaulon fuliginosum, Elephantopus* ssp.

4.1 Order: RHYNCHOSPORO-XYRIDETALIA Borhidi (1979) et in Bal.–Tul. et Capote 1985

Short wet grassland vegetation on oligotrophic, mostly white sand soils.

Characteristic species: *Rhynchospora cyperoides, R. filifolia, R. podosperma, R. brachychaeta, R. tenuis, R. tracei. R. leptorrhyncha, Acisanthera quadrata, Rhexia cubensis, Eleocharis capillacea, Herpyza grandiflora, Lachnocaulon ekmanii, Lachnanthes tinctoria, Panicum wrightianum, Scleria* ssp., *Xyris bicarinata, X. navicularis, X. elliottii,* etc.

4.1.1 Alliance: ***Rhynchosporo-Xyridion***
Borhidi (1979) et in Bal.—Tul. et Capote 1985

Closed wet short grasslands highly rich in endemics and plants of northern distribution pattern.

Association observed and studied in Cuba:

Xyridi-Hypericetum fasciculati Borhidi (ined.)

Burmannio bicolori-Hypericetum fasciculati Balátová-Tuláčková in Bal.—Tul. et Capote 1985

Closed wet oligotrophic sandy peat community, shallowly flooded during the rainy season. The substrate is formed by white sand with an admixture of humus on the surface. The community can be found in the south-west part of the white sand area of the Isle of Pines (Isla de la Juventud) between the Hotel Colony and the Siguanea Hills. The association is to be divided into two subassociations: the longer flooded wetter one is named as *utricularietosum fimbriatae* Bal.-Tul. 1985 (Table 82. rel. 1), while the drier variant is considered as the typical representative of the community (rels 2 and 3).

Spigelio sphagnicolae-Paepalanthetum seslerioidis
Balátová-Tuláčková et Capote 1985

This is the community the herbaceous clearings of the ammophylous pine woodlands, *Paepalantho-Pinetum tropicalis* association. It develops in the small depressions of the white sand dunes flooded seasonally by shallow acid and nutrient poor water. It forms a dynamic complex with the pine woodland and sandy savanna communities, even scattered *Pinus tropicalis* trees may occur in this association. In its species composition endemics play a relevant role, therefore the community is

considered as an endemic association of the sandy areas of Isle of Pines. Two subassociations are differentiated, the typical one and the *hypericetosum styphelioidis* (Table 83. rel. 1) which represente a transitional variant to the pine woodland communities with a more developed shrub layer.

Chaetolepidi-Rhynchosporetum filifoliae Borhidi

4.2 Order: PAEPALANTHO-ERIOCAULETALIA Knapp (1964), emend. Borhidi (1979), and in Balátová-Tuláčková and Capote 1985

These are seasonally dry oligotrophic open short grasslands, formed by small rosette perennials, dwarf and needle-leaved shrubs, cushion-shaped plants, essentially on white sand, rarely on humid serpentine laterite, both extremely poor in nutrients.

Characteristic species: *Eriocaulon arenicola, E. fuliginosum, E. ovoideum,* etc., *Paepalanthus alsinoides, P. seslerioides, P. lamarckii, Syngonanthus androsaceus, S. insularis, S. lagopodioides, S. leonis, S. wilsonii, Xyris ekmanii, Scleria pauciflora, S. interrupta, S. ciliata, Richardia arenicola, R. ciliata, Nodocarpaea radicans, Borreria strumpfioides, Mitracarpus depauperatus, Cuphea pseudosilene, Cenchrus distichophyllus,* etc.

4.2.1 Alliance: ***Eriocaulo-Paepalanthion*** Borhidi (1979) et in Balátová-Tuláčková and Capote 1985

With the same characteristics as the order.

Associations observed and studied in Cuba:

Syngonantho-Paepalantheum alsinoidis Borhidi (ined.)

Xyridi-Paepalanthetum seslerioidis Borhidi 1979 (ined.)

4.3 Order: HYDROLAEETALIA NIGRICAULIS Balátová-Tuláčková in Balátová-Tuláčková and Capote 1985

Open herbaceous plant communities occurring in the depressions of the sandy savannas of Isle of Pines. The sandy soil is acid regularly flooded during the rainy season and it is covered by a thin layer of mud. Because of this muddy surface, the ecologic character of the site is less oligotrophic than in the other *Parvirhynchosporo-Eriocauletea* communities. This moderately acid and oligotrophic character is reflexed by the characteristic species composition of the community. It is composed of moderately acidophilous white sand elements as *Phyllanthus heliotropus, Eriocaulon fuliginosum, Rhynchospora divergens (?), Chaetolepis cubensis,*

Table 82 Burmannio-bicolori—Hypericetum fasciculati
Balátová-Tuláčková in Balátová-Tuláčková and Capote 1985

	1	2	3	Pr_3
Cover %:	80	92	80	
Characteristic and differential species of the association				
Burmannia bicolor Mart.	+	2	2	3
Panicum albomarginatum Nash	+	2	2	3
Cuphaea cordifolia (Sw.) Koehne	+	—	—	1
Differential species of *utricularietosum fimbriatae* subass.				
Eriocaulon cf. *olivaceum* Mold.	1	.	.	1
Syngonanthus androsaceus (Griseb.) Ruhl.	+	.	.	1
Utricularia fimbriata HBK.	+	.	.	1
Lycopodium meridionale Underw. and Lloyd	r	.	.	1
Blechnum serrulatum A. Rich. ssp. *roigii* Bobrov	r	.	.	1
Characteristic species of the alliance and order				
Hypericum fasciculatum Lam.	3	3	+	3
Xyris elliottii Chapm.	1	3	4	3
Rhynchospora brachychaeta C Wr.	1	1	+	3
Burmannia capitata (Walt.) Mart.	+	r	+	3
Panicum erectifolium Nash	1	—	—	1
Characteristic species of the *Parvirhynchosporo-Eriocauletea* class				
Chaetolepis cubensis (A. Rich.) Triana	1	+	+	3
Lachnorrhiza piloselloides A. Rich.	2	2	+	3
Polygala leptocaulis Torr. and Gray	+	+	+	3
Paspalum nanum C. Wr.	+	1	1	3
Paspalum pulchellum Kunth	—	1	+	2
Xyris bicarinata Griseb.	+	.	.	1
Drosera rotundifolia L.	+	.	.	1
Characteristic species of the *Eriocaulo-Paepalanthion* alliance				
Syngonanthus lagopodioides (Griseb.) Ruhl.	+	1	1	3
Helenium scaposum Britt.	+	.	.	1
Borreria strumpfioides Wr. ex Griseb.	.	.	r	1
Characteristic species of the *Hydrolaeetalia nigricaulis* order				
Phyllanthus heliotropus Griseb.	1	1	1	3
Panicum laxum Sw.	r	+	+	3
Elephantopus pratensis Wr. in Sauv.	—	+	+	2
Companion species, *Curatello-Byrsonimetea*				
Rhynchospora plumosa Ell.	1	+	1	3
Rhynchospora podosperma C. Wr.	2	+	2	3
Panicum tenerum Beyr.	+	1	+	3
Andropogon virginicus L.	+	+	+	3
Agalinis albida Britt. and Penn.	+	+	+	3
Rhynchospora globosa (HBK.) Roem. and Schult.	+	+	—	2
Rhynchospora subimberbis Griseb.	r	—	+	2
Sauvagesia brownei Planch.	r	—	r	2
Phyllanthus selbyi Britt. and Wils.	—	+	+	2
Borreria thymocephala Griseb.	—	+	+	2
Cassia diphylla L.	—	(+)	r	2

Other companions				
Scleria baldwinii (Torr.) Steud.	+	+	+	3
Cassytha filiformis L.	+	2	2	3
Panicum leucothrix Nash	+	—	+	2
Scleria interrupta A. Rich.	.	+	+	2
Ischaemum rugosum Salisb.	r	(+)	—	2
Fuirena simplex Vahl	(+)	(r)	—	2
Leptocoryphium lanatum (HBK.) Nees	+	—	—	1
Aristida vilfifolia Henr.	r	—	—	1
Aristida brittonorum Hitchc.	+	—	—	1
Andropogon bicornis L.	r	—	—	1
Cuphea pseudosilene Griseb.	r	—	—	1
Colpothrinax wrightii Griseb. and Wendl.	r	—	—	1
Myrica cerifera L.	+	—	—	1
Tabebuia lepidophylla (A. Rich.) Greenm.	+	—	—	1
Melochia savannarum Britt.	—	+	—	1
Cyperus polystachyos Rottb.	—	+	—	1
Cyperus ligularis L.	—	r	—	1
Mesosetum wrightii Hitchc.	—	—	1	—
Scleria muhlenbergii Steud.	—	—	+	1
Oldenlandia uniflora L.	—	—	+	1

Elephantopus pratensis, and of species of swamp communities as *Encopella tenuifolia, Panicum laxum, Eleocharis caribaea, Fimbristylis complanata, Pluchea rosea, Centella erecta*, etc.

Balátová-Tuláčková constructed a separate association class for this community (*Hydrolaeetea nigricaulis* Bal.-Tul. in Balátová-Tuláčková and Capote 1985a) but the given characteristic composition does not seem to justify her decision. One half of the listed species proposed as characteristic by Balátová-Tuláčková is a group of both ecologically and phytogeographically widely distributed species, common in several swamp and marshland communities. The other half is composed of oligotrophic species mostly occurring in other moist white sand associations as well, therefore they are to be considered as characteristic species of the *Parvirhyncho-sporo–Eriocauletea* class. For characteristic species of the order and alliance the following are to be considered:

Hydrolaea nigricaulis, Encopella tenuifolia, Elephantopus pratensis, Phyllanthus heliotropus, Eriocaulon fuliginosum.

4.3.1 Alliance: ***Hydrolaeion nigricaulis***
Balátová-Tuláčková in Balátová-Tuláčková and Capote 1985

With the same characters as in the order.

Encopello-Hydrolaeetum nigricaulis Bal.-Tul. and Capote 1985

This association grows in the south-west of Isle of Pines and can be divided into two subassociations. The subass *ludwigietosum erectae* occurs on sites with higher water table (Table 84, rels 1—2) than the typical subassociation (rel. 3—5)

Table 83 Spigelio sphagnicolae-Paepalanthetum seslerioidis Balátová-Tulácková and Capote 1985

	1	2	3	Pr_3
Cover %:	80	75	85	
Characteristic and differential species of the association				
Spigelia sphagnicola C. Wr. in Sauv.	r	+	r	3
Diodia ciliata Britt. et Wils.	+	1	+	3
Mitracarpus depauperatus Britt. et Wils.	+	+	—	2
Utricularia pusilla Vahl	—	r	r	2
Differential species of the *hypericetosum styphelioidis* subass.				
Hypericum styphelioides A. Rich.	2	+	—	2
Calyptranthes pinetorum Wils.	2	1	—	2
Miconia androsaemifolia Griseb.	1	(r)	—	2
Characteristic species of *Paepalantho-Eriocauletalia* order	+	2	+	3
Syngonanthus lagopodioides (Griseb.) Ruhl.	+	+	+	3
Borreria strumpfioides Wr. ex Griseb.	+	+	+	3
Helenium scaposum Britt.	+	+	—	2
Hyptis ammotropha Wr. ex Griseb.	+	+	—	2
Heptanthus cochlearifolius Griseb.	—	1	+	2
Acisanthera quadrata Juss.	—	—	+	1
Characteristic species of *Hydrolaeetalia nigricaulis* order				
Eriocaulon fuliginosum C. Wr. in Sauv.	+	+	+	3
Panicum laxum Sw.	—	+	—	1
Characteristic species of the *Parvirhynchosporo-Eriocauletea* class				
Chaetolepis cubensis (A. Rich.) Triana	+	+	1	3
Lachnorrhiza piloselloides A. Rich.	+	r	2	3
Cuphea pseudosilene Griseb.	1	1	1	3
Croton cerinus Muell. Arg.	1	1	1	3
Xyris bicarinata Griseb.	+	+	+	3
Pinguicula filiformis Wr. ex Griseb.	+	+	+	3
Drosera rotundifolia L.	+	r	+	3
Elephantopus arenarius Britt. and Wils.	+	r	+	3
Polygala leptocaulis Torr. and Gray	+	+	+	3
Paspalum pulchellum Kunth	+	—	+	2
Polygala uncinata C. Wr. in Sauv.	—	+	—	1
Companion species, *Curatello-Byrsonimetea*				
Rhynchospora globosa (HBK.) Roem. and Schult.	2	+	3	3
Rhynchospora subimberbis Griseb.	2	2	1	3
Sauvagesia brownei Planch.	2	2	1	3
Phyllanthus selbyi Britt. and Wils.	1	1	1	3
Aeschynomene tenuis Griseb.	+	+	+	3
Mesosetum loliiforme (Hochst.) Chase	+	1	1	3
Panicum tenerum Beyr.	+	1	+	3
Rhynchospora podosperma C. Wr. in Sauv.	+	+	+	3
Dichromena seslerioides (Griseb.) Clarke	+	+	+	3
Aristida vilfifolia Henr.	+	+	+	3
Stenandrium droseroides Nees	+	+	+	3
Aristida brittonorum Hitchc.	+	—	+	2
Buchnera elongata HBK.	+	—	—	1

Cameraria retusa Briseb.	–	+	–	1
Agalinis albida Britt. et Penn.	–	–	+	1
Characteristic species of *Byrsonimo-Pinetea* class				
Tabebuia lepidophylla (A. Rich.) Greenm.	–	1	+	2
Brya depressa Borhidi	–	+	+	2
Panicum leucothrix Nash	+	+	+	3
Scleria interrupta A. Rich.	+	+	+	3
Byrsonima wrightiana Urb. et Niedz.	1	–	–	1
Ouratea elliptica (A. Rich.) Maza	+	–	–	1
Acoelorraphe wrightii Wendl.	(+)	–	–	1
Pinus tropicalis Morelet	–	r	–	1
Characteristic species of the *Sclerio baldwinii-Andropogenetea gracilis* class				
Cynanchum savannarum Alain	r	+	+	3
Sachsia polycephala Griseb.	+	+	+	3
Angadenia sagraei A. DC.	–	r	+	2
Scleria baldwinii (Torr.) Steud.	–	–	r	1
Other companions				
Rhynchospora sp. div.	r	+	+	3
Guettarda calyptrata A. Rich.	–	1	+	2
Leptocoryphium lanatum (HBK.) Nees	(+)	–	+	2
Lagenocarpus guianensis Nees	1	+	–	2
Schwenkia americana L.	+	–	+	2
Oldenlandia uniflora L.	r	–	r	2
Cassytha filiformis L.	–	+	2	2
Eragrostis cubensis Hitchc.	r	–	–	1
Schultesia guianensis (Aubl.) Malme	r	–	–	1
Aristida refracta Griseb.	–	+	–	1
Cyperus surinamensis Rottb.	–	–	+	1
Manisuris loricata (Trin.) kuntze	–	–	+	1
Malpighia horrida Small	–	–	+	1
Coccoloba microphylla Griseb.	–	–	(+)	1
Stigmaphyllum sagraeanum A. Juss.	–	–	(r)	1

5. Class: **ZOSTERETEA** Chapman 1974

Submarine, rooted swards formed by submerged phanerogams of wide, mostly pan-tropical distribution.

5.1 Order: RUPPIETALIA MARITIMAE J. Tx. 1960

Submarine swards of the temperate seas, and submerged vegetation of the continental and insular salt lakes.

Characteristic species: *Ruppia maritima, Najas marina, N. guadalupensis, N. wrightiana, Halodule beaudettii, H. wrightii.*

Table 84 Encopello tenuifoliae-Hydrolaeetum nigricaulis Balátová-Tuláčková and Capote 1985

	1	2	3	4	5
Cover %:	60	50	65	60	65
Characteristic and differential species of the association					
Hydrolaea nigricaulis Wr. ex Griseb.	2	2	1	1	3
Cyperus haspan L. (diff.)	+	+	+	+	+
Encopella tanuifolia (Griseb.) Pennell	—	1	1	4	1
Differential species of the *ludwigietosum erectae* subass.					
Ludwigia erecta (L.) H. Hara	3	3	+	—	—
Paspalum erecta (L.f.) Fern.	+	+	—	—	—
Centella erecta (L.f.) Fern.	2	—	—	—	—
Cyperus surinamensis Rottb.	—	r	—	—	—
Characteristic and differential species of alliance and order					
Panicum laxum Sw.	+	+	+	+	+
Phyllanthus heliotropus Griseb	1	—	3	+	+
Pluchea rosea Godfrey (diff.)	+	+	—	+	+
Rhynchospora divergens Curtis	+	—	+	+	+
Eleocharis caribaea (Rottb.) Blake (diff.)	—	1	3	1	3
Fimbristylis complanata (Retz) Link (diff.)	—	—	+	+	+
Characteristic species of the *Parvirhynchosporo-Eriocauletea* class					
Elephantopus pratensis Wr. ex Sauv.	+	+	+	+	(r)
Chaetolepis cubensis (A. Rich.) Triana	+	r	+	+	—
Eriocaulon fuliginosum Wr. in Sauv.	—	—	1	+	+
Acisanthera quadrata Juss.	—	—	(r)	+	—
Utricularia pusilla Vahl	—	—	r	+	—
Croton cerinus Muell. Arg.	—	+	—	—	—
Lachnorrhiza piloselloides A. Rich.	—	—	(r)	—	—
Characteristic species of the *Curatello-Byrsonimetea* class					
Panicum tenerum Beyr.	1	+	2	1	1
Borreria thymocephala Griseb.	+	(+)	+	+	+
Phyllanthus selbyi Britt. and Wils.	—	—	+	1	—
Jatropha angustifolia Griseb.	—	—	—	—	r
Other companions					
Eragrostis elliottii S. Wats.	+	+	r	—	+
Cassytha filiformis L.	1	+	+	(+)	—
Ischaemum rugosum Salisb.	+	(+)	+	(+)	—
Scleria baldwinii (Torr.) Steud.	+	+	—	1	—
Dichanthium sp.	—	—	(r)	+	+
Andropogon virginicus L.	—	—	+	—	r
Manisuris loricata (Trin.) Kuntze	—	—	+	+	—
Aristida vilfifolia Henr.	—	—	—	+	—
Cassia diphylla L.	—	—	—	r	—
Brya depressa Borhidi	—	—	—	r	—
Mikania ranunculifolia A. Rich.	—	—	—	—	(r)

5.1.1 Alliance: ***Ruppion maritimae*** Br.-Bl. 1931

Associations observed and studied in Cuba:

Halodulo-Ruppietum maritimae
Borhidi and Del-Risco in Borhidi et al. 1983

This is a community of the moderately to extremely saline waters of estuaries and the shallow mangrove-areas. Five representative relevés were made by Borhidi in February, 1981, in Las Salinas, Zapata Peninsula, Bahia de Cochinos. Type relevé: no. 2. (Table 85)

5.2 Order: THALASSIO-SYRINGODIETALIA FILIFORMIS Knapp (1964) in Borhidi et al. 1983

Tropical submarine swards in the Caribbean region.

Characteristic species: *Thalassia testudinum, Syringodium filiforme, Halodule wrightii, Halophila baillonis, H. aschersonii, Limnobium laevigatum.*

5.2.1 Alliance: ***Syringodio-Thalassion***
Borhidi in Borhidi et al. (1979) 1983

With the same characteristics as the order.

Associations observed and studied in Cuba:

Syringodio-Thalassietum (Ciferri 1936) Borhidi in Borhidi et al. 1983

Submarine phanerogamic swards of the shallow sublittoral zones of the sandy beaches. Five representative relevés were made by Borhidi in the Casilda Peninsula (Sancti Spiritus Province) in September, 1969, and in Punta Maisi (Baracoa Province) in March, 1970. Type relevé: no. 2. (Table 86)

Limnobietum laevigati Borhidi in Borhidi et al. 1983

(Syn.: *Hydromistrietum stoloniferae* Borhidi in Borhidi et al. 1979 n. nud.)

This is an open submarine sward community formed mostly by stoloniferous phanerogams in shallow sublittoral zone of sandy beaches. Five relevés were made by Borhidi in Jibacoa (November, 1969; May 1974) Varadero (June, 1976) and Casilda (September, 1969). Type relevé: no. 2 (Table 87).

Table 85 Halodulo-Ruppietum maritimae Borhidi and Del-Risco in Borhidi et al. 1983

	1	2	3	4	5
Cover %:	70	80	65	80	70
Ruppia maritima L.	4.4	4.4	3.3	4.5	4.4
Najas guadelupensis (Spreng.) Magnus	–	+.1	2.2	–	–
Halodule beaudettii (d. Hart.) d. Hart.	–	+.1	–	–	+.1
Syringodium filiforme Kütz.	–	–	–	1.2	–

Table 86 Syringodio-Thalassietum (Ciferri 1936) Borhidi in Borhidi et al. 1983

	1	2	3	4	5
Cover %:	90	95	90	85	90
Syringodium filiforme Kütz.	2.3	1.3	3.3	3.4	4.4
Thalassia testudinum Banks and Sol. ex König	4.4	5.5	3.4	2.3	2.2
Halodule wrightii Aschers.	—	—	—	+.2	—

Table 87 Limnobietum laevigati Borhidi in Borhidi et al. 1983

	1	2	3	4	5
Cover %:	70	75	70	80	70
Limnobium laevigatum (H. and B.) Mort.	4.4	4.4	3.4	4.5	4.4
Halodule wrightii Aschers.	—	+.1	—	+.1	—
Syringodium filiforme Kütz.	—	—	—	1.2	—
Ruppia maritima L.	—	—	2.2	—	—
Halophila baillonis Aschers. ex Dickie	+.2	1.2	—	—	+.1

6 Class: **IPOMOEO-MALLOTONIETEA** Knapp 1964 emend. Borhidi in Borhidi et al. (1979) 1983

(Syn.: *Ipomoeo-Tournefortietea* Knapp 1964 p.p.)

Herbaceous and shrubby vegetation of the tropical sandy sea shores.

6.1 Order: CANAVALIO-IPOMOEETALIA Knapp 1964 emend. Borhidi in Borhidi et al. (1979) 1983

Open pioneering vegetation of the beaches formed by creeping lianes and stoloniferous grasses.

Characteristic species: *Canavalia, maritima, Ipomoea pes-caprae, I. alba, Cakile maritima, Cenchrus tribuloides, Diodia maritima, Philoxerus vermicularis, Sporobolus virginicus, Paspalum vaginatum, Stemodia maritima,* etc.

6.1.1 Alliance: ***Ipomoeo-Canavalion maritimae*** Samek 1973

With the same characteristics as the order.

Associations studied in Cuba:

Sesuvio-Ipomoeetum pes-caprae Borhidi in Borhidi et al. 1983

It is a pioneer community of the sandy beaches. Originally it is a very common plant community, but heavily damaged and destroyed by man in most of the sandy shore areas. Five representative relevés were made by Borhidi at Alamar and Tarara near Habana, in August, 1696. Type relevé: no. 4 (Table 88).

Ipomoeo-Canavalietum maritimae Samek 1973

Ambrosio hispidae-Ipomoeetum pedis-caprae Bal.-Tul. et Garcia 1987

Ambrosio hispidae-Ipomoeetum stoloniferae Bal.-Tul. et Garcia 1987

Ipomoeo-Paspaletum distachyi Samek 19783

Paspalo-Sesuvietum portulacastri Samek 1973

Table 88 Sesuvio-Ipomoeetum pes-caprae Borhidi in Borhidi et al. 1983

	1	2	3	4	5
Cover %:	60	80	55	50	60
Ipomoea pes-caprae (L.) Sweet	3.3	4.4	3.4	3.3	3.3
Canavalia maritima (Aubl.) Thouars	+.1	1.1	—	+.1	1.1
Cakile lanceolata (Willd.) Schulz	+.1	—	—	+.1	—
Cenchrus brownei Roem. and Schult.	+.1	—	1.1	—	—
Sesuvium portulacastrum L.	2.3	3.3	2.3	1.2	1.2
Sporobolus virginicus spp. littoralis (Kunth) Borhidi	2.3	1.2	1.1	1.2	1.1
Mallotonia gnaphaloides (L.) Britt.	+.1	—	—	+.1	r.
Ipomoea alba L.	+.1	—	+.1	+.r	+.1
Eclipta prostrata (L.) L.	+.r	—	—	—	+.r
Chamaesyce buxifolia (Lam.) Small	+.r	+.1	—	+.1	—
Rhizophora mangle L.	+.r	—	—	—	—
Laguncularia racemosa (L.) Gaertn.f.	+.r	—	—	—	—
Stachytarpheta jamaicensis (L.) Vahl	+.r	—	+.r	+.1	—
Ipomoea triloba L.	+.r	—	—	—	—
Eragrostis salzmannii Steud.	+.2	—	—	—	—
Diodia serulata (Beauv.) Tayl.	—	—	+.1	+.1	—
Stemodia maritima L.	—	+.1	—	—	1.1
Philoxerus vermicularis (L.) R. Br.	—	+.1	+.1	—	+.1

Table 89 Borrichio-Mallotonietum Borhidi in Borhidi et al. 1983

	1	2	3	4	5
Cover %:	85	80	90	80	85
Borrichia arborescens (L.) DC.	3.3	1.3	3.3	2.2	1.2
Mallotonia gnaphaloides (L.) Britt.	1.1	2.2	1.3	2.2	2.3
Ernodea littoralis Sw.	1.2	1.1	+.1	—	+.2
Uniola virgata (Poir.) Griseb.	1.3	2.3	1.1	1.2	—
Sporobalus virginicus ssp. *littoralis* (Kunth.) Borhidi	1.1	2.2	2.2	1.2	1.2
Turnera ulmifolia L.	+.1	—	—	+.r	—
Pectis cubensis (A. Rich.) Griseb.	—	+.r	—	—	—
Distichlis spicata (L.) Greene	+.2	1.2	2.3	1.2	3.3
Chamaesyce hyssopifolia (L.) Small	—	+.1	+.1	—	—
Erithalis fruticosa L.	—	—	—	+.1	+.1
Cenchrus brownei Roem. et Schult.	—	—	+.1	+.1	—
Canavalia maritima (Aubl.) Thouars	+.1	—	—	—	+.1
Stemodia maritima L.	—	+.1	—	—	—
Stachytarpheta jamaicensis (L.) Vahl	—	—	+.1	—	—
Chamaesyce brasiliensis (Lam.) Small	—	—	+.1	—	—
Suriana maritima L.	—	—	—	+.1	+.1

6.2 Order: BORRICHIO-MALLOTONIETALIA Borhidi in Borhidi et al. (1979) 1983

(Syn.: *Tournefortio-Surianion maritimae* Samek 1973)

These are closed littoral sandy meadows and low coastal scrubs on beaches, formed by leaf-succulent shrubs and suffrutescent plants.

Characteristic species: *Borrichia arborescens, B. cubana, Mallotonia gnaphaloides, Distichlis spicata, Ernodea littoralis, Suriana maritima Scaevola plumieri, Erithalis fruticosa, Spartina juncea, Uniola virgata, Casasia clusiifolia,* etc.

6.2.1 Alliance: ***Borrichio-Mallotonion*** Borhidi in Borhidi et al. (1979) 1983

Closed sandy meadows and seaside prairies on the sandy shores.

Associations studied in Cuba:

Borrichio-Mallotonietum Borhidi in Borhidi et al. 1983

This is a closed sandy sward or prairie community formed by stoloniferous grasses and succulent leaved *hemicryptophytes,* suffrutescents and low shrubs. It is a widely distributed community but mostly heavily damaged and destroyed by the use of the beaches for recreational purposes. Five representative relevés were made by Borhidi at Alamar, Tarara and Guanabo east of Habana, in August-October, 1969. Type relevé no. 3 at Alamar. (Table 89).

Other communities:

Tournefortietum gnaphaloidis Samek 1973

6.2.2 Alliance: ***Suriano-Baccharidion halimifoliae***
Borhidi in Borhidi et al. (1979) 1983

Littoral thickets in the transition of the littoral meadows towards the *Coccoloba*-scrub.

Associations observed and studied in Cuba:

Ernodeo-Surianetum maritimae Ciferri 1936 n. nud

Surianetum maritimae Samek 1973

Suriano-Baccharidetum halimifoliae Borhidi in Borhidi et al. 1983

The *Suriana-Baccharis* thicket is rather common in the seaward slopes of the coastal dunes, forming mostly a thin skirt along the edge of the *Coccoloba*-scrub. It develops in greater extension and with a more species-rich variant in the undisturbed flat beaches and on the edge of the coastal lagoons. Five representative relevés made at Punta del Este, Punta Gorda, Carapachibey, all in the south part of Isla de Pinos. Type relevé: no. 3 (Table 90). Carapachibey, December, 1969. A. Borhidi.

Table 90 Suriano-Baccharidetum halimifoliae Borhidi in Borhidi et al. 1983

	1	2	3	4	5
Cover %:	75	85	100	95	85
Suriana maritima L.	3.3	3.3	3.4	4.5	4.5
Baccharis halimifolia L.	2.3	3.3	2.3	1.1	+.1
Borrichia arborescens (L.) DC.	+.1	+.1	1.2	1.2	+.1
Uniola paniculata L.	2.2	1.2	2.3	1.1	+.1
Ernodea littoralis Sw.	–	–	1.2	+.1	2.2
Erithalis fruticosa L.	+.1	–	1.1	–	+.1
Mallotonia gnaphaloides (L.) Britt.	–	+.1	1.1	–	+.1
Sporobolus virginicus ssp. *littoralis* (Kunth.) Borhidi	1.2	1.2	–	2.3	+.1
Turnera ulmifolia L.	–	–	+.r	+.1	–
Fimbristylis spathacea Roth	1.2	1.1	–	–	–
Torulinium filiforme Clarke	–	–	–	+.2	–
Distichlis spicata (L.) Greene	–	–	1.2	+.2	+.2
Batis maritima L.	+.2	+.2	–	–	–
Chamaesyce hyssopifolia (L.) Small	–	–	+.1	–	+.1
Cassia lineata Sw.	–	–	–	+.2	–
Flaveria trinervia (Spr.) Mohr	+.1	–	–	–	+.2
Eclipta prostrata (L.) L.	–	+.r	–	+.r	–
Ipomoea triloba L.	–	+.r	+.r	–	–
Paspalum fimbriatum HBK.	–	+.2	–	–	–
Dactyloctenium aegyptium (L.) Richt.	–	–	+.1	–	–
Sesuvium portulacastrum L.	–	–	–	–	+.2
Cynodon dactylon (L.) Pers.	–	–	–	+.2	–

7 Class: **SESUVIO-RACHICALLIETEA**
Borhidi in Borhidi et al. (1979) 1983

Orophilous halophytic vegetation of the supratidal rocky shores, conditioned by the influence of salt spray, the unprotected exposure and the extremely poor soil conditions. In the hard limestone coastal areas it can extend inlandwards to a 100—200 m wide range.

7.1 Order: TRIANTHEMO-SESUVIETALIA
Borhidi in Borhidi et al. (1979) 1983

Pioneer rock vegetation on the coastal cliffs and supratidal rock pavements, formed mostly by creeping, leaf-succulent plants, under a continuous influence of the tidal spray.

Characteristic species: *Sesuvium portulacastrum, S. maritimum, Trianthema portulacastrum, Lithophila muscoides,* etc.

7.1.1 Alliance: ***Trianthemo-Sesuvion***
Borhidi in Borhidi et al. (1979) 1983

Open, species poor coastal rock pavement vegetation, formed mostly by prostrate, leaf-succulent plants.

Association studied in Cuba:

Lithophilo-Trianthemetum portulacastri Borhidi in Borhidi et al. 1983

Open prostrate vegetation formed by *Lithophila muscoides* and *Trianthema portulacastrum* in the outmost strip of the rocky shore zonation. Five representative relevés made by Borhidi at Jibacoa, (October, 1969), at Alamar (August, 1969) and at Punta Colorados (Cienfuegos Province) in September, 1969. Type relevé: no. 2 at Jibacoa (Table 91).

Table 91 Lithophilo-Trianthemetum portulacastri Borhidi in Borhidi et al. 1983

	1	2	3	4	5
Cover %:	25	35	30	40	20
Lithophila muscoides Sw.	1.2	2.3	1.2	2.2	1.2
Trianthemum portulacastrum L.	2.2	2.2	2.3	3.4	2.3
Rhachicallis americana (Jacq.) Hitchc.	+.r	—	—	+.1	—
Conocarpus erecta L.	—	+.1	—	—	—
Sesuvium portulacastrum L.	—	+.1	+.1	+.r	—

Trianthemo-Sesuvietum portulacastri Borhidi in Borhidi et al. 1983

Somewhat closer prostrate vegetation on the landward range of the pioneering zone of the rocky shore zonation (petrohalophytia) formed by *Sesuvium portulacastrum* and *Trianthema portulacastrum* and a few accompanying littoral halophytes. Five relevés were made by Borhidi at the same places as the former association. Type relevé: no. 4 at Jibacoa, (Table 92).

Table 92 Trianthemo-Sesuvietum portulacastri Borhidi in Borhidi et al. 1983

	1	2	3	4	5
Cover %:	45	55	50	60	40
Sesuvium portulacastrum L.	3.3	3.4	3.3	4.4	2.3
Trianthema portulacastrum L.	1.2	1.3	2.2	1.2	2.2
Rhachicallis americana (Jacq.) Hitchc.	—	+.1	+.1	—	—
Conocarpus erecta L.	—	—	—	+.2	—
Heliotropium humifusum HBK.	—	—	—	+.1	—
Chamaesyce buxifolia (Lam.) Small	—	+.r	—	—	—
Lithophila muscoides Sw.	—	—	—	—	+.1
Flaveria linearis Lag.	—	—	+.r	—	—

7.2 Order: BORRICHIO-RACHICALLIETALIA Borhidi in Borhidi et al. (1979) 1983

Moderately closed vegetation of the rocky shores formed mostly by cushion-shaped hemicryptophytes, and dominantly by succulent-leaved dwarf shrubs and shrubs. This plant community group is distributed all over the Caribbean shores.

Characteristic species: *Rachicallis americana, Borrichia arborescens, B. cubana, Conocarpus erecta* f. *caespitosa, Heliotropium humifusum, Chamaesyce buxifolia, Pectis* spp., *Strumpfia maritima, Erithalis vacciniifolia, Flaveria linearis, Opuntia dillenii,* etc.

7.2.1 Alliance: ***Rachicalli-Borrichion*** Samek 1973

With the same characteristics as the order.

Associations observed and studied in Cuba:

Sesuvio-Rachicallietum americanae Borhidi (ined.)

Conocarpo-Rachicallietum americanae Borhidi in Borhidi et al. 1983

This is the plant association of the high, seaside, intensively eroded limestone banks, a humid, saline dog-tooth site. The prostrate form of *Conocarpus erecta* may

Table 93 Conocarpo-Rachicallietum americanae Borhidi in Borhidi et al. 1983

	1	2	3	4	5
Cover %:	45	45	60	70	80
Rachicallis americana (Jacq.) Hitchc.	3.3	2.3	3.4	3.3	1.2
Conocarpus erecta L. f. *caespitosa*	1.2	2.2	1.2	3.4	4.4
Chamaesyce buxifolia (Lam.) Small.	+.2	+.1	+.1	—	—
Chamaesyce adenoptera (Bertol.) Millsp.	+.r	—	+.1	—	—
Pectis leptocephala (Cass.) Urb.	—	+.1	+.1	—	—
Heliotropium humifusum HBK.	1.1	+.1	+.1	+.2	+.r
Cassia lineata Sw.	—	+.1	—	—	—
Melochia tomentosa L.	+.1	—	—	—	—
Flaveria linearis Lag.	—	+.1	1.1	—	—
Tephrosia senna HBK.	+.r	+.1	—	—	—
Coccoloba uvifera L.	+.1	—	—	—	—
Suriana maritima L.	+.1	+.1	—	+.1	—
Opuntia dillenii Ker.-Gawl.	1.1	1.1	—	—	1.1
Turnera ulmifolia L.	+.1	+.1	—	+.1	—
Stachytarpheta jamaicensis (L.) Vahl.	+.r	—	+.r	—	—
Chenopodium ambrosioides L.	+.r	—	—	—	—
Cassia clarensis (Britt.) Howard	+.1	—	—	—	—
Pectis ritlandi Howard et Briggs	+.r	—	—	—	—
Morinda royoc L.	+.1	—	1.1	1.2	—
Chamaesyce hirta (L.) Millsp.	—	—	+.r	+.1	—
Canavalia miritima (Aubl.) Thouars	—	—	+.1	+.1	+.1
Solanum bahamense L.	—	+.1	—	—	—
Borrichia arborescens (L.) DC.	—	+.1	+.1	+.2	+.1
Sesuvium portulacastrum L.	+.2	+.1	+.1	1.2	1.2
Mallotonia gnaphaloides (L.) Britt.	+.2	+.1	—	—	—
Catesbaea parviflora Sw.	—	—	—	—	+.1
Castela calcicola (Britt. and Small) Ekm. et Urb.	—	—	+.1	—	1.2
Jacquemontia jamaicensis (Jacq.) Hall f.	—	—	+.2	—	1.2
Ipomoea pes-caprae (L.) Sweet	—	—	—	—	+.2

constitute a continuous closed carpet together with *Rachicallis, Catesbaea, Castela, Opuntia* intertwined by xerophytic lianes as *Morinda royoc, Jacquemontia jamaicensis* and *Ipomoea spp.* Five representative relevés were made by Borhidi at Punta Colorados in September, 1969, at Mal Paso in May, 1970 and at Punta del Holandés (Peninsula of Guanahacabibes) in December, 1974. Type: relevé no. 3. Mal Paso (East of Playa Girón), (Table 93).

Borrichio-Rachicallietum americanae (Uphof 1924) Samek 1973

Erithali-Strumpfietum Borhidi in Borhidi et al. 1983

It is an endemic littoral dwarf shrub community of the southern seaside limestone cliffs in South Oriente and Hispaniola mostly distributed along the coastal belt between Siboney and Maisi. The association is formed by two co-dominant leaf

Table 94 Erithali-Strumpfietum Borhidi in Borhidi et al. 1983

	1	2	3	4	5
Cover %:	60	70	40	50	70
Erithalis vacciniifolia (Griseb.) Wr. in Sauv.	3.4	4.4	3.3	2.3	3.3
Strumpfia maritima Jacq.	2.3	2.3	1.2	3.3	3.4
Conocarpus erecta L. f. *caespitosa*	—	—	+.1	+.1	—
Rhachicallis americana (Jacq.) Hitchc.	—	1.1	—	—	+.1
Sesuvium portulacastrum L.	—	—	+.1	—	—
Trinathema portulacastrum L.	+.1	—	—	—	—
Lithophila muscoides Sw.	+.1	—	—	—	—
Caribaea littoralis Alain	—	—	—	—	+.2
Caesalpinia pauciflora (Griseb.) Wr. in Sauv.	—	—	—	+.2	—

succulent dwarf shrubs the subendemic *Erithalis vacciniifolia* and the West Indian *Strumpfia maritima*. A notable companion is the endemic Cuban littoral cushion-plant: *Caribaea littoralis*. Five relevés were made by Borhidi at Siboney and Macambo (near to San Antonio del Sur) in January and February, 1976. Type: relevé no. 1. E. of Playa Siboney, (Table 94).

8 Class: **BATIDI-SALICORNIETEA** Knapp (1964) in Borhidi hoc loco

Vegetation of the salines formed by leaf-succulent dwarf shrubs and annual or perennial succulents and by grasses of high osmotic tension. This belt of the salt vegetation is developed inlandwards behind the mangrove-zone, in the area flooded only twice a year by the high aequinoctial tides, where the salt tends to concentrate extremely by evaporation, and allows the development of herbaceous flats with *Salicornia* mats and/or low *Batis maritima* scrub.

8.1 Order: BATIDI-SALICORNIETALIA AMBIGUAE Knapp (1964) in Borhidi hoc loco

Tropical vegetation of saline sites formed mostly by succulent plants.

Characteristic species: *Batis maritima, Salicornia ambigua, S. perennis, Suaeda fruticosa, S. linearis, Fimbristylis spathacea*, etc.

8.1.1 Alliance: ***Fimbristyli-Salicornion perennis*** (Chapman 1960)

Open vegetation of saline sites formed by suffrutescent plants.

Table 95 Fimbristyli-Salicornietum perennis Borhidi in Borhidi et al. 1983

	1	2	3	4	5
Cover %:	35	40	40	50	45
Salicornia perennis Mill.	2.3	2.3	3.3	3.3	1.2
Fimbristylis spathacea Roth	2.2	1.2	1.2	2.2	2.3
Distichlis spicata (L.) Greene	—	1.2	—	+.2	—
Heliotropium curassavicum L.	+.1	—	+.1	—	—
Batis maritima L.	—	—	—	+.2	1.2
Suaeda linearis Moq.	+.1	—	—	—	—
Nostoc commune L.	—	—	—	—	+.2

Associations studied in Cuba:

Fimbristyli-Salicornietum perennis Borhidi in Borhidi et al. 1983

This is the community of saline vegetation developed on humid, seasonally flooded shallow sandy seaside sites. Five representative relevés were made by Borhidi at the Guanahacabibes Peninsula and the southern shore of the Pinar del Rio Province at La Coloma in March, 1976. Type relevé: no. 1. at El Veral (Table 95).

Salicornietum bigelowii Samek 1973

Salicornietum perennis Samek 1973

8.1.2 Alliance: ***Batidion maritimae*** Borhidi (1979) hoc loco

(Syn.: *Conocaspo-Batidion* Samek 1973 p. p.)

Closed vegetation of the saline belt, formed mostly by succulent suffrutescent plants.

Association studied in Cuba:

Batidetum maritimae (Ciferri 1936) Samek 1973

8.2 Order: DISTICHLIO-SPARTINETALIA (Chapman 1974) Borhidi and Del-Risco in Borhidi et al. (1979) 1983

Saline prairie vegetation of the supratidal belt formed by grasses and sedges of high osmotic tension.

Table 96 Salicornio-Distichlietum spicatae Borhidi in Borhidi et al. 1983

Cover %:	85	90
Distichlis spicata	5.5	5.5
Heliotropium curassavicum	+.r	+.1
Portulaca oleracea	+.r	+.1
Fimbristylis annua	+.r	+.1
Conocarpus erecta var. *prostrata*	1.2	—
Salicornia perennis	+.r	—

Characteristic species: *Distichlis spicata, Spartina juncea, Sporobolus virginicus* ssp. *littoralis, Chloris sagraeana, Eragrostis salzmannii, Philoxerus vermicularis, Heliotropium curassavicum,* etc.

8.2.1 Alliance: ***Distichlion spicatae***
(Chapman 1960) Borhidi and Del-Risco in Borhidi et al. 1979, 1983

With the same characteristics as the order.

Association studied in Cuba:

Salicornio-Distichlietum spicatae (Ciferri 1936)
Borhidi and Del-Risco in Borhidi et al. 1983

It is a species poor, monodominant saline prairie community in the higher flat terrains of the mangrove belt. The type relevé made by Borhidi and Del-Risco in March, 1975 in Las Salinas, Peninsula de Zapata, (Table 96). The *Distichlis*-community described by G. K. Mueller and P. Gutte from Willa (Peru) in 1983 seems to be identical with the Cuban association.

9 Class: RHIZOPHORO-AVICENNIETEA GERMINANTIS Knapp (1964) emend. Borhidi and Del-Risco in Borhidi et al. 1979

Neotropical mangrove vegetation.

9.1 Order: RHIZOPHORETALIA Cuatrecasas 1958

Steadily flooded mangrove vegetation with anchoring aerial roots and viviparismus.

9.1.1 Alliance: ***Rhizophorion occidentalis*** Cuatrecasas 1958

Characteristic species: *Rhizophora mangle, Rh. occidentalis.*

Table 97 Dalbergio-Rhizophoretum manglis Borhidi ass. nova

Number of relevés	1.	2.	3.	4.	5.	C_5
Canopy layer, 15—22 m high, cover %:	90	100	90	85	95	
Rhizophora mangle L.	5.5	5.5	5.5	5.5	5.5	V
Laguncularia racemosa L.	+.1	1.1	+.1	—	+.1	IV
Bucida palustris Borhidi	—	+.1	—	+.1	+.1	III
Conocarpus erecta L.	+.1	—	+.1	—	—	II
Tabebuia angustata Britt.	—	+.1	—	+.1	—	II
Roystonea regia (HBK.) Cook	—	—	—	+.1	—	I
Sabal parviflora Becc.	—	—	—	—	+.1	I
Shrub layer, 1—3 m high, cover %	1	3	5	5	1	
Dalbergia ecastophyllum (L.) Taub.	+.2	+.2	1.3	1.3	+.2	V
Pavonia spicata Cav.	+.1	+.1	+.1	+.1	+.1	V
Rhabdadenia biflora (Jacq.) Muell. Arg.	+.1	—	+.1	+.1	—	III
Lianes, cover %	5	5	5	10	5	
Dalbergia ecastophyllum (L.) Taub.	1.2	+.2	+.2	1.3	1.3	V
Rhabdadenia biflora (Jacq.) Muell. Arg.	+.1	1.1	1.1	1.1	+.1	V
Sarcostemma clausum L.	—	—	—	+.1	+.1	II
Cissus trifoliata L.	—	—	—	+.1	—	I
Epiphytes, cover %	—	1	—	1	1	
Hohenbergia penduliflora (A. Rich.) Mez.	—	—	—	+.1	+.1	II
Tillandsia fasciculata Sw.	—	1.+	—	+.2	—	II
T. usneoides L.	—	—	—	+.3	+.3	II
T. valenzuelana A. Rich.	—	+.1	—	—	+.2	II

Association studied in Cuba:

Dalbergio–Rhizophoretum manglis Borhidi hoc loco

Mangrove forest community of the estuaries flooded regularly by brackish water during the rainy season and by more or less salty water during the dry season. It forms a rather narrow fringe along the shores of the bigger lowland rivers near to the estuaries. The canopy is 15—22 m high formed mostly by the dominant *Rhizophora mangle* with anchoring aerial roots hanging from 5—8 m height. Scattered individuals of *Laguncularia racemosa* and other trees of the swamp forests are mixed mostly at the landward side of the community belt. A scarce shrub layer and a more densely developed stratum of climbers are characteristic. In both of them *Dalbergia ecastophyllum* is common and the constant presence of *Pavonia spicata* can be also considered as a characteristic feature of the commmunity. Herb layer is completely lacking. Some xerophytic epiphytes are also present. Five relevés were made in the Zapata Peninsula, in the estuary of the Rio Negro, by A. Borhidi, in 23 August, 1984 (Table 97). Type relevé is No. 2.

9.2 Order: AVICENNIETALIA Cuatrecasas 1958

Seasonally flooded mangrove vegetation, or steadily by shallow saltwater, which permits the root-respiration by pneumatophores.

9.2.1 Alliance: ***Avicennion occidentalis*** Cuatrecasas 1958

Characteristic species: *Avicennia germinans, Batis maritima, Rhabdadenia biflora, Lycium tweedianum,* etc.

Association studied in Cuba:

Rhizophoro-Avicennietum germinantis Borhidi and Muñiz in Borhidi et al. 1979

Batidi-Avicennietum germinantis Borhidi and Del-Risco ass. nova

This association is developed on flat rocky shores, where the reef platform is somewhat higher and inundated only by tidal storms. Six representative relevés were made by Borhidi and Del-Risco in Las Salinas, Peninsula de Zapata, in March, 1975 and by Borhidi in February, 1981 (Table 98). Type relevé: no. 1.

Table 98 Batidi-Avicennietum germinantis Borhidi et Del-Risco ass. nova 1983

	1	2	3	4	5	6
Tree layer: 5–8 m high cover %:	55	65	75	80	70	70
Avicennia germinans (L.) L.	4.5	4.5	4.5	5.5	4.5	4.4
Laguncularia racemosa (L.) Gaertn. f.	–	–	–	–	–	+.1
Herb layer: 30–50 cm high cover %:	35	30	25	20	25	50
Batis maritima L.	3.3	2.3	2.3	2.2	2.3	3.4
Conocarpus erecta L. var. *sericea* (Forst.) Borhidi	+.1	–	–	–	–	+.2
Baccharis halimifolia L.	–	+.1	+.1	+.1	–	–
Iva cheiranthifolia L.	–	–	–	–	–	+.2
Heliotropium curassavicum L.	+.r	–	–	–	–	–
Distichlis spicata (L.) Greene	–	–	–	–	–	1.3
Fimbristylis spathacea Roth	–	+.1	–	–	–	–
Rhabdadenia biflora (Jacq.) Muell. Arg.	–	–	–	+.1	–	–
Sarcostemma clausum (Jacq.) R. and S.	–	+.r	–	–	+.r	–
Sesuvium portulacastrum L.	+.1	–	–	–	–	+.2
Salicornia perennis Mill.	–	–	+.1	–	–	+.1



Fig. 340 Plant community of the salt swamp forest: *Acrostycho-Conocarpetum erectae,* with large populations of *Batis maritima* near Playa Larga, Zapata Peninsula (Photo: A. Borhidi)

9.3 Order: COMBRETALIA Cuatrecasas 1958

Seasonally flooded mangrove vegetation on extremely saline silt, with or without pneumatophores.

9.3.1 Alliance: ***Conocarpo-Laguncularion***
(Cuatrecasas 1958) Borhidi in Borhidi et al. 1979

Characteristic species: *Conocarpus erecta, Laguncularia racemosa, Acrostichum aureum, A. danaifolium,* etc.

Association studied in Cuba:

Conocarpo-Laguncularietum racemosae Del-Risco ined

Acrosticho-Conocarpetum erectae Borhidi and Del-Risco ass. nova

This community is forming a rather large subzone at the inner edge landward the mangrove belt, mostly in deeper isolated lagoons with highly concentrated stagnant saltwater. (Fig. 340) Three relevés were made by Borhidi and Del-Risco in the Zapata Swamp in March, 1975 and by Borhidi and Muñiz between Santiago de Cuba and Siboney. Type relevé: no. 1. at Zapata (Table 99).

Table 99 Acrosticho-Conocarpetum erectae Borhidi et Del-Risco ass. nova

	1	2	3
Tree layer, 4–5 m high, cover %:	75	80	70
Conocarpus erecta L.	4.5	5.5	4.5
Laguncularia racemosa (L.) Gaertn, f.	–	–	+.1
Herb layer, 1–2 m high, cover %:	80	35	45
Conocarpus erecta L.	1.1	–	+.1
Acrostichum aureum L.	3.3	2.3	2.3
Acrostichum danaifolium Lengsd. and Fisch.	2.2	–	+.1
Cladium jamaicense Cr.	1.2	1.2	1.1
Fimbristylis spadicea (L.) Vahl	+.1	1.2	–
Schoenoplectus americanus (L.) Pall.	+.1	–	–
Eleocharis cellulosa Torr.	–	1.1	1.2
Baccharis halimifolia L.	+.1	–	–
Epiphytes:			
Tillandsia valenzuelena A. Rich.	+.1	+.1	–
Tillandsia flexuosa Sw.	+.1	–	–
Lianes:			
Ipomoea triloba L.	–	–	+.1

10 Class: CHRYSOBALANO-ANNONETEA GLABRAE Borhidi and Muñiz in Borhidi 1979 et al. et hoc loco

Evergreen or deciduous swamp forests and shrub vegetation on steadily humid silty or peaty soils. They develop in basins and lowlands of deficient drainage, in the shores of lakes and large rivers, in the subcoastal swamps, estuaries of rivers, all sites flooded during the rain period. This vegetation group is distributed in the West Indies, Florida, in the coastal belt of the Caribbean area from Mexico to South America.

Characteristic species: *Chrysobalanus icaco, Annona glabra, Myrsine cubana, M. guianensis, Bucida buceras, B. spinosa, B. plaustris, B. subinermis, Metopium brownei, Pterocarpus officinalis, Sterculia caribaea, Acoelorraphe wrightii, Copernicia glabrescens, Dryopteris patens, D. serra, Osmunda regalis, O. cinnamomea,* etc.

10.1 Order: CHRYSOBALANO-ANNONETALIA Glabrae Borhidi and Del-Risco in Borhidi et al. 1979 et hoc loco

Swamp woodlands and low swamp forests seasonally flooded by rather deep eutrophic, distrophic, oligotrophic or slightly saline freshwater.

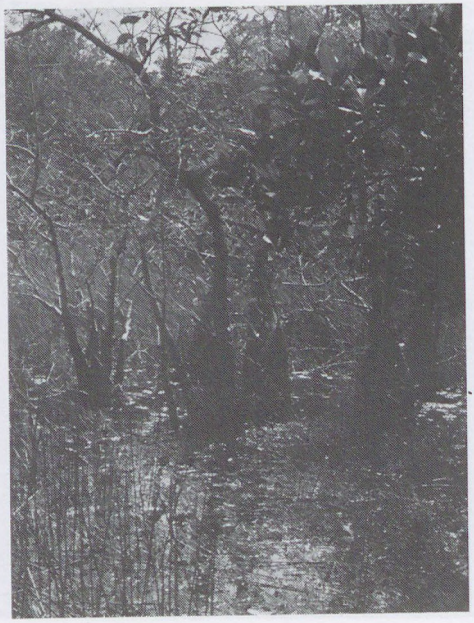


Fig. 341 Community of the permanent swamp forest: *Chrysobalano-Annonetum glabrae* with "high footed" individuals of *Annona glabra* L. in the Zapata Peninsula (Photo: A. Borhidi)

10.1.1 Alliance: ***Chrysobalano-Annonion glabrae***
Borhidi and Muñiz in Borhidi et al. 1979 et hoc loco

Seasonally flooded swamp- and marsh-woodlands with an extreme fluctuation of water supply. Plant communities with one seasonal aspect or two alternant seasonal aspects, an aquatic one in summer and a dry one in winter.

Association studied in Cuba:

Chrysobalano-Annonetum glabrae (Ciferri 1936) Borhidi and Del-Risco ass. nova

This is a swamp woodland association community on shallow peat with limestone underground (Fig. 341) The type relevé was made by Borhidi and Del-Risco in the Zapata Peninsula near El Maiz, in March, 1975 (Table 100).

Osmundo-Chrysobalanetum icaconis Borhidi (ined.)

Copernicio-Bucidetum spinosae Borhidi and Capote ass. nova

It is a seaside rocky limestone swamp-woodland dominated by *Bucida spinosa* with a mosaic of grassland patches. The shallow peaty soil is slightly saline. Type relevé was made by Borhidi and Capote near La Coloma (Pinar del Rio Province) at Playa Las Canas in September, 1975 (Table 101).

10.1.2 Alliance: ***Salicion carolinianae***
Del-Risco in Borhidi et al. 1979

These are low monodominant riparian forest communities along the shores of the eutrophic or slightly dystrophic lakes. Communities rather poor in species.

Characteristic species: *Salix caroliniana, Myrica cerifera, Dalbergia monetaria, D. ecastophyllum,* etc.

Table 100 Chrysobalano-Annonetum glabrae (Ciferri 1936)
Borhidi et Del-Risco ass. nova

Canopy layer, 3—5 m high, cover 35%	
Annona glabra L.	3.2
Chrysobalanus icaco L.	1.2
Lianes:	
Sarcostemma clausum L.	+.r
Epiphytes: cover 20%	
Tillandsia valenzuelana A. Rich.	2.2
T. fasciculata Sw.	1.1
T. recurvata L.	1.1
T. bulbosa Hook.	+.1
T. flexuosa Sw.	+.1
T. usneoides L.	+.2
T. balbisiana Schult.	+.r
T. pruinosa Sw.	+.r
Herb layer, up to 1.5 m high, cover 80%	
Elocharis interstincta (Vahl) R. et S.	4.5
Hydrocotyle umbellata L.	2.2
Capraria biflora L.	1.2
Eragrostis hypnoides (Lam.) BSP.	1.2
Heliotropium procumbens Mill.	1.2
H. antillanum Urb.	1.1
Sida rhombifolia L.	1.1
Annona glabra L.	+.1
Bacopa monnieri (L.) Penn.	+.1
Centella erecta (L.f.) Fern.	+.1
Ludwigia palustris L.	+.1
Panicum coerulescens Hack.	+.1
Phyla stoechadifolia (L.) Small	+.1
Polygonum punctatum Ell.	+.1
Aeschynomene villosa Poir. in Lam.	+.r
Rhynchospora cyperoides (Sw.) Mart.	+.r
Solanum torvum Sw.	+.r
Soil layer, up to 20 cm high, cover 80%	
Chara domingensis	4.5

Table 101 Copernicio-Bucidetum spinosae
Borhidi et Capote ass. nova

Tree layer, 3—4 m high, cover: 50—60%	
Copernicia glabrescens Wendl. ex Becc.	3.1
Bucida spinosa (Northrop) Jennings	3.3
Conocarpus erecta L.	1.1
Cameraria retusa Griseb.	+.1
Coccoloba microphylla Griseb.	+.1
Shrub layer, 0.5—1.5 m high, cover: 20%	
Bucida spinosa (Northrop) Jennings	2.2
Copernicia glabrescens Wendl. ex Becc.	1.2
Cameraria retusa Griseb.	1.1
Herb layer, 0.3—1 m high, cover 50—60%	
Distichlis spicata (L.) Greene	3.3
Fimbristylis spathacea Roth	2.2
Andropogon pertusus (L.) Willd.	1.2
Chloris inflata Link	1.2
Manisuris loricata (Trin.) Kuntze	1.1
Sporobolus virginicus (L.) Kunth ssp. *littoralis* (Kunth) Borhidi	1.1
Iresine flavescens H. and B.	+.1
Heliotropium procumbens Urb.	+.1
H. curassavicum L.	+.1
Paspalum fimbriatum HBK.	+.1
Sesuvium portulacastrum L.	+.1
Stenotaphrum secundatum (Walt.) Kuntze	+.1
Lianes: cover 10%	
Echites umbellata Jacq.	1.1
Heteropteris laurifolia (L.) Juss.	1.1
Mesechites rosea (A. DC.) Miers	1.1
Stigmaphyllum diversifolium (Kunth) Juss.	1.2

Association studied in Cuba:

Salicetum carolinianae Del-Risco (ined.)

10.2 Order: TABEBUIO-BUCIDETALIA
(Lvov 1967) Borhidi and Del-Risco in Borhidi et al. 1979 et hoc loco

Swamp forest vegetation flooded by freshwater or slightly saline water during the whole year. Soil is mostly rather deep vertisol, frequently gleyzed, somewhere the underground is gravillous or rocky originating from the littoral coral reefs,

sometimes covered by a shallow peaty soil layer. The tree layer is 6—20 m high, with an abundant shrub layer.

Characteristic species: *Tabebuia angustata, Bucida palustris, Bucida subinermis, Fraxinus caroliniana* ssp. *cubensis, Manilkara wrightii, M. jaimiquii, Ilex cassine, Myrsine cubana, Xylopia obtusifolia, Guettarda combsii, Erythroxylon confusum, Sabal parviflora, Smilax laurifolia,* etc.

10.2.1 Alliance: ***Tabebuio-Bucidion***

Borhidi and Del-Risco in Borhidi et al. 1979 et hoc loco

With the same characteristics as the order.

Table 102 Tabebuio angustatae—Bucidetum palustris Borhidi and Del-Risco ass. nova

	1	2	3	4	5
First tree layer, 8—15 m. high, cover %:	60	70	65	25	55
Bucida palustris Borhidi	3.3	4.4	3.4	1.1	3.3
Lysiloma bahamense Benth.	3.3	+.1	—	—	1.1
Swietenia mahagoni (L.) Jacq.	2.1	—	—	+.1	
Tabebuia angustata Britt.	+.1	1.1	+.1	+.1	1.2
Metopium brownei (Jacq.) Urb.	1.1	—	1.1	—	1.1
Myrsine cubana A. DC.	—	—	1.1	1.1	+.1
Calphyllum antillanum Britt.	—	—	+.1	—	+.1
Manilkara jaimiqui (Wr. ex Griseb.) Dub.	—	—	+.1	—	—
Sabal parviflora Becc.	—	—	—	2.2	—
Second tree layer 3—8 m. high, cover %:	40	50	40	45	40
Metopium brownei (Jacq.) Urb.	2.2	—	1.1	—	+.1
Coccoloba diversifolia Jacq.	2.2	+.1	1.2	—	+.2
Acoelorraphe wrightii Wendl.	—	1.1	2.2	3.4	+.2
Bucida palustris Borhidi	1.1	2.2	1.1	+.1	+.1
Lysiloma bahamense Benth.	1.1	+.1	—	—	+.1
Myrsine cubana A. DC.	1.1	—	2.2	1.2	1.2
Tabebuia angustata Britt.	+.1	1.1	+.1	+.1	+.1
Guettarda combsii Urb.	+.1	1.1	1.1	1.2	1.2
Annona glabra L.	+.r	—	1.1	—	+.1
Myrica cerifera L.	—	+.1	1.2	1.1	+.1
Ilex cassine L.	—	1.1	2.2	—	—
Ouratea nitida (Sw.) Engl.	—	2.2	1.2	—	—
Erythroxylum arcolatum L.	+.1	—	+.1	—	+.1
Erythroxylum confusum Britt.	+.1	—	—	+.1	+.1
Sabal parviflora Becc.	—	—	—	+.1	—
Calophyllum antillanum Britt.	+.1	—	+.1	—	+.1

Swietenia mahagoni (1), *Chrysophyllum oliviforme* (1), *Dipholis salicifolia* (1), *Nectandra coriacea* (1), *Cassine xylocarpa* (1), *Ateleia apetala* (1), *Xylopia obtusifolia* (1), *Citharexylum caudatum* (2), *Manilkara jaimiqui* (3), *Conocarpus erecta* (4), *Byrsonima lucida* (5).

Shrub layer 1–3 m high, cover %:	40	30	20	30	25
Metopium brownei (Jacq.) Urb.	2.2	+.r	1.1	+.1	+.1
Guettarda combsii Urb.	+.r	—	+.1	+.1	+.r
Myrsine cubana A. DC.	+.1	+.r	+.2	+.1	+.1
Bucida palustris Borhidi	1.1	1.1	+.r	+.1	+.1
Coccoloba diversifolia Jacq.	2.2	+.1	1.2	1.1	+.1
Ouratea nitida (Sw.) Engl.	+.r	1.1	1.1	—	—
Chrysobalanus icaco L.	1.1	—	2.2	—	2.2
Myrica cerifera L.	+.r	1.1	—	2.2	+.r
Annona glabra L.	1.1	+.1	+.1	+.r	+.1
Caloptranthes pallens (Poir.) Griseb.	+.1	—	+.1	—	+.1
Calophyllum antillanum Britt.	+.1	—	+.r	+.r	+.1
Sabal parviflora Becc.	+.1	1.1	—	—	—
Tabebuia angustata Britt.	+.r	+.1	—	—	+.r
Erythroxylum areolatum L.	—	+.1	—	+.1	—
Acoelorraphe wrightii Wendl.	—	1.1	1.1	—	—
Rauvolfia cubana A. DC.	—	1.1	+.1	+.r	—
Ilex cassine L.	—	2.2	1.2	1.2	—
Erythroxylum confusum Britt.	—	+.1	+.r	+.1	—
Ficus jacquinifolia A. Rich.	—	+.r	+.r	—	—
Manilkara jaimiquii (Wr. ex Griseb.) Dub.	—	—	+.r	+.r	—

Salvia bahamensis +.r (1), *Swietenia mahagoni* +.1 (1), *Ouratea ilicifolia* +.1 (1), *Diospyrus crassinervis* +.1 (1), *Jacquinia stenophylla* 1.1 (1), *Polygala scabridula* +.1 (1), *Dipholis salicifolia* +.r (1), *Ilex nitida* +.r (1), *Psychotria revoluta* +.r (1), *Amyris elemifera* +.r (1), *Bursera simaruba* +.r (1), *Allophylus cominia* +.r (1), *Roystonea regia* +.1 (2), *Hibiscus elatus* +.r (2), *Citharexylum caudatum* +.r (4)

Herb layer 30–200 cm high, cover %:	5	40	60	80	40
Cladium jamaicense Cr.	1.1	2.4	3.4	4.4	2.3
Typha domingensis (Pers.) Kunth.	—	—	+.r	—	—
Blechnum serrulatum A. Rich.	—	2.2	2.2	2.1	1.1
Lasiacis rugelii (Griseb.) Hitchc.	1.1	—	—	+.r	+.1
Pluchea purpurascens (Sw.) DC.	+.r	+.1	+.1	+.1	1.1
Sagittaria lancifolia L.	+.1	+.1	+.r	+.r	+.1
Pavonia spicata Cav.	—	1.1	+.r	—	—
Scleria lacustris Wr.	—	+.1	1.2	—	—
Acrostichum danaifolium Lengsd. et Fisch.	—	+.r	—	+.1	—
Justicia reptans Sw.	—	—	+.r	+.r	—
Psilotum nudum (L.) Griseb.	—	—	+.r	—	+.r
Baccharis halimifolia L.	—	—	+.r	+.r	+.1
Rhynchospora stellata Griseb.	+.r	+.1	1.2	+.2	1.2
Crinum oliganthum Urb.	—	—	+.1	—	+.r
Osmunda regalis L.	—	—	—	1.1	+.1
Dryopteris sclerophylla (Ktze) C. Chr.	—	—	—	+.r	+.1
Panicum coerulescens Hack.	—	—	—	+.r	+.r
Centella erecta (L.f.) Fern.	—	—	—	+.2	+.1
Panicum virgatum var. *cubense* Griseb.	—	+.1	—	+.1	—

Scleria phylloptera +.1 (1), *Malpighia urens* +.1 (1), *Eleocharis interstincta* +.1 (4), *Sisyrinchium recurvatum* +.r (4)

Lianes:

Smilax laurifolia L.	—	1.1	2.1	1.2	—
Smilax havanensis Jacq.	2.2	2.1	+.1	+.1	1.1

Cissus grisebachii Planch.	—	—	—	+.1	+.r
Echites umbellata Jacq.	—	—	—	+.1	+.r
Urechites lutea (L.) Britt.	1.1	—	—	+.r	—
Cassytha filiformis L.	—	—	+.1	2.2	—
Securidaca virgata Sw.	—	+.r	—	+.1	+.1
Chiococca alba (L.) Hitchc.	+.1	+.1	+.1	—	+.2
Passiflora suberosa L.	—	+.r	—	+.r	+.1
Morinda royoc L.	+.r	—	—	+.r	+.1
Selenicereus grandiflorus (L.) Britt. et Rose	+.1	—	+.r	—	+.1
Mesechites rosea (A. DC.) Miers	—	1.1	+.1	—	—
Serjania diversifolia (Jacq.) Radlk.	+.r	+.1	—	—	+.r
Merremia cissoides (Lam.) Hall f.	—	+.1	—	+.1	—
Vanilla phaeantha Rchb. f.	+.1	+.1	1.1	—	+.1
Pisonia aculeata L.	+.1	—	—	—	+.2
Sarcostemma clausum L.	+.1	—	—	—	+.1
Stigmaphyllum diversifolium A. Juss.	+.1	—	—	—	1.2

Vanilla articulata +.r (1), *Mikania hastata* +.r (4), *Mikania ranunculoides* +.1 (2), *Cayaponia racemosa* +.r (4), *Ipomoea tenuissima* +.r (4)

Epiphytes:

Tillandsia valenzuelana A. Rich.	4.4	+.r	—	—	+.2
Tillandsia fasciculata Sw.	2.2	—	+.r	—	1.2
Tillandsia festucoides Brogn. ex Mez	+.1	+.r	+.r	+.r	—
Tillandsia pruinosa Sw.	+.r	—	—	—	+.1
Catopsis floribunda (Brogn.) L. B. Sm.	+.r	—	—	—	+.r
Hohenbergia penduliflora (A. Rich.) Mez	+.r	—	—	+.1	—
Epidendrum cochleatum L.	+.r	—	—	—	+.1
Epidendrum phoenicum Lindl.	+.1	—	+.1	—	—
Cattleyopsis ortgiesiana (Rchb. f.) Cogn.	+.r	—	—	+.r	—
Polystachya luteola (Sw.) Hook.	+.r	—	—	—	+.1
Phlebodium aureum (L.) Gmel.	—	+.r	—	—	+.2

Association studied in Cuba:

Tabebuio angustatae-Bucidetum palustris Borhidi and Del-Risco ass. nova

The dominant swamp forest association of the Zapata Swamp in Cuba, with two tree layers, a well developed shrub layer and a rather poor and scarce herb layer. Lianes are few, epiphytes rather frequent. Five representative relevés were made by Borhidi and Del-Risco in March, 1975, in the Peninsula de Zapata. Type relevé: no. 1. (Table 102).

Rhizophoro-Chrysobalanetum icaconis Del-Risco and Borhidi ass. nova

It is a pioneer shrubforest community in the succession of the swamp vegetation of the Zapata Peninsula, exhibiting round stands in the higher level of the swamp basin covered by sawgrass, cattail and sedge marshes. The individual stands are highest at the center, occupied mostly by a *Sabal parviflora* palm surrounded by a dense shrub population tending to be lower centrifugally. The edge of the stands is formed by a dense populations of ferns, most frequently by *Blechnum serrulatum*.

Table 103 Rhizophoro-Chrysobalanetum icaconis
Del-Risco and Borhidi ass. nova

14 km de Jagüey Grande, Playa Larga	
E_3 4–6 m 70%	
Rhizophora mangle L.	2.2
Conocarpus erecta L.	3.2
Sabal parviflora Becc.	1.1
Myrica cerifera L.	2.2
Ilex cassine L.	1.1
Tabebuia shaferi Britt.	+.1
Erythroxylum confusum Britt.	+.1
Chrysobalanus icaco L.	1.1
Salix longipes Schuttl.	+.r
Cladium jamaicense Cr.	1.1
Ouratea nitida (Sw.) Engl.	+.r
Smilax laurifolia L.	1.1
Myrsine cubana A. DC.	+.1
E_2 1–3 m 50%	
Cladium jamaicense Cr.	3.5
Ilex cassine L.	2.2
Ouratea nitida (Sw.) Engl.	1.1
Conocarpus erecta L.	1.1
Nephrolepis biserrata (Sw.) Schott	+.r
Rhizophora mangle L.	+.1
Chrysobalanus icaco L.	2.3
Blechnum serrulatum A. Rich.	+.r
Annona glabra L.	+.r
Typha domingensis (Pers.) Kunth	+.r
E_1 1 m 5%	
Myrica cerifera L.	1.1
Ouratea nitida (Sw.) Engl.	+.1
Ilex cassine L.	1.1
Chrysobalanus icaco L.	+.1
Conocarpus erecta L.	+.1
Dichromena colorata (L.) A. S. Hitchc.	+.r
Sagittaria lancifolia L.	+.r
Sabal parviflora Becc.	+.r
E_0 40%	
Ludwigia natans Ell.	2.2
Proserpinaca palustris L.	2.2
Centella erecta (L.f.) Fern.	1.1
Bacopa monnieri (L.) Penn.	1.2
Epiphytes: 5%	
Tillandsia fasciculata Sw.	+.1
Tillandsia valenzuelana A. Rich.	+.2

Tillandsia fleuxosa Sw.	+.r
Tillandsia pruinosa Sw.	+.r
Lianes:	
Mikania hastata (L.) Willd.	+.r
Cassytha filiformis L.	1.2

Table 104 Conocarpo-Bucidetum palustris Borhidi and Del-Risco ass. nova

	1	2	3
Canopy layer, 3–8 m high, cover %	70	65	80
Bucida palustris Borhidi	2.2	4.4	3.4
Conocarpus erecta L.	4.4	2.3	3.3
Tabebuia angustata Britt.	+.1	+.1	+.1
Salix caroliniana Michx.	+.r	+.1	–
Myrica cerifera L.	2.2	+.1	–
Erythroxylum areolatum L.	+.r	–	+.1
Calophyllum antillanum Britt.	–	–	1.1
Sabal paraviflora Becc.	–	+.1	–
Shrub layer, 1–3 m high, cover %	20	35	15
Bucida palustris Borhidi	+.1	1.1	+.r
Conocarpus erecta L.	1.1	1.2	1.1
Chrysobalanus icaco L.	+.r	2.3	1.2
Myrica cerifera L.	2.2	1.1	+.r
Myrsine cubana A. DC.	–	+.1	+.1
Erythroxylum areolatum L.	±.1	+.1	–
Tabebuia angustata Britt.	+.r	–	+.r
Herb layer, 0.5–2 m high, cover %	65	70	55
Cladium jamaicensis Crantz	4.3	4.4	3.3
Acrostichum areum L.	2.2	1.2	+.2
Blechnum serrulatum A. Rich.	+.r	1.1	1.1
Nephrolepis biserrata (Sw.) Schott	+.r	–	1.2
Agalinis maritima (Rat.) Raf. var. *grandiflora* (Benth.) Shinn.	+.r	+.r	–
Dalbergia ecastophyllum (L.) Taub.	–	+.2	+.r
Baccharis halimifolia L.	–	1.1	+.r
Fimbristylis spathacea Roth	–	+.1	–
Cassia lineata Sw.	–	–	+.1
Ernodea littoralis Sw.	–	+.1	–
Stemodia maritima L.	–	–	+.r
Proserpinaca plaustris L.	+.r	–	–

Type relevé No.1. made by Borhidi and Del-Risco at Guamutal, March 1975. Relevé nos 2. and 3. were made by Borhidi et Hato de Jicarita, Zapata Swamp, April, 1983

The type relevé was made by Borhidi and Del-Risco, near Laguna del Tesoro, Zapata Swamp in March, 1975 (Table 103).

Conocarpo-Bucidetum palustris Borhidi and Del-Risco ass nova

It is a swamp forest association flooded seasonally by freshwater and seasonally by slightly salt water. This community forms a rather wide intermediate subzone between the mangrove and high swamp forest belts. The type relevé (no. 1.) was made by Borhidi and Del-Risco at Guamutal, Zapata Swamp in March, 1975 (Table 104).

Bucido-Fraxinetum cubensis Borhidi and Del-Risco hoc loco

It is a rather rare community of the Zapata Peninsula characterized by the co-dominance of the *Fraxinus caroliniana* ssp. *cubensis* and *Bucida palustris*. It represents a higher stage in the swamp succession than *Tabebuio-Bucidetum* does. The stands of this community tend to be more reduced by exploitation of charcoal woods.

11 Class: **SWIETENIO-BROSIMETEA** Knapp (1964) in Borhidi hoc loco

Lowland and submontane rainforest vegetation (in Cuba till 800 m a.s.l.) with three tree layers or with two tree layers or with two tree layers and emergents, formed by evergreen trees, the emergents sometimes can be deciduous. Lianes, epiphytes and epiphyllous plants are scarce or not very abundant.

11.1 Order: DIPHOLI-CALOPHYLLETALIA Knapp (1964) in Borhidi hoc loco

Submontane rainforest vegetation of the Caribbean area, — in Cuba between 250 and 800 m a.s.l. — conditioned by a continuously humid climate with 0—1 dry month per year and with an annual precipitation over 2000 mm.

11.1.1 Alliance: ***Calophyllo-Dipholion*** Borhidi in Borhidi et al. 1979 et hoc loco

Submontane rainforests of the Greater Antilles. In Cuba they are represented only in the eastern provinces (Oriente), (Fig. 342).

Characteristic species in Cuba: *Dipholis jubilla, D. ekmanii, Calophyllum utile, Carapa guianensis, Ochroma pyramidalis, Terminalia maestrensis, Zizyphus*



Fig. 342 The submontane rainforests of the grope of Yumuri River near Baracoa (Photo: A. Borhidi)

rhodoxylon, Ficus berteroi, F. wrightii, Manilkara albescens, Bactris cubensis, Cordia sulcata, Miconia elata, Heliconia caribaea, Oxandra laurifolia, Dalbergaria cubensis, C. tincta, Hillia spp., *Psychotria guadelupensis, Phaius tankervilliae,* etc.

Association studied in Cuba:

Calophyllo-Carapetum guianensis Borhidi and Muñiz ass. nova

It is zonal submontane rainforest community of the Sagua-Baracoa Massif in north-eastern Oriente, especially well-developed in the valleys of the Rio Toa and Rio Jaguani. For its detailed description see pages 389—391 A synthetic list of five relevés shows its composition (Table 25. Appendix column no. 19). A structure profile of the community is found on p. 390 (Fig. 273).

Oxandro-Dipholietum jubillae Borhidi ass. nova

It is the zonal submontane rainforest association of the Sierra Maestra range, developed mostly on yellow-red mountain soils derived from andesite and granodiorite rocks. Its detailed description can be found on page 405 and for its composition see the column no. 24 of the Table 25 (Appendix) the synthetic list of five relevés made by Borhidi and Muñiz in December, 1969.

11.1.2 Alliance: ***Alchorneo-Pseudolmedion spuriae***
Borhidi in Borhidi et al. 1979 et hoc loco

Seasonal evergreen submontane rainforest of Central and West Cuba, in Yucatan and northern Central America, between 300 and 800 m a.s.l.

Characteristic species in Cuba: *Matayba oppositifolia, M. apetala, Alchornea latifolia, Pseudolmedia spuria, Trophis racemosa, Margaritaria nobilis, Tabebuia shaferi, Antirhea radiata, Terminalia intermedia, Sloanea amygdalina, Dendropanax arboreus, Zanthoxylum martinicense, Z. ekmanii.*

Mataybaeo-Pseudolmedietum spuriae Borhidi and Capote in Capote et al. 1985

This is the zonal seasonal rainforest association of theSierra del Rosario at the submontane level, between 250 and 600 m a.s.l. It contains two tree layers and high emergent trees, which are mostly lacking in consequence of forest exploitation. The most important timber trees of this community, as *Cedrela odorata, Swietenia mahagoni, Manilkara grisebachii, Cynometra cubensis* occur very rarely in the forest stands. The overwhelming dominance of *Matayba* and *Pseudolmedia* indicates as certain human influence, which is more accentuated by the frequent presence of trumpet wood *(Cecropia peltata)* and the royal palm *(Roystonea regia)* in the second-growth stands (see Figs 288—289 and Table 105).

11.1.3 Alliance: ***Calophyllo-Guettardion valenzuelanae***
Capote and Borhidi in Capote et al. 1985

Evergreen tropical forests in West Cuba characterized by a great participation of micro- and sclerophyllous trees and shrubs growing on lixiviated yellowish-red fersiallitic soils derived from limestone but influenced by components of serpentine or other ultrabasic rocks. Characteristic species: *Dipholis neglecta, Zanthoxylum cubense, Calophyllum calaba ssp. pinetorum, Coccoloba retusa, Pachyanthus tetramerus, Trichlia trachyantha, Dendropanax cuneifolius, Calyptranthes caroli, Picramnia reticulata, Myrcia valenzuelana, Acunaeanthus tinifolius, Lagetta wrightiana, Malpighia wrightiana,* etc.

Associaton studied in Cuba:

Calophyllo-Coccolobetum retusae Capote and al. 1985

Table 105 Mataybaeo–Pseudolmedietum spuriae Borhidi and R. Capote ass. nova

	1	2	3	4	5
Emergent Trees 25–30 m high, cover %	25	50	25	35	30
Matayba oppositifolia (A. Rich.) Britt.	2.2	1.1	–	1.2	2.2
Pseudolmedia spuria (Sw.) Griseb.	1.1	3.3	1.1	1.2	1.1
Fagara ekmanii Urb.	–	–	–	–	+.1
Prunus occidentalis Sw.	1.1	1.2	–	–	1.1
Mastichodendron foetidissimum (Jacq.) Cronq.	–	–	1.1	–	+.1
Alchornea latifolia Sw.	–	–	–	2.2	–
Hyeronima havanensis Urb.	–	–	–	+.1	–
Fagara martinicensis Lam.	1.1	–	–	1.1	–
Drypetes alba Poit.	–	–	1.1	–	–
Calophyllum antillanum Britt.	–	–	1.1	–	–
Antirhea radiata (Griseb.) Urb.	–	–	1.1	–	–
Cinnamomum triplinervis (R. et P.) Kosterm.	1.1	–	–	–	–
Sapium jamaicense Sw.	1.1	–	–	–	–
Margaritaria nobilis L.f.	1.1	–	–	–	–
Cedrela mexicana Roem.	+.1	–	–	–	–
High tree layer 15–20 m high, cover %:	90	75	90	60	60
Pseudolmedia spuria (Sw.) Griseb.	5.5	3.3	3.3	3.3	3.3
Mastichodendron foetidissimum (Jacq.) Crong.	1.1	–	–	–	1.1
Tabebuia shaferi Britt.	–	1.1	–	–	–
Trophis racemosa (L.) Urb.	–	2.2	2.3	1.2	+.1
Fagara martinicensis Lam.	–	1.1	–	–	–
Hibiscus elatus Sw.	–	–	2.2	–	1.1
Matayba oppositifolia (A. Rich.) Britt.	–	–	1.1	+.1	1.1
Alchornea latifolia Sw.	–	–	1.1	1.1	–
Ficus subscabrida Warb.	–	–	1.1	–	–
Cinnamomum elongatum (Nees) Kosterm.	–	–	–	1.1	–
Chionanthus domingensis Lam.	1.1	–	–	1.1	–
Wallenia bumelioides (Griseb.) Mez	1.1	–	–	–	–
Sapium jamaicense Sw.	–	–	–	–	+.1
Oxandra lanceolata (Sw.) Baill.	–	–	–	–	+.1
Rauvolfia nitida Jacq.	–	–	–	–	+.1
Calophyllum antillanum Britt.	–	–	–	–	–
Nectandra earlei Britt	–	–	–	–	–
Low tree layer 5–12 m high, cover %:	50	75	60	85	70
Pseudolmedia spuria (Sw.) Griseb.	2.3	3.3	3.3	3.4	3.4
Trophis racemosa (L.) Urb.	2.3	1.2	2.2	1.2	2.3
Oxandra lanceolata (Sw.) Baill.	1.2	2.3	+.1	1.2	2.2
Matayba oppositifolia (A. Rich.) Britt.	+.1	+.1	1.1	+.1	1.2
Dendropanax arboreus (L.) Dec. et Planch.	1.1	+.1	+.1	2.2	1.1
Mastichodendron foetidissimum (Jacq.) Cronq.	1.2	1.2	–	+.1	+.1
Nectandra coriacea (Sw.) Griseb.	–	–	+.1	+.1	+.1
Wallenia laurifolia (Jacq.) Sw.	1.2	+.1	+.1	1.1	+.1
Enallagma latifolia (Mill.) Small	+.1	–	+.1	+.1	+.1
Guarea guidonia (L.) Sleumer	+.1	–	+.1	–	+.1
Exostema ellipticum Griseb.	–	–	–	–	+.1
Alchornea latifolia Sw.	–	+.1	–	–	+.1

Bursera simaruba (L.) Sarg.	–	–	–	–	+.1
Geoffroya inermis W. Wright	–	–	–	–	+.1
Chrysophyllum oliviforme L.	–	–	–	+.1	–
Faramea occidentalis (L.) A. Rich.	–	+.1	+.1	–	–
Prunus occidentalis Sw.	–	–	+.1	–	–
Fagara martinicensis Lam.	–	+.1	+.1	–	–
Syzygium jambos (L.) Alst.	–	+.1	+.1	–	–
Margaritaria nobilis L.f.	–	+.1	–	–	–
Psychotria grandis Sw.	+.1	+.1	–	–	–
Calophyllum antillanum Britt.	+.1	–	–	–	–
Ocotea leucoxylon (Sw.) Mez	–	–	–	+.1	–
Shrub layer 2–4 m high, cover %:	50	40	20	30	25
Oxandra lanceolata (Sw.) Baill.	2.3	2.3	+.1	+.1	2.2
Dendropanax arboreus (L.) Dec. et Planch.	+.1	–	–	+.1	1.1
Matayba oppositifolia (A. Rich.) Britt.	1.2	1.2	+.1	+.1	1.1
Pseudolmedia spuria (Sw.) Griseb.	2.2	1.1	1.2	2.3	1.1
Trophis racemosa (L.) Urb.	1.1	1.1	2.2	1.2	+.1
Wallenia laurifolia (Jacq.) Sw.	1.1	+.1	+.1	–	+.1
Calophyllum antillanum Britt.	+.1	–	–	–	+.1
Pouteria domingensis (Gaertn. f.) Baehni	1.1	–	–	–	–
Mastichodendron foetidissimum (Jacq.) Cronq.	+.1	+.1	+.1	1.1	–
Faramea occidentalis (L.) A. Rich.	+.1	+.1	+.1	1.1	–
Drypetes alba Poir.	+.1	–	+.1	–	–
Chrysophyllum oliviforme L.	+.1	+.1	+.1	+.1	+.1
Picramnia pentandra Sw.	+.1	+.1	+.1	–	–
Tabernaemontana amblyocarpa Urb.	+.1	+.1	+.1	–	–
Licaria triandra (Sw.) Kosterm.	+.1	+.1	–	–	–
Cinnamomum triplinervis (R. et P.) Kosterm.	+.1	–	+.1	–	–
Gonzalagunia sagraeana Urb.	+.1	+.1	+.1	–	+.1
Eugenia farameoides A. Rich.	+.1	+.1	–	–	+.1
Prunus occidentalis Sw.	–	1.1	–	–	+.1
Psychotria horizontalis Sw.	+.1	1.1	+.1	+.1	2.2
Samyda macrantha P. Wils.	–	+.1	–	–	–
Trichilia glabra L.	–	+.1	+.1	+.1	–
Hibiscus elatus Sw.	–	+.1	+.1	+.1	–
Palicourea domingensis (Jacq.) DC.	–	–	–	–	1.2
Psychotria grandis Sw.	–	+.1	–	–	–
Clerodendron grandiflorum (Hook.) Schau.	–	+.1	–	–	–
Pisonia aculeata L.	+.1	+.1	+.1	+.1	+.1
Casearia silvestris Sw.	–	+.1	–	+.1	–
Urera baccifera (L.) Gaud.	–	–	–	+.1	+.1
Nectandra coriacea (Sw.) Griseb.	–	–	–	+.1	+.1
Ocotea leucoxylon (Sw.) Mez	–	–	–	–	+.1
Vernonia havanensis DC.	–	–	–	–	+.1
Psychotria undata Jacq.	–	–	+.1	+.1	+.1
Cordia valenzuelana A. Rich.	+.1	–	–	–	+.1
Simaruba laevis Griseb.	–	–	+.1	–	+.1
Herb layer 20–200 m high, cover %:	50	50	70	35	5
Oplismenus hirtellus (L.) Beauv.	1.1	1.1	1.1	–	1.2
Olyra latifolia L.	1.2	–	1.1	1.2	1.1
Cupania glabra Sw.	+.1	+.1	–	–	+.1
Oxandra lanceolata (Sw.) Baill.	2.2	1.1	–	+.1	+.1

Cinnamomum elongatum (Nees) Kosterm.	–	–	+.1	+.1	+.1
Matayba oppositifolia (A. Rich.) Britt.	+.1	1.1	1.1	+.1	+.1
Faramea occidentalis (L.) A. Rich.	+.1	+.1	+.1	+.1	+.1
Dryopteris normalis C. Chr.	+.1	–	–	+.r	+.1
Vernonia havanensis DC.	–	+.1	–	–	+.r
Cordia valenzuelana A. Rich.	–	–	–	+.1	+.1
Prescottia stachyoides (Aw.) Lindl.	–	–	–	–	+.1
Erythrodes sagraeana (A. Rich.) Leon	–	–	–	–	+.1
Adianthum cristatum L.	–	+.r	+.1	+.1	+.1
Tectaria heracleifolia (Willd.) Underw.	–	–	+.r	–	+.1
Clerodendron grandiflorum (Hook.) Schau.	+.1	–	+.r	–	+.1
Trichilia glabra L.	+.1	+.r	+.1	–	+.1
Prunus occidentalis Sw.	+.r	2.2	1.1	+.1	+.1
Hibiscus elatus Sw.	–	–	1.1	+.1	+.1
Pharus glaber HBK.	+.1	+.1	+.1	1.1	+.1
Schoepfia didyma Wr. ex Griseb.	+.r	+.r	+.1	+.1	–
Polygala stipitata Blake	–	+.r	+.1	+.r	–
Malpighia biflora Poir.	+.r	+.r	+.r	+.r	–
Blechnum occidentale L.	+.r	–	–	+.1	–
Ardisia dentata (A. DC.) Mez	–	+.r	–	+.1	–
Dryopteris patens (Sw.) Ktze	–	+.r	+.1	+.1	–
Tournefortia glabra L.	–	–	–	+.1	–
Psychotria horizontalis Sw.	+.1	2.3	3.4	2.1	1.1
Miconia laevigata (L.) DC.	–	–	–	+.1	–
Trophis racemosa (L.) Urb.	–	1.1	2.1	1.1	–
Psychotria pubescens Sw.	–	–	–	+.1	–
Wallenia laurifolia (Jacq.) Sw.	+.1	–	–	+.1	–
Picramnia pentandra Sw.	+.r	+.r	+.r	+.r	–
Cupania americana L.	–	+.1	+.r	+.r	–
Psychotria grandis Sw.	–	–	–	+.r	–
Mastichodendron foetidissimum (Jacq.) Cronq.	–	+.1	+.1	+.r	–
Dendropanax arborens (L.) Dec. et Planch.	–	–	+.1	+.r	–
Casearia hirsuta Sw.	+.r	–	–	+.r	–
Cordia gerascanthus L.	–	–	–	+.r	–
Fagara martinicensis Lam.	–	+.1	+.1	–	+.1
Pseudolmedia spuria (Sw.) Griseb.	–	+.1	1.1	–	+.1
Wallenia laurifolia (Jacq.) Sw.	–	+.1	+.1	–	–
Piper umbellatum L.	–	–	+.1	–	–
Cinnamomum triplinervis (R. et P.) Kosterm.	+.r	+.1	+.1	+.1	–
Syzygium jambos (L.) Alst.	–	+.1	+.1	+.1	–
Cestrum laurifolium L'Hér.	+.1	–	+.1	–	–
Chrysophyllum oliviforme L.	–	–	+.r	–	–
Alchornea latifolia Sw.	–	+.1	+.r	–	–
Drypetes alba Poir.	–	+.r	–	–	–
Nectandra coriacea (Sw.) Griseb.	+.1	+.r	–	–	–
Cedrela mexicana Roem.	–	+.r	–	–	–
Roystonea regia (HBK.) Cook.	+.r	+.r	+.r	–	–
Cordia nitida Vahl.	+.1	+.1	–	–	–
Licaria triandra (Sw.) Kosterm.	+.r	+.r	–	–	–
Psychotria undata Sw.	1.1	+.r	+.1	–	–
Hyperbaena columbica (Eichl.) Miers	+.1	–	–	–	–
Ixora floribunda (A. Rich.) Griseb.	+.r	–	–	+.r	–
Tabebuia shaferi Britt.	+.r	–	–	–	–
Mappia racemosa Jacq.	–	–	–	+.r	–
Bunchosia nitida (Jacq.) DC.	–	+.r	–	–	–

Lianes:

Gouania lupuloides Urb.	1.1	1.1	+.r	1.1	+.1
Smilax domingensis Willd.	1.1	2.2	+.1	1.1	1.1
Philodendron krebsii Schott	+.1	—	+.r	+.1	+.1
Polypodium heterophyllum L.	+.1	+.1	—	—	+.1
Davilla rugosa Poir.	1.1	—	—	+.1	2.2
Merremia cissoides (Lam.) Hall f.	—	1.1	+.r	—	+.1
Lygodium cubense HBK.	—	+.r	—	—	—
Lasiacis divaricata (L.) Hitchc.	—	+.r	—	—	—
Forsteronia corymbosa (Jacq.) G. Meyer	—	1.2	—	—	—
Triopteris rigida Sw.	—	+.r	—	—	—
Cissius sicyoides L.	—	—	—	+.1	1.1
Cydista diversifolia (HBK.) Miers	—	—	—	+.1	—
Pristimera coriacea (Nr.) Miers	—	—	—	+.r	—
Heteropteris laurifolia A. Juss.	—	—	—	—	+.1
Chiococca alba L.	—	—	—	+.1	+.1
Vanilla phaeantha Rchb. f.	—	—	—	—	+.1

12 Class: **CEIBETEA OCCIDENTALIS** Knapp (1964) Borhidi hoc loco

Lowland seasonal evergreen forests extending to the lower zone of the middle ranges of the Caribbean area, conditioned by a seasonal tropical climate with 1400—2000 mm annual precipitation and 2—4 dry months. The structure of the forests is characterized by two tree layers with mostly deciduous emergents, by the high frequency and abundance of macro- and mesophyllous climbers and those of xerophytic epiphytes (*Tillandsia* spp.)

Characteristic species in Cuba: *Ceiba pentandra, Guazuma ulmifolia, Luehea speciosa, Calycophyllum candidissimum, Cedrela odorata, C. cubana, Swietenia mahagoni, Hibiscus elatus, Calophyllum antillanum, Cupania glabra, Lonchocarpus domingensis, L. latifolius, Roystonea regia, Dipholis salicifolia, Mastichodendron foetidissimum,* etc.

12.1 Order: LONCHOCARPO-CEIBETALIA Borhidi and Muñiz in Borhidi 1979 et hoc loco

Lowland seasonal evergreen forests in the Antilles, distributed mainly in the alluvial plain of the rivers and in the regularly flooded basins at the edge of the swamps, etc. They have two tree layers with some deciduous elements. Characteristic species as in the class.

12.1.1 Alliance: ***Guazumo-Cupanion*** Borhidi and Del Risco in Borhidi et al. 1979 et hoc loco

Meso-macrophyllous seasonal evergreen forests with few deciduous elements.

Association studied in Cuba:

Guazumo-Ceibetum Borhidi ass. nova

This is probably the dominant zonal lowland evergreen forest community of Cuba and the Greater Antilles, but it is everywhere destroyed and substituted by second-growth deciduous forests, palm-brakes and overwhelmingly by savannas and sugarcane fields. Nearly natural stands were studied by Borhidi near Polondrón, Jagüey Grande, Torriente y Pedro Betancourt, Matanzas Province in May, 1974 (Table 106. type relevé: no. 1). Its structure is characterized by two tree layers and deciduous emergents. Dominant tree and shrub layers are developed, the herb layer is almost completely missing. Lianes are frequent and abundant, epiphytes occur rather rarely. Nearly each isolated remnant stand represents a different species combination resulting from various kinds of natural, seminatural and mostly human interferences.

Table 106 Guazumo-Ceibetum occidentalis Borhidi ass. nova

	1	2	3	4	5	C_5
Emergent trees, 25—30 m high, cover %:	30	20	5	10	5	
Ceiba pentandra L.	1.2	+.1	+.1	+.1	+.1	V
Roystonea regia (HBK.) O. F. Cook	1.1	1.2	+.1	+.1	+.1	V
Spondias mombin L.	2.1	1.1	+.1	1.1	+.1	V
Mastichodendron foetidissimum (Jacq.) Cronq.	+.1	1.2	—	+.1	+.1	V
Lonchocarpus domingensis (Pers.) DC.	2.2	—	+.1	1.1	—	III
Andira inermis (Sw.) HBK.	—	1.1	+.1	—	—	II
Dipholis salicifolia (L.) DC.	—	1.1	—	+.1	—	II
Ficus membranacea C. Wr. in Sauv.	—	1.1	—	+.1	—	II
Canopy layer, 20—25 m high, cover %:	80	85	50	60	50	
Guazuma ulmifolis Lam	3.3	2.3	2.2	3.3	2.3	V
Dipholis salicifolia (L.) DC.	+.1	+.1	1.2	2.2	1.2	V
Mastichodendron foetidissimum (Jacq.) Cronq.	2.1	2.1	2.2	1.2	2.3	V
Spondias mombin L.	1.1	1.2	2.2	1.2	2.2	V
Andira inermis (Sw.) HBK.	+.1	1.1	—	+.1	+.1	IV
Bursera simaruba (L.) Sarg.	—	+.1	+.1	1.1	+.1	IV
Ficus membranacea C. Wr. in Sauv.	+.1	+.1	—	1.2	+.1	IV
Lonchocarpus domingensis (Pers.) DC.	2.2	+.1	2.2	—	+.1	IV
Cedrela mexicana Roem.	—	—	1.1	+.1	+.1	III
Cordia gerascanthus L.	+.1	—	—	+.1	+.1	III
Cupania macrophylla A. Rich.	2.2	+.1	+.1	—	—	III
Drypetes alba Poit.	—	+.1	—	+.1	+.1	III
Guettarda combsii Urb.	—	1.1	+.1	+.1	—	III
Metopium brownei (Jacq.) Urb.	—	—	1.1	+.1	+.1	III
Poeppigia procera Presl	+.1	—	—	1.1	+.1	III
Samanea saman (Jacq.) Merrill	2.1	—	+.1	—	+.1	III
Swietenia mahagoni (L.) Jacq.	—	—	+.1	1.2	+.1	III
Calophyllum antillanum Britt.	—	—	+.1	+.1	—	II

Chlorophora tinctoria (L.) Gaud.	–	+.1	–	–	+.1	II
Cordia collococca L.	1.3	+.2	–	–	–	II
Cupania glabra Sw.	1.2	2.2	–	–	–	II
Guarea guidonia (L.) Sleumer	1.2	+.1	–	–	–	II
Hibiscus elatus Sw.	–	–	1.2	+.1	–	II
Guapira obtusata (Jacq.) Little	–	–	1.1	+.1	–	II
Licaria jamaicensis (Nees) Kosterm.	+.1	1.2	–	–	–	II
Luehea speciosa Willd.	1.2	+.1	–	–	–	II
Spondias purpurea L.	+.1	+.1	–	–	–	II
Trichilia hirta L.	+.1	1.2	–	–	–	II

Beilschmiedia pendula 1.1 (1), *Faramea occidentalis* +.1 (1.1), *Trophis racemosa* +.1 (1), *Genipa americana* +.1 (1), *Casasia calophylla* +.1 (2), *Trichilia havanensis* +.2 (1), *Jambosa vulgaris* (1), *Cupania americana* (1), *Ficus aurea* (2), *Nectandra antillana* (1).

Low canopy layer, 8–12 m high, cover %:	30	25	60	80	60	
Allophylus cominia (L.) Sw.	1.2	+.1	+.1	+.1	+.1	V
Dipholis salicifolia (L.) DC.	+.1	+.1	+.1	+.1	+.1	V
Eugenia axillaris (Juss.) Radlk.	2.2	1.2	+.1	+.1	3.3	V
Guazuma ulmifolia Lam.	+.1	+.1	+.1	1.2	1.2	V
Lonchocarpus domingensis (Pers.) DC.	+.1	+.1	2.3	+.1	1.1	V
Mastichodendron foetidissimum (Jacq.) Cronq.	+.1	+.1	+.1	2.2	2.2	V
Nectandra coriacea (Sw.) Griseb.	1.2	1.2	3.3	1.2	1.1	V
Adelia ricinella L.	+.1	+.1	+.1	–	+.1	IV
Drypetes alba Poit.	+.1	–	+.1	+.1	1.2	IV
Eugenia maleolens Poir.	+.1	+.1	1.2	1.2	–	IV
E. rhombea (Berg) Kr. et Urb.	+.1	2.2	2.2	2.3	–	IV
Oxandra lanceolata (Sw.) Baill.	+.2	2.1	–	2.3	1.2	IV
Guapira obtusata (Jacq.) Little	–	–	+.1	+.1	+.1	III
Guettarda combsii Urb.	–	+.1	2.2	2.3	–	III
G. elliptica Sw.	–	–	1.2	2.2	1.1	III
Hibiscus elatus Sw.	–	–	+.1	+.1	+.1	III
Picramnia pentandra Sw.	+.1	+.1	–	–	+.1	III
Swietenia mahagoni (L.) Jacq.	–	–	+.1	1.1	+.1	III
Bursera simaruba (L.) Sarg.	–	–	–	+.2	+.1	II
Calophyllum antillanum Britt.	–	–	1.1	–	+.1	II
Espadaea amoena A. Rich.	+.1	+.1	–	–	–	II
Guettarda calyptrata A. Rich.	+.1	+.1	–	–	–	II
Hamelia patens Jacq.	+.1	–	–	–	+.1	II
Casearia hirsuta Sw.	+.1	+.1	–	–	–	II
Hypelate trifoliata Sw.	–	–	–	+.1	1-2	II
Schoepfia chrysophylloides (A. Rich.) Planch	–	+.1	–	–	+.1	II

Faramea occidentalis (1), *Trophis racemosa* (1), *Erythroxylum havanense* (1), *Casearia oculeata* (2), *C. spinescens* (1), *Alibertia edulis* (1), *Chrysophyllum oliviforme* (1), *Zanthoxylum fagara* (1), *Samyda macrantha* (2), *Erythroxylum areolatum* (3), *Hebestrigma cubense* (2), *Annona glabra* (3), *Thrinax morrisii* (3), *Margaritaria nobilis* (3), *Zuelania guidonia* (3), *Clusia rosea* (3), *Plumeria emarginata* (3), *Drypetes lateriflora* (4).

Shrub layer 2–5 m high, cover %:	30	40	70	20	20	
Eugenia axillaris (Sw.) Willd.	+.1	1.2	2.3	2.2	2.1	V
E. maleolens Poir.	+.1	1.2	2.2	1.1	2.2	V
Nectandra coriacea (Sw.) Griseb.	1.2	1.2	3.3	+.1	+.1	V

Adelia ricinella L.	+.1	+.1	1.1	—	+.1	IV
Allophylus cominia L.	+.1	+.1	1.2	1.2	—	IV
Coccoloba diversifolia Jacq.	+.1	+.1	+.1	1.2	—	IV
Oxandra lanceolata (Sw.) Baill.	1.1	1.2	—	+.1	+.1	IV
Ateramnus lucidus (Sw.) Rothm.	—	—	2.2	+.1	2.2	III
Casearia hirsuta Sw.	+.1	+.1	—	—	+.1	III
Erythroxylum havanense Jacq.	+.1	1.2	—	—	+.1	III
Eugenia rhombea (Sw.) Kr. et Urb.	1.1	+.1	2.2	—	—	III
Guettarda combsii Urb.	—	—	+.1	1.2	+.1	III
G. elliptica Sw.	—	—	+.1	1.2	+.1	III
Hamelia patens Sw.	+.1	—	—	+.1	+.1	III
Picramnia pentandra Sw.	1.1	2.2	—	—	1.2	III
Psychotria horizontalis Sw.	+.1	—	—	+.1	+.1	III
Casearia aculeata Jacq.	+.1	1.2	—	—	—	II
C. spinescens (Sw.) Griseb.	+.1	+.1	—	—	—	II
Malvaviscus arboreus Cav.	—	—	—	+.1	+.1	II
Plumeria emarginata Griseb.	—	—	+.1	+.1	—	II
Swietenia mahagoni (L.) Jacq.	—	—	+.1	—	+.1	II

Alibertia edulis (1), *Rauvolfia ligustrina* (1), *R. tetraphylla* (1), *Ouratea nitida* (1), *Tournefortia hirsutissima* (1), *Psychotria brownei* (1), *P. grandis* (1), *Eugenia galalonensis* (1), *Zanthoxylum fagara* (1), *Guettarda calyptrata* (2), *Trichilia havanensis* (2), *Casearia sylvestris* (2), *Zuelania guidonia* (3), *Bourreria succulenta* (4), *Colubrina ferruginea* (4), *Polygala montana* (4), *Terminalia intermedia* (4).

Lianes:

Chiococca alba (L.) Hitchc.	2.2	1.2	2.2	2.2	2.2	V
Securidaca elliptica Turcz.	1.1	+.1	1.1	+.1	1.2	V
Lasiacis divaricata (L.) Hitchc.	2.2	2.2	1.2	—	+.1	IV
Rourea glabra HBK.	—	+.1	2.2	1.2	+.1	IV
Cydista diversifolia (HBK.) Miers	1.2	2.1	—	—	+.1	III
Serjania diversifolia (Jacq.) Radlk.	—	1.2	—	1.2	+.1	III
Bauhinia divaricata L.	—	—	—	1.2	+.1	II
Echites umbellata Jacq.	—	—	—	+.1	+.1	
Gouania lupuloides (L.) Urb.	2.2	2.1	—	—	—	II
G. polygama (Jacq.) Urb.	—	+.1	+.1	—	—	II
Heteropteris laurifolia (L.) Juss.	1.2	—	—	—	+.1	II
Lasiacis sloanei (Griseb.) Hitchc.	1.1	+.1	—	—	—	II
Morinda royoc L.	+.1	+.1	—	—	—	II
Passiflora suberosa L.	+.1	+.1	—	—	—	II

Serjania atrolineata (1), *S. occidentalis* (5), *Abrus precatorius* (2), *Tournefortia volubilis* (2), *Galactia dubia* (1), *Mucuna pruriens* (1), *Platygyne hexandra* (1), *Tragia volubilis* (1), *Vigna luteola* (1), *Selenicereus grandiflorus* (3), *S. urbanianus* (3), *Smilax havanensis* (1), *Vanilla eggersii* (3), *Rajania cubensis* (4).

Herb layer, 0.5—2 m high, cover %:	30	20	15	10	10	
Lithachne pauciflora Sw.	2.2	1.2	2.2	2.2	2.1	V
Olyra latifolia L.	1.2	1.2	+.1	+.1	+.1	V
Desmodium canum (Gmel.) Sch. et Thell.	—	+.1	+.1	+.1	+.1	IV
Ichnanthus nemorosus (Sw.) Doell.	2.2	+.1	+.1	+.1	—	IV
Oplismenus hirtellus (L.) Beauv.	1.1	2.2	+.1	—	+.1	IV
Imperata contracta (HBK.) Hitchc.	1.1	1.1	—	+.1	—	III
Setaria tenax (L. C. Rich.) Desv.	—	1.2	+.1	+.1	—	III
Heliotropium procumbens Mill.	—	+.1	+.1	—	—	II

Panicum zizanoides HBK.	+.1	—	+.1	—	—	II
Oplismenus setarius (Lam.) R. et S.	+.1	—	+.1	—	—	II
Triumfetta semitriloba Jacq.	—	+.1	—	+.1	—	II

Leptochloa fascicularis (1), *Lasiacis rhizophora* (1), *Gayoides crispum* (2), *Panicum pilosum (2), P. joorii* (3), *P. coerulescens* (4).

Epiphytes:

Polypodium aureum L.	+.1	+.1	—	+.1	+.1	IV
T. valenzuelana A. Rich.	2.2	2.2	1.2	—	1.2	IV
Hohenbergia penduliflora (A. Rich.) Mez	+.1	—	—	+.1	+.1	III
Polypodium heterophyllum (L.) Watt	+.1	+.1	—	—	+.1	III
Tillandsia flexuosa Sw.	+.1	—	—	+.1	+.1	III
Polypodium phyllitidis L.	+.1	—	—	—	+.1	II

Hibisco-Calophylletum antillanae Del-Risco

This is a seasonally flooded evergreen forest community occurring on the higher plains, of the swamp basins and in the supralittoral marsh-zone, mostly in the great peninsulas (Guanahacabibes, Zapata, South Isle of Pine) and along the low southern coastal area of the Cuban plain.

Mastichodendro-Dipholietum salicifoliae Borhidi and Muñiz ass nova

It is the limestone evergreen seasonal forest of the Cuban plains and colline areas. It is widely distributed from the Guanahacabibes Peninsula, South Isle of Pine, and in the foothills of the limestone middle ranges of West and Central Cuba. It occurs in many types of forest, with different species combinations due to the different human interferences. In the Appendix Table 25 two variants are listed, each based on 5—5 relevés made by Borhidi and Muñiz in 1969 and 1970. Column 29 gives the synthetic list of a variant from Isla de Pinos, column no. 30. represents a Central Cuban hill-variant of the limestone ranges of Matanzas and Las Villas provinces.

Spondiato-Roystonietum Ciferri 1936

This association described by Ciferri from Hispaniola as a lowland rainforest association is obviously a second-growth forest community on the sites of once existed lowland evergreen seasonal forests, as it can be observed also in similar Cuban examples.

12.1.2 Alliance: ***Hibisco-Swietenion mahagoni***
Del-Risco and Borhidi in Borhidi et al. 1979 et hoc loco

Seasonal evergreen forests of the regularly flooded alluvial and swamp areas, characterized by noto- and microphyllous elements and deciduous trees.

Associations studied in Cuba:

Lysilomo-Metopietum brownei Borhidi and Del-Risco ass. nova

This is an alluvial seasonal evergreen forest association on regularly flooded lowland limestone areas. Column 38 of the Appendix, Table 25 presents a synthetic list of 5 relevés made by Borhidi and Muñiz in 1969—70 in the areas of Isla de Pinos and Zapata Swamp of an association-complex of this alliance.

Calophyllo-Swietenietum mahagoni Del-Risco (ined.)

12.2 Order: OXANDRO-BURSERETALIA Borhidi and Muñiz in Borhidi et al. 1979 et hoc loco

Semi-deciduous forests of the West Indies with two tree layers, the upper one up to 20—25 m high, formed mostly by deciduous trees. To this order belong very common and frequently occurring communities of the lowland and colline zones, conditioned by a seasonal tropical climate with 3—6 dry months and 800—1600 mm annual precipitation. Soils are moderately deep, gravillous brown tropical or red latosolic soils on limestone rock. The second-growth forests resulting after the clear cut of the seasonal evergreen lowland forests belong also to this community group.

Characteristic species in Cuba: *Bursera simaruba, Spondias mombin, Andira inermis, Cordia collococca, C. gerascanthus, Zanthoxylum elephantiasis, Casearia hirsuta, C. spinescens, Jacaranda coerulea, Samanea saman, Pithecellobium cubense, Buchenavia capitata, Hypelate trifolia, Amyris elemifera, A. balsamifera, Trichilia* spp., etc.

12.2.1 Alliance: ***Oxandro-Burserion*** Borhidi and Muñiz in Borhidi et al. 1979 et hoc loco

With the same characteristics as the order.

Associations studied in Cuba:

Mastichodendro-Cupanietum glabrae Borhidi and Muñiz ass. nova

This is the semi-deciduous tropical forest association in the colline zone of the Central Cuban limestone ranges. The high tree level is often reduced to emergents due to deforestation. Type relevé was made by Borhidi and Muñiz in the Cerro Taubaquey, Sierra de Cubitas (prov. Camagüey) in southern exposition; declination 15°, at approximately 150 m. a.s.l.; October, 1977. (Table 107).

Table 107 Mastichodendro–Cupanietum glabrae Borhidi and Muñiz ass. nova

Emergents:	cover 30%:		height: 18–20 m
Roystonea regia	1.1	*Cedrela mexicana*	+.1
Gastrococos crispa	+.1	*Swietenia mahagoni*	1.2
Coccotrhinax salvatoris	1.1	*Mastichodendron foetidissimum*	2.2
Hypelate trifoliata	1.1	*Spondias mombin*	1.2
Andira inermis	1.2		
Tree layer:	cover 70%:		height: 10–15 m
Cupania glabra	3.3	*Andira inermis*	1.1
Cupania grandifolia	1.1	*Plumeria emarginata*	+.1
Trichilia hirta	2.3	*Guettarda calyptrata*	+.1
Hypelate trifoliata	1.2	*Guettarda scabra*	+.1
Eugenia confusa	+.1	*Guettarda munizii*	+.1
Eugenia axillaris	1.2	*Exothea paniculata*	2.1
Casearia silvestris	+.1	*Coccoloba retusa*	+.1
Casearia spinescens	1.1	*Bursera simaruba*	2.2
Trichilia havanensis	+.1	*Amyris elemifera*	1.1
Erythroxylum rotundifolium	+.1	*Ateramnus albicans*	1.1
Erythroxylum havanense	1.1	*Ateramnus lucidus*	1.2
Coccothrinax salvatoris	1.2	*Gastrococos crispa*	+.1
Shrub layer:	cover 60%:		height: 2–6 m
Eugenia confusa	1.1	*Schaefferia frutescens*	2.2
Eugenia maleolens	3.3	*Savia bahamensis*	1.2
Eugenia asperifolia	+.1	*Ateramnus lucidus*	2.2
Casearia spinescens	1.2	*Ateramnus albicans*	1.1
Hypelate trifoliata	+.1	*Diospyrus crassinervis*	+.1
Cupania glabra	1.1	*Callicarpa cubensis*	+.1
Trichilia havanensis	+.1	*Polygala montana*	+.1
Trichilia hirta	1.1	*Comocladia dentata*	1.2
Erythroxylum havanense	1.1	*Picramnia pentandra*	+.2
Erythroxylum rotundifolium	+.1	*Guettarda scabra*	1.1
Roystonea regia	+.1	*Exothea paniculata*	1.1
Coccothrinax salvatoris	1.2	*Amyris elemifera*	+.1
Oxandra lanceolata	1.2		
Psychotria revoluta	+.1	*Hamelia patens*	+.1
Psychotria nervosa	1.1	*Espadaea amoena*	+.1
Herb layer:	cover 1%		
Oplismenus hirtellus	1.1	*Isachne leersioides*	+.1
Lasiacis divaricata	+.2	*Panicum boliviense*	+.1
Dryopteris patens	+.1	*Tectaria heracleifolia*	+.1
Dryopteris megalodus	+.1	*Adiantum cuneatum*	+.1
Adiantum cristatum	+.2	*Adiantum tenerum*	+.1
Lianes:	5–8%		
Smilax havanensis	1.1	*Duranta repens*	1.2
Platygyne hexandra	1.1	*Serjania diversifolia*	2.1
Gouania polygama	2.1	*Hyperbaena domingensis*	+.1

Epiphytes:

Polypodium polypodioides	+.1	*Polypodium aureum*	+.1
Tillandsia canescens	+.1	*Tillandsia fasciculata*	+.2

Mastichodendro-Trichilietum hirtae Schubert et al. 1979

A rather common semi-deciduous tropical forest association at the feet and slopes of limestone hills, mostly on shallow gravillous rendzina soils. The tree layer is lower and the shrub layer is generally more intensively developed. Deciduous and spiny elements are more frequent than in the former community.

13 Class: **TABEBUIO-BURSERETA** Knapp (1964) Borhidi hoc loco

Semi-deciduous or deciduous tropical forests with one or two tree layers. The upper one is formed by deciduous trees, the lower one is composed of evergreen sclerophyllous and deciduous elements. They are distributed in the lowland and colline limestone areas, mostly on shallow gravillous soils, conditioned by a considerably dry seasonal tropical climate with 5—7 dry months per year, or by a more humid climate but controlled edaphically in the areas of the limestone cliffs of the haystack mountains, or in the dry littoral dog-tooth areas.

Characteristic species in Cuba: *Bursera simaruba, Gossypiospermum praecox, Cordia gerascanthus, Cordia alliodora, Celtis trinervia, Hebestigma cubense, Drypetes mucronata, Lysiloma bahamense, Catalpa punctata, Bombacopsis cubensis, Hildegaardia cubensis, Tabebuia* spp. *Chionanthus bumelioides, Piscidia* spp., *Guettarda elliptica, G. amblyocarpa, Savia sessilifolia, Hypelate trifoliata, Pithecellobium lentiscifolium, Alvaradoa amorphoides* ssp. *psilophylla, Crescentia cujete* (Fig. 343) with cacti in the shrub layer and abundance of xerophytic climbers.

13.1 Order: TABEBUIO-BURSERETALIA Knapp (1964) Borhidi hoc loco

With the same characteristics as the class.

13.1.1 Alliance: ***Lysilomo-Burserion simarubae*** Borhidi in Borhidi et al. 1979 et hoc loco

Mesophilous deciduous tropical forests with evergreen sclerophyllous elements living near the littoral zones, frequently at the edge of swamp areas, under a seasonal climate with an emphasized dry season.



Fig. 343 The famous "güira", *Crescentia cujete* L. in a deciduous tropical forest of the Zapata Peninsula (Photo: A. Borhidi)

Association studied in Cuba:

Lysilomo-Burseretum simarubae Borhidi and Del-Risco ass. nova

This forest association is rather common in the humid limestone areas and swamps. It was studied in the southern Island of Pine and in the Zapata Swamp by Borhidi and Muñiz (see column no. 37. in the Appendix, Table 25.) and a profile is presented in Fig. 229. made by Borhidi and Del Risco, in the Zapata Swamp, March, 1975.

13.1.2 Alliance: ***Pithecellobion lentiscifolii***
Del-Risco in Borhidi et al. 1979 et hoc loco

Deciduous, microphyllous tropical forests, mostly on dry limestone reefs and dog-tooth areas. (Fig. 344.). They are rather low, the tree layer is up to 15 m high, all layers are poor in species.

Spondiato-Pithecellobietum lentiscifolii Borhidi and Del-Risco ass. nova

This community can be found in the eastern basin of the Zapata swamp, developing on a former quaternary limestone reef. The type relevé was made by

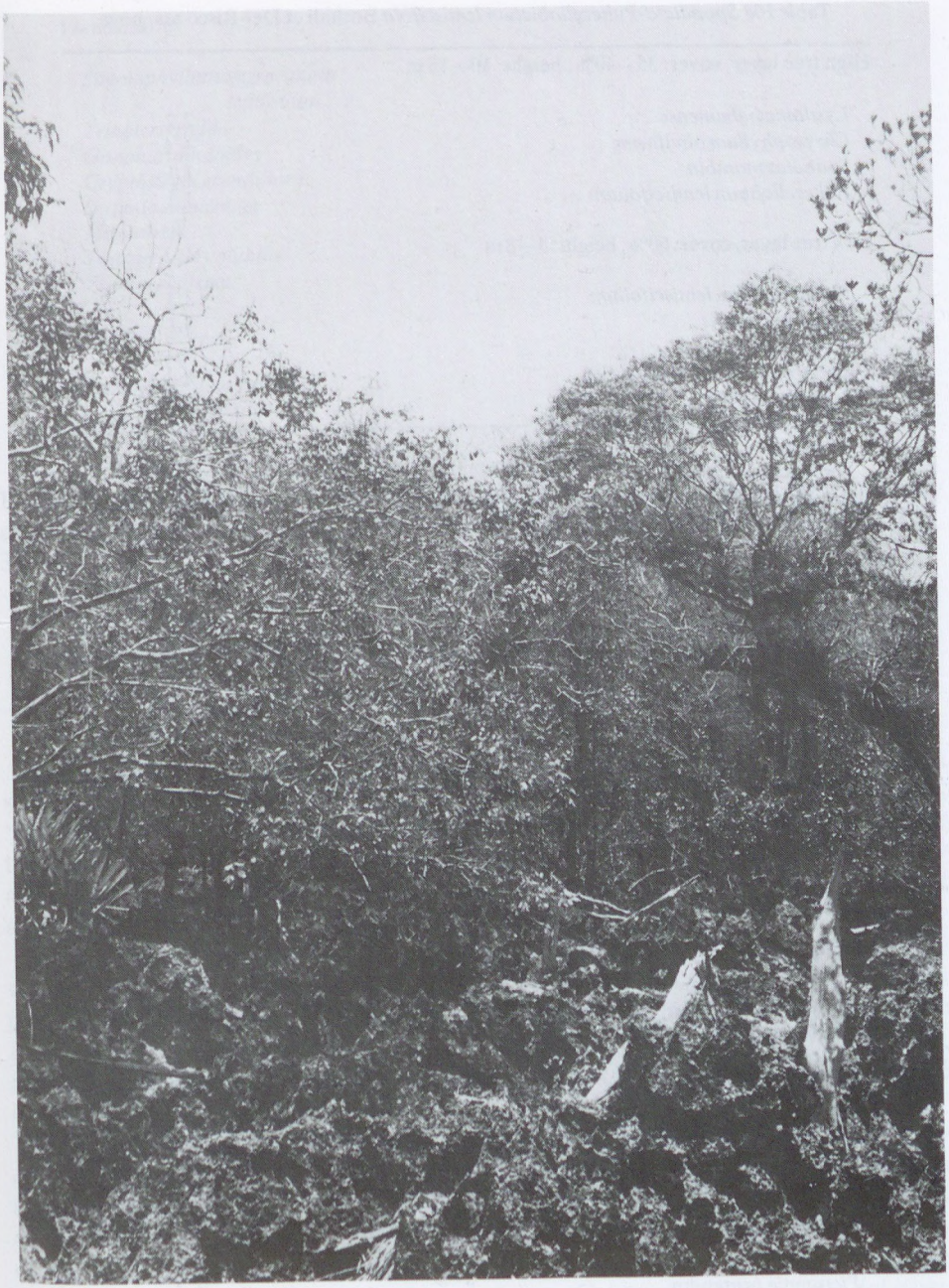


Fig. 344 Semi-deciduous littoral forest on rough limestone dog-tooth formation in the Zapata Peninsula (Photo: A. Borhidi)

Table 108 Spondiato-Pithecellobietum lentiscifolii Borhidi et Del-Risco ass. nova

High tree layer, cover: 35—40%; height: 10—15 m	
Lysiloma bahamense	2.2
Chrysophyllum oliviforme	+.1
Spondias mombin	1.1
Pithecellobium lentiscifolium	1.1
Low tree layer, cover: 60%; height: 3—8 m	
Pithecellobium lentiscifolium	3.3
Eugenia axillaris	1.1
E. maleolens	+.1
Erythroxylum havanense	+.1
Celtis trinervia	+.r
Lysiloma bahamensis	1.1
Clusia rosea	+.r
Spondias mombin	2.2
Antirhea lucida	+.1
Ficus subscabrida	+.r
Shrub layer, cover: 65%; height: 1—3 m	
Erythroxylum havanense	3.3
Zanthoxylum fagara	1.1
Croton lucidus	2.2
Picramnia pentandra	+.r
Simaruba glauca	+.r
Coccothrinax litoralis	+.r
Cordia globosa ssp. *humilis*	+.1
Chrysophyllum oliviforme	+.1
Eugenia maleolens	1.1
Mimosa sp.	+.1
Comocladia dentata	+.r
Guapira pemnsularis	+.r
Herb layer, cover: 5%	
Eugenia ligustrina	+.r
Simaruba glauca	+.r
Eugenia maleolens	+.1
Casearia silvestris	+.r
Mimosa sp.	+.r
Chrysophyllum oliviforme	+.r
Celtis trinervia	+.r
Cordia globosa ssp. humilis	+.1
Erythroxylum havanense	+.1
Lantana involucrata	+.1
Croton lucidus	1.1
Picramnia pentandra	+.1
Adelia ricinella	+.r
Zanthoxylum fagara	+.1
Justicia alainii	+.r
Rhynchospora diodon	1.2

Lianes: 20%	
Stigmaphyllum sagraeanum	2.2
ledifolium	+.1
Triopteris rigida	1.1
Gouania lupuloides	+.1
Cryptostegia grandiflora	1.2
Serjania subdentata	1.1
Mimosa sp.	+.1
Tournefortia volubilis	+.r
Pisonia aculeata	+.r
Epiphytes: 1%	
Tillandsia valenzuelana	+.2
recurva	+.r

Borhidi and Del-Risco near Cocodrilo in March, 1975 (Table 108). It is presumably a second growth community which replaced a sclerophyllous littoral forest. (Fig. 345.)

14 Class: **COCCOTHRINACETO-PLUMERIETEA** Knapp (1964) Borhidi hoc loco

Low, partly deciduous shrub forests of the West Indies rich in climbers and in sclerophyllous evergreen elements. They are named commonly as dry forests, "monte seco". They grow mostly on the eroded limestone of the coastal and seaside terraces and on the karstic mountains of Central Cuba and Oriente, conditioned by a seasonal, frequently bixeric climate with 7—9 dry months and 600—1200 mm of annual precipitation.

Knapp (1964) included in this class the serpentine pine forests and the sand pine woodlands as well which obviously do not belong to this group based on either physiognomic or floristic criteria. The Cuban pinelands must be divided into two independent classes: the West Cuban pineland belongs to the *Byrsonimo-Pinetea*, and the East Cuban serpentine pinelands to the *Caseario-Pinetea*, as discussed below.

Characteristic species: *Coccothrinax*, spp., *Plumeria* spp., *Bumelia* spp., *Coccoloba diversifolia, Canella winterana, Omphalea trichotoma, Ateramnus* (Gymnanthes) *lucidus, Gyminda latifolia, Crossopetalum rhacoma, Eugenia maleolens, Amyris balsamifera, A. diatrypa, Tabebuia myrtifolia, Jaquinia brevifolia, J. keyensis, Guajacum officinale, G. sanctum, Erythroxylon* spp., *Capparis* spp., *Malpighia* spp., *Krugiodendron ferreum, Grimmeodendron eglandulosum, Picrodendron macrocarpum, Metopium toxiferum, M. brownei, Guapira* (Torrubia) spp., *Lantana involucrata, Cordia globosa* ssp. *humilis, Bourreria succulenta, Ficus jacquinifolia, Hippomane mancinella, Diospyros grisebachii, Selenicereus grandiflorus, Pilosocereus robinii, Dendrocereus nudiflorus*, etc.



Fig. 345 Dry deciduous limestone forest in the Zapata Peninsula with *Pithecellobium lentiscifolium, Bursera simaruba, Spondias mombin* and with *Dendrocereus nudiflorus,* an endemic tree-shaped cactus (Photo: A. Borhidi)



Fig. 346 Two characteristic shrubs or little trees of the littoral deciduous forest: *Omphalea trichotoma* Muell. Arg. with fruits and *Comocladia platyphylla* A. Rich (Photo: A. Borhidi)

14.1 Order: EUGENIO-METOPIETALIA TOXIFERI Knapp (1964) Borhidi hoc loco

Coastal and semicoastal or quasicoastal shrub forests and shrublands of the West Indies.

Characteristic species in Cuba: *Metopium toxiferum, M. brownei, Coccothrinax borhidiana, C. litoralis, C. fragrans, Plumeria obtusa, P. keyensis, P. sericifolia, Omphalea trichotoma,* (Fig. 346.) *Krugiodendron ferreum, Grimmeodendron eglandulosum, Picrodendron macrocarpum, Calyptranthes pallens, C. dodecandra, Colubrina arborescens, C. elliptica, C. cubensis, Guapira longifolia, Castela* spp., *Bumelia celastrina, B. glomerata* ssp. *horrida, Pouteria domingensis, Thouinia elliptica, Croton lucidus,* etc.



Fig. 347 Two characteristic elements of the dry littoral limestone forest at Punta Colorados (Las Villas): *Caesalpinia bonduc* (L.) Roxb. with spiny fruits and *Pouteria domingensis* (Gaertn. f.) Baehni (Photo: A. Borhidi)

14.1.1 Alliance: ***Eugenio-Capparidion***
Borhidi in Borhidi et al. 1979 et hoc loco

Littoral dry forests and dry woodlands (Fig. 347) in the Greater Antilles on coral limestone and low terraces near the coastal belt. They can be characterized by the presence of deciduous and evergreens sclerophyllous trees, palms, evergreen, often spiny shrubs, columnar and arborescent cacti and other succulents.

Characteristic species: *Capparis flexuosa, C. cynophallophora, Colubrina elliptica, Hippomane mancinella, Tabebuia myrtifolia, Krugiodendron ferreum, Grimmeodendron eglandulosum, Eugenia maleolens, Catalpa punctata, Bourreria succulenta, Cordia galeottiana, C. sebestena, Opuntia dillenii* s.l., etc.

Associations studied in Cuba:

Guayaco-Pithecellobietum guadelupensis Borhidi ass. nova

The littoral shrub forest of the northern coast of Central Cuba, well developed in the Hicacos Peninsula. The type relevé was made by Borhidi at Varadero, Rincón Francés in August, 1970 (Table 109).

Picrodendro-Burseretum simarubae Del-Risco

It is a rather common littoral dry forest community along the southern rocky shores of Cuba. It is composed of sclerophyllous and deciduous, bom-shaped, densely ramified small trees. The structure and composition of the association are exhibited in the profile of Fig. 348, made by Borhidi and Del-Risco, in March, 1975, between Playa Girón and Cocodrilo (Matanzas Province).

Table 109 Guayaco-Pithecellobietum guadelupensis Borhidi ass. nova

Life form	Leaf size	Dist. pattern		
		Tree layer: cover 20%; height: 4—6 m		
MesPscap	no	A	*Hypelate trifoliata* Sw.	2.1
MiPsucc	aph	ECoc	*Pilosocereus robinii* (Lem.) Byl. and Row.	1.3
MesPscap	mi	CB	*Picrodendron macrocarpum* (A. Rich.) Britt.	1.2
NPcaesp	mi	ECoc	*Neobracea angustifolia* Britt.	1.1
MesPsucc	aph	EPC	*Dendrocereus nudiflorus* (Engelm.) Britt. and Rose	+.2
		Shrub layer: cover 85%; height: 1—4 m		
MesPscap	no	NCar	*Guajacum sanctum* L.	3.4
MiPscap	no	NCar	*Pithecellobium guadelupense* (Pers.) Chapm.	3.4
MesPscap	mi	A	*Eugenia maleolens* Poir.	2.3
MiPscap	mi	GA	*Erythroxylum rotundifolium* Lunan	1.2
MiPcaesp	no	A	*Forestiera segregata* (Jacq.) Kr. and Urb.	1.2
MiPcaesp	no	NCar	*Jacquinia keyensis* Mez	1.2
NPcaesp	mi	A	*Savia bahamensis* Britt.	1.2
MiPscap	mi	A	*Schaefferia frutescens* Jacq.	1.2
MesPscap	me	NCar	*Citharexylum caudatum* L.	1.2
MesPscap	me	NCar	*Ateramnus lucidus* (Sw.) Rothm.	1.1
NPcaesp	no	PT	*Capsicum frutescens* L.	1.1
MesPscap	no	PCar	*Colubrina elliptica* (Sw.) Briz. and Stearn	1.1
NPcaesp	no	PCar	*Erithalis fruticosa* L.	1.1
MiPscap	no	NCar	*Exostema caribaeum* (Jacq.) R. and S.	1.1
NPcaesp	mi	ECoc	*Guettarda undulata* Gris.	1.1
MesPscap	na	GAB	*Lysiloma sabicu* Benth.	1.1
MiPcaesp	mi	GAB	*Maytenus buxifolius* (A. Rich.) Gris.	1.1
MesPscap	no	NT	*Bursera simaruba* (L.) Sarg.	+.2
MiPscap	mi	NCar	*Caesalpinia vesicaria* L.	+.2
NPcaesp	no	A	*Argythamnia candicans* Sw.	+.1
MesPscap	no	PCar	*Ateleia gummifera* var. *cubensis* (Gris.) Mohl.	+.1
MiPscap	mi	EPC	*Belairia spinosa* A. Rich.	+.1
MiPscap	no	NT	*Capparis cynophyllophora* L.	+.1
NPcaesp	no	A	*Cassia ligustrina* L.	+.1
MiPcaesp	mi	EPC	*Diospyros grisebachii* (Hiern.) Standl.	+.1
NPcaesp	no	ECoc	*Helicteres furfuracea* Gris.	+.1
MiPcaesp	me	A	*H. jamaicensis* Jacq.	+.1
MesPscap	na	CB	*Jacaranda coerulea* (L.) Gris.	+.1
MesPscap	mi	NCar	*Metopium brownei* (Jacq.) Urb.	+.1
MiPros	me	ECoc	*Plumeria sericifolia* Wr. ex Gris.	+.1
MiPscap	me	EPC	*Pseudocarpidium neglectum* Bisse	+.1

Life form	Leaf size	Dist. pattern		
			Herb layer: absent	
			Lianes: cover 25%	
PLfrut	ma	NT	*Gouania polygama* (Jacq.) Urb.	2.2
PLfrut	mi	PT	*Caesalpinia bonduc* (L.) Roxb.	1.3
Chrept	me	NCar	*Urechites lutea* (L.) Hitchc.	1.1
PLfrut	no	NT	*Chiococca alba* (L.) Hitchc.	1.1
PLfrut	mi	A	*Distictis lactiflora* (Vahl) DC.	1.1
Chrept	no	NT	*Echites umbellata* Jacq.	1.1
Chrept	me	PT	*Ipomoea alba* L.	1.1
PLsuff	no	NT	*Cissus trifoliata* L.	+.2
Chrept	me	A	*Galactia dubia* DC.	+.1
Chrept	no	CB	*Ipomoea carolina* L.	+.1

Type relevé made by A. Borhidi 5.8. 1970. Locality: North Cuba, Hicacos Peninsula, Rincón Francés, near Varadero, 2 m a.s.l. Exposition: 0°. Sample plot area: 10×30 m

Grimmeodendro-Gochnatietum sagraeanae Borhidi ass. nova

This is a dry littoral forest community on the second terrace of the northern high limestone shore of Cuba between Jibacoa and Matanzas. The tree layer is formed by the dominant spiny 4—6 m high trees of *Gochnatia sagraeana,* accompanied by *Grimmeodendron eglandulosum, Thrinax radiata, Capparis cynophallophora* and others.

Krugiodendro-Drypetetum Ciferri 1936

Sarcomphalo-Reynosietum septentrionalis Borhidi ass. nova

This is a dry littoral forest association on the low limestone terraces of northern Camagüey and Oriente. The type relevé was made by Borhidi at Playa Pesquero Nuevo in 14. February, 1976. It is a community very rich in species with a high frequency of thorny trees and shrubs and that of cacti.

14.1.2 Alliance: ***Bombacopsi-Burserion simarubae*** Borhidi all. nova

Two-layered deciduous tropical forests on lowland subcoastal reefs of West Cuba, formed by deciduous emergents and sclerophyllous trees in the second tree layer.

Characteristic species: *Bombacopsis cubensis,* (Fig. 349) *Guajacum officinale, G. sanctum, Catalpa punctata, Diospyros crassinervis, Clerodendron calcicola, Vitex acunae, Callicarpa roigii,* etc.

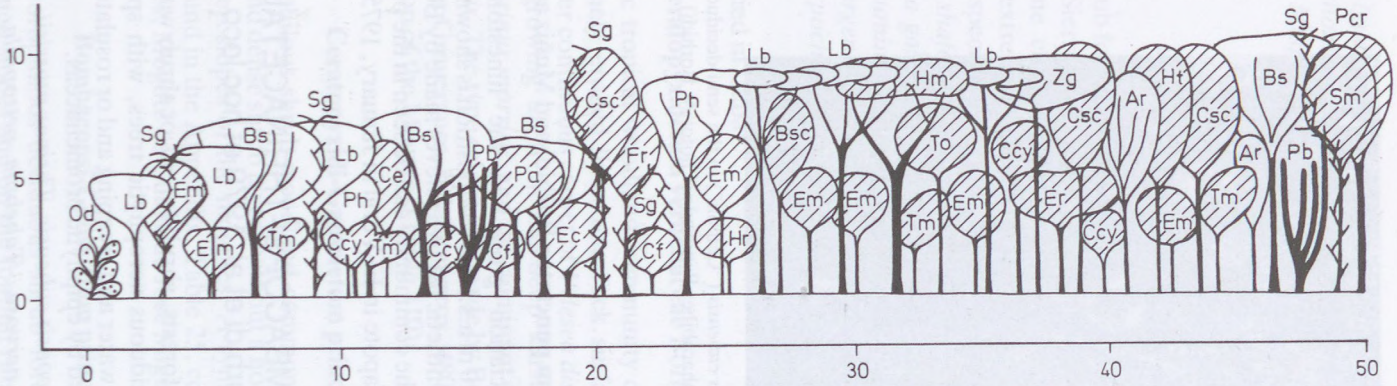


Fig. 348 Structure profile of a subcoastal semi-deciduous scrub woodland *(Eugenio-Capparidion* alliance) in the southern coast of the Zapata Peninsula near Cocodrilo (Borhidi, Del-Risco and Ovideo) Ar=*Adelia ricinella;* Bs=*Bursera simaruba;* Bsc=*Bourreria succulenta;* Ccy=*Capparis cynophyllophora;* Cf=*Capparis flexuosa;* Cr=*Colubrina reclinata;* Csc=*Casasia calophylla;* Ec=*Exostema caribaeum;* Em=*Eugenia maleolens;* Er=*Erythroxylum rotundifolium;* Fr=*Forestiera rhamnifolia;* Hm=*Hippomane mancinella;* Hr=*Hyperbaena racemosa;* Ht=*Hypelate trifoliata;* Lb=*Lysiloma bahamense;* Od=*Opuntia dillenii;* Pa=*Peltophorum adnatum;* Pb=*Pilosocereus brooksianus;* Pcr=*Picrodenron macrocarpum;* Ph=*Piscidia havanensis;* Sg=*Selenicereus grandifolius;* Sm=*Swietenia mahagoni;* Tm=*Tabebuia myrtifolia;* To=*Torrubia* (Guapira) *obtusata;* Zg=*Zuelania guidonia*



Fig. 349 Giant example of *Bombacopsis cubensis* ("Ceibón") in the semi-deciduous littoral limestone forest of the Guanahacabibes Peninsula (Photo: A. Borhidi)

Bombacopsi-Catalpetum punctatae Borhidi and Muñiz ass. nova

This deciduous forest association grows on the limestone reefs of the Guanahacabibes Peninsula 5 to 10 m a.s.l. Its composition is shown in the Appendix Table 25. in column no. 28 in a synthetic list five relevés made by Borhidi and Muñiz January, 1970. The structure of the community can be seen in the profile of Fig. 295, (p. 413), made by Borhidi and Capote in El Veral in January, 1975.

14.2 Order: BOMBACOPSI-THRINACETALIA Borhidi in Borhidi et al. 1979 et hoc loco

Orophytic deciduous tropical forests, shrub forests or shrub woodlands of West Cuba, composed of palms, deciduous xerophytic trees, with special adaptation mechanisms for accumulation of water and creeping and or rosulate succulents, and climbers. The herb layer is formed by epiphytic bromeliaceas.

Characteristic species: *Bombacopsis cubensis, Thrinax morrisii, Erythrina cubensis, Agave tubulata, Thouinia nervosa, Tabebuia petrophila, T. calcicola, T. jackiana, Thouinia canescens, Plumeria emarginata, Terminalia neglecta, Actinostemon brachypodus, Oplonia purpurascens, Leptocereus* spp., *Vitex divaricata* ssp.

cubensis, Celtis iguanaea, Pristimera coriacea, Cuervea integrifolia, Psidium scopulorum, P. thomasianum, P. vicentinum, Plinia spp., *Rochefortia spinosa, Lantana strigosa, Malpighia roigiana*, etc.

14.2.1 Alliance: ***Spathelio-Gaussion***
Borhidi in Borhidi et al. 1979 et hoc loco

Orophilous shrub forests and deciduous forests growing on the Jurassic hard blue limestone in the Sierra de los Organos, Sierra de la Güira, Pan de Guajaibón and the high limestone cliffs of the Sierra del Rosario (Peña Blanca, etc.) These communities are extremely rich in endemic species.

Characteristic species: *Spathelia brittonii, Gaussia princeps, Ceratopyxis verbenacea, Bursera shaferi, Ekmanianthe actinophylla, Siemensia pendula, Guettarda calcicola, Eugenia galeata, E. cristata, Lobelia cubana, Tetrazygia lanceolata* s.l. *Auerodendron acuminatum, Lantana strigosa, Bourreria mucronata, B. polyneura, Leptocereus assurgens, L. ekmanii, Vriesea dissitiflora, Omphalea hypoleuca, Ancistranthus harpochiloides, Microcycas calocoma* (diff.), *Zanthoxylum pimpinelloides*, etc.

Associations studied in Cuba:

Vrieseo-Ceratopyxidetum verbenaceae Borhidi and Capote ass. nova

This is a karstic tropical woodland community of the very tops of the haystack hills. The extremely eroded limestone rock surface of the peaks and tops are covered by a rather continuous carpet of *Vriesea dissitiflora.* Sparsely situated trees and shrubs are growing up from the deep karstic holes and crevices, such as *Bombacopsis, Thrinax morrisii*, and the dominant shrub of the endemic Rubiaceae genus, *Ceratopyxis*. The type relevé was made by Borhidi and Capote in Sierra de la Güira, Mogote de Graveranes, height approx. 480 m a.s.l. Sample plot 10×25 m. Exposition: 0°. Top of the Mogote. (Table 110).

Ceratopyxidi-Gaussietum principis Borhidi

This is an orophilous shrub woodland community formed by sparse emergent trees and palms and dense shrub layer, without a notable herb layer. It grows mainly on the sunny steep slopes of the mogotes. A synthetic list of five representative relevés can be found in the Appendix, Table 25, column no. 25, made by Borhidi, June, 1970 Viñales, Mogote de Cueva de José Miguel, Mogote del Mural, Sierra de la Valle.

Bombacopsi-Gaussietum principis Borhidi

This is a low orophilous deciduous shrub forest community growing on the moderately declined slopes and on the foothill rubbles. *Bombacopsis* and *Gaussia* are accompanied by *Bursera shaferi* and *Microcycas calocoma;* in the herb layer *Ancistranthus* (endemic Acanthaceae genus) *harpochiloides* is abundant.

Table 110 Vrieseo-Ceratopyxidetum verbenaceae Borhidi and Capote ass. nova

Emergent trees: 4—6 m high, cover 5%			
Thrinax morrisii	+.1	*Tabebuia calcicola*	1.1
Bombacopsis cubensis	+.1	*Plumeria* obtusa *emarginata*	+.1
Shrub layer: 2—3 m high, cover 60—70%			
Ceratopyxis verbenacea	3.4	*Bourreria mucronata*	3.3
Tetrazygia minor	1.1	*Picrammia pentandra*	1.1
Exostema rotundatum	1.1	*Ateramnus lucidus*	1.1
Oplonia purpurascens	1.2	*Tabebuia calcicola*	+.1
Thrinax morrisii	+.1	*Diospyrus crassinervis*	+.1
Caesalpinia bahamensis	+.1	*Psidium seopulorum*	+.1
Polygala montana		*Hippomane mancinella*	+.1
Herb layer: up to 1.5 m height, cover 100%			
Vriesea dissitiflora	5.5	*Hohenbergia penduliflora*	1.1
Tillandsia fasciculata	1.1	*Tillandsia argentea*	1.1
Agave tubulata	+.1	*Selenicereus grandiflorus*	+.1
Leptocereus assurgens	+.1	*Lantana strigosa*	+.1
Lobelia cubana	+.1	*Adiantopsis paupercula*	+.1
Epidendrum nocturnum	+.1	*Erythrodes sagraeana*	+.1
Epiphytes: cover 15%			
Tillandsia fasciculata	2.3	*Tillandsia valenzuelana*	1.2
Tillandsia bulbosa	+.1	*Tillandsia pruinosa*	+.1
Tillandsia usneoides	+.1	*Polypodium heterophyllum*	+.2
Polypodium polypodioides	+.1	*Pleurothallis tribuloides*	+.1
Lianes: cover 20—30%			
Cuervea integrifolia	2.3	*Smilax havanensis*	1.2
Serjania diversifolia	1.1	*Passiflora suberosa*	1.1
Philodendron lacerum	+.2	*Celtis iguanea*	+.1
Securidaca elliptica	+.1	*Duranta repens*	+.1
Cynanchum ephedroides	+.1		

14.2.2 Alliance: ***Thrinacion morrisii***
Borhidi in Borhidi et al. 1979 et hoc loco

Orophilous karstic tropical shrub forests on soft. Tertiary limestone in West Cuba (Sierra de Anafe, Mogotes de Jaruco, Highlands of Habana and Matanzas) poor in species and endemics.

Characteristic species: *Celtis trinervia, Cordia gerascanthus, Hebestigma cubense, Gossypiospermum praecox, Tabebuia myrtifolia, T. petrophila, Leptocereus leoni, Eugenia duplicata, E. serrei, E. anafensis, Tournefortia maculata, Solandra longiflora* (Fig. 350) *Pseudocarpidium neglectum, Sapium leucogynum, Picramnia pentandra,* etc.



Fig. 350 One of the most common woody climbers of the mogote vegetation: *Solandra longiflora* Tuss. (Photo: A. Borhidi)

Bombacopsi-Thrinacetum morrisii Borhidi and Muñiz ass. nova

This is the deciduous karstic shrub forest association of the Habana Matanzas limestone ranges, characterized by the dominance of *Thrinax morrisii* and *Rhytidophyllum exsertum* in the tree and shrub layer, respectively. The type relevé was made by Borhidi and Muñiz in the Escaleras de Jaruco, at Tapaste in September, 1969. Exposition: SSW; declination 35—45°; cover of the nude rocks 75% (Table 111).

Celtidi-Hebestigmentum cubensis Borhidi

This is the deciduous orophilous shrub forest community of the southern slopes of the Sierra de Anafe, characterized by the presence of *Leptocereus leoni, Eugenia anafensis* and *E. duplicata* and the dominance of *Celtis trinevia, Cordia gerascanthus* and *Hebestigma cubense* in the tree layer.

14.3 Order: TABEBUIO-COCCOTHRINACETALIA Borhidi and Muñiz in Borhidi et al. 1979 et hoc loco

Tropical shrub forests on the Tertiary limestone cliffs in the mountains of Central Cuba and Oriente (Sierra de Escambray, Sierra Maestra and limestone cliffs and

Table 111 Bombacopsi-Thrinacetum morrisii Borhidi et Muñiz ass. nova

Emergent trees: 10—12 m high; cover: 10%			
Bombacopsis cubensis	1.1	*Cecropia peltata*	1.1
Tree layer: 5—8 m high; cover: 70%			
Thrinax Morrisii	4.4	*Ficus jaquinifolia*	1.1
Ficus subscabrida	+.1	*Ficus aurea*	+.1
Shrub layer: 2—3 m high; cover: 60%			
Erythroxylum areolatum	2.2	*Erythroxylum havanense*	2.1
Picramnia pentandra	2.2	*Allophylus Cominia*	2.2
Trichilia glabra	2.2	*Trichilia hirta*	1.1
Bunchosia nitida	1.1	*Bunchosia media*	1.1
Schaefferia frutescens	1.1	*Schoepfia chrysophylloi-*	1.1
Casearia hirsuta	1.1	*des*	
Trema micrantha	1.1	*Eugenia maleolens*	1.1
Eugenia asperifolia	+.1	*Trema micrantha*	+.1
Ateleia apetala	+.1	*Cordia globosa* ssp.	+.1
Casearia guianensis	+.1	*humilis*	
Trema micrantha	+.1	*Triumfetta semitriloba*	+.1
Vernonia menthaefolia	+.1	*Eupatorium havanense*	+.1
Hamelia patens	1.1	*Tournefortia glabra*	+.1
Herb layer: up to 1 m high: cover: 20%			
Rhytidophyllum exsertum	2.2	*Pilea microphylla*	2.2
Dryopteris patens	1.1	*Dryopteris sclerophylla*	+.1
Dryopteris normalis	+.1	*Dryopteris reptans*	+.1
Adiantum cristatum	1.1	*Adiantum dentatum*	+.1
Tectaria coriandrifolia	+.1	*Adiantum fragilis*	+.1
Pharus glaber	1.1	*Rivina humilis*	+.1
Fleurya cuneata	+.1		
Lianes up to a height of 3—4 m; cover: 40—50%			
Banisteria pauciflora	2.3	*Platygyne hexandra*	2.2
Philodendron Clementis	2.2	*Chiococca alba*	1.2
Pithecoctenium echinatum	1.2	*Gouania lupuloides*	1.1
Clematis dioica	+.2	*Melothria guadelupensis*	+.2
Passiflora multiflora	+.1	*Passiflora suberosa*	+.2
Lasiacis divaricata	+.1		

Mosses: *Bryum coronatum, Thuidium involvens, Barbula agraria*

ranges of the Sagua-Baracoa Massif). This vegetation type is very rich in species, endemics, and palms. The forests are composed of sclerophyllous trees and shrubs, of climbers and columnar cacti. Unlike in the West Cuban mogote-vegetation, the epiphytic bromeliaceas are missing in the herb layer, and the outstanding abundance of *Pilea* species can be observed as a characteristic feature.

Characteristic species: *Coccothrinax* spp., *Hemithrinax compacta, Tabebuia* spp., *Fagara coriacea, Gesneria heterochroa, G. cubensis, G. salicifolia, G. gibberosa, G. purpurascens, Phyllanthus epiphyllanthus* ssp. *dilatatus, Neobracea susannina, N. howardii, Eupatorium carsticola, Synapsis ilicifolia, Thouinia* spp., *Siphocampylus* spp., *Euleria tetramera, Savia erythroxyloides, Pilea* spp., etc.

14.3.1 Alliance: ***Tabebuio-Coccothrinacion***
Borhidi and Muñiz in Borhidi et al. 1979 et hoc loco

Tropical karstic shrub forests or shrub woodlands in montane rather isolated limestone areas, represented by a number of different vicarious associations, characterized by different endemic species of the same genera as *Coccothrinax, Tabebuia, Pilea, Gesneria, Thouinia,* etc. On the highest limestone peaks the mogote-forest tends to have a montane character, manifested as a combination of montane rainforest elements.

Association studied in Cuba:

Coccothrinaci-Tabebuietum bibracteolatae Borhidi and Muñiz ass. nova

It is the endemic community of the limestone cliff area of the Sierra Maestra range, south of Baire. It is characterized by a considerable number of endemics such as *Neobracea susannina, Malpighia acunana, Tabebuia bibracteolata, Pilea uninervis, Coccothrinax elegans,* etc. A synthetic list of five relevés is given in the Appendix Table 25, column no. 25. all made by Borhidi and Muñiz between Baire, Matias and La Tabla in October, 1969 and January, 1970. The type relevé was also made by Borhidi and Muñiz E. of Matias in October, 1969 (Table 112).

Ekmanio-Erythroxyletum baracoënsis Borhidi ass. nova

It is an endemic orophilous shrub forest association of Yunque de Baracoa, living in the limestone cliffs bordering the plateau of the characteristic shaped mount. The community is characterized by a great number of local endemics such as *Ekmania lepidota, Vernonia ekmanii, Pilea pulchra, Auerodendron reticulatum, Erythroxylon baracoënse, Calycogonium plicatum, Croton yunquensis, Coccothrinax yunquensis,* etc. The type relevé was made by Borhidi at the peak of the Yunque de Baracoa, at 520 m a.s.l. in November, 1978 (Table 113).

Tabebuio sauvallei-Garryetum Borhidi and Muñiz ass. nova

Montane karstic shrub woodland community of the high limestone peaks of the Sierra de Escambray, characterized by a number of endemic species such as *Euleria tetramera, Citharexylum matheanum, Rondeletia potrerillona, Rhamnidium potrerilloanum, Erythroxylon clarense, Daphnopsis alainii,* and by montane elements, for example, *Garrya fadyenii, Torralbasia cuneifolia* s.l., *Gesneria viridiflora* s.l.,

Table 112 Coccothrinaci-Tabebuietum bibracteolatae Borhidi and Muñiz ass. nova

Emergent trees: cover: 5%, 10—12 m high;			
Coccothrinax elegans	1.2	*Ficus wrightii*	1.1
Tree layer: cover: 10—15%; 8—10 m high;			
Synapsis ilicifolia	1.1	*Strempeliopsis strempelioides*	+.1
Fagara cubensis	1.1	*Ficus jacquinifolia*	1.1
Alvaradoa arborescens	+.1	*Ficus aurea*	1.1
Tabebuia bibracteolata	1.2	*Swietenia mahagoni*	+.1
Calycophyllum candidissimum	+.1	*Cedrela mexicana*	+.1
Zizyphus rhodoxylon	+.1	*Bursera simaruba*	1.1
Shrub layer: cover: 50—60%; 3—5 m high;			
Neobracea susannina	2.3	*Helietta glaucescens*	1.1
Tabebuia bibracteolata	3.3	*Ateleia apetala*	1.1
Catalpa brevipes	1.1	*Swietenia mahagoni*	2.2
Eugenia asperifolia	1.1	*Erythrina cubensis*	1.1
Pithecellobium hystrix	+.1	*Ateramnus lucidus*	3.3
Fagara cubensis	+.1	*Cordia gerascanthus*	1.1
Eupatorium carsticola	1.1	*Comocladia dentata*	1.1
Malpighia acunana	1.1	*Savia erythroxyloides*	1.1
Krugiodendron ferreum	+.1	*Vernonia wrightii*	1.2
Oplonia acunae	1.1	*Agave underwoodiana*	+.1
Citharexylum caudatum	+.1	*Forsteronia segregata*	1.1
Clerodendron denticulatum	+.1	*Casearia spinescens*	1.1
Climbers: 40%			
Forsteronia corymbosa	2.2	*Allophylus cubensis*	1.1
Celtis iguanea	+.1	*Serjania subdentata*	1.2
Byttneria scorpiura	+.1	*Passiflora sexflora*	+.1
Cynanchum ephedroides	1.1	*Passiflora foetida*	+.1
Platygyne dentata	1.2	*Chiococca alba*	2.2
Melothria guadelupensis	+.1	*Momordica charantia*	1.1
Echites umbellata	1.1	*Galactia spiciformis*	1.2
Selenicereus urbanianus	1.2	*Smilax havanensis*	2.3
Clitoria rubiginosa	+.1	*Centrosema virginianum*	+.1
Philodendron lacerum	1.2	*Trixis radialis*	+.1
Epiphytes: 10%			
Hohenbergia penduliflora	2.2	*Tillandsia fasciculata*	1.1
Tillandsia usneoides	1.1	*Epidendrum cochleatum*	+.1
Epidendrum umbellatum	+.1	*Rhipsalis baccifera*	1.1
Herb layer: cover: 40%; 0.1—1 m high;			
Pilea uninervis	3.3	*Tillandsia fasciculata*	1.1
Epidendrum cochleatum	1.1	*Pilea microphylla*	1.1
Peperomia obovata	+.1	*Begonia cubincola*	+.1
Lasiacis divaricata	2.2	*Lithachne pauciflora*	1.2

Table 113 Ekmanio-Erythroxyletum baracoënsis Borhidi ass. nova

Emergent trees: cover: 30%; 5—8 m high;			
Coccothrinax yunquensis	1.1	*Tabebuia polymorpha*	2.2
Exostema valenzuelae ssp. *wrightii*	1.2	*Guettarda lindeniana*	1.2
Illicium cubense	1.1	*Protium fragrans*	+.1
Shrub layer: cover 70%; 1—4 m high;			
Ekmania lepidota	2.2	*Erythroxylum baracoense*	2.3
Auerodendron reticulatum	1.2	*Exostema valenzuelae* ssp. *wrightii*	1.1
Savia erythroxyloides	2.3	*Croton yuquensis*	2.2
Calycogonium echinatum	1.1	*Ossaea heterotricha*	1.2
Myrtus nummularioides	1.2	*Psidium parvifolium*	+.1
Vernonia yunquensis	1.3	*Strychnos grayi*	+.1
Eupatorium ekmanii	+.1	*Callicarpa wrightii*	+.1
Herb layer: cover: 20%; 0.5—1.5 m high;			
Pilea spathulata	1.1	*Siphocampylus manettiaeflorus*	+.1
Sapium adenodon	+.1	*Gesneria viridiflora* var. *obovata*	+.1
Phyllanthus epiphyllanthus ssp. *dilatatus*	+.1	*Hillia parasitica*	+.1
Vernonia yunquensis	1.2	*Hillia tetrandra*	+.1
Spiranthes elata	+.1	*Zamia latifoliolata*	+.1
Tabebuia polymorpha	+.1	*Liabum wrightii*	+.1
Begonia wrightii	+.1	*Rajania baracoensis*	+.1
Dioscorea grisebachii	+.1		

etc. A synthetic list of five relevés is found in the Appendix Table 25, column no. 27 representing the association. The relevés were made by Borhidi and Muñiz, in June, 1970 at Pico Potrerillo between 850 and 930 m a.s.l.

14.4 Order: LANTANO-CORDIETALIA Borhidi in Borhidi et al 1979 et hoc loco

Littoral scrub woodlands and thickets on the dry limestone terraces in the West Indies. It is a desert-like vegetation type, somewhere really related to a semi-desert vegetation zone, conditioned by a monoxeric or bixeric seasonal, tropical climate, with 8—10 dry months and 600—1000 mm annual rainfall. This vegetation unit is characterized by low boomshaped trees and micro-, nano-, and leptophyllous, sclerophyllous or deciduous, frequently spiny shrubs.

Characteristic species: *Lantana* spp., *Cordia* spp., *Jacquinia berterii, J. maisiana, Croton* spp., *Pseudocarpidium* spp., *Guajacum officinale, Polygala cuneata, Bursera glauca, Guettarda* spp., *Coccothrinax* spp., *Eugenia* spp., *Myrtus oonophylla, Amyris diatrypa, Spirotecoma spiralis, Tabebuia* spp., *Melocactus* spp., *Oplonia polyece, Leucocroton microphyllus, Bellonia spinosa, Maytenus buxifolia* ssp. *cochlearifolia, Barleriola saturejoides* ssp. *hirsuta, Reynosia mucronata* ssp. *azulensis, Neea shaferi,* etc.

14.4.1 Alliance: ***Lantano-Cordion***

Borhidi in Borhidi et al. 1979 et hoc loco

Moderately dry littoral scrub woodlands with emergent palms and succulents and with few spiny elements. This community group can be found mostly in the limestone coastal areas of West and Central Cuba.

Characteristic species: *Cordia sebestena, C. galeottiana, C. globosa* ssp. *humilis, Lantana involucrata, Savia bahamensis, Oplonia tetrasticha, Chionanthus bumelioides, Caesalpinia pauciflora, Malpighia pallens, Castela calcicola, Tabebuia myrtifolia, T. capotei, Vitex* spp.

Association studied in Cuba:

Linociero-Savietum bahamensis Borhidi and Del-Risco ass. nova

Low and dense littoral scrub woodland of the southern limestone shores of West and Central Cuba. The type relevé was made by Borhidi and Del-Risco in Paso Malo, south -west of Cienfuegos. The emergent palm is *Coccothrinax cupularis* and the emergent columnar succulent is *Pilosocereus robinii* (Table 114).

Table 114 Linociero-Savietum bahamensis Borhidi and Del-Risco ass. nova

Life-form	Leaf size	Distr. pattern		
		Emergents 4—5 m tall, cover: 1%		
MesPros		ECoc	*Coccothrinax cupularis* (León) Muñiz	+.1
MiPsucc	aph	ECoc	*Pilosocereus robinii* (Lem.) Byl. and Row.	+.1
		Shrub layer 1—3 m tall, cover: 90%		
MesPscap	me	GA	*Linociera bumelioides* Gris.	2.4
NPcaesp	mi	A	*Savia bahamensis* Britt.	4.4
MesPscap	no	NCar	*Ateramnus lucidus* (Sw.) Rothm.	2.3
NPcaesp	na	A	*Caesalpinia pauciflora* (Gris.) Wr.	2.3
MiPscap	na	EPC	*Tabebuia myrtifolia* (Gris.) Britt.	2.2
MiPscap	mi	NCar	*Caesalpinia vesicaria* L.	1.2
MiPcaesp	mi	GA	*Bumelia glomerata* ssp. *horrida* (Gris.) Borhidi	1.1
MiPcaesp	mi	EPC	*Diospyrus grisebachii* (Hiern.) Standl.	1.1
MiPcaesp	mi	NT	*Erithalis fruticosa* L.	1.1
NPcaesp	lp	CB	*Pithecellobium hystrix* (A. Rich.) Benth.	1.1
MiPros	me	EPC	*Plumeria emarginata* Gris.	1.1
MiPscap	no	GA	*Guapira discolor* (Spr.) Lundell	+.2
NPcaesp	me	EPC	*Cordia galeottiana* A. Rich.	+.2
MesPscap	no	NT	*Capparis flexuosa* L.	+.1
MesPscap	me	EPC	*Casasia calophylla* A. Rich.	+.1
MesPros		ECoc	*Coccothrinax cupularis* (León) Muñiz	+.1
NPcaesp	mi	NCar	*Crossopetalum uragoga* (Jacq.) Rotm.	+.1
NPcaesp	no	GAB	*Croton lucidus* L.	+.1

NPcaesp	no	A	*Malpighia pallens* Small	+.1
MiPscap	mi	GAB	*Maytenus buxifolius* (A. Rich.) Gris.	+.1
MesPscap	no	NT	*Bursera simaruba* (L.) Sarg.	r.1
NPcaesp	no	EPC	*Diospyrus* × *leonis* (Britt. and Wils.) Borhidi	r.1
MiPscap	me	GAB	*Guapira obtusata* (Jacq.) Lundell	r.1
MiPscap	no	NCar	*Gyminda latifolia* (Sw.) Urb.	r.1
MesPscap	no	NT	*Hippomane mancinella* L.	r.1
MesPscap	no	A	*Hypelate trifoliata* Sw.	r.1
			Herb layer, up to 1 m high, cover: 15—20%	
NPcaesp	na	EPC	*Oplonia tetrasticha* (Wr. ex Gris.) Stearn	2.3
MiPcaesp	mi	GA	*Bumelia glomerata* ssp. *horrida* (Gris.) Borhidi	1.2
NPcaesp	mi	A	*Savia bahamensis* Britt.	1.1
NPcaesp	me	EPC	*Cordia galeottiana* A. Rich.	+.2
MesPscap	me	NCar	*Ateramnus lucidus* (Sw.) Rotm.	+.1
MesPscap	no	NT	*Capparis flexuosa* L.	+.1
NPcaesp	no	A	*Malpighia pallens* Small	+.1
NPcaesp	lp	CB	*Pithecellobium hystrix* (A. Rich.) Benth.	+.1
MesPros		ECoc	*Coccothrinax cupularis* (León) Muñiz	r.1
NPcaesp	mi	NCar	*Crossopetalum uragoga* (Jacq.) Rotm.	r.1
NPcaesp	no	GAB	*Croton lucidus* L.	r.1
MiPcaesp	mi	NT	*Erithalis fruticosa* L.	r.1
			Lianes, cover: 20%	
PLsuff	mi	PCar	*Jacquemontia jamaicensis* (Jacq.) Hall. f.	1.2
PLsuff	mi	EPC	*Mesechites rosea* (A. DC.) Miers	1.1
PLfrut	no	GA	*Stigmaphyllum diversifolium* (Kunth) Juss.	1.1
PLsuff	aph	A	*Vanilla eggersii* Correl	1.1
PLfrut	no	NT	*Chiococca alba* (L.) Hitchc.	+.1
PLfrut	no	PCar	*Morinda royoc* L.	+.1
PLsuff	no	NCar	*Smilax havanensis* Jacq.	+.1
PLsuff	me	GAB	*Stigmaphyllum sagraeanum* Juss.	+.1

Type relevé made by A. Borhidi and E. Del-Risco at 13. 1975. in the Zapata Peninsula, Paso Malo SW of Cienfuegos, on limestone embankment. Sample plot area 10×10 m

Tabebuio-Viticetum guanahacabibensis Borhidi and Capote ass. nova

This is the endemic littoral scrub woodland community of the southern limestone shores of the Guanahacabibes Peninsula. Emergents are *Coccothrinax cupularis, C. miraguama, Copernicia pauciflora* var. *ramosissima, Harrisia taetra* and *Dendrocereus nudiflorus*. In the dominant shrub layer two local endemics *Tabebuia capotei* and *Vitex guanahacabibensis* are abundant. The type relevé was made by Borhidi and Capote in Punta Leones in October, 1978. (Table 115).

Eugenio buxifoliae-Erithalietum fruticosae Borhidi ass. nova

It is a widely distributed littoral scrub woodland association, existing in numerous isolated local variants in the northern limestone shores of Cuba and in the different islands of the Bahamas and Antilles. The local variant of the northern littoral area

Table 115 Tabebuio-Viticetum guanahacabibensis Borhidi and Capote ass. nova

Emergents: 15%			
Coccothrinax cupularis	1.2		
C. miraguama	+.1		
High shrub layer 2—3 m tall, cover: 70%			
Vitex guanahacabibensis	2.3	*Tabebuia myrtifolia*	2.3
V. divaricata ssp. *cubensis*	1.2	*T. capotei*	1.1
Savia bahamensis	2.2	*Gymnanthes lucida*	2.2
Capparis flexuosa	1.2	*Croton lucidus*	1.2
C. cynophallophora	1.2	*Erythroxylum areolatum*	1.1
Picrodendron macrocarpum	1.1	*Hippomane mancinella*	+.1
Hyperbaena racemosa	1.1	*Omphalea trichotoma*	+.1
Plumeria emarginata	1.2	*Harrisia taetra*	+.2
Low shrub layer, less than 1 m tall, cover: 40%			
Lantana involucrata	2.3	*Savia bahamensis*	2.2
Vitex divaricata ssp. *cubensis*	1.1	*Plumeria emarginata*	1.2
Tabebuia myrtifolia	1.1	*Capparis flexuosa*	1.2
Drypetes mucronata	1.1	*Catesbaea spinosa*	1.1
Castela calcicola	1.1	*C. parviflora*	1.1
Malpighia pallens	+.1	*Opuntia dillenii*	1.1
Cordia sebestena	+.1	*Cordia galeottiana*	+.1
Lianes: cover: 25%			
Cissus trifoliata	2.2	*Echites umbellata*	1.1
Stigmaphyllum sagraeanum	1.2	*Smilax havanensis*	1.1
Angadenia cubensis	1.1	*Ipomoea alba*	+.1
Serjania occidentalis	+.1	*Triopteris rigida*	+.1
Selenicereus grandiflorus	+.1	*Mesechites rosea*	+.1

Sampling plot area: 10×10 m

of the provinces Habana and Matanzas (see Fig. 197, p. 329) is characterized by some local endemics, such as the emergent and highly endangered rare palm *Coccothrinax borhidiana,* and other species such as *Croton litoralis* ssp. *rugelianus, Colubrina cubensis.* The type relevé was made by Borhidi at Punta Guanal (Province Matanzas) in June, 1974. (Table 116).

14.4.2 Alliance: ***Pseudocarpidio-Guettardion***

Borhidi and Muñiz in Borhidi et al. 1979 et hoc loco

Dry littoral scrub woodlands formed by sclerophyllous and deciduous, often spiny micro-, nano- and leptophyllous, rarely aphyllous little trees and shrubs, with a notable participation of xerophytic, small-leaved palms and columnar and/or

tree-shaped cacti. This alliance is abundantly represented in the northern limestone shores of the provinces Camagüey. Tunas and Holguin (formerly Oriente), and the southern limestone shores and terraces of Oriente, especially between Guantánamo and Punta Maisi.

Characteristic species: *Pseudocarpidium avicennioides, P. multidens, P. shaferi, Cordia leucosebestena, C. curbeloi, C. pulverulenta, Guettarda cueroensis, G.*

Table 116 Eugenio-Erithalietum fruticosae Borhidi ass. nova

Life-form	Leaf size	Dist. pattern		
			Emergent trees, cover: 10%, 3—4 m tall	
MiPcaesp	mi	NT	*Erithalis fruticosa* L.	3.4
MesPscap	mi	A	*Eugenia maleolens* Poir.	3.3
MesPscap	me	NCar	*Ateramnus lucidus* (Sw.) Rothm.	2.3
NPcaesp	mi	NT	*Lantana involucrata* L.	2.2
MiPscap	me	A	*Coccoloba diversifolia* Jacq.	1.2
MiPscap	me	EPC	*Cordia galeottiana* A. Rich.	1.2
NPcaesp	mi	A	*Savia bahamensis* Britt.	1.2
MiPcaesp	no	NCar	*Bourreria ovata* Miers	1.1
MesPscap	no	NT	*Capparis flexuosa* L.	1.1
MiPscap	no	SCar	*Casearia spinescens* (Sw.) Gris.	1.1
MesPscap	ma	PCar	*Colubrina arborescens* (Mill.) Sarg.	1.1
MiPscap	no	PCar	*Colubrina elliptica* (Sw.) Briz. et Stearn	1.1
NPcaesp	no	GAB	*Croton lucidus* L.	1.1
MiPcaesp	no	NCar	*Gyminda latifolia* (Sw.) Urb.	1.1
MiPscap	no	A	*Adelia ricinella* L.	+.1
MesPscap	me	NCar	*Citharexylum caudatum* L.	+.1
MiPros		ECoc	*Coccothrinax borhidiana* Muñiz	+.1
MiPcaesp	no	ECoc	*Colubrina cubensis* (Jacq.) Brogn. ssp. *cubensis*	+.1
NPcaesp	mi	NCar	*Crossopetalum uragoga* (Jacq.) Rothm.	+.1
MesPscap	no	GAB	*Diospyros crassinervis* (Kr. et Urb.) Standl.	+.1
MiPscap	no	NCar	*Exostema caribaeum* (Jacq.) R. et S.	+.1
MiPscap	no	GA	*Guapira discolor* (Spr.) Lundell	+.1
MiPscap	no	PCar	*Guettarda elliptica* Sw.	+.1
MesPscap	no	NT	*Hippomane mancinella* L.	+.1
MesPscap	mi	CB	*Picrodendron macrocarpum* (A. Rich.) Britt.	+.1
MiPscap	mi	EPC	*Piscidia havanensis* (Britt. et Wils.) Urb. et Ekm.	+.1
MiPros	me	EPC	*Plumeria emarginata* Gris.	+.1
MiPscap	na	EPC	*Tabebuia myrtifolia* (Gris.) Britt.	+.1
			Herb layer, cover 20%, 0.1—1 m tall	
NPsucc	aph	PCar	*Opuntia dillenii* (Ker.-Gawl.) Haw.	1.2
NPcaesp	na	EPC	*Oplonia tetrasticha* (Wr. ex Gris.) Stearn	1.2
MiPscap	me	GA	*Comocladia dentata* Jacq.	1.2
MiPcaesp	mi	EPC	*Castela calcicola* (Britt. et Small) Ekm.	1.1
Hscap	me	NT	*Jatropha gossypifolia* L.	1.1
MiPscap	no	A	*Adelia ricinella* L.	+.1
NPcaesp	no	A	*Argythamnia candicans* Sw.	+.1
NPcaesp	no	PT	*Capsicum frutescens* L.	+.1

Life-form	Leaf size	Dist. pattern		
NPcaesp	lp	NCar	*Catesbaea parviflora* Sw.	+.1
NPcaesp	mi	ECoc	*Croton litoralis* Urb. ssp. *rugelianus* (Urb.) Borhidi	+.1
MiPscap	mi	GA	*Erythroxylum rotundifolium* Lunan	+.1
MiPcaesp	no	A	*Forestiera segregata* (Jacq.) Kr. and Urb.	+.1
Chpulv	lp	GA	*Heliotropium humifusum* HBK.	+.1
NPcaesp	mi	A	*Malpighia coccigera* L.	+.1
Chsuffrept	mi	PT	*Philoxerus vermicularis* (L.) R. Br.	+.1
			Lianes: cover: 15%	
PLsuff	mi	PCar	*Jacquemontia jamaicensis* (Jacq.) Hall f.	1.2
NPcaesp	no	PCar	*Morinda royoc* L.	1.2
Plsuff	no	NCar	*Smilax havanensis* Jacq.	1.1
PLfrut	no	GA	*Stigmaphyllum diversifolium* (Kunth) Juss.	1.1
Chherbrept		PT	*Ipomoea pes-caprae* (L.) Sweet	+.1
Chherbrept	mi	EPC	*Mesechites rosea* (A. DC.) Miers	1.1
Chherbrept		NT	*Sarcostemma clausum* (Jacq.) R. and S.	+.1

Sampling plot area: 10×10 m; relevé made by A. Borhidi 10. 6. 1974. at Punta Guanal, Matanzas Province, on limestone dog-tooth-embankment, in 10m. a.s.l.

coxiana, G. rigida, Thouinia pseudopunctata, T. stricta, T. leonis, Rondeletia apiculata, R. ingrata, Myrtus oonophylla, Guajacum officinale, Tabebuia libanensis, T. polymorpha, Coccothrinax munizii, C. alexandri, C. hiorami, Plumeria lanata, Callicarpa bucheri, and succulents, as *Melocactus acunai, M. borhidii, M. harlowii, Harrisia taylori, Consolea macracantha, Dendrocereus nudiflorus,* etc.

The associations of the alliance often form a vegetation continuum, in which the limits of the individual communities are difficult to mark. A combined synthetic list of the following three associations are found in the Appendix Table 25, column no. 39, based on 10 relevés made by Borhidi in 1970, 1976 and 1978 and by Borhidi and Muñiz made in February and March, 1970 all in the coastal region of southern Oriente between Siboney and Maisi.

Associations studied in Cuba:

Pseudocarpidio-Guettardetum cueroensis Borhidi ass. nova

It is the littoral scrub woodland community of the low limestone terraces and seaside karstic slopes between Santiago de Cuba and Imias. The type relevé was made by Borhidi in the Yunque de Daiquiri in October, 1969 on dry southern limestone slopes (Table 117).

Guettardo-Coccothrinacetum munizii Borhidi and Muñiz ass. nova

It is the dry scrub woodland association on the second and third limestone terraces between. Tortuguilla and Imias (Fig. 351). The tall, extremely xerophytic,

small-leaved *Coccothrinax munizii* (closely related to *C. ekmanii* of Haiti) can also form a closer tree layer on the more eroded limestone surfaces. The type relevé was made by Borhidi and Muñiz in the Terraces of Macambo, west of Imias in March, 1970 (Table 118). Figure 352 shows the place of this association and that of the following community in the coastal zonation.

Table 117 Pseudocarpidio-Guettardetum cueroensis Borhidi ass. nova

Emergents: cover: 20%; height: 4—6 m			
Coccothrinax fragrans	2.2	*Picrodendron macrocarpum*	1.2
Ficus laevigata	+.2	*Grimmeodendron eglandulosum*	+.1
Spirotecoma spiralis	+.1		
Shrub layer: cover 60%; height: 1—3 m			
Colubrina elliptica	3.3	*Thouinia pseudopunctata*	1.2
Lasiocroton bahamensis	1.2	*Cassia emarginata*	1.2
Guettarda cueroensis	2.2	*Pseudocarpidium avicennioides*	2.2
Guettarda coxiana	+.1	*Tabebuia myrtifolia*	+.1
Pseudocarpidium multidens	+.1	*Exostema caribaeum*	1.1
Pseudocarpidium purgens	+.1	*Exostema spinosum*	+.1
Cordia leucosbestena	1.2	*Caesalpinia pauciflora*	1.2
Cordia rotundata	+.1	*Cassia sclerophylla*	+.1
Cordia globosa ssp. *humilis*	1.1	*Belairia spinosa*	1.1
Cordia brittonii	1.2	*Eugenia cowellii*	1.1
Maytenus buxifolia ssp. *cochlearifolia*	1.2	*Myrtus oonophylla*	+.1
Croton myricifolius	+.1	*Forestiera segregata*	2.2
Croton rosmarinoides	+.1	*Randia spinifex*	+.1
Calliandra colletioides	2.2	*Savia clusiifolia*	1.2
Bourreria succulenta	1.2	*Eugenia maleolens*	1.2
Bourreria taylori	+.1	*Rochefortia oblongata*	+.1
Bursera glauca	+.1	*Polygala cuneata*	+.1
Polygala guantanamana	+.1	*Plumeria lanata*	+.1
Erythroxylum rotundifolium	1.1	*Ateramnus lucidus*	1.2
Crossopetalum aquifolium	+.1	*Harrisia taylori*	+.1
Agave underwoodii	1.1	*Callicarpa grisebachii*	+.1
Herb layer: cover: 10%; height: 0.1—1 m			
Paspalum ruperstre	1.1	*Cordia leptoclada*	1.1
Melocactus harlowii	+.1	*Heliotropium ternatum*	1.1
Turnera diffusa	+.1	*Bellonia spinosa*	+.1
Oplonia polyece	1.2	*Malpighia linearis*	+.1
Castela victorini	+.1	*Leucocroton microphyllus*	+.1
Rhytidophyllum acunae	+.2	*Jacquinia stenophylloides*	+.1
Lianes: cover: 10%			
Smilax havanensis	1.2	*Banisteria pauciflora*	+.1
Aristolochia clementis	1.1	*Stigmaphyllum sericeum*	1.1
Mesechites rosea	1.1	*Stigmaphyllum lineare*	+.1
Tournefortia stenophylla	+.1	*Urechites lutea*	+.1
Tournefortia polyochros	+.1	*Echites umbellata*	+.1



Fig. 351 An extremely xerophytic palm: *Coccothrinax munizii* Borhidi in the *Guettardo-Coccothrinacetum munizii* community on the dry rocky limestone slopes of the subcoastal terraces in south-east Oriente between Tortuguilla and Maisi (Photo: A. Borhidi)

Erythroxylo-Coccothrinacetum alexandri Borhidi and Muñiz ass. nova

It is the endemic scrub-woodland association on the low limestone terrace of the coastal plain of Maisi, characterized by continuously elevating, unpenetrable, dense and 1 to 3 m high shrub carpet and by the highly emergent individuals of *Coccothrinax alexandri.* (Fig. 353) The occurrence of columnar and tree-shaped cacti and some leafless dwarf shrubs such as *Schaefferia ephedroides* (Fig. 354) and *Euphorbia marchii* are characteristic. The type relevé was made by Borhidi and Muñiz in the Plain of Maisi in March, 1970 (Table 119). See also Fig 352B.

14.4.3 Alliance: ***Crotono-Lantanion***

Borhidi in Borhidi et al. 1979 et hoc loco

Dry littoral thickets formed by micro-, nano- and leptophyllous shrubs on shallow sandy soils accumulated mostly in the pits and crevices of the eroded limestone reefs and low terraces. They are also characterized by the dominance of the genera *Croton* and *Lantana,* and by a reduced participation of succulents and spiny elements. They can be of natural origin and also as secondary communities, on the sites of disturbed littoral scrub woodlands, distributed over all the West Indies. In Cuba, they are found more frequently in the coasts of Matanzas and Oriente Provinces.

Table 118 Guettardo coxianae–Coccothrinacetum munizii Borhidi et Muñiz ass. nova

Life-form	Leaf size	Distr. pattern		
			Emergents 4—5 m tall, cover: 1%	
MesPros		ECso	*Coccothrinax munizii* Borhidi	3.3
			Shrub layer: cover 40%, alt 1—4 m	
NPcaesp	mi	ECso	*Guettarda coxiana* Britt.	2.3
MiPcaesp	no	A	*Forestiera segregata* (Jacq.) Kr. et Urb.	1.2
NPcaesp	na	ECso	*Neea shaferi* Standl.	1.2
NPcaesp	mi	ECso	*Guettarda cueroensis* Britt.	1.1
MiPscap	no	NCar	*Colubrina elliptica* (Sw.) Briz. et Stearn	1.1
MiPscap	mi	ECo	*Pseudocarpidium avicennioides* (A. Rich.) Millsp.	1.1
MiPsucc	aph	ECso	*Consolea macracantha* (Gris.) Berg.	+.1
MiPsucc	aph	GA	*Ritterocereus hystrix* (Haw.) Bakeb.	+.1
NPcaesp	no	GAB	*Cordia brittonii* (Millsp.) Macbr.	+.1
NPcaesp	no	PCar	*C. globosa* (Jacq.) HBK. ssp. *humilis* (Johnst.) Borhidi	+.1
MiPscap	me	ECso	*C. leucosebestena* Gris.	+.1
NPcaesp	mi	ECo	*Croton myricifolius* Gris.	+.1
NPcaesp	mi	CB	*C. rosmarinoides* Millsp.	+.1
NPcaesp	no	ECso	*Callicarpa bucheri* Mold.	+.1
NPcaesp	mi	A	*Lantana arida* Britt.	+.1
MiPcaesp	na	ECso	*Maytenus buxifolius* (A. Rich.) Gris. ssp. *cochlearifolius* (Gris.) Borhidi.	+.1
MiPscap	me	ECso	*Thouina pseudopunctata* Lippold	+.1
NPcaesp	mi	A	*Malpighia linearis* Jacq.	+.1
NPcaesp	na	ECo	*Oplonia polyece* (Stearn) Borhidi	+.1
MiPscap	no	A	*Adelia ricinella* L.	+.r
NPcaesp	mi	AB	*Securinega acidoton* (L.) Fawc. et Rendle	+.r
			Herb layer: cover 1%, alt.: 0.1—0.5 m	
Chsucc	aph	ECso	*Melocactus harlowii* (Britt. et Rose) Vaupel	1.1
			Lianes: cover: 10%	
PLsuff		NCar	*Smilax havanensis* Jacq.	2.1
GL		ECso	*Passiflora santiagana* (Killip) Borhidi	2.1
HL		NCar	*Jacquemontia jamaicensis* (Jacq.) Hall f.	1.2
HL		ECso	*Galactia maisiana* Alain	1.1
Plsuff		ECo	*Stigmaphyllum lineare* Wr. in Sauv.	+.1
HL		NCar	*Urechites lutea* (L.) Britt.	+.1
PLsuff		ECo	*Tournefortia stenophylla* Urb.	+.1
			Epiphytes: cover less than 1%	
Eros		NT	*Tillandsia recurvata* L.	r.1

Type relevé made by A. Borhidi and O. Muñiz, 16. 3. 1970. Locality: SE Cuba, Limestone terrace of Macambo near San Antonio del Sur, 50 m a.s.l. Exposition: S 20° Sample polot area 20×20 m

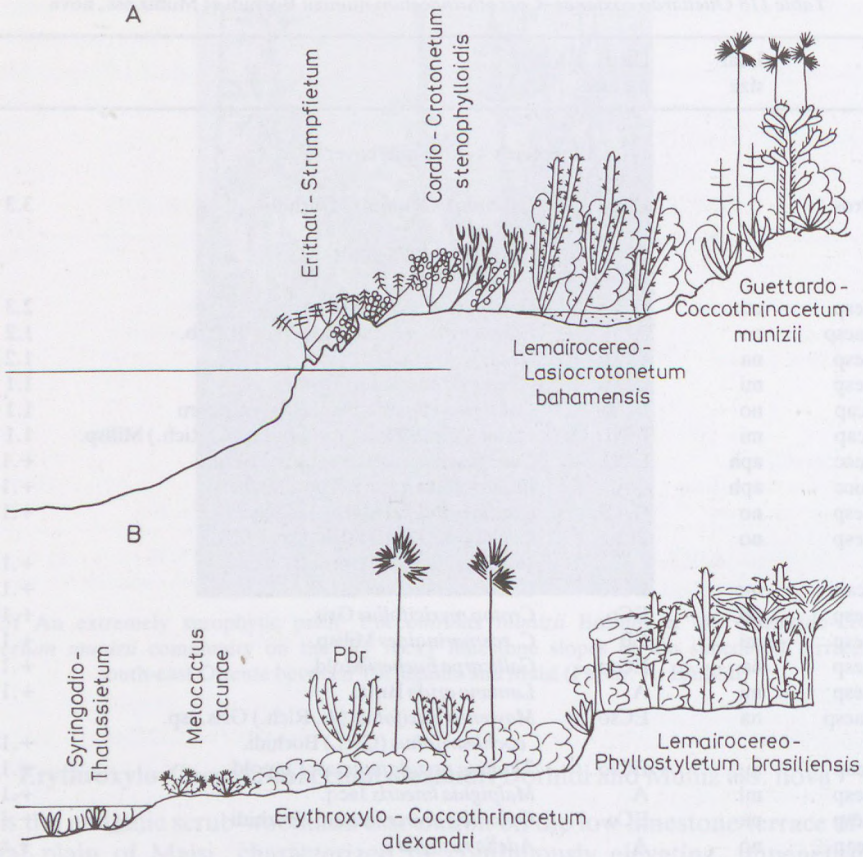


Fig. 352 Zonation of the coastal vegetation at Imias (A) and Maisi (B) Pbr=*Pilosocereus brooksianus*, (*Lemairocereus*=*Ritterocereus hystrix*)

Characteristic species in Cuba: *Croton litoralis, C. litoralis* ssp. *rugelianus, C. betulinus, C. micradenus, C. corallicola, C. rosmarinoides, C. myricifolius, C. tenuirameus, C. stenophyllus, C. excisus, C. munizii, Lantana parvifolia, L. involucrata, L. arida, Cordia globosa* ssp. *humilis, C. brittonii, C. leptoclada, C. corallicola, Neea shaferi, Heliotropium ternatum, Eugenia cowellii, Myrtus cabanasensis, Thouinia leonis, Mollugo cuneifolia, Ayenia violacea, Callicarpa bucheri*, etc.

Associations studied in Cuba:

Eugenio-Crotonetum rosmarinioidis Borhidi and Muñiz (ined.)

Cordio-Crotonetum stenophylli Borhidi (ined.)

Heliotropio-Pithecellobietum hystricis Borhidi (ined.)



Fig. 353 Wind-out dry evergreen sclerophyllous scrub — *Erythroxylo-Coccothrinacetum alexandri* community — of the limestone plain of Maisi with emergent palms of *Coccothrinax alexandri* León (Photo: A. Borhidi)



Fig. 354 A typical semi-globose shaped leafless semi-desert shrub: *Schaefferia ephedroides* Urb. at Maisi (Photo: A. Borhidi)

Table 119 Erythroxylo-Coccothrinacetum alexandri Borhidi et Muñiz ass. nova

Life-form	Leaf size	Distr. pattern		
		Emergent trees, cover: 10% 12—15 m tall		
MesPros		ECso	*Coccothrinax alexandri* León	2.1
		Shrub layer, cover: 90%, 1.5—3 m tall		
MesPscap	mi	A	*Erythroxylum brevipes* DC.	3.4
MiPcaesp	mi	ECso	*Guettarda cueroensis* Britt.	3.3
MiPcaesp	lp	ECo	*Neea shaferi* Standl.	2.3
NPcaesp	mi	NT	*Lantana involucrata* L.	2.3
MesPscap	me	NCar	*Ateramnus lucidus* (Sw.) Rothm.	2.2
NPcaesp	mi	ECo	*Croton stenophyllus* Gris.	2.2
MesPscap	mi	A	*Eugenia maleolens* Poir.	2.2
MiPscap	mi	A	*Forestiera segregata* (Jacq.) Kr. et Urb.	2.2
NPscap	na	ECso	*Acacia cowellii* (Britt. et Rose) León	1.2
NPscap	na	A	*Caesalpinia pauciflora* (Gris.) Wr.	1.2
NPcaesp	no	PCar	*Croton lucidus* L.	1.2
MesPscap	mi	A	*Drypetes mucronata* Gris.	1.2
NPcaesp	na	ECso	*Jacquinia maisiana* Borhidi	1.2
NPcaesp	na	ECso	*Oplonia polyece* (Stearn) Borhidi	1.2
MiPsucc	aph	ECo	*Pilosocereus brooksianus* (Britt. et Rose) Byl. et Row.	1.2
NPcaesp	mi	ECso	*Rondeletia baracoensis* Britt.	1.2
NPcaesp	lp	ECso	*Sarcomphalus bullatus* Urb.	1.2
MiPscap	mi	ECso	*Tabebuia polymorpha* Urb.	1.2
NPcaesp	na	ECso	*Gochnatia maisiana* (León) Jerv. et Alain	2.2
NPcaesp	no	ECso	*Callicarpa bucheri* Mold.	1.1
NPcaesp	na	ECo	*Calliandra colletioides* Gris.	1.1
NPcaesp	lp	ECso	*Catesbaea flaviflora* Urb.	1.1
MiPscap	me	ECo	*Cordia leucosebestena* Gris.	1.1
MiPscap	na	GA	*Croton betulinus* Vahl	1.1
NPcaesp	mi	ECso	*Croton tenuirameus* Urb.	1.1
MiPscap	mi	ECo	*Doerpfeldia cubensis* (Britt.) Urb.	1.1
MiPcaesp	mi	NCar	*Erithalis fruticosa* L.	1.1
NPcaesp	mi	A	*Lantana arida* Britt.	1.1
NPcaesp	na	ECso	*Machaonia microphylla* Gris.	1.1
NPcaesp	na	EPC	*Malpighia horrida* Small	1.1
NPscap	na	ECso	*Maytenus buxifolius* ssp. *cochlearifolius* (Gris.) Borhidi	1.1
NPscap	mi	ECso	*Pseudocarpidium pungens* Urb.	1.1
MiPscap	lp	ECso	*Reynosia mucronata* ssp. *azulensis* Borhidi et Muñiz	1.1
NPcaesp	aph	GA	*Schaefferia ephedroides* Urb.	1.1
NPcaesp	na	AB	*Securinega acidoton* (L.) Fawc. et Rendle	1.1
NPcaesp	mi	ECso	*Castela victorini* Acuña et Roig	+.2
NPcaesp	no	GAB	*Cordia brittonii* (Millsp.) Macbr.	+.2
NPcaesp	no	ECso	*C. leptoclada* Urb. et Britt.	+.2
Chsuff	na	ECso	*Barleriola saturejoides* ssp. *acunae* Borhidi et Muñiz	+.1
MiPscap	mi	ECso	*Caesalpinia pinnata* Urb.	+.1
NPsucc	aph	CB	*Consolea millspaughii* (Britt.) Berg.	+.1

MiPscap	mi	PCar	*Crossopetalum rhacoma* Cr.	+.1
NPcaesp	mi	ECso	*Croton micradenus* Urb.	+.1
NPcaesp	mi	ECso	*Jacquinia stenophylloides* Borhidi	+.1
NPcaesp	lp	ECso	*Myrtus oonophylla* (Urb.) Burr.	+.1
NPscap	lp	ECo	*Pithecellobium prehensile* (Wr.) Benth.	+.1
MiPscap	mi	ECso	*Pseudocarpidium shaferi* Britt.	+.1
NPcaesp	mi	A	*Savia bahamensis* Britt.	+.1
NPcaesp	na	ECso	*Scolosanthus nannophyllus* Borhidi	+.1
NPcaesp	na	ECo	*Tabebuia libanensis* Urb.	+.1
MiPscap	mi	ECso	*Thouinia pseudopunctata* Lippold	+.1
			Lianes, cover: 30%	
PLsuff	mi	NCar	*Jacquemontia jamaicensis* (Jacq.) Hall f.	2.3
PLsuff	mi	ECo	*Angadenia cubensis* Lippold	2.2
Chherbrept	mi	EPC	*Mesechites rosea* (A. DC.) Miers	2.2
PLsuff	nt	EPC	*Stigmaphyllum sagraeanum* Juss.	2.2
GL	nt	GAB	*Passiflora cuprea* L.	2.1
PLsuff	nt	ECo	*Stigmaphyllum sericeum* Wr. in Sauv.	1.3
PLfrut	mi	PT	*Cissus trifoliata* L.	1.1
Chherbrept	aph	GA	*Cynanchum ephedroides* (Gris.) Alain	1.1
PLsuff	mi	NT	*Echites umbellata* Jacq.	1.1
PLsuff	na	ECso	*Marsdenia alainii* Woods.	1.1
PLsuff	aph	GA	*Selenicereus grandiflorus* (L.) Britt. et Rose	1.1
PLsuff	mi	GAB	*Tournefortia polyochros* Spr.	1.1
PLsuff	mi	ECso	*T. stenophylla* Urb.	1.1
PLsuff	mi	GA	*Triopteris rigida* Sw.	1.1
HL	me	A	*Urechites lutea* (L.) Britt.	1.1
Chherbrept	no	NT	*Sarcostemma clausum* (Jacq.) R. et S.	+.1

Type relevé made by A. Borhidi and O. Muñiz 19. 3. 1970. in the plain of Maisi, East Cuba, on the first limestone terrace, about 5—15 m a.s.l. Sample plot area 10×10 m

15 Class: **COCCOLOBETEA UVIFERAE** Del-Risco in Borhidi et al. (1979) et Borhidi hoc loco

Littoral scrub and low forests formed mostly by the monodominant, macrophyllous sea-grape *(Coccoloba uvifera)* on the sandy shores and on the first littoral dunes of the low limestone rocky shores of the Antilles, Bahamas and Florida. The unique physiognomy, one-layered structure, the deciduous character and the poor species composition make it necessary to consider these communities as a separate association class. They do not belong to *Coccothrinacio-Plumerietea,* as it was originally suggested by Knapp (1964).

Characteristic species: *Coccoloba uvifera, Leucaena leucocephala, Thespesia populnea, Erithalis fruticosa, Hippomane mancinella, Casasia clusiifolia, Scaevola plumieri, Conocarpus erecta* var. *sericea, Bursera simaruba, Crossopetalum rhacoma, Thrinax radiata,* etc.

15.1 Order: COCCOLOBETALIA UVIFERAE Knapp (1964) Samek 1973

15.1.1 Alliance: ***Coccolobion uviferae*** Samek 1973

Littoral scrubs and low forests, sometimes palm-brakes on the sand dunes and beaches.

Association studied in Cuba:

Coccolobetum uviferae (Gleason and Cook 1926) Samek 1973

Monodominant *Coccoloba uvifera* scrub on the sandy shores of the West Indies. A very common association with *Morinda royoc, Rivina humilis, Commelina elegans*.

Opuntio-Coccolobetum uviferae Borhidi ass. nova

The monodominant *Coccoloba uvifera* scrub community was described first by Gleason and Cook (1926) from Puerto Rico. Although the monodominant character of the *Coccoloba* stands is essential all over the West Indian islands, there are also notable differences with respect to the floristic composition of these communities in the different regions. The community of *Coccoloba* and *Opuntia dillenii* is growing on dry coastal areas, where the sand dunes are settled on shallow coral reefs or low banks. In the herb layer *Hymenocallis arenicola* and dry-tolerant grasses occur scarcely. Five relevés made by A. Borhidi in Boca de Jaruco, Jibacoa and Arroyo Blanco on the northern coast and at Pasa Caballo on the south coast are presented in Table 120 (Type: No. 5).

Coccolobo-Thrinacetum radiatae Borhidi and Muñiz

It is a low littoral forest with an open tree layer formed by the palm *Thrinax radiata* and with a dense shrub layer dominated by *Coccoloba uvifera.* This community originally must have been rather common. It can be found on some undisturbed beaches in the Guanahacabibes Peninsula. South of the Isle of Pine, in some localities it has been transformed by man into a monodominant palm brake of *Thrinax radiata* and generally its stands are completely destroyed. The type relevé was made by Borhidi and Muñiz, in the Casilda Peninsula, S. of Trinidad in August, 1969. (Table 121).

Bursereto-Thrinacetum radiatae Schubert *et al.* 1979

(*Thrinax wendlandiana–Bursera simaruba* Ges. Schubert et al.) It is a higher littoral forest on a higher level or on the second dunes of the sandy shores. It has a deciduous character. The type relevé was made by Schubert et al. near Playa

Table 120 Opuntio-Coccolobetum uviferae Borhidi ass nova.

Life-form	Leaf size	Distr. pattern		1.	2.	3.	4.	5.	A—D	K_5
			Shrub layer, 3—5 m tall, cover in %:	90	85	100	95	80		
MesPcaesp	ma	NT	*Coccoloba uvifera* (L.) Jacq.	5.5	5.5	5.5	5.5	5.5	5	V
			Herb layer, 0.1—1.5 m tall, cover in %:	1	5	1	10	5		
NPsucc	aph	PCar	*Opuntia dillenii* (Ker.-Gawl.) Haw.	+.1	1.3	+.2	2.4	1.2	+—2	V
Chherbrept	me	PT	*Canavalia maritima* (Aubl.) Thouars.	+.1	—	+.1	+.1	+.1	+	IV
NPcaesp	mi	NT	*Borrichia arborescens* (L.) DC.	—	+.1	—	+.1	+.1	+	III
Gbulb	me	NCar	*Hymenocallis arenicola* Northrop	—	+.2	—	—	+.1	+	II
Hcaesp	mi	CB	*Panicum caerulescens* Hack.	+.1	+.1	—	—	—	+	II
Hcaesp	mi	A	*Chloris sagraeana* A. Rich.	—	—	—	+.1	+.1	+	II
Chsuffrept	mi	PT	*Philoxerus vermicularis* (L.) R. Br.	—	—	+.1	—	+.2	+	II
Tscap	me	NT	*Euphorbia heterophylla* L.	—	—	—	+.1	+.1	+	II
Chsuff	me	PCar	*Iresine flavescens* H. et B.	+.r	—	—	—	—	+	I
Tscap	mi	NT	*Chamaesyce brasiliensis* (Lam.) Small	—	—	—	—	+.1	+	I
Tscap	me	Cosm	*Bidens pilosa* L.	—	—	+.1	—	—	+	I
Hcaesp	mi	PCar	*Chloris petraea* Sw.	—	+.1	—	—	—	+	I
Hcaesp	mi	PT	*Digitaria horizontalis* Willd.	—	—	—	+.1	—	+	I

Table 121 Coccolobeto-Thrinacetum radiatae Borhidi et Muñiz ass. nova

Life-form	Leaf size	Distr. pattern		
		Tree layer: 8—12 m tall, cover: 30—40%		
MesPros		PCar	*Trinax radiata* Lodd. ex Schult.	3.3
MesPscap	na	PCar	*Lysiloma bahamensis* Benth.	+.1
		Shrub layer: 2—5 m tall; cover: 80%		
MiPcaesp	ma	PCar	*Coccoloba uvifera* (L.) Jacq.	4.4
MiPros		PCar	*Thrinax radiata* Lodd. ex Schult.	2.3
MesPscap	mi	NCar	*Caesalpinia vesicaria* L.	1.1
MesPscap	na	PCar	*Lysiloma bahamensis* Benth.	1.1
NPcaesp	na	A	*Caesalpinia pauciflora* (Gris.) Wr.	+.1
MiPros	no	ECc	*Comocladia intermedia* Urb.	+.1
		Herb layer: up to 1 m tall; cover: 10%		
NPcaesp	mi	GAB	*Cassia lineata* Sw.	1.1
Hscap	me	NT	*Turnera ulmifolia* L.	1.1
Hros		NCar	*Ageratum maritimum* HBK.	+.1
MiPcaesp	ma	PCar	*Coccoloba uvifera* (L.) Jacq.	+.1
MiPros	no	ECc	*Comocladia intermedia* Urb.	+.1
PLfrut	no	PCar	*Morinda royoc* L.	+.1
Hscap	no	NT	*Stachytarpheta jamaicensis* (L.) Vahl.	+.1
MesPros		PCar	*Thrinax radiata* Lodd. ex Schult.	+.1
		Lianes: cover: 10%		
PLsuff	no	NT	*Passiflora suberosa* L.	1.1
PLfrut	no	GA	*Stigmaphyllum diversifolium* (Kunth) Juss.	1.1
Chherbrept	no	NT	*Echites umbellata* Jacq.	+.1
Chherbrept	no	Ncar	*Galactia spiciformis* Torr. et Gray	+.1
Chherbrept	me	NCar	*Urechites lutea* (L.) Britt.	+.1

Type relevé made by A. Borhidi and O. Muñiz at 17. 8. 1969. in the sandy beach of the Casilda Peninsula, south of Trinidad city. Sampling plot area: 10×10 m

Bibijagua, Isle of Pine. The following sample was made by Borhidi and Muñiz in the Guanahacabibes Peninsula, in El Veral, January, 1970. Sample plot area 10×30 m^2, (Table 122).

15.1.2 Alliance: ***Leucaenion leucocephalae***
Borhidi and Muñiz in Borhidi et al. 1979

Dense, essentially monodominant littoral scrubs or low forests on moderately silty or muddy sand beaches or in the estuaries of smaller rivers.

Table 122 Thrinaceto radiatae–Burseretum simarubae Schubert et al. 1979

Life-form	Leaf size	Distr. pattern		
		Tree layer: 10—15 m tall, cover: 40—50%		
MesPros		NCar	*Thrinax radiata* Lodd. ex Schult.	2.3
MesPscap	no	NT	*Bursera simaruba* (L.) Sarg.	2.3
MgPscap	me	A	*Ficus crassinervis* Willd.	2.1
MgPscap	me	NT	*Cedrela mexicana* Roem.	1.1
MesPros	ma	NT	*Cecropia peltata* L.	1.1
MesPscap	me	A	*Ficus aurea* Nutt.	+.1
		Shrub layer: 2—6 m tall, cover: 70—80%		
MesPros		NCar	*Thrinax radiata* Lodd. ex Schult.	3.3
MesPscap	no	NT	*Bursera simaruba* (L.) Sarg.	3.3
MiPcaesp	ma	NT	*Coccoloba uvifera* (L.) Jacq.	1.1
MgPscap	me	A	*Ficus crassinervis* Willd	1.1
MiPcaesp	me	GAB	*Allophylus cominia* (L.) Sw.	+.1
NPcaesp	mi	NCar	*Baccharis halimifolia* L.	+.1
MiPscap	me	A	*Bourreria succulenta* Jacq.	+.1
NPcaesp	na	A	*Caesalpinia pauciflora* (Gris.) Wr.	+.1
MesPscap	mi	NCar	*C. vesicaria* L.	+.1
MiPscap	no	NT	*Capparis cynophallophora* L.	+.1
NPcaesp	mi	EPC	*Cassia chrysocarpa* Desv.	+.1
MesPscap	me	PCar	*Cordia gerascanthus* L.	+.1
MiPscap	ma	NT	*C. sebestana* L.	+.1
NPcaesp	nt	NCar	*Erythrina standleyana* Krukoff	+.1
MesPscap	me	A	*Ficus aurea* Nutt.	+.1
MiPcaesp	ma	NT	*Hamelia patens* Jacq.	+.1
MesPscap	na	GA	*Pithecellobium lentiscifolium* (A. Rich.) Wr. in Sauv.	+.1
		Herb layer: up to 1 m tall; cover: 25%		
Hros		NCar	*Ageratum maritimum* HBK.	2.2
Chscap	mi	NT	*Capraria biflora* L.	1.1
Hscap	me	NT	*Argemona mexicana* L.	+.1
NPcaesp	no	PT	*Capsicum frutescens* L.	+.1
Hcaesp		A	*Torulinium filiforme* (Sw.) Clarke	+.1
Hscap	no	GA	*Diodia simplex* Sw.	+.1
Hcaesp		Cosm	*Fimbristylis spathacea* Roth	+.1
Hscap	me	NT	*Iresine celosia* L.	+.1
NPcaesp	mi	NT	*Lantana involucrata* L.	+.1
NPsucc	aph	PCar	*Opuntia dillenii* (Ker.-Gawl.) Haw.	+.1
		Lianes: cover 30%		
PLfrut	no	PT	*Caesalpinia bonduc* (L.) Roxb.	2.2
PLsuff	me	GA	*Solandra longiflora* Tuss.	2.2
PLsuff	mi	NT	*Echites umbellata* Jacq.	1.2
PLfrut	no	GA	*Stigmaphyllum diversifolium* (Kunth) Juss.	1.2
PLsucc	aph	GA	*Selenicereus grandiflorus* (L.) Britt. et Rose	1.1
PLFrut	mi	GA	*Triopteris rigida* Sw.	1.1

Life-form	Leaf size	Distr. pattern		
PLfrut	no	NT	*Chiococca alba* (L.) Hitchc.	+.2
PLfrut	me	NT	*Clematis dioica* L.	+.2
PLfrut	mi	PT	*Duranta repens* L.	+.2
PLfrut	me	NT	*Cissus sicyoides* L.	+.1
Chherbrept	me	NT	*Ipomoea tiliacea* (Willd.) Choisy	+.1
NPcaesp	no	PCar	*Morinda royoc* L.	+.1
PLsuff	me	NT	*Turbina corymbosa* (L.) Raf.	+.1

Relevé made by A. Borhidi and O. Muñiz at 13. 1. 1970. in the Guanahacabibes Peninsula, El Veral Nature Conservation Area. Sample plot area 10×30 m

Associations studied in Cuba:

Leucaenetum leucocephalae
(Stoffers 1956) Borhidi and Muñiz in Borhidi et al. 1979

16 Class: **BYRSONIMO-PINETEA CARIBAEAE** Samek and Borhidi in Borhidi et al. 1979 et hoc loco

Pine and oak forests and woodlands in the lowlands and colline regions of Honduras, Nicaragua, West Cuba, Bahamas and Florida, developed on acidic to neutral, sometimes slightly basic tropical soils (Fig. 355), derived from white sand, slate, sandstone or rarely limestone rocks. The original stands of these forests occur very scarcely, they are commonly influenced by man or mostly destroyed and transformed into savannas.

Characteristic species: *Pinus caribaea* s.l., *P. tropicalis, P. elliottii, Quercus oleoides* s.l. incl. ssp. *sagraeana, Q. virginiana, Q. minima, Q. myrtifolia, Q. pumila, Byrsonima crassifolia* and other spp. *Curatella americana, Coccothrinax* spp. *Myrica cerifera, Miconia ibaguensis, M. splendens, Conostegia xalapensis, Blechnum serrulatum* ssp. *roigii, Pteridium caudatum, Andropogon* spp. *Aristida* spp. *Rhynchospora* spp., *Trachypogon* spp., *Leptocoryphium lanatum, Axonopus compressus,* etc.

16.1. Order: PINETALIA TROPICALIS-CARIBAEAE Samek et Borhidi in Borhidi et al. 1979 et hoc loco

Pine forests and woodlands of West Cuba and Isle of Pines.

Characteristic species: *Pinus caribaea* ssp. *caribaea, P. tropicalis, Coccothrinax miraguama* ssp. *arenicola, Pachyanthus poiretii, P. cubensis, P. wrightii, Roigella correifolia, Vaccinium cubense* ssp. *ramonii, Purdiaea cubensis, Tetrazygia delicatula, Hypericum styphelioides, Hyptis minutifolia, Parathesis cubana, Tabebuia lepidophylla, Sachsia polycephala, Andropogon gracilis, Aristida refracta, A. vilfifolia, Arundinella deppeana, Mesosetum loliiforme,* etc.

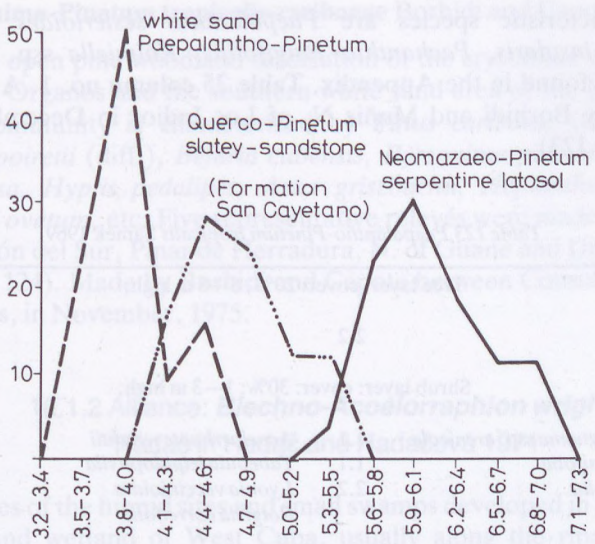


Fig. 355 Ecological range of the West Cuban pine woodland and pine forest associations according to their request of soil acidity (Samek 1973)

16.1.1 Alliance: ***Acoelorrapho-Pinion tropicalis***
Samek in Borhidi et al. 1979

Open or moderately closed pine forests and pine woodlands on hard slate rocks and white sand soils with a trend to get transformed easily into savannas. They are distributed in the Isle of Pines in the western and southern part of the Province Pinar del Rio, Isthmus of Guanahacabibes, where they disappeared almost completely during the last ten years. Their stands can also be found in the western and south-western part of the Sierra de los Organos, on hard crystalline slates.

Characteristic species: *Pinus tropicalis, Acoelorraphe wrightii, Colpothrinax wrightii, Chaetolepis cubensis, Miconia androsaemifolia, Pachyanthus cubensis, P. wrightii, Tetrazygia delicatula, Cuphea pseudosilene, Croton cerinus, C. craspedotrichus, Pachyanthus mantuensis, Byrsonima verbascifolia, B. pinetorum, B. wrightiana, Calyptranthes pinetorum, Melochia savannarum, Befaria cubensis, Pavonia intermixta, Lyonia vaccinioides, Polygala squamifolia, P. wrightii.*

Associations studied in Cuba:

Paepalantho-Pinetum tropicalis Samek 1969

This is an open pinewoodland community in the western part of Isle of Pines on white sand, described based on 11 relevés. Three subassociations have been distinguished: *hypericetosum styphelioidis, typicum* and *jatrophetosum angus-*

tifoliae. Characteristic species are *Paepalanthus seslerioides, P. alsinoides, Syngonanthus insularis, Pachanthus longifolius, Kalmiella* ssp. The combined synthetic list is found in the Appendix, Table 25 column no. 1. A further pattern relevé made by Borhidi and Muñiz N. of Los Indios in December, 1978. here follows: (Table 123).

Table 123 Paepalantho-Pinetum tropicalis Samek 1969

Tree layer: cover: 20%, 6—8 m high;			
Pinus tropicalis	2.2		
Shrub layer: cover: 30%; 1—3 m high;			
Coccothrinax miraguama ssp. *arenicola*	1.1	*Acoelorrhapte wrightii*	+.1
Miconia androsaemifolia	1.1	*Tabebuia leipidophylla*	1.1
Byrsonima crassifolia	2.2	*Lyonia vaccinioides*	+.1
		Roigella correifolia	1.2
Herb layer: cover: 50%; 0.2—0.5 m high;			
Byrsonima wrightiana	1.2	*Croton cerinus*	1.1
Paepalanthus seslerioides	2.2	*Croton craspedotrichus*	+.2
Chaetolepis cubensis	1.1	*Hypericum styphelioides*	3.3
Phyllanthus heliotropus	+.1	*Syngonanthus insularis*	+.1
Lachnorrhiza piloselloides	+.1	*Tetramicra eulophiae*	+.1
Aristida refracta	1.2	*Andropogon multinervosus*	+.2
Aristida vilfifolia	+.2	*Andropogon gracilis*	+.1
Rhynchospora globosa	1.2	*Polygala uncinata*	+.1
Rhynchospora cyperoides	+.2	*Phyllanthus junceus*	+.1
Buchnera elongata	+.1	*Calyptranthes pinetorum*	+.1
Cassytha filiformis	1.1	*Eugenia punicifolia*	+.2
Evolvulus grisebachii	+.1	*Sauvagesia brownei*	+.1
Trachypogon filifolius	1.2	*Xiphidium xanthorrhizon*	1.1
Scleria verticillata	+.2	*Xyris elliottii*	+.1

Pinetum tropicalis-caribaeae Samek 1969

This is the closed pine forest association of the colline belt in the Isle of Pines, characterized by *Byrsonima wrightiana, Tetrazygia delicatula, Clitoria laurifolia, Phyllanthus junceus, Lyonia myrtilloides, Trachypogon filifolius* and by the closed tree and herb layer. The association is divided into two subassociations: typicum and lyonietosum. Ten relevés made by Samek are summarized in the synthetic list of column no. 2 in the Appendix Table 25.

Eragrosti cubensi-Pinetum tropicalis Samek in Hadač and Hadačova 1971 nom. nud.

Open pine woodland association of the white sand area in the West Cuban wetland Remates de Guane.

Byrsonimo-Pinetum tropicalis-caribaeae Borhidi and Capote ass. nova

This is the open pine woodland association of the crystalline slatey range of the Sierra de los Organos and the southern white sand area of the Province Pinar del Rio. The community is characterized by *Pinus caribaea,* (diff.) *Pachyanthus wrightii, P. poiretii* (diff.), *Befaria cubensis, Byrsonima pinetorum, B.×hybrida, Brya depressa, Hyptis pedalipes, Aster grisebachii, Heptanthus cochlearifolius, Stenandrium ovatum,* etc. Five representative relevés were made at La Coloma, S. of Consolación del Sur, Pinar de Herradura, N. of Guane and Dimas. Type relevé: no. 3 (Table 124). Made by Borhidi and Capote between Consolación del Sur and Alonso Rojas, in November, 1975.

16.1.2 Alliance: ***Blechno-Acoelorraphion wrightii***
Hadač in Hadač and Hadačová 1971

Palm brakes of the humid sites and small swamps developed in the depressions of the white sand wetland of West Cuba, usually along the riparian zone of the

Table 124 Byrsonimo-Pinetum tropicalis-caribaeae Borhidi et Capote ass. nova

	1	2	3	4	5
Tree layer, 8—10 m high, cover %	35	20	20	20	30
Pinus tropicalis Morel.	3.2	2.2	2.2	2.2	2.3
Pinus caribaea Morel.	+.1	—	+.1	+.1	1.1
Colpothrinax wrightii Griseb. et Wendl.	+.1	1.1	—	+.r	+.1
Coccothrinax miraguama ssp. *arenicola* (León) Borhidi et Muñiz	+.1	—	—	+.r	+.r
Copernicia curtissii Becc.	—	+.1	—	—	—
Acoelorrhaphe wrightii Wendl.	—	—	—	1.1	+.1
Shrub layer, 2—6 m high, cover %	15	40	40	35	30
Colpothrinax wrightii Griseb. et Wendl.	+.r	+.r	+.1	—	+.1
Acoelorrhaphe wrightii Wendl.	—	3.2	2.4	+.1	+.2
Pinus tropicalis Morel.	—	+.r	+.1	+.r	—
Pinus caribaea Morel.	—	—	+.r	+.r	—
Pachyanthus cubensis A. Rich.	+.1	—	+.r	—	—
Pachyanthus poiretii Griseb.	2.1	+.1	+.1	1.1	2.1
Tabebuia lepidophylla (A. Rich.) Greenm.	2.1	1.2	2.2	2.1	+.1
Roigella correifolia (Griseb.) Borhidi et Fndez.	1.1	1.3	—	+.1	+.1
Byrsonima crassifolia (L.) HBK.	+.1	2.2	2.2	3.2	2.2
B. pinetorum Wr. ex Griseb.	+.1	+.1	+.1	—	1.2
B. hybrida Borhidi	+.1	+.1	+.1	—	+.1
Curatella americana L.	+.1	—	—	+.1	+.1
Brya depressa Borhidi	+.1	+.1	—	—	1.1
Eugenia punicifolia (HBK.) DC.	+.1	+.1	+.1	—	+.1
Pisonia rotundata Griseb.	—	2.2	—	—	1.1

	1	2	3	4	5
Conostegia xalapensis (Bonpl.) D. Don	–	+.1	–	–	+.1
Chrysobalanus pellocarpus G. Mey.	–	+.1	+.2	–	–
Swietenia mahagoni (L.) Jacq.	–	+.r	–	–	–
Eupatorium villosum Sw.	–	+.1	–	–	–
Tabernaemontana amblyocarpa Urb.	–	+.r	–	–	–
Mesechites rosea (A. DC.) Miers	–	+.1	+.1	+.1	+.1
Myrica cerifera L.	–	–	1.1	–	+.1
Pachyanthus wrightii Griseb.	–	–	+.r	–	+.r
Tetrazygia bicolor (Mill.) Cogn.	–	–	1.1	–	+.1
Tetrazygia delicatula (A. Rich.) Borhidi	–	–	+.r	+.1	–
Lyonia myrtilloides Griseb.	–	–	1.1	2.2	–
Miconia ibaguensis (Bonpl.) Triana	–	–	–	+.1	+.r
Befaria cubensis Griseb.	–	–	–	–	+.2
High herb layer, 30–100 cm high, cover %	80	80	80	50	75
Tabebuia lepidophylla (A. Rich.) Greenm.	1.1	+.1	1.1	1.1	+.1
Eugenia punicifolia (HBK.) DC.	+.1	+.1	+.1	+.1	+.1
Byrsonima pinetorum Wr. ex Griseb.	1.2	–	1.1	1.1	1.2
Coccothrinax miraguama HBK. ssp. *arenicola* (León) Borhidi and Mz.	+.r	+.r	–	–	–
Mesosetum liliiforme (Hochst.) Chase	4.4	3.4	3.3	2.3	3.4
Aristida neglecta León	3.3	1.1	1.1	2.2	1.2
Aristida vilfifolia Henr.	1.1	2.2	+.1	1.1	–
Sporobolus virginicus (L.) Kunth	+.1	1.2	1.1	2.2	–
Setaria corrugata (Ell.) Schult.	1.1	+.1	–	–	–
Ichnanthus mayarensis (Wr.) Hitchc.	1.1	–	1.2	+.1	–
Andropogon gracilis Spr.	+.1	–	–	+.1	+.1
Andropogon virginicus L.	–	+.1	1.1	–	–
Andropogon nashianus Hitchc.	–	1.1	1.1	–	+.1
Andropogon virgatus Desv.	–	3.4	2.2	1.1	–
Sida linifolia Cav.	1.1	+.1	+.1	+.1	+.1
Cassia diphylla L.	+.1	+.1	+.1	+.1	–
Waltheria americana L.	+.1	–	–	–	+.1
Achlaena piptostachya Griseb.	1.1	–	–	+.1	–
Piriqueta cistoides (L.) Meyer	+.1	–	–	–	+.1
Mitracarpus glabrescens (Griseb.) Urb.	+.1	–	–	–	–
Eragrostis cubensis Hitchc.	1.2	–	–	+.1	–
Sebastiania corniculata (Vahl) Pax	+.1	+.1	–	+.1	+.1
Croton cerinus Muell. Arg.	1.1	1.2	1.1	+.1	+.1
Rhynchospora cyperoides (Sw.) Mart.	1.1	1.1	1.2	1.1	–
Rhynchospora plumosa Ell.	1.1	1.2	–	+.1	–
Rhynchospora tenuis Link	2.2	2.2	+.1	1.1	1.1
Brya depressa Borhidi	1.1	–	+.1	1.2	+.1
Richarida muricata (Griseb.) B. L. Robins.	+.1	2.2	+.1	+.1	+.1
Diodia teres Walt.	+.1	+.1	–	+.1	+.1
Borreria thymocephala Griseb.	+.1	–	+.1	+.1	+.1
Desmodium barbatum (L.) Benth. et Oerst.	+.1	+.1	–	+.1	+.1
Eriosema crinitum (HBK.) G. Don	–	+.1	–	+.1	+.1
Leptocoryphium lanatum (HBK.) Nees	–	1.2	3.2	+.2	–
Trachypogon filifolius (Hack.) Hitchc.	–	3.2	1.2	+.2	+.2
Cassia pilosa L.	–	+.r	–	+.r	+.1
Melochia savannarum Britt.	1.1	+.2	–	+.1	+.1
Cordia lineata (L.) Roem. et Schult.	–	+.1	–	–	–

Cynanchum savannarum Alain	–	+.1	+.1	–	+.1
Paspalum multicaule Poir.	+.1	+.1	+.1	–	+.1
Richardia scabra L.	+.1	–	–	+.1	+.1
Centrosema virginianum (L.) Benth.	–	+.1	–	+.1	+.2
Commelina angustifolia Michx.	–	+.r	–	–	–
Acoelorrhaphe wrightii Wendl.	–	+.r	+.2	+.1	+.1
Byrsonima crassifolia (L.) HBK.	–	–	1.1	1.1	+.1
Calyptranthes pinetorum Britt. et Wils.	–	–	+.r	–	+.r
Myrica cerifera L.	–	–	+.1	–	–
Aristida ternipes Cav.	–	–	2.2	–	+.1
Panicum fusiforme Hitchc.	–	–	+.1	–	+.1
Rhynchospora wrightiana Boeckl.	–	–	+.1	+.1	–
Rhynchospora seslerioides Griseb.	–	–	2.2	+.1	+.1
Xyris elliottii Chapm.	–	–	+.1	–	–
Xyris navicularis Griseb.	–	–	+.1	–	–
Rhexia cubensis Griseb.	–	–	+.2	–	+.1
Polygala wrightii Chod.	–	–	+.1	–	+.1
Polygala squamifolia Wr. ex Griseb.	–	–	1.1	–	+.1
Jatropha angustifolia Griseb.	–	–	+.1	–	–
Xiphidium xanthorrhizon Wr. in Sauv.	–	–	+.r	–	–
Lachnanthes tinctoria (Walt.) Ell.	–	–	+.1	–	–
Cassytha filiformis L.	–	–	+.1	2.2	1.1
Declieuxia fruticosa (Willd.) Kuntze	–	–	–	+.1	+.1
Malpighia horrida Small	–	–	–	–	+.1
Aeschynomene tenuis Griseb.	–	–	–	–	+.1
Scoparia dulcis L.	–	–	–	–	1.2
Pavonia intermixta A. Rich.	–	–	–	–	+.1
Angelonia pilosella Kickx	–	–	–	+.1	+.1
Chaetolepis cubensis (A. Rich.) Triana	–	+.1	–	–	+.1
Low herb layer, 0–20 cm high, cover %	40	50	25	10	40
Hyptis pedalipes Griseb.	2.3	2.3	2.1	+.1	2.2
Aster grisebachii Britt.	–	+.2	–	1.1	–
Croton craspedotrichus Griseb.	2.3	2.2	1.1	+.1	+.2
Stenandrium ovatum Urb.	+.1	–	1.1	–	–
Heptanthus cochlearifolius Griseb.	1.2	2.2	+.1	+.1	1.2
Galactia isopoda Urb.	+.1	–	–	+.1	–
Cassia serpens L.	1.2	–	+.1	1.1	1.2
Borreria strumpfioides Wr. ex Griseb.	1.1	–	+.1	–	–
Chamaesyce pinariona (Urb.) Alain	–	+.1	+.1	+.1	–
Phyllanthus junceus Muell. Arg.	–	–	+.1	–	+.1
Pinguicula filifolia Wr. ex Griseb.	–	–	+.1	–	–
Cuphea micrantha HBK.	–	–	+.1	–	+.1
Buchnera elongata Sw.	–	–	+.1	–	–
Burmannia capitata (Walt.) Mart.	–	–	+.1	–	+.r
Schultesia guianensis (Aubl.) Malme ssp. *nana*	–	–	–	+.1	+.1
Sauvagesia tenella Lam.	–	–	+.2	–	+.1
Lachnorrhiza piloselloides A. Rich.	–	–	1.1	+.1	–
Sachsia polycephala Griseb.	–	–	+.2	+.1	1.2
Stigmaphyllum microphyllum A. Juss.	–	–	+.1	–	–
Herpyza grandiflora (Griseb.) Wr. in Sauv.	–	–	+.1	+.1	–
Evolvulus grisebachii Peter	–	–	–	–	+.2
Bulbostylis setacea (Griseb.) Svens.	–	–	–	–	1.2
Oxalis pinetorum Urb.	–	+.1	–	–	+.1
Panicum aciculare Desv.	–	–	–	–	1.2

oligotrophic lakes. Communities rather rich in species. Some of the stands can be judged as being natural, but the majority of them are second growth stands resulting after the cut of an originally existing pine woodland.

Associations studied in Cuba:

Blechno-Acoelorraphetum wrightii Hadač in Hadač and Hadačová 1971

Chrysobalano-Colpothrinacetum wrightii Borhidi and Capote (ined.)

16.1.3 Alliance: *Neomazaeo-Pinion caribaeae*
Borhidi in Borhidi et al. 1979 et hoc loco

Closed pine forests and open rocky pine woodlands on ferritic soils and serpentine rocks of the Sierra de Cajalbana.

Characteristic species: *Neomazaea phialanthoides, Acunaeanthus tinifolius, Psidium cymosum, Tetrazygia coriacea, Coccothrinax yuraguana, Phania cajalbanica, Agave cajalbanensis, Sauvallella immarginata, Mitracarpus glabrescens, Hyperbaena columbica, Tabebuia lepidota, Eugenia rigidifolia, E. ramoniana, Rondeletia chamaebuxifolia, Vernonia valenzuelana, Heptanthus ranunculoides, Anemia cajalbanica.*

Associations studied in Cuba:

Neomazaeo-Pinetum caribaeae (Samek 1973)
Borhidi in Borhidi et al. 1979 nom. nov.

(Syn.: *Pinetum caribaeae cajalbanensis typicum Samek 1973*)

It is the common pine forest association of the Cajalbana range covering all the ridge and slopes on the northern part. It was necessary to give a new name because this community is quite different from *Pinetum caribaeae* Samek 1969 described from the slatey hillsides of Isle of Pines. The type relevé is considered list no. 39 of Samek (1973). A synthetic list of 5 relevés made by Borhidi in Cajalbana in June, 1970 is found in column no. 4. of the Appendix Table 25.

Guettardo-Pinetum caribaeae (Samek 1973)
Borhidi in Borhidi et al. 1979 nom. nov.

(Syn.: *Pinetum cajalbanensis comocladietosum* Samek 1973 p.p.)

This is a humid riverside and lowland pine forest community in the Cajalbana range. It is characterized by the presence of many broad-leaved trees as shrubs.

Characteristic species: *Guettarda valenzuelana, G. calyptrata, Cyrilla racemi-*

flora, Calophyllum calaba ssp. *pinetorum, Gesneria ferruginea, Rondeletia odorata* (diff.) *Comocladia dentata, Copernicia curtissii,* etc. Type relevé: Samek 1973a, Table 15. rel. 57.

Agavo cajalbanensi-Pinetum caribaeae Samek 1973

This is the open rock pinewoodland community on serpentine in the Cajalbana range characterized by a number of heliophilous scrub-elements such as *Agave cajalbanensis, Eugenia rigidifolia, Erythroxylon minutifolium, Jacquinia brunnescens, Lescaillea equisetiformis, Plumeria sericifolia, Garcinia serpentini, Machaonia dumosa* and *Scolosanthus acunae,* etc. The type relevé is considered in list no. 55 of Samek (1973a).

16.1.4 Alliance: ***Pachyantho poiretii-Pinion caribaeae***
Borhidi and Capote in Borhidi et al. 1979 et hoc loco

Pine forests and pine-oak mixed forests living on the special slatey sandstone "San Cayetano" formation in the Sierra de los Organos and Sierra del Rosario.

Characteristic species: *Pinus caribaea, Quercus oleoides* ssp. *sagraeana, Pachyanthus cubensis, P. poiretii, Clidemia neglecta, Vaccinium cubense* ssp. *ramonii, Clidemia strigillosa, Odontosoria wrightiana, Miconia ibaguensis, M. prasina, Psidium salutare, Ossaea parviflora, Rhus copallina* ssp. *leucantha, Xylopia aromatica Roigella correifolia* and *Phania matricarioides.*

Associations studied:

Pinetum caribaeae Samek 1969

Querco-Pinetum caribaeae Borhidi and Capote ass. nova

Mixed pine-oak forests of the colline-submontane belts of the Sierra de los Organos and Rosario ranges on slightly acidic soils derived from Cayetano sandstone. The type relevé was made by Borhidi, Capote and Urbino in Juan Manuel, S. of San Andrés, in August, 1975 (Table 125). See also column no. 3 in the Table 25 (Appendix).

16.2 Order: QUERCETALIA OLEOIDIS
Borhidi in Borhidi et al. 1979 et hoc loco

Sclerophyllous evergreen oak forests in the lowlands and middle altitudes of Honduras, Nicaragua, Mexico, West Cuba and Florida.

Table 125 Querco-Pinetum caribaeae Borhidi and Capote

High tree layer: cover: 40%; 15–18 m high;

Pinus caribaea	3
Quercus sagraeana	1–2

Low tree layer: cover: 60–70%; 6–10 m high;

Quercus sagraeana	3
Calophyllum calaba ssp. *pinetorum*	2
Xylopia aromatica	2
Matayba oppositifolia	1
Clusia rosea	1
Didymopanax morototoni	+
Guarea guidonia	+

Shrub layer: cover: 50–60%; 2–4 m high;

Calophyllum calaba ssp. *pinetorum*	1
Didymopanax morototoni	+
Dendropanax cuneifolius	+
Amaioua corymbosa	1
Miconia prasina	2
M. ibaguensis	2
Tetrazygia bicolor	+
Clusia minor	+
Alsophila myosuroides	1
Alchornea latifolia	+
Quercus sagraeana	1
Psychotria revoluta	1–2
Clidemia strigillosa	+
C. hirta	+
Ossaea parviflora	1
Eugenia farameoides	+

Herb layer: cover: 70%; up to 1 m high;

Quercus sagraeana	+
Panicum boliviense	1–2
P. chrysopsidifolium	+
Blechnum serrulatum	2
Rhus copallina ssp. *leucantha*	1
Amaioua corymbosa	+
Davilla rugosa	1–2
Barbieria pinnata	1–2
Scleria cubensis	1
Clusia minor	+
Centrosema virginianum	+
Tillandsia fasciculata	+
Renealmia sp.	+.1
Miconia ibaguensis	+
Rhynchosia minima	+
Alsophila myosuroides	+.1
Didymopanax morototoni	+
Panicum aciculare	+

Panicum ischaemum	1—2
Mikania ranunculoides	+
Phania matricarioides	+(1)
Panicum scoparium	+.1
Jambosa vulgaris	+
Vernonia cubensis	+
V. sagraeana	+
Pachyanthus poiretii	+
Ossaea parviflora	+
Caloiphyllum calaba ssp. *pinetorum*	+
Wedelia rugosa	1
Desmodium canum	1
Lasiacis divaricata	+
Hibiscus costatus	+
Urena lobata	+

Lianes: 1%

Davilla rugosa
Cissus sicyoides

Epiphytes: 4—6%

Tillandsia fasciculata, on *Quercus sagraeana*

16.2.1 Alliance: ***Quercion sagraeanae***
Borhidi and Capote in Borhidi et al. 1979 et hoc loco

Sclerophyllous evergreen oak forests of West Cuba on deep, brownish-yellow, pseudogleyic soils derived from San Cayetano sandstone, rarely on humid, white sand. In their composition species of the pine forests, and those of broad-leaved, semi-deciduous forests are united.

Characteristic species: *Quercus oleoides* ssp. *sagraeana, Xylopia aromatica, Amaioua corymbosa, Alibertia edulis, Pithecellobium obovale, P. cubense, Miconia ibaguensis, M. splendens, Henriettea patrisiana, Tabebuia lepidophylla, Clidemia* spp., *Eugenia punicifolia, Psidium salutare, Conostegia xalapensis, Clusia minor, Cordia linnaei, Barbieria pinnata, Eugenia farameoides, Scleria cubensis, Ichnanthus mayarensis* and *Rhynchospora cephalotoides.*

Associations studied:

Miconio ibaguensi-Quercetum sagraeanae Borhidi and Capote ass. nova

The type relevé was made by Borhidi and Capote between Puerta de Golpe and Alonso Rojas on pseugleyized, sandy yellow soil, in October, 1975 (Table 126).

Table 126 Miconia ibaguensis-Quercetum sagraeane
Borhidi and Capote ass. nova

Tree layer: cover: 30%; 10—12 m high;	
Quercus sagraeana	3
Shrub layer: cover: 85%; 1—6 m high;	
Quercus sagraeana	2
Xylopia aromatica	3
Miconia splendens	3
Amaioua corymbosa	2—3
Byrsonima crassifolia	1
Curatella americana	+
Eugenia farameoides	+
Engeria punicifolia	1—2
Eugenia axillaris	+
Roigella correifolia	1
Davilla rugosa	1—2
Clidemia hirta	1
Clidemia strigillosa	+
Byrsonima × *hybrida*	+
Coccotrinax miraguama ssp. *arenicola*	+
Tabebuia lepidophylla	+—1
Herb layer: cover: 60%; up to 1.5 m high;	
Mesosetum loliiforme	2—3
Andropogon hirtiflorus	1
Andropogon virginicus	1
Imperata cylindrica	1
Panicum virgatum	1
Achlaena piptostachya	1
Sebastiania corniculata	1
Melochia villosa	+
Cassia diphylla	+
Miconia ibaguensis	1
Hirtella americana	1
Cuphaea micrantha	+
Brya ebenus	1
Sacciolepis striata	+
Panicum aciculare	+
Croton glandulosus	+
Cordia linnaei	1
Coccocypselum hirsutum	+
Scleria cubensis	1—2
Eupatorium havanense	+
Rhynchospora cephalotoides	1—2
Polypodium aureum	+
Eugenia sp.	+
Davilla rugosa	1
Clidemia neglecta	+
Xylopia aromatica	1
Wedelia rugosa	+
Erythroxylum areolatum	+

Lasiacis divaricata	+
Urena lobata	+
Allophyllus cominia	+
Casearia aculeata	+
Eriosema crinitum	+
Evolvulus sericeus	+
Chymaesyce pinariona	+
Borreria verticillata	+
Richardia americana	+
Aeschynomene sensitiva	+
Sida linifolia	+
Ichnanthus mayrensis	+
Miconia splendens	1–2

17 Class: **CASEARIO-PINETEA CUBENSIS** Borhidi and Muñiz in Borhidi et al. 1979 et hoc loco

Pine forests and pine woodlands of eastern Cuba, living on acidic ferritic soils derived from serpentine rocks. Their composition is extremely rich in endemic species.

Characteristic species: *Pinus cubensis, Coccothrinax orientalis, Lyonia macrophylla, L. glandulosa, L. myrsinifolia, Casearia crassinervis, C. moaënsis, C. ophiticola, Clerodendron nipense, Gesneria, duchartreoides, G. norlindii, G. pachyclada, Galactia rudolphioides, Ossaea pauciflora, O. munizii, O. navasensis, Myrtus micarensis, M. ophiticola, Suberanthus canellifolius, S. stellatus, Ouratea striata, Anemia coriacea* s.l., *Eupatorium ayapanoides, E. lantanifolium, E. polystictum, Eugenia pinetorum, E. ramonae, Baccharis scoparioides, B. shaferi, Vernonia urbaniana, Bisgoeppertia scandens, Vaccinium cubense* ssp. *cubense, Schmidtottia shaferi, Coccoloba shaferi, Jacaranda arborea* and *Siphocampylus* spp.

17.1 Order: PINETALIA CUBENSIS Borhidi and Muñiz in Borhidi et al. 1979 et hoc loco

With the same characteristics as the class.

17.1.1 Alliance: ***Guettardo-Pinion cubensis*** Borhidi in Borhidi et al. 1979 et hoc loco

Xero-megathermic lowland and colline pine forests on ferritic soils and open pine woodlands on bare serpentine rocks, both with a well-developed evergreen shrub layer formed by the endemics of the serpentine scrubs of East-Cuba (charrascales).

Characteristic species: *Anemia coriacea* s.l. *Casearia* spp. *Euphorbia helenae, Tabebuia simplicifolia, T. pinetorum, Plumeria nipensis, Clerodendron nipense,*



Fig. 356 Guettarda monocarpa Urb. an evergreen shrub of the montane serpentine *Pinus cubensis* forests (Photo: A. Borhidi)

Guettarda crassipes, G. monocarpa, (Fig. 356) *G. ferruginea, G. shaferi, Agave shaferi, Ariadne shaferi, Garcinia ophiticola, Eugenia cycloidea, Mouriri emarginata, Linodendron aronifolium, Callicarpa oblanceolata* and *C. wrightii,* etc.

Associations studied in Cuba:

Anemio coriaceae-Pinetum cubensis (Samek 1973) Borhidi in Borhidi et al. 1979

Extreme xerophytic pine woodland community on eroded, shallow ferritic soils often rich in hardpan or ferrioxide concretions. From the relevés made by Samek only those of "*Pinetum anemietosum Rhynchosia* variant" belong to this association, in my interpretation. Type relevé can be considered the list no. 42 of Samek (1973b: Table 14). A synthetic list of further ten relevés can be found in column no. 6 of the Table 25. (Appendix) made by Borhidi and Muñiz, July, 1970 and by Borhidi and Capote, September, 1974. A pattern relevé of the association made by Borhidi and Muñiz in the Valley of Rio del Medio, Sierra de Nipe, is given in Table 127.

Euphorbio helenae-Pinetum cubensis (Samek 1973)
Borhidi in Borhidi et al. 1979

While *Anemio-Pinetum* occurs mainly in the Sierra de Nipe, *Euphorbio helenae-Pinetum* can be found in all the range of the Sagua-Baracoa Massif on shallow stony serpentine ferritic soils. It is a pine-woodland association with a well-developed shrub layer composed of many elements of serpentine scrub-woodland. Samek

Table 127 Anemio coriaceae-Pinetum cubensis (Samek) 1973 Borhidi in Borhidi et al. 1979

Tree layer: cover: 70%; height: 12—15 m			
Pinus cubensis	4.5	*Coccothrinax orientalis*	1.1
Shrub layer: cover: 200; height: 1—4 m			
Bactris cubensis	+.1	*Coccothrinax orientalis*	×.1
Clerodendron nipense	1.1	*Casearia crassinervis*	1.1
Clidemia rubrinervis	+.1	*Casearia myricoides*	+.1
Dodonaea viscosa	2.2	*Eugenia pinetorum*	1.1
Eupatorium polystictum	1.1	*Vaccinium cubense*	+.1
Eupatorium ayapanoides	+.1	*Guettarda monantha*	+.1
Rondeletia alaternoides	+.1	*Dipholis cubensis*	+.1
Herb layer: cover: 70%; height: 0.1—1 m			
Baccharis scoparioides	2.2	*Bletia purpurea*	+.1
Galactia rudolphioides	+.1	*Sauvagesia brownei*	1.2
Vernonia urbaniana	1.1	*Waltheria americana*	+.1
Andropogon bicornis	+.2	*Aristida refracta*	2.2
Andropogon gracilis	3.3	*Imperata contracta*	+.2
Andropogon nashianus	1.2	*Panicum xalapense*	+.2
Andropogon reinoldii	+.2	*Panicum aciculare*	+.2
Ascyrum hypericoides	+.1	*Panicum fusiforme*	1.2
Ossaea pauciflora	1.1	*Rhynchospora tenuis*	2.2
Ichnanthus mayarensis	1.2	*Rhynchospora shaferi*	+.2
Lianes: cover: 10%			
Angadenia cubensis	1.1	*Odontosoria aculeata*	1.1
Bisgoeppertia scandens	+.1	*Pteridium caudatum*	1.2
Cassytha filiformis	+.1	*Centrosema virginianum*	+.1
Smilax balbisiana	+.1	*Rajania howardii*	+.1
Stigmaphyllum lineare	+.1	*Echites crassipes*	+.1
Epiphytes: cover: < 1%			
Catopsis berteroniana	r.1	*Tillandsia fasciculata*	r.1

published 5 relevés, but any of them can reflect the essential characteristics of this community. I am tempted to consider the following relevé as typical one, (Table 128) made by Borhidi and Muñiz in the NE slope of Loma Mensura in a height of about 800 m. a.s.l. A synthetic list of other 5 relevés made in other serpentine mountains of Oriente, (Moa, Sierra Maguey, Mt. Libano) by Borhidi and Muñiz in February-March, 1970, (Table 25, col. 11., Appendix) can give a more complete idea about this very interesting and showy community.

Agavo shaferi-Pinetum cubensis (Samek 1973) Borhidi in Borhidi et al. 1979

This is the open pine woodland community on the rocky peaks and steep rocky slopes in the serpentine ranges of the Sagua-Baracoa Massif. The association has

been studied in the Sierra de Nipe but it was observed also in the Sierra de Micara and Sierra de Maguey. Samek published five relevés for characterizing the community at the subassociation level, but his relevés are not informative enough. I propose to typify this community as an association based on the following relevé (Table 129) made by Borhidi and Muñiz at the northern foot of the Loma Mensura, 750 m a.s.l. in July, 1970. The community is characterized by a number of species missing from the relevés of Samek. They are: *Callicarpa cuneifolia, Agave shaferi, Phyllanthus shaferi, Vaccinium cubense, Clusia nipensis, Rondeletia myrtacea, Psychotria graminifolia, Xylosma buxifolium* and *Platygyne triandra*, etc. A synthetic list of five relevés made by Borhidi and Muñiz in the Sierra the Nipe is in the column no. 9 of Table 25 (Appendix).

Dracaeno-Pinetum Borhidi ass. nova

It is a xerothermic lowland pine forest community of the coastal plain between Moa and Baracoa in northern Oriente, living on deep acidic ferritic soil. (Fig. 357)

Table 128 Euphorbia helenae-Pinetum cubensis (Samek 1973) Borhidi in Borhidi et al. 1979

Tree layer: cover: 50%; height: 6—10 m			
Pinus cubensis	3.4	*Coccothrinax orientalis*	2.1
Shrub layer: cover: 50%; height: 1—3 m			
Euphorbia helenae	3.3	*Casearia crassinervis*	1.1
Baccharis shaferi	1.2	*Ariadne shaferi*	1.1
Vaccinium cubense	1.1	*Lyonia nipensis*	1.1
Scaevola wrightii	+.1	*Spathelia pinetorum*	1.1
Gochnatia attenuata	+.1	*Guettarda ferruginea*	1.2
Gochnatia shaferi	r.1	*Guettarda monocarpa*	+.1
Machaonia nipensis	+.1	*Phyllanthus shaferi*	+.1
Rhynchosia nipensis	+.1	*Clerodendron nipense*	+.1
Rondeletia myrtacea ssp.	+.1	*Senecio plumbeus*	+.1
Eupatorium lantanifolium	+.1	*Vernonia urbaniana*	+.1
Herb layer: cover: 30%; height: 0.1—1.5 m			
Andropogon gracilis	2.2	*Leptocoryphium lanatum*	1.2
Andropogon nashianus	+.1	*Rhynchospora tenuis*	2.1
Andropogon reinoldii	r.2	*Rhynchospora cernua*	1.2
Aristida refracta	1.2	*Polygala saginoides*	r.1
Aristida eggersii	r.1	*Chaptalia pumila*	r.1
Ichnanthus mayarensis	1.2	*Turnera diffusa*	r.1
Lianes: 10%			
Angadenia cubensis	1.1	*Ipomoea ophiticola*	1.1
Smilax havanensis	1.1	*Bisgoeppertia scandens*	1.1
Rajania howardii	+.1	*Stigmaphyllum sagraeanum*	1.1
Pteridium caudatum	1.2	*Galactia rudolphioides*	+.1
Cassytha filiformis	+.1	*Marsdenia linearis*	r.1

Table 129 Agavo shaferi-Pinetum cubensis (Samek 1973) Borhidi in Borhidi et al. 1979

Tree layer: cover: 20%; height: 6—10 m			
Pinus cubensis	2.3	*Coccothrinax orientalis*	1.1
Shrub layer: cover: 40%; height: 1—3 m			
Pinus cubensis	+.1	*Coccothrinax orientalis*	1.3
Vaccinium cubense	1.1	*Lyonia nipensis*	1.2
Callicarpa cuneifolia	+.1	*Lyonia glandulosa*	1.1
Phyllanthus shaferi	1.1	*Psychotria revoluta*	+.1
Baccharis shaferi	1.2	*Psychotria graminifolia*	+.1
Casearia crassinervis	2.2	*Eupatorium polystictum*	1.1
Clusia nipensis	1.1	*Vernonia nipensis*	+.1
Eupatorium ayapanoides	+.1	*Vernonia urbaniana*	+.1
Eupatorium lantanifolium	+.1	*Eugenia pinetorum*	1.2
Ouratea striata	1.1	*Eugenia subspinulosa*	+.1
Rondeletia myrtacea ssp.	1.1	*Guettarda monocarpa*	1.1
Purdiaea nipensis	+.1	*Xylosma buxifolium*	+.1
Herb layer: cover: 60%; height: 0.1—1 m			
Andropogon gracilis	2.2	*Rhynchospora diodon*	1.2
Andropogon reinoldii	+.2	*Rhynchospora tenuis*	2.2
Aristida refracta	1.2	*Rhynchospora cernua*	1.2
Anemia coriacea	1.1	*Anemia nipensis*	+.1
Ichnanthus mayarensis	+.1	*Chaptalia pumila*	r.1
Polygala saginoides	r.1	*Setaria tenax*	+.1
Paspalum breve	+.2		
Lianes: 25%			
Pteridium caudatum	1.1	*Bisgoeppertia scandens*	1.1
Stigmaphyllum sagraeanum	2.2	*Smilax balbisiana*	1.1
Playgyne triandra	+.1	*Galactia rudolphioides*	1.1
Angadenia cubensis	1.1	*Rajania nipensis*	+.1
Arthrostylidium capillifolium	1.2		
Epiphytes: < 1%			
Catopsis berteroniana	r.1	*Tillandsia bulbosa*	r.1
Epidendrum howardii	r.1	*Epidendrum cochleatum*	r.1
Epidendrum nocturnum	r.1		

The community has a rather closed tree layer, a moderately developed shrub layer and an abundant herb layer. Characteristic species: *Dracaena cubensis, Casearia bissei, Jacquinia roigii, Chaetocarpus oblongatus, Schmidtottia shaferi, Cordia duartei* etc. A synthetic list of 5 relevés made by Borhidi and Muñiz in the Moa Baracoa Jauco range, is column no. 13 of the Table 25 (Appendix). The type relevé was made by Borhidi and Muñiz in March, 1970, between Santamaria and Rio Yamanigüey. (Table 130)



Fig. 357 The lowland pine forest of the Moa range *(Dracaeno-Pinetum cubensis)* between Moa and Punta Gorda, with the relict endemic: *Dracaena cubensis* (Photo: A. Borhidi)

Table 130 Dracaeno-Pinetum cubensis Borhidi ass. nova

Tree layer: cover: 75%; height: 12—16 m			
Pinus cubensis	4.5	*Coccothrinax orientalis*	2.2
Dracaena cubensis	1.1	*Guatteria moralesi*	+.1
Shrub layer: cover: 20%; height: 1—4 m			
Dracaena cubensis	2.1	*Guettarda crassipes*	2.2
Casearia bissei	1.1	*Callicarpa wrightii*	+.1
Euphorbia helenae	+.1	*Lyonia glandulosa*	+.1
Mouriri emarginata	+.1	*Eugenia cycloidea*	+.1
Rheedia polyneura	+.1	*Jacquinia roigii*	+.1
Psidium parvifolium	1.1	*Chaetocarpus oblongatus*	1.1
Schmidtottia shaferi	1.1	*Myrtus ophiticola*	1.1
Phyllanthus pachystylus	+.1	*Spirothecoma apiculata*	+.1
Clidemia rubrinervis	+.1	*Antirhea shaferi*	r.1
Herb layer: cover: 80%; height: 0.1—1 m			
Leptocoryphium lanatum	3.3	*Andropogon gracilis*	2.3
Aristida refracta	1.1	*Andropogon reinolldii*	1.1
Ichnanthus mayarensis	1.2	*Rhynchospora lindeniana*	1.2
Setaria tenax	1.1	*Rhynchospora diodon*	1.1
Panicum xalapense	2.2	*Panicum scoparium*	+.1
Panicum aciculare	1.1	*Panicum breve*	+.1
Cassia lineata	+.1	*Casearia ophiticola*	+.1
Cordia duartei	+.1	*Callicarpa oblanceolata*	+.1
Chaptalia shaferi	r.1	*Heptanthus shaferi*	r.1
Lianes: cover: 5%			
Aristolochia lindeniana	1.1	*Bisgoeppertia scandens*	1.1
Angadenia moaensis	+.1	*Platygyne obovata*	+.1
Echites crassipes	+.1	*Rajania baracoensis*	+.1
Galactia revoluta	+.1	*Stigmaphyllum sagraeanum*	+.1

17.1.2 Alliance: ***Andropogo-Pinion cubensis***
Borhidi in Borhidi et al. 1979 et hoc loco

These are the montane and mesophilous pine forests of the serpentine ranges of eastern Cuba, on ferritic soils with a mixed tree layer with combined broad-leaved evergreen trees and a highly developed herb layer.

Characteristic species: *Pinus cubensis, Tabebuia dubia, Scolosanthus lucidus, Spirotecoma apiculata, Hyeronima nipensis, Terminalia nipense, Terminalia orientensis, Guatteria moralesii, Chaetocarpus* spp. *Miconia cerasiflora, M. obovata, Ossaea rufescens, O. pinetorum, O. pseudopinetorum, Cordia pedunculosa, C. toaensis, Eupatorium grandiceps, Lyonia obovata, L. macrophylla, L. longipes, Calycogonium grisebachii, Myrica shaferi, Cestrum buxoides, Bletia violacea* (Fig. 358), and *Phyllanthus pachystylus*, etc.



Fig. 358 Bletia violacea, a beautiful terrestrial orchid of the *Pinus cubensis* forest belt (Photo: A. Borhidi)

Association studied in Cuba:

Rhynchosporo-Pinetum cubensis (Samek 1973) Borhidi in Borhidi et al. 1979

This is the montane pine forest community of the Sierra de Nipe on humid, more fertile, deep ferritic soils. Samek described this association as two different units: *Pinetum nipense typicum* and *Pinetum panicetusum.* Two synthetic lists of both communities are presented in Table 25 (Appendix) columns no. 7 and 8 each based on 10 relevés made by Borhidi and Muñiz in the Sierra de Nipe in 1970.

Shafero-Pinetum cubensis Borhidi and Muñiz ass. nova

This is the montane pine forest community on deep, rather humid and fertile ferritic soils of the Plateau of Sierra de Maguey (Cupeyal del Norte). It is characterized by a number of endemic species, such as *Shafera platyphylla, Bactris cubensis, Cordia toaensis, Ossaea rufescens, O. vazquezii, O. pseudopinetorum* and *Vaccinium alainii,* etc. A synthetic list of ten relevés made by Borhidi and Muñiz in February, 1970, can be found in Table 25 (Appendix) in column. no. 12.

18 Class: **PHYLLANTHO-NEOBRACETEA VALENZUELANAE**

Borhidi and Muñiz in Borhidi et al. 1979 et hoc loco

Sclerophyllous evergreen scrub vegetation of the lowland and submontane serpentine areas of Cuba, formed by sclerophyllous micro-, nano- and leptophyllous shrubs and small trees, frequently with a notable spinescence and with a high presence of endemics.



Fig. 359 Leucocroton moaënsis Borhidi et Muñiz endemic of the montane serpentine scrub of the Moa range, at the Cupeyal Reserve (Photo: A. Borhidi)

Characteristic species: *Phyllanthus orbicularis* and other spp. *Neobracea valenzuelana, Moacroton* spp., *Leucocroton* spp., (Fig. 359) *Harpalyce* spp., *Buxus* spp., *Coccoloba* spp., *Euphorbia* sect. *Euphorbiodendron, Erythroxylon minutifolium, Annona bullata, Myrtus anomala, M. elliptica* s.l. *Tabebuia lepidota, Notodon* spp., *Piscidia cubensis, Phialanthus* spp., *Malpighia nummulariifolia, M. cnide, Rondeletia camarioca, R. savannarum, R. chamaebuxifolia, Suberanthus brachycarpus, Zanthoxylum ramoni, Scolosanthus crucifer, Bourreria divaricata, B. microphylla, Passiflora cubensis, Cynanchum ophiticola* and *C. orientensis*, etc.

18.1 Order: ARIADNO-PHYLLANTHETALIA
Borhidi and Muñiz in Borhidi et al. 1979 et hoc loco

Sclerophyllous evergreen scrubs of the lowland and submontane belts of the serpentine ranges of eastern Cuba, formed by an overwhelming majority of endemic species and a great number of endemic genera, on primary, stony shallow serpentine "rendzinas" or on highly mature, sterile and eroded laterites with a shallow hardpan layer in the subsoil. The order is very rich in plant communities occasionally forming a vegetation continuum. Future studies have to distinguish further alliances.



Fig. 360 Byrsonima minutifolium Alain a characteristic leptophyllous shrub of the pine woodlands and serpentine scrubs of North Oriente (Photo: A. Borhidi)

Characteristic species: *Ariadne shaferi* s.l., *Phyllanthus myrtilloides* s.l., *P. chamaecristoides* s.l., *P. comosus, P. chryseus, Ateramnus recurvus, Garcinia ophiticola, G. ruscifolia, G. polyneura, G. revoluta, Moacroton lanceolatus, Adenoa cubensis, Pseudocarpidium pungens, Crossopetalum ternifolium*, s.l., *Galactia revoluta, Annona sclerophylla, Calycogonium rosmarinifolium, C. moanum, Euphorbia podocarpifolia, E. helenae, Coccoloba nipensis, C. acuna, C. praestans, Byrsonima minutifolium* (Fig. 360) *B. biflora, Machaonia nipensis, Antirhea abbreviata* s.l. *Xylosma buxifolium, Guettarda sciaphila, G. shaferi, Oplonia cubensis, Erythroxylon pedicellare, E. coriaceum, Spathelia pinetorum*, and *S. splendens*, etc.

18.1.1 Alliance: ***Ariadno-Phyllanthion***

Borhidi and Muñiz in Borhidi et al. 1979 et hoc loco

With the same characteristics as the order.

Associations studied:

Spathelio-Bourrerietum pauciflorae Borhidi ass. nova

It is the high serpentine scrub-woodland community of the Sierra de Nipe, developed on the western and northern slopes of the mountains (e.g., Loma Mensura, Loma Bandera, Valley of Guayabo river, Valley of Sojo river, etc.). A synthetic list of five relevés made by Borhidi and Muñiz in the Sierra de Nipe, in July, 1970 can be found in Table 25, (Appendix), column no. 18. The type relevé was made by Borhidi and Muñiz in the NE slopes of the Loma Mensura, Sierra de Nipe, at about 850—900 m a.s.l. (declination: 20°) It is presented in Table 131.

Antirheo-Acrosynanthetum minoris Borhidi and Muñiz ass. nova

It is the low serpentine scrub-woodland community of the dry seaside area of the northern coastal region between Cananova and Baracoa. Emergents are: *Thrinax rivularis* var. *savannarum, Acrosynanthus minor, Dracaena cubensis.* The shrub layer is extremely rich in sclerophyllous small-leaved endemic shrubs. The type locality of the association is the south slope of Cerro de Miraflores near Cananova. A combined synthetic list contains three relevés of this association together with those of the following one in Table 25, in column. no 17.

Jacquinio-Tabebuietum linearis Borhidi and Muñiz ass. nova

It is an open serpentine scrub-woodland community on the extremely dry, shallow, stony soils of the northern coastal region of Moa and Baracoa. Two representative relevés were made by Borhidi and Muñiz on the Cerro de Miraflores and on the Cerro de Yamanigüey in March, 1970.

Characteristic species of the association: *Tabebuia linearis, Jacquinia moana, Casasia jacquinioides, Shaferocharis multiflora, Phyllanthus comosus, P. chryseus,* etc.

Byrsonimo-Myrtetum acunae Borhidi

It is a low serpentine scrub formed by spiny and nanophyllous shrubs on rocky sharp ridges, (e.g. Loma Bandera). Characteristic species are *Byrsonima minutifolia, Myrtus acunae, Zanthoxylum* (Fagara) *ramoni, Oplonia cubensis, Erythroxylon pedicellare, Eugenia banderensis, Ateramnus recurvus, Calycogonium rosmarinifolium,* and *Coccoloba reflexa,* etc.

Euphorbio helenae-Lyonietum myrsinifoliae Borhidi and Muñiz ass. nova

It is a low serpentine scrub association on heavily eroded ferritic soils with hardpan concretions, probably a second growth community after the cut of rocky

Table 131 Spathelio-Bourrerietum pauciflorae Borhidi ass. nova

Shrub layer: cover: 70%; height: 2—4 m

Coccothrinax nipensis	1.1	*Myrcia retivenia*	1.2
Bourreria pauciflora	2.3	*Cyrilla cubensis*	2.2
Spathelia cubensis	1.1	*Cestrum pinetorum*	+.1
Coccoloba reflexa	+.1	*Byrsonima minutifolia*	1.1
Coccoloba nipensis	2.2	*Rondeletia myrtacea*	+.1
Coccoloba praestans	+.1	*Croton borhidii*	+.1
Purdiaea nipensis	+.1	*Lyonia nipensis*	1.1
Lagetta pauciflora	+.1	*Calycogonium rosmarinifolium*	1.1
Chaetocarpus globosus	1.1	*Cassine attenuata*	
Cordia pedunculosa	+.1	ssp. *nipensis*	1.1
Annona sclerophylla	1.2	*Colubrina nipensis*	1.1
Exostema nipensis	+.1	*Rondeletia nipensis*	+.1
Maytenus loeseneri	+.1	*Crossopetalum ternifolium*	+.1
Psidium parvifolium	1.2	*Myrtus ekmanii*	+.1
Amyris stromatophylla	+.1	*Eugenia pinetorum*	+.1
Psychotria revoluta	+.1	*Phyllathus shaferi*	+.1
Psychotria lopezii	+.1	*Machaonia nipensis*	1.1
Bumelia glomerata	1.1	*Eupatorium polystictum*	1.1
Ossaea acunae	+.1	*Senecio subsquarrosus*	+.1
Vernonia wrightii	1.1		

Herb layer: cover: 5%;

Rhynchospora diodon	1.1	*Polygala saginoides*	+.1
Rhynchospora cernua	1.2	*Turnera diffusa*	1.1
Rhynchosia nipensis	+.1	*Pilea mensuraensis*	+.1
Chaptalia nipensis	+.1		

Lianes: 20%

Triopteris rigida	1.1	*Clematis dioica*	1.2
Jacquemontia nipensis	+.1	*Stigmaphyllum ledifolium*	2.2
Rajania linearis	+.1	*Platygyne triandra*	+.1
Dioscorea nipensis	+.1	*Galactia revoluta*	1.1
Smilax havanensis	1.2	*Angadenia cubensis*	1.1

pine woodland *Euphorbio–Pinetum cubensis* stands. The type relevé was made at Cupeyal, Sierra de Maguey, by Borhidi and Muñiz in February, 1970.

Characteristic species: *Coccothrinax moaensis, Miconia lenticellata, Suberanthus stellatus* (Fig. 361) *Rondeletia vazquezii, Euphorbia helenae, Vaccinium alainii* and *Senecio trichotomus,* etc. (Table 132).

18.2. Order: PHYLLANTHO-NEOBRACETALIA VALENZUELANAE Borhidi and Muñiz in Borhidi et al. 1979 et hoc loco

Dry sclerophyllous evergreen scrubs and scrub-woodlands with a high proportion of spiny elements, covering the serpentine lowland and submontane areas of West- and Central Cuba to Holguin.



Fig. 361 Suberanthus stellatus (Griseb.) Borhidi and Fernandez, endemic to the Moa and Baracoa ranges, as a characteristic element of the serpentine montane scrub communities (Photo: A. Borhidi)

Characteristic species: *Phyllanthus orbicularis, Neobracea valenzuelana, Tabebuia lepidota, T. trachycarpa, Rondeletia camarioca, R. savannarum, Eugenia camarioca, Scolosanthus crucifer* s.l., *Pseudocarpidium ilicifolium, Zanthoxylum ramoni, Oplonia nannophylla, Coccoloba armata, C. pallida, C. microphylla, Guettarda, calyptrata, G. rigida, G. echinodendron, Galactia galactioides, Erythroxylon minutifolium, Copernicia macroglossa, C. hospita, Bursera angustata, Bourreria divaricata, B. microphylla, B. setoso-hispida,* etc.

18.2.1 Alliance: ***Neomazaeo-Reynosion retusae***

Borhidi and Capote in Borhidi et al. 1979 et hoc loco

Dry evergreen sclerophyllous scrubs and scrub-woodlands of the serpentine-laterite areas of the Cajalbana and Sierra del Rosario ranges, characterized by a high number of endemics.

Characteristic species: *Neomazaea phialanthoides, Reynosia retusa, Zanthoxylum* (Fagara) *dumosum, Buxus wrightii, Scolosanthus acunae, Rheedia fruticosa, Leucocroton revolutus, Moacroton trigonocarpus, Machaonia dumosa, Bourreria badia, Coccoloba coriacea, Lescaillea equisetiformis, Agave cajalbanensis, Ayenia cajalbanensis, Helicteres trapezifolia, Pisonia petiolaris, Rondeletia venosa, R. chamaebuxifolia, Eugenia cajalbanica, Eugenia rigidifolia, Phyllanthus discolor, Maytenus buxifolia* ssp. *serpentini, Gochnatia intertexta, Phialanthus rigidus, Phyllomelia coronata, Plinia dermatodes,* etc.

Associations studied:

Erythroxylo-Coccolobetum armatae Borhidi and Capote ass. nova

Dense, spiny, sclerophyllous evergreen scrub-woodland on stony slopes, with a certain second growth character. The type relevé was made by Borhidi and Capote, in SW slope of the Loma Preluda de Cajalbana in January, 1976 (Table 133).

Eugenio-Moacrotonetum trigonocarpi Borhidi and Capote ass. nova

Dense, evergreen scrub of humid serpentine slopes or riverside areas, with a low participation of spiny elements.

Table 132 Euphorbia helenae-Lyonietum myrsinifoliae Borhidi and Muñiz ass. nova

Emergents: cover: 15%; height: 1.5—3 m			
Coccothrinax moaensis	2.1	*Pinus cubensis*	1.1
Shrub layer: cover: 50%; height: 0.5—1.5 m			
Euphorbia helenae	2.3	*Lyonia myrsinifolia*	2.2
Coccothrinax moaensis	+.1	*Pinus cubensis*	+.1
Ariadne shaferi	1.1	*Rondeletia vazquezii*	+.1
Miconia cerasiflora	1.1	*Clidemia capitellata*	1.1
Miconia lenticellata	+.1	*Clidemia rubrinervis*	+.1
Miconia baracoensis	+.1	*Ossaea pauciflora*	1.1
Guettarda ferruginea	1.3	*Ossaea vazquezii*	+.1
Guettarda monocarpa	1.1	*Cyrilla cubensis*	2.2
Tapura cubensis	1.2	*Rauvolfia salicifolia*	+.1
Ilex macfadyenii	+.1	*Gesneria norlindii*	+.1
Eugenia pinetorum	1.3	*Xylosma buxifolium*	1.1
Suberanthus stellatus	+.1	*Cordia toaensis*	+.1
Psychotria revoluta	+.1	*Senecio trichotomus*	+.1
Psychotria linearifolia	+.1	*Gochnatia recurva*	1.2
Scaevola wrightii	1.1	*Tabebuia simplicifolia*	1.1
Oplonia cubensis	1.1	*Eugenia acrantha*	+.1
Scolosanthus lucidus	+.1	*Vaccinium alainii*	1.1
Baccharis shaferi	1.2	*Lasianthus lanceolatus*	+.1
Eupatorium ayapanoides	+.1	*Vernonia orbicularis*	+.1
Eupatorium polystictum	1.1	*Vernonia segregata*	+.1
Linodendron aronifolium	+.1	*Callicarpa oblanceolata*	+.1
Herb layer: cover: 70%; height: 0.1—1.5 m			
Aristida refracta	3.4	*Rhynchospora tenuis*	2.2
Aristida multinervis	1.2	*Rhynchospora cernua*	1.2
Andropogon gracilis	2.2	*Rhynchospora shaferi*	1.1
Ichnanthus mayarensis	2.2	*Eriochloa setosa*	1.1
Bisgoeppertia scandens	1.1	*Polygala saginoides*	+.1
Sachsia polycephala	+.1	*Chaptalia shaferi*	+.1
Coccocypselum herbaceum	1.1	*Bulbostylis capillaris*	1.1
Clidemia neglecta	+.1	*Cassytha filiformis*	1.1

Table 133 Erythroxylo–Coccolobetum armatae
Borhidi and Capote ass. nova

Emergents: cover: 30%, height: 4–6 m	
Pseudocarpidium wrightii	1.2
Guapira cajalbanensis	1.2
Neomazaea phialanthoides	1.1
Bursera angustata	+
Coccoloba armata	1.2
Phialanthus rigidus	+.1
Phyllanthus discolor	+
Coccothrinax yuraguana	1.2
Tabebuia leptopoda	+.1
Guettarda calyptrata	+.1
Brya ebenus s.l.	1.1
Pisonia petiolaris	1.1
Shrub layer: cover: 90%, height: 2–3 m	
Coccoloba armata	4.5
Erythroxylon minutifolium	2
Brya ebenus	3.3
Phyllanthus orbicularis	3.3
P. discolor	1.1
Reynosia retusa	+.1
Jacquinia brunnescens	+.1
Malpighia horrida	+.1
Maytenus buxifolia ssp. *cajalbanica*	+.1
Bumelia glomerata ssp.	+.1
Zanthoxylum phyllopterum	1.2
Zanthoxylum dumosum	+.1
Garcinia fruticosa	+.1
Coccoloba coriacea	
Tabebuia leptopoda	1.1
Bourreria badia	1.1
Machaonia dumosa	1.1
Rondeletia chamaebuxifolia	1.1
Pisonia petiolaris	+.1
Guettarda calyptrata	+.1
Noemazaea phialanthoides	1.1
Exostema valenzuelae	+.1
Plumeria sericifolia	+.1
Eugenia cajalbanica	+.1
Eugenia rigidifolia	1.1
Calyptranthes enneantha	+.1
Psychotria revoluta	+.1
Lianes: 30%	
Arthrostylidium capillifolium	2
Stigmaphyllon sagraeanum	1
Angadenia sagraei	+
Mesechites rosea	+
Galactia galactioides	+
Lescaillea equisetiformis	1
Smilax havanensis	1.2

Herb layer: cover: 20%

Agave cajalbanensis	2.2
Oplonia nannophylla	1.1
Evolvulus sericeus	+.1
Chamaesyce pinariona	+.1
Rhynchospora tenuis	1.2
Aristida refracta	+.1
Aristida vilfifolia	+.1
Heptanthus ranunculoides	+.1
Heliotropium humifusum	2.1
Coccoloba armata	1.1
Erythroxylon minutifolium	+.1
Rondeletia chamaebuxifolia	+.r
Neomazaea phialanthoides	+.r
Phyllanthus discolor	+.r
Mitracarpus glabrescens	+.1
Phania cajalbanica	+.1

Epiphytes: 1%

Tillandsia flexuosa	+
T. balbisiana	+
T. bulbosa	+
Epidendrum plicatum	+

Zanthoxylo-Reynosietum retusae Borhidi

Dry, extremely spiny serpentine scrub on rolling serpentine stones.

Characteristic species: *Reynosia retusa, Zanthoxylum phyllopterum, Z. dumosum, Pseudocarpidium ilicifolium, Scolosanthus acunae, Oplonia nannophylla, Machaonia dumosa, Jacquinia brunnescens, Brya ebenus, Eugenia rigidifolia,* etc.

Neomazaea-Phyllanthetum orbicularis Borhidi and Capote ass. nova

It is the most common, widely distributed dry sclerophyllous scrub community covering the majority of the southern slopes of the Sierra de Cajalbana. The type relevé was made by Borhidi near the peak of Cajalbana in July, 1974. SW slope, in about 450 m a.s.l. (Table 134).

18.2.2 Alliance: ***Coccothrinaci-Tabebuion lepidotae***

Borhidi and Muñiz in Borhidi et al. 1979 et hoc loco

Dry evergreen sclerophyllous scrubs or scrub-forests with numerous spiny elements, growing in the serpentine areas of the western part of Central Cuba (Habana and Matanzas Provinces).

Characteristic species: *Bucida ophiticola, Leucocroton havanensis, L. moncadae, Lasiocroton bahamensis, Eugenia sauvallei, E. camarioca, Psidium havanense,*

Table 134 Neomazaeo-Phyllanthetum orbicularis
Borhidi and Capote ass. nova

Emergents: cover: 5%, height: 4—6 m	
Coccothrinax yuraguana	+.1
Neobracea valenzuelana	+.1
Coccoloba armata	1.1
Pisonia petiolaris	+.1
Bursera angustata	(+)
Guettarda calyptrata	+(2)
Tabebuia leptopoda	1.1
Phialanthus rigidus	+.1
Plumeria sericifolia	+.(2)
Shrub layer: cover: 90%; height: 1—3 m	
Brya ebenus	3.3
Eugenia rigida	2.3
Leucocroton revolutus	3.3
Neomazaea phialanthoides	1.2
Coccoloba pallida	2.2
Coccoloba coriacea	+.3
Gochnatia intertexta	1.3
Erythroxylum minutifolium	2.3
Phyllanthus orbicularis	2.3
Buxus wrightii	2.3
Moacroton trigonocarpus	2.(3)
Phialantus rigidus	+.1
Bonania emarginata	+.1
Ottoschmidtia dorsiventralis	+.1
Reynosia retusa	+.1
Zanthoxylum phyllopterum	1.1
Bourreria badia	1.1
Tabebuia leptopoda	1.2
Rondeletia chamaebuxifolia	1.1
Machonia dumosa	+.1
Bumelia glomerata	+.1
Malpighia horrida	+.1
Oplonia nannophylla	+.r
Plumeria sericifolia	+.r
Scolosanthus acunae	+.r
Jacquinia brunnescens	+.r
Herb layer: cover: 10%, height: 0—30 cm	
Rhynchospora tenuis	1.2
Hepthanthus ranunculoides	1
Heliotropium humifusum	+.1
Borreria erithrichoides	+
Anemia cajalbanica	+
Evolvulus cf. *minimus*	+
Agave cajalbanensis	1.2
Aristida vilfifolia	+
Aristida refracta	+.1
Chamaesyce sp.	+

Coccoloba armata	+.1
Leococroton revolutus	+
Coccoloba pallida	+
Phyllanthus orbicularis	+.1
Mitracarpus glabrescens	+
Lianes: 60—70%	
Arthrostylidium capillifolium	4
Mesechites rosea	+
Jacquemontia serpyllifolia	+
Lescaillea equisetiformis	1
Stigmaphyllon sagraeanum	1
Galactia galactioides	+.1
Epiphytes: 1%	
Tillandsia flexuosa	+
Catopsis floribunda	+

Harpalyce cubensis, Buxus flaviramea, Reynosia intermedia, Guilleminia heterophylla, Borreria eritrichoides, Ottoschmidtia dorsiventralis, Melocactus matanzanus, Moacroton revolutus, Acacia daemon, Coccothrinax miraguama ssp. *roseocarpa, Copernicia ramosissima.*

Association studied:

Coccothrinaci-Bucidetum ophiticolae Berazain 1981

It is the zonal dry sclerophyllous scrub community of the area of the Loma Galindo (Prov. Matanzas) and Tetas de Camarioca (Fig. 362). The following relevé made by Borhidi, Del-Risco and Capote in Piedra Sola, Loma Galindo near Corral Nuevo in May, 1974 can give an idea about the composition of this characteristic association (Table 135). A synthetic list of five relevés made by Borhidi and Muñiz on the Loma de Coca (Habana Province) and Loma Galindo represents a combined floristic composition of different communities belonging to the *Coccothrinaci–Tabebuion lepidotae* alliance (see Table 25, column. no. 31.).

Bucido-Pseudocarpidietum ilicifolii Borhidi (ined.)

Eugenio-Coccothrinacetum roseocarpae Borhidi (ined.)

18.2.3 Alliance: ***Guettardo-Jacarandion cowellii***

Borhidi and Muñiz in Borhidi et al. 1979 et hoc loco

Dry evergreen sclerophyllous serpentine scrubs with high participation of spiny elements growing on the lowland and submontane serpentine areas of the eastern part of Central Cuba (Motembo, Santa Clara, Escambray, Camagüey,Holguin).



Fig. 362 The dry evergreen thorn woodland *(Coccothrinaci-Bucidetum ophiticolae)* of the serpentine areas of Habana and Matanzas, with *Bucida ophiticola* Bisse, *Coccothrinax miraguama* ssp. *roseocarpa* (León) Borhidi et Muñiz and *Tabebuia lepidota* (HBK.) Britt. (Photo: A. Borhidi)

They are composed of micro-, nano- and leptophyllous shrubs and small trees, and a considrable number of them are local vicarious endemics.

Characteristic species: *Guettarda clarensis, G. roigiana, G. camagüeyensis, Zanthoxylum nannophyllum, Coccoloba geniculata, Jacaranda cowellii, Pictetia marginata, Behaimia cubensis, Notodon savannarum, Henoonia myrtifolia, Croton heteropleurus, C. camagüeyensis, C. nephrophyllus, C. acunae, Eugenia melanadenia* and other spp. *Copernicia cowellii, C. hospita, Coccothrinax clarensis, C. pseudorigida, C. garciana, Tabebuia trachycarpa* (Fig. 363), *Platygyne parvifolia, Machaonia subinermis, M. minutifolia, M. urbinoi, Jacquinia shaferi* (Fig. 364), *Karwinskia oblongifolia, K. orbiculata, Daphnopsis oblongifolia, Melocactus actinacanthus, M. holguinensis,* etc.

Associations studied:

Rondeletio camariocae-Guettardetum clarensis Borhidi and Muñiz ass. nova

It is the zonal dry evergreen serpentine scrub of the Las Villas Province, characterized by the presence of local endemics such as *Coccothrinax clarensis, Guettarda clarensis, G. roigiana, Xylosma acunae, Polygala scabridula, Agave brittoniana, Eugenia clarensis, Machaonia subinermis.* A synthetic list of ten

Table 135 Coccothrinaci roseocarpae-Bucidetum ophiticolae Berazain 1981

Emergents: cover: 30%; height: 4—6 m			
Coccothrinax miraguama ssp. *roseocarpa*	2.1	*Bucida ophiticola*	1.2
		Pseudocarpidium ilicifolium	1.1
Shrub layer: cover: 80%; height: 0.5—3 m			
Bucida ophiticola	1.1	*Bursera angustata*	1.1
Moacroton revolutus	1.2	*Bumelia glomerata*	1.2
Pisonia rotundata	2.2	*Rondeletia camarioca*	1.2
Buxus flaviramea	+.1	*Leucocroton havanensis*	2.2
Guettarda rigida	1.1	*Zanthoxylum ramoni dumosa*	2.2
Guettarda echinodendron	1.1	*Myrtus matanzasia*	1.1
Guettarda calyptrata	+.1	*Simaruba laevis*	+.1
Reynosia mucronata	1.1	*Ottoschmidtia dorsiventralis*	+.1
Reynosia microphylla	2.3		
Plumeria obovata	+.1	*Phyllanthus orbicularis*	2.2
Pera bumelioides	+.1	*Harpalyce cubensis*	+.1
Maytenus buxifolia	1.2	*Acacia daemon*	+.1
Calliandra pauciflora	+.1	*Malpighia horrida*	+.1
Brya ebenus	1.2		
Herb layer: cover: 40%; height: 0.1—1 m			
Coccothrinax miraguama ssp. *roseocarpa*	1.1	*Borreria erithrichoides*	1.2
Buchnera elongata	+.1	*Borreria matanzasia*	1.1
Reynosia microphylla	1.1	*Oplonia nannophylla*	2.2
Polygala saginoides	+.1	*Jacquinia brunnescens*	1.1
Mitracarpus glabrescens	1.1	*Bourreria microphylla*	1.1
Stenandrium droseroides	+.1	*Crossopetalum ilicifolium*	+.1
Aristida refracta	2.3	*Furcraea hexapetala*	+.1
Aristida vilfifolia	1.1	*Andropogon gracilis*	1.1
Rhynchospora tenuis	2.2	*Trachypogon filifolius*	+.1
Gossypianthus heterophylla	+.1	*Chaptalia media*	+.1
Lianes: cover: 25%			
Smilax havanensis	1.2	*Evolvulus sericeus*	+.1
Mesechites rosea	2.2	*Angadenia sagraei*	2.2
Galactia galactioides	1.1	*Platygyne hexandra*	1.1
Cynanchum savannarum	+.1	*Jacquemontia serpyllifolia*	+.1
Centrosema virginianum	+.1	*Cassytha filiformis*	+.1
Rajania ekmanii	+.1	*Clitoria ternatea*	+.1
		Ipomoea microdactyla	+.1

representative relevés made by Borhidi and Muñiz in 1969 and 1970 can be found in column. no. 32 of the Table 25. The type relevé was made by Borhidi and Muñiz, in Cerro Pelo Malo east of Santa Clara in July, 1970 (Table 136).

Copernicio cowellii-Tabebuietum trachycarpae Borhidi and Muñiz ass. nova

It is the zonal sclerophyllous dry evergreen scrub and scrub-woodland community of the serpentine areas of Camagüey Province. Characteristic species are: *Cocco-*



Fig. 363 Tabebuia trachycarpa (Griseb.) K. Schum. a dominant shrub of the dry thorn serpentine scrub of Camagüey Province near Cromo (Photo: A. Borhidi)



Fig. 364 Jacquinia shaferi Urb. a thorny endemic element of the serpentine scrubs of Camagüey and Holguin (Photo: A. Borhidi)

Table 136 Rondeletio camariocae-Guettardetum clarensis Borhidi and Muñiz ass. nova

Emergents: cover: 30%; height: 4—5 m			
Coccothrinax clarensis	2.3	*Gastrococos crispa*	1.1
Bucida ophiticola	+.1	*Swietenia mahagoni*	+.1
Shrub layer: cover: 80%; height: 2—3 m			
Plumeria obtusa	+.1	*Annona bullata*	1.1
Brya ebenus	3.4	*Tabebuia lepidota*	3.4
Bourreria microphylla	3.4	*Erythroxylum minutifolium*	2.3
Lasiocroton bahamensis	1.1	*Bucida ophiticola*	+.1
Myrtus anomala	2.2	*Eugenia clarensis*	1.2
Rondeletia camarioca ssp.	2.3	*Ouratea ilicifolia*	+.1
Guettarda clarensis	2.2	*Pseudocarpidium ilicifolium*	1.1
Guettarda scabra	1.2	*Ternstroemia peduncularis* ssp.	+.1
Guettarda elliptica	1.1	*Jacaranda cowellii*	+.1
Diospyrus crassinervis	1.2	*Polygala scabridula*	+.1
Zanthoxylum nannophyllum	+.1	*Noebracea valenzuelana*	+.1
Phyllanthus orbicularis	2.2	*Xylosma acunae*	+.1
Banara reticulata	+.1	*Croton heteropleurus*	+.1
Rheedia cubensis	+.1	*Diospyrus grisebachii*	1.1
Coccothrinax clarensis	+.1	*Bourreria setoso-hispida*	r.1
Gochnatia cowellii	+.1	*Acidocroton acunae*	1.2
Herb layer: cover: 50%; height: 0.1—1 m			
Aristida refracta	3.3	*Eragrostis cubensis*	2.3
Rhynchospora tenuis	2.3	*Paspalum rupestre*	1.1
Ayenia euphrasifolia	1.1	*Buchnera elongata*	+.1
Croton nummulariifolius	2.3	*Sachsia polycephala*	1.1
Evolvulus sericeus	+.1	*Stenandrium droseroides*	+.1
Heliotropium humifusum	+.1	*Diodia rigida*	1.1
Borreria thymocephala	+.1	*Jacquinia stenophylla*	+.1
Scleria lithosperma	1.1	*Andropogon gracilis*	1.2
Agave brittoniana	1.1	*Furcraea hexapetala*	+.1
Zamia kickxii	+.1	*Polygala saginoides*	+.1
Lianes: cover: 30%			
Galactia savannarum	1.2	*Lygodium cubense*	+.1
Centrosema virginianum	1.1	*Smilax havanensis*	2.2
Triopteris rigida	1.1	*Aristolochia passiflorifolia*	1.1
Urechites lutea	+.1	*Stigmaphyllum sagraeanum*	1.1
Mesechites rosea	2.2	*Echites crassipes*	1.1
Passiflora cubensis	+.1	*Cassytha filiformis*	1.1
Cynanchum ophiticola	1.1	*Passiflora foetida* var. *polyadena*	+.1
Jacquemontia serpyllifolia	+.1		
Lygodium cubense	+.1		

Table 137 Coprnicio cowellii-Tabebuietum Borhidi and Muñiz ass. nova

Emergents: cover: 10%; height: 4—6 m			
Coccothrinax camagüeyena	2.1	*Phyllanthus orbicularis*	2.2
Shrub layer: cover: 60%; height: 3—4 m			
Tabebuia trachycarpa	3.3	*Phyllanthus orbicularis*	2.2
Guettarda camagüeyensis	1.2	*Ateleia apetala*	1.1
Guettarda scabra	+.1	*Plumeria obtusa*	2.2
Guettarda calyptrata	1.1	*Bourreria microphylla*	2.2
Solanum bahamense	+.1	*Bourreria setoso-hispida*	+.1
Diospyrus crassinervis	1.1	*Ouratea ilicifolia*	+.1
Copernica cowellii	1.2	*Machaonia microphylla*	+.1
Coccothrinax pseudorigida	2.2	*Randia spinifex*	1.1
Rondeletia camarioca ssp.	+.1	*Annona bullata*	+.1
Banara reticulata	1.1	*Bourreria divaricata*	1.1
Brya ebenus	2.2	*Coccoloba cowellii*	1.2
Cordia grisebachii	+.2	*Coccoloba geniculata*	+.1
Erythroxylum minutifolium	1.2	*Eugenia camarioca*	1.1
Gochnatia cowellii	+.1	*Eugenia melanadenia*	+.1
Exostema spinosum	+.1	*Jacquinia shaferi*	+.1
Malpighia nummulariifolia	1.1	*Myrtus anomala*	1.1
Notodon savannarum	2.2	*Fagara ramoni*	+.1
Herb layer: cover: 60%; height: 0.1—1 m			
Andropogon gracilis	2.3	*Eriochloa setosa*	1.2
Andorpogon hirtiflorus	1.1	*Eragrostis cubensis*	+.1
Aristida refracta	2.3	*Chloris ekmanii*	1.2
Aristida vilfifolia	1.3	*Andropogon bicornis*	+.2
Angelonia pilosella	+.1	*Buchnera elongata*	+.1
Anisantherina hispidula	+1	*Paspalum rupestre*	+.2
Croton nummulariifolius	2.2	*Rhynchospora tenuis*	2.3
Croton origanifolius	+.1	*Ayenia euphrasifolia*	1.2
Chamaesyce camagüeyensis	+.2	*Ayenia tenuicaulis*	+.1
Sachsia polycephala	+.1	*Polygala saginoides*	+.1
Piscidia cubensis	+.1	*Borreria thymocephala*	+.2
Evolvulus sericeus	+.1	*Mitracarpus squarrosus*	+.1
Elytraria planifolia	+.1	*Heliotropium humifusum*	+.1
Thymopsis thymoides	+.1	*Sporobolus cubensis*	+.1
Lianes: cover: 25%			
Stigmaphyllum sagraeanum	1.2	*Aristolochia passiflorifolia*	+.1
Triopteris jamaicensis	1.1	*Mesechites rosea*	2.2
Angadenia cubensis	1.2	*Cassytha filiformis*	2.2
Passiflora foetida var *polyadena*	+.1	*Centrosema virginianum*	1.1
Cynanchum ophiticola	+.1	*Echites crassipes*	1.1
Galactia galactioides	1.1	*Ipomoea polydactyla*	+.1
Platygyne parvifolia	1.1	*Smilax havanensis*	2.2



Fig. 365 Coccothrinax garciana León, an endemic little palm of the serpentine areas near Holguin (Oriente) (Photo: A. Borhidi)

thrinax camagüeyana, Coperinicia cowellii, Guettarda camagüeyensis, Coccothrinax pseudorigida, Gochnatia cowellii, Coccoloba cowellii, Croton camagüeyenus, Machaonia minutifolia, Richardia pectidifolia. A synthetic list of 5 relevés made by Borhidi and Muñiz July, 1970 in the San Serapio savannas can be found in column no. 33. of Table 25. The type relevé was made by Borhidi and Muñiz in July, 1970 at Santayana, NE of Camagüey (Table 137).

Erythroxylo-Spirotecometum holguinensis Borhidi ass. nova

It is zonal sclerophyllous dry evergreen scrub and scrub-woodland association of the lowland and colline serpentine areas NE of Holguin (Maniabón group). In this area several serpentine communities are to be distinguished. A combined synthetic list of these associations is in column no. 34. of Table 25. To *Erythroxylo–Spirotecometum* the following species are characteristic: *Coccothrinax garciana* (Fig. 365) *Erythroxylon minutifolium, E. horridum, Croton holguinensis, Henoonia myrtifolia, Spirotecoma holguinensis, Cordia holguinensis, Rondeletia savannarum, Notodon savannarum, Acacia belairioides* etc. The type relevé was made by Borhidi in February, 1976. in the Ceja de Melones, NE of Holguin (Table 138).

Table 138 Erythroxylo-Spirotecometum holguinensis Borhidi ass. nova

Emergents: cover 20%; height: 3–5 m

Coccothrinax garciana	2.2	*Spirotecoma holguinensis*	1.2
Acacia belairioides	+.1	*Phialanthus oblongatus*	+.1
Copernicia hospita	1.1	*Henoonia myrtifolia*	1.2
Neobracea valenzuelana	+.1	*Guettarda calyptrata*	+.1
Bursera glauca	+.1	*Coccoloba nipensis*	1.1

Shrub layer: cover: 80%; height: 1–2 m

Zanthoxylum nannophyllum	+.1	*Jacaranda cowellii*	1.1
Erythroxylum minutifolium	2.3	*Guettarda shaferi*	1.2
Erythroxylum horridum	1.3	*Notodon savannarum*	3.3
Croton holguinensis	2.2	*Piscidia cubensis*	1.2
Malpighia nummulariifolia	2.2	*Coccoloba nipensis*	1.2
Cordia holguinensis	+.1	*Coccoloba microphylla*	+.1
Pictetia marginata	1.1	*Phyllanthus orbicularis*	2.2
Comocladia dentata	1.1	*Bursera glauca*	1.1
Neobracea valenzuelana	1.1	*Henoonia myrtifolia*	+.1
Coccothrinax garciana	+.2	*Jacquinia shaferi*	1.1
Rondeletia savannarum	+.2	*Euphorbia podocarpifolia*	1.2
Eugenia melanadenia	+.1	*Exostema myrtifolium*	+.1
Psychotria revoluta	+.1	*Scolosanthus pycnophyllus*	+.1
Bourreria divaricata	1.1	*Connarus reticulatus*	+.1
Bourreria cassinifolia	+.1	*Maytenus buxifolia*	+.1

Herb layer: cover: 10%; height: 0.1–1 m

Aristida refracta	1.2	*Heliotropium humifusum*	1.1
Aristida vilfifolia	2.1	*Turnera diffusa*	+.1
Rhynchospora tenuis	1.2	*Eupatorium hypoleucum*	1.1
Helicteres furfuracea	+.1	*Evolvulus sericeus*	+.1
Hybanthus havanensis	+.1	*Dorstenia* sp.	r.1
Diospyrus grisebachii	+.1	*Cordia grisebachii*	1.1
Croton nummulariifolius	1.2	*Randia spinifex*	+.1

Lianes: cover: 20%;

Platygyne parvifolia	2.2	*Salacia nipensis*	1.1
Mesechites minima	+.2	*Angadenia sagraei*	+.1
Stigmaphyllum nipense	1.1	*Echites crassipes*	1.1
Aristolochia passiflorifolia	+.1		

19 Class: **SABALO-ROYSTONIETEA**
Borhidi and Muñiz in Borhidi and Herrera 1977

Savannas formed by high palms and herbs, generally as a secondary vegetation type on alluvial or deep red ferralitic soils influenced regularly and repeatedly by human activities, mainly by fire and pasture.

19.1 Order: PASPALO-ROYSTONIETALIA
Borhidi and Muñiz in Borhidi et al. 1979

Royal palms savannas distributed on the lowland plains and in the colline areas of Central Cuba, mostly on fertile ferralitic soils.

19.1.1 Alliance: ***Ceibo-Roystonion***
Borhidi and Muñiz in Borhidi and Herrera 1977

Royal palm savannas on deep latosolic soils of the fertile lowland belts, distributed in the areas originally occupied by humid tropical seasonal forests conditioned by a seasonal tropical climate with a 1—2 months long dry winter season.

Characteristic species: *Roystonea regia, Ceiba pentandra, Spondias mombin, Andira inermis, Guazuma ulmifolia, Chrysophyllum oliviforme, Andropogon virginicus, A. caricosus, A. pertusus, Paspalum notatum, P. distichum, P. divaricatum, P. fimbriatum, Panicum geminatum, P. caespitosum, P. pilosum, P. adspersum, Sporobolus indicus, Cyperus haspan, C. surinamensis, Setaria tenax, Imperata contracta, Reynaudia filiformis, Rhynchelytrum repens,* etc.

19.1.2 Alliance: ***Samaneo-Roystonion***
Borhidi and Muñiz in Borhidi and Herrera 1977

Royal palm savannas on moderately fertile, less deep ferralitic soils of the lowland areas. They can be found in areas originally covered by semi-deciduous forests and conditioned by a seasonal tropical climate with a 3—6 month-long dry winter season.

Characteristic species: *Roystonea regia, Samanea saman, Peltophorum adnatum, Pithecellobium cubense, Psidium guayava, Anacardium edule, Bursera simaruba, Cordia gerascanthus, Paspalum plicatum, Andropogon saccharoides, Panicum ghisbreghtii, Setaria geniculata, Sorghastrum setosum, Cassia aeschynomene, Stylosanthes hamata, Alysicarpus vaginalis, Pectis floribunda, Borreria verticillata,* and the formerly mentioned gramineas and ciperaceas.

19.2 Order: MACROCOPERNICIO-SABALETALIA
Borhidi in Borhidi et al. 1979

Semi-anthropic, more or less edaphically conditioned savannas, seasonally flooded in the valleys of rivers on alluvial, gleyized soils or in shallow hardpans or mocarreros.

19.2.1 Alliance: ***Copernicion giganti-rigidae***
Borhidi in Borhidi and Herrera 1977

Seasonally flooded savannas on gleyized or mocarrero soils sometimes in natural conditions. They are controlled edaphically by the extreme fluctuation of the soil water table. The majority of their stands have a secondary character resulting after a cut of the original alluvial forests of the eastern Central Cuban lowland areas. (Las Villas, Camagüey, Oriente).

Characteristic species: *Copernicia gigas, C. baileyana, C. sueroana, C. rigida, C. hospita, C.×vespertilionum, C. textilis, Belairia mucronata, Acacia* spp., *Caesalpinia* spp., *Pithecellobium* spp., *Andropogon* spp., *Scleria* spp., *Rhynchospora* spp., *Fimbristylis* spp., etc.

19.2.2 Alliance: ***Andropogoni-Sabalion***
Borhidi in Borhidi and Herrera 1977

Natural edaphic or semi-anthropical savannas on seasonally flooded mocarrero soils, controlled by the fluctuation of the water table and by fire. They are distributed mainly in the lowland areas of West and western Central Cuba (Isle of Pines, province of Pinar del Rio, Habana and Matanzas).

Characteristic species: *Sabal parviflora, Bucida subinermis, Belairia savannarum, Cameraria retusa, Croton sagraeanus, Caesalpinia savannarum, Acacia* spp., *Cheilophyllum* spp., *Andropogon virginicus, A. saccharoides, A. gracilis, Paspalum distortum, Panicum stenodes, Eriochloa setosa, Chloris cubensis, Setaria geniculata, Scleria* spp., *Rhynchospora* spp., etc.

19.3 Order: ARCHLAENETALIA PIPTOSTACHYAL
Bal.-Tul. in Bal.-Tul. and Capote 1982.

Treeless submontane tall grasslands in the natural area of the royal palm, with the *Achlaenion piptostachyae* alliance and the *Bletio purpureae-Andropogonetum gracilis* Bal.-Tul. and Capote 1982 association. **Achlaena piptostachya, Panicum aciculare, Scleria ciliata, Cynanchum savannarum Erigeron cuneifolius, Lisianthus silenifolius, Fibristylis autumnalis** and **Pteridium caudatum** are proposed for characteristic species.

20 Class: **CURATELLO-BYRSONIMETEA**
Borhidi in Borhidi et al. (1979) ex Balátová–Tuláčková and Surli 1983

Dry Neotropical shortgrass savannas on poor sandy or loamy soils of low fertility usually with a shallow hardpan layer in the subsoil (arrecife or mocarrero). The communities are generally characterized by dispersed groups of sclerophyllous evergreen shrubs, or micro-, nano- or leptophyllous small trees, pines or small palms.

Characteristic species: *Byrsonima crassifolia, B. verbascifolia, Curatella americana, Bulbostylis paradoxa, Andropogon gracilis, Rhynchospora tenuis,* etc.

20.1 Order: PARVICOPERNICIO—COCCOTHRINACETALIA
Borhidi and Muñiz in Borhidi and Herrera 1977

Semi-anthropic serpentine and sandy savannas, resulting from the cutting, burning, and pasturing of the original pine woodlands and scrubs.

Characteristic species: *Andropogon virgatus, A. gracilis, Aristida* spp. *Leptocoryphium lanatum, Eriochloa setosa, Eragrostis cubensis, Rhynchospora diodon, Panicum aciculare, P. chrysopsidifolium, Ichnanthus mayarensis,* etc.

20.1.1 Alliance: ***Parvicopernicio—Coccothrinacion***
Borhidi and Muñiz in Borhidi and Herrera 1977

Serpentine savannas in Cuba.

Characteristic species: *Copernicia, macroglossa* (Fig. 366), *C. pauciflora, C. cowellii, C. yarey, Coccothrinax miraguama* ssp. diff. *C. pseudorigida, C. clarensis, C. camagüeyana, C. garciana, Rondeletia* spp., *Tabebuia lepidota, Bourreria* spp., *Mitracarpus squarrosus, Tripogon spicatus, Ayenia euphrasifolia, Croton nummulariifolius, Polygala saginoides, Evolvulus* spp., *Aristolochia passiflorifolia,* etc.

20.1.2 Alliance: ***Cassio lineatae–Aristidion neglectae***
Bal.-Tul. in Bal.-Tul. and Capote 1985

Heavily disturbed serpentine savannas in Havana and Matanzas provinces originated from different communities of the *Coccothrinaci–Tabebuion lepidotae* alliance. Perhaps it does not differ from the 20.1.1 alliance. It is represented by the *Cassio lineatae–Aristidion neglectae* association.

20.2 Order: ACOELORRAPHO–COLPOTHRINACETALIA
Bal.-Tul. in Bal.-Tul. and Capote 1985

20.2.1 Alliance: ***Acoelorrapho-Colpothrinacion***
Borhidi and Capote in Borhidi et al. 1979

Dry and moderately humid savannas on white sand areas formed by a short, occasionally open herb layer with dispersed individuals of pines and palms, in SW-Cuba and Isle of Pines, mostly as a result of the degradation of sand pine woodlands.



Fig. 366 Copernicia macroglossa Wend. ex Becc. a characteristic palm species of the serpentine areas, at the foot of the Loma de Galindo, Matanzas (Photo: A. Borhidi)

Characteristic species: *Acoelorraphe wrightii, Colpothrinax wrightii, Pinus tropicalis, Melochia savannarum, Hyptis pedalipes, Aster grisebachii, Aristida* spp., *Mesosetum loliiforme, Turnera acaulis, Croton cerinus, C. craspedotrichus,* and synusia of eriocaulaceas and xyridaceas.

Association studied:

Phyllantho selbyi–Aristidetum brittonorum
Bal.-Tul. and Capote 1985

20.3 Order: BYRSONIMO–ANDROPOGONETALIA TENERIS Balátová–Tuláčková in Balátová–Tuláčková and Surli 1983

Seasonally dry, shortgrass savannas without trees or scattered palms, growing on seasonally flooded alluvial or mocarrero soils, controlled by a considerable fluctuation of the water table.

Characteristic species: *Andropogon gracilis, A. tener, A. hirtiflorus, A. multinervosus, Rhynchospora diodon, R. plumosa, R. cubensis, Stenandrium droseroides, Buchnera elongata.*

20.3.1 Alliance: ***Guillemineo-Aristidion refractae***
Balátová-Tuláčková in Balátová-Tuláčková and Surli 1983

Dry shortgrass savannas on extremely dry mocarrero soils with a shallow hardpan layer and conditioned by a long flood in the summer.

Characteristic species: *Aristida refracta, A. vilfifolia, Gossypianthus brittonii, Stenandrium ovatum, Scleria georgiana, Bulbostylis tenuifolia, B. junciformis,* etc.

Association studied:

Sclerio interruptae Rhynchosporetum semiterbis
Balátová-Tuláčková in Balátová-Tuláčková and Surli 1983

Polygalo omissae-Rhynchosporetum diodontis Bal.-Tul. in Bal.-Tul. and Surli 1983

20.3.2 Alliance: ***Byrsonimo-Andropogonion teneris***
Bal.-Tul. in Bal.-Tul. and Surli 1983

Semi-dry shortgrass mocarrero savannas on moderately dry soils, conditioned by shorter inundation period and a better drainage in the subsoil.

Characteristic species: *Byrsonima crassifolia, Andropogon tener, Scleria geogiana, Bulbostylis setacea, Buchnera elongata.*

Association studied:

Byrsonimo-Andropogonetum teneris Bal.-Tul. in Bal.-Tul. and Surli 1983

20.3.3 Alliance: ***Roigello–Andropogonion multinervosi***
Bal.-Tul. in Bal.-Tul. and Surli 1983

Short grass savannas on siliceous acid soils of Pinar del Rio and Isle of Pines originated from the *Pinus tropicalis* and Picaribaea woodlands.

Association studied:

Roigello-Andropogonetum multinervosi: Bal.-Tul. in Bal.-Tul. and Garcia 1987.

21 Class: CERCIDI-PROSOPIDETEA
Knapp (1964) ex Borhidi hoc loco

Deciduous thorn woodlands and thorn-shrub forests formed mostly by thorny mimosaceas and caesalpiniaceas in Central America and West Indies.

21.1 Order: ACACIO-CAPPARIDETALIA Knapp (1964) ex Borhidi hoc loco

Thorn woodlands and dense thorn scrub forests of the hyperxerophytic coastal and subcoastal zones in the West Indies, growing mainly on limestone conditioned by a bixeric climate with 7—9 dry months and 600—800 mm of annual precipitation.

21.1.1 Alliance: ***Acacio-Caesalpinion coriariae*** Borhidi in Borhidi et al. 1979

With the same characteristics as the order.

Characteristic species: *Acacia farnesiana, A. curbeloi, A. cupeyensis, A. roigii, A. lutea, A. cowellii, Pithecellobium mucronatum, P. oppositifolium, Prosopis juliflora, Phyllostylon brasiliense, Cassia stenophylla, Haematoxylon campechianum, Caesalpinia bahamensis* s.l., *C. pauciflora, C. coriaria, C. pinnata, C. subglauca, Capparis* spp., *Agave underwoodii, A. legrelliana, Scolosanthus bahamensis,* etc.

22 Class: **CERCIDI-CEREETEA** Knapp (1964) in Borhidi hoc loco

Open desert and semi-desert vegetation with the dominance of columnar and tree-shaped cacti in North and Central America and the West Indies (Fig. 367).

22.1 Order: RITTEROCEREETALIA HYSTRICIS Knapp (19647 in Borhidi hoc loco

Semi-desert vegetation in the coastal and subcoastal belts of the Greater Antilles and the Bahamas, conditioned by an arid climate with 9—11 dry months and 300 to 600 mm annual precipitation.

Characteristic species: *Ritterocereus hystrix, Pilosocereus* spp., *Consolea* spp., *Melocactus* spp., *Cylindropuntia hystrix, Opuntia dilleni, Capparis* spp., *Guajacum officinale, Croton* ssp., *Agave* spp.

22.1.1 Alliance: ***Consoleo-Ritterocereion hystricis*** Borhidi and Muñiz in Borhidi et al. 1979 et hoc loco

Semi-desert vegetation with the dominance of columnar and tree-shaped cacti, represented by local vicarious endemics in each island of the Greater Antilles and the southern Bahamas.

Characteristic species in Cuba: *Consolea macracantha, C. millspaughii* (Fig. 368), *Ritterocereus hystrix, Pilosocereus brooksianus, P. robinii, Cylindropuntia*

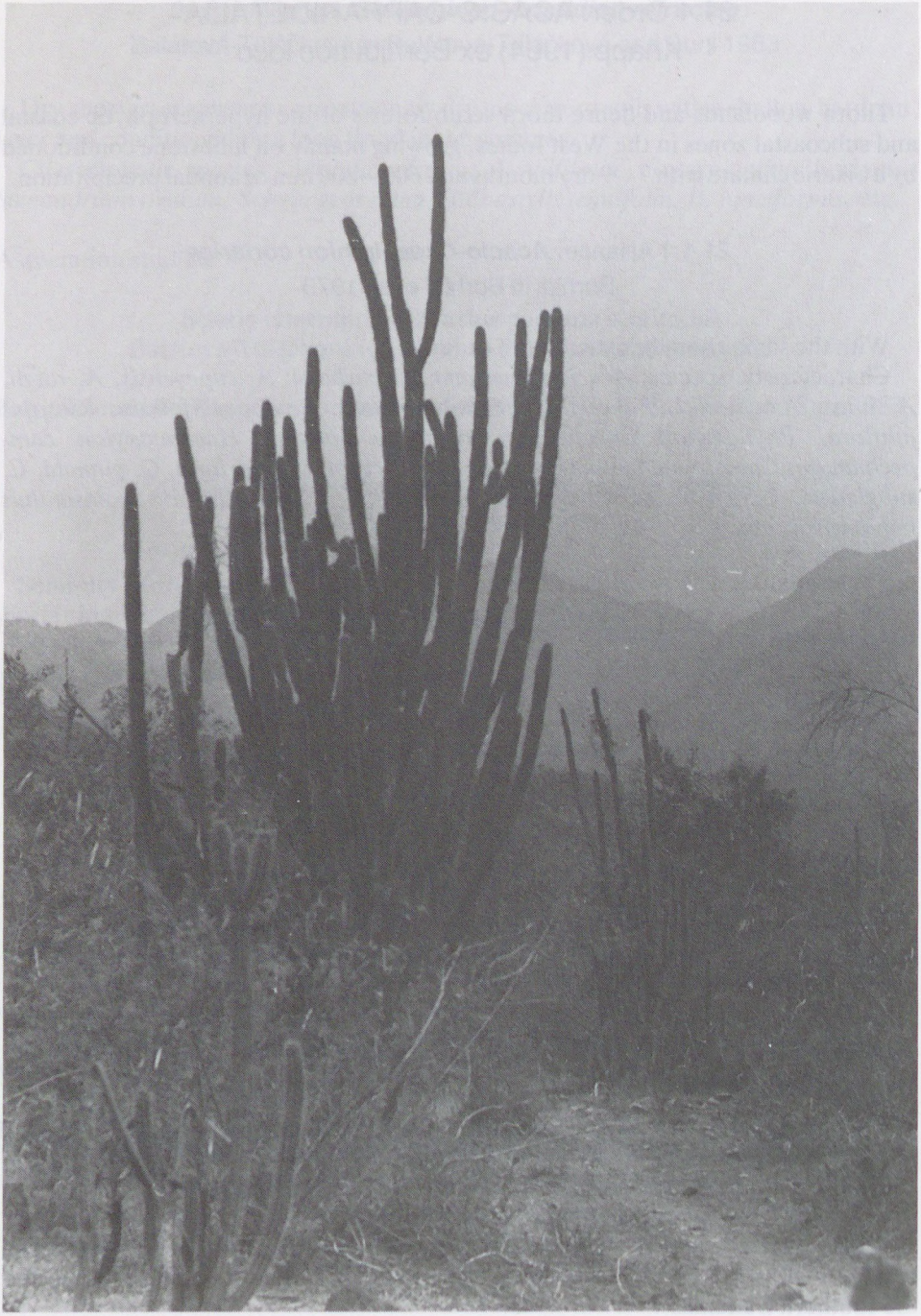


Fig. 367 Dry cactus-scrub vegetation in the valley of Tacre river in Sierra de Imias near Cajobabo (Photo: A. Borhidi)



Fig. 368 Individuals of *Consolea millspaughii* at Maisi (Photo: A. Borhidi)



Fig. 369 Capparis flexuosa L., a common tree and shrub of the semi-desert cactus-scrub in South Oriente (Photo: A. Borhidi)

hystrix, Melocactus harlowii, M. borhidii, M. acunai, Rhodocactus cubensis, Opuntia militaris, Harrisia fernowii, Agave albescens, Caesalpinia pinnata, C. pauciflora, Capparis grisebachii, C. flexuosa (Fig. 369), *Gochnatia microcephala,* etc.

Association studied:

Consoleo-Colubrinetum ellipticae Borhidi and Muñiz ined.

Ritterocereo-Lasiocrotonetum bahamensis Borhidi and Muñiz ined.

It is a common semi-desert community distributed on the shallow sand covering the limestone terrace along the coastal plain of South Oriente between Tortuguilla and San Antonio del Sur, frequently forming a mosaic-complex with the following association.

Cappari-Ritterocereetum hystricis Borhidi and Muñiz

This community replaces the former one on the deeper sandy soils on the coastal semidesert plains. A synthetic combined list of three associations belonging to this alliance represented with ten relevés is found in column no. 40 of table 25.

Ritterocereo-Guettardetum cueroensis Borhidi

It is a semi-desert community growing on the steep slopes of the second coastal limestone terrace along the southern rocky shores of Oriente, especially between

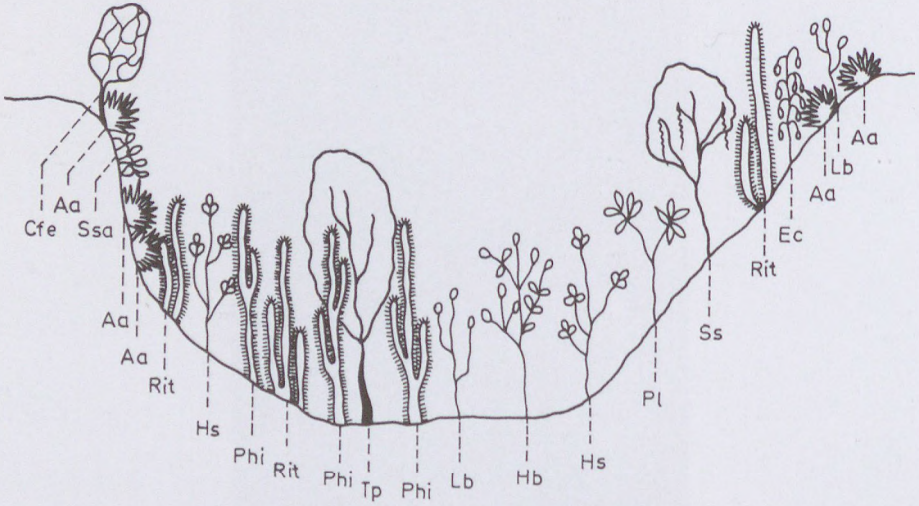


Fig. 370 Vegetation transect in the *Ritterocereo-Lasiocrotonetum bahamensis* community (made by Rodriguez N. N. *et al.* 1982) Aa: *Agave albescens;* Cfe: *Capparis ferruginea;* Ec: *Exostema caribeum;* Hs: *Helicteres semitriloba;* Hb: *Henoonia brittonii;* Lb: *Lasiocroton bahamensis;* Rhi: *Pilosocereus brooksianus;* Pl: *Plumeria lanata;* Rit: *Ritterocereus hystrix;* Sa: *Stigmaphyllon sagraeanum:* Ss: *Spirotecoma spiralis;* Tp: *Thuinidium pulverulentum*

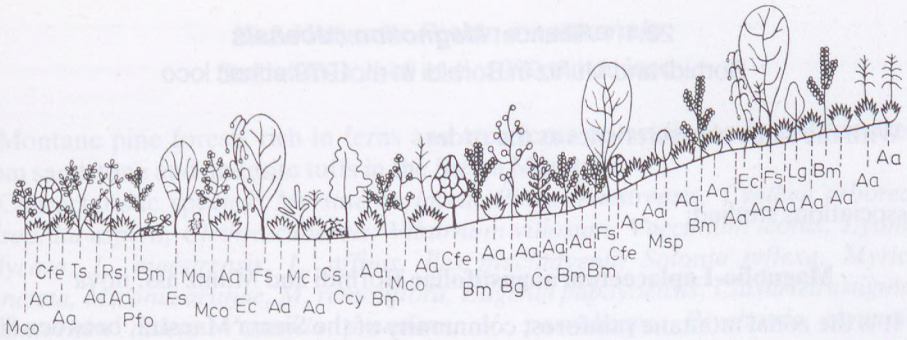


Fig. 371 Vegetation transect in the *Agavo-Melochietum tomentosae* Rodriguez N. N. et al. community made by the authors in 1982. For abbreviations see Fig. 370 and the following: Bm: *Brya microphylla,* Cs: *Caespalpinia decapetala,* Cr: *Colubrina elliptica,* Fs: *Forestiera segregata;* Go: *Guaiacum officinale;* Ma: *Melocactus acunai;* Mco: *Maytenus cochlearifolius,* Rs: *Randia spinifex,* Tsp: *Tetrapteris buxifolia*

Daiquiri and Maisi. The semi-desert plant associations usually form a vegetation continuum, in which the delimitation of the different communities is problematic. (Figs 370—371)

23 Class: **OCOTEO-MAGNOLIETEA**
Borhidi and Muñiz in Borhidi et al. 1979 et hoc loco

Montane rainforests of the Caribbean region, especially in the eastern ranges of Mexico and in the mountains of the Antilles. They are characterized by the constant presence of the fern trees, by the abundance of epiphytes, mosses and epiphyllous liverworts.

Characteristic species: *Ocotea* spp., *Magnolia* spp., *Laplacea* spp., *Cyrilla* spp., *Brunellia comocadifolia, Freziera* spp., *Podocarpus* spp., *Talauma* spp., *Cyathea* spp., *Nephelea* spp., *Lophosoria quadripinnata, Hemitelia horrida, Clethra* spp., *Prestoea montana, Calyptronoma* spp.

23.1 Order: OCOTEO-MAGNOLIETALIA
Muñiz in Borhidi et al. 1979 et hoc loco

Humid montane broad-leaved rainforests growing on mountain yellow tropical soils and forming a vegetation belt — in Cuba between 800 and 1600 m a.s.l. in the Sierras de Escambray, Maestra and Imias ranges.

Characteristic species: *Magnolia cubensis* s.l., *M. cacuminicola, Ocotea cuneata, O. leucoxylon, O. acunaiana, O. ekmanii, Persea* spp., *Beilschmiedia pendula, Guatteria blainii, Laplacea angustifolia, L. urbanii, Matayba domingensis, Prestoea montana, Talauma minor, Ossaea ottoschmidtii, O. turquinii, Hedyosmum nutans, Mecranium amygdalinum, Meriania leucantha* s.l. *Gesneria viridiflora* s.l., *Torralbasia lenticellata, Freziera grisebachii,* etc.

23.1.1 Alliance: ***Magnolion cubensis***
Borhidi and Muñiz in Borhidi et al. 1979 et hoc loco

With the same characteristics as the order:

Associations studied:

Magnolio-Laplaceetum angustifoliae Borhidi and Muñiz ass. nova

It is the zonal montane rainforest community of the Sierra Maestra, between 800 and 1600 m a.s.l. The upper tree layer is formed by the co-dominant *Magnolia cubensis* spp. *cubensis* and *Laplacea angustifolia,* accompanied by many other sclerophyllous trees as *Guatteria blainii, Ocotea ekmanii, O. cuneata, Freziera grisebachii, Laplacea urbanii, Cleyera nimanimae, Cyrilla racemiflora* s.l., etc. The second tree layer is composed of meso- and macrophyllous melastomataceas and fern trees. The synthetic list of five relevés made by Borhidi and Muñiz in the Turquino-group between 1300 and 1600 m a.s.l. in December 1969 is represented in column no. 20 of Table 25. For structure profile see Fig. 278 (p. 394).

Ocoteo ekmanii-Cyrilletum racemiflorae Borhidi

It is the dry montane rainforest community of the Sierra Maestra, at the same high level as the former one but conditioned edaphically on the humid sandstone areas, or mesoclimatically on the steep, dry ridges and slopes.

It can be characterized by microphyllous sclerophyllous trees as *Ocotea ekmanii, Cyrilla racemiflora, Persea similis, Tabebuia oligolepis, Myrsine coriacea,* and by the absence of the tree ferns in the second tree layer.

Magnolio acunae-Cyrilletum racemiflorae Borhidi and Muñiz ass. nova

It is the zonal or usually extrazonal montane rainforest association of the Sierra de Escambray between 800 and 1100 m a.s.l. Its species composition is poorer than that of the Sierra Maestra community. Of this association the presence of *Magnolia cubensis* ssp. *acunae, Ocotea acunaiana, Torralbasia lenticellata, Ocotea floribunda, Gesneria viridiflora* ssp. *colorata, Miconia cubensis* and *M. albescens* are characteristic. The synthetic list of five relevés made by Borhidi and Muñiz in June, 1970 on the northern slopes of the Potrerillo Peak, is presented in column no. 21 of Table 25 (Appendix).

23.2 Order: PINETALIA OCCIDENTALIS-MAESTRENSIS Knapp 1964 emend. Borhidi in Borhidi et al. 1979 et hoc loco

Montane pine forests in the montane rainforest belts of the Greater Antilles.

Characteristic species: *Pinus occidentalis, P. maestrensis, Gleichenia bifida, G. flexuosa, G. palmata, G. pectinata, Alsophila* spp., *Cyathea* spp., *Clethra* spp.

23.2.1 Alliance: ***Pinion maestrensis***
Borhidi in Borhidi et al. 1979 et hoc loco

Montane pine forests rich in ferns and tree ferns on acidic sandy soils derived from sandstone and andesite tuffs in the Sierra Maestra.

Characteristic species: *Myrsine coriacea, Pinus maestrensis, Cyathea arborea, Alsophila aspera, Clethra cubensis, Viburnum villosum, Vaccinium leonis, Lyonia calycosa, L. maestrensis, L. affinis, Ilex macfadyenii, Solonia reflexa, Myrica punctata, Miconia acunae, M. remotiflora, Eugenia papayoensis, Clusia tetrastigma, Eupatorium dalea, Vernonia praestans, V. parvuliceps, Psychotria ekmanii, Podocarpus aristulatus,* etc.

Associations studied:

Clethro-Pinetum maestrensis Borhidi ass. nova

It is a pine forest community formed by two tree layers on the oligotrophic soils of the montane rainforest belt in the Sierra Maestra. The upper tree layer is formed by the dominant *Pinus maestrensis* accompanied by evergreen broad-leaved trees. In the lower tree layer the constant presence of tree ferns and acidophilous elements *(Clethra, Vaccinium, Lyonia, Viburnum, Myrica)* is characteristic. Five representative relevés made by Borhidi in the pine forest area of Alto de la Siberia-Pico Bayamesa in January, 1976 and November, 1978. These are presented in Table 139. Type relevé: no. 4. Loma Ruiseñor, Pico Bayamesa above Pino de Agua, 1300 m a.s.l. For structure profile see Fig. 318 (p. 441).

23.3 Order: PODOCARPO-SLOANETALIA
Borhidi and Muñiz in Borhidi et al. 1979 et hoc loco

Montane, semi-dry, micro- and notophyllous rainforests, poor in epiphytes, mosses and epiphyllous liverworts. They grow on acid ferralitic serpentine soils poor in nutrients, in the Sierra de Nipe, Sierra del Cristal, Cuchillas de Moa, Toa and Baracoa ranges (eastern Cuba).

23.3.1 Alliance: ***Podocarpo-Byrsonimion orientensis***
Borhidi and Muñiz in Borhidi et al. 1979 et hoc loco

Characteristic species: *Podocarpus aristulatus, P. ekmanii, Sloanea curatellifolia, Hyeronima nipensis, Talauma minor* ssp. *oblongata, Guatteria moralesii, Byrsonima orientensis, B. biflora, Calophyllum utile, Terminalia nipensis, T. pachystyla, T. orientensis, Mozartia gundlachii, Ocotea moaënsis, Coccoloba costata, Leucocroton wrightii, L. longibracteatus,* etc.

Table 139 Clethro-Pinetum maestrensis Borhidi ass. nova

	1	2	3	4	5
High tree layer 18—22 m high, cover %:	70	65	60	75	70
Pinus maestrensis Bisse	4.5	4.4	4.4	4.5	4.5
Cyrilla nipensis Urb.	+.1	—	+.1	—	—
Myrsine coriacea (L.) R. Br.	—	—	+.1	+.1	1.1
Brunellia comocladifolia H. and B.	+.1	+.1	—	—	+.1
Tabebuia hypoleuca Griseb.	—	—	—	+.1	—
Low tree layer 3—8 m high, cover %:	30	40	25	20	35
Pinus maestrensis Bisse	—	—	+.1	—	+.1
Myrsine coriacea (L.) R. Br.	+.1	+.1	+.1	1.1	—
Brunellia comocladifolia H. and B.	+.1	1.1	—	—	—
Weinmannia pinnata L.	—	+.1	—	—	+.1
Myrica punctata Griseb.	1.1	+.1	+.1	—	—
Vaccinium leonis Acuña and Roig	—	1.1	+.1	+.1	—
Clusia rosea Jacq.	+.1	—	—	—	+.1
Clethra cubensis A. Rich.	+.1	1.1	+.1	+.1	—
Matayba domingensis (DC.) Radlk.	—	—	—	+.1	+.1
Clusia minor L.	—	—	—	—	+.1
Clusia tetrastigma Vesque	—	+.1	+.1	—	—
Viburnum villosum Sw.	1.1	1.2	+.1	+.1	1.1
Trema cubensis Urb.	+.1	+.1	—	—	—
Ilex macfadyenii (Walp.) Rehder	1.1	2.2	+.1	+.1	2.2
Cyathea araneosa Max.	+.1	—	—	+.1	—
Cyathea armata (Sw.) Domin	+.1	+.1	+.1	—	—
Cyathea arborea (L.) Sm.	—	+.1	—	+.1	+.1
Lophosoria quadripinnata (Gmel.) C. Chr.	—	—	+.1	+.1	—
Myrica cacuminis Britt. and Wils.	—	—	—	+.1	1.2
Miconia dodecandra (Desv.) Cogn.	+.1	—	—	—	1.1
Miconia punctata (Desm.) D. Don	—	+.1	+.1	—	—
Heterotrichum umbellatum (Mill.) Urb.	+.1	1.1	+.1	+.1	+.1
Shrub layer 1—2 m high, cover %:	5	10	25	25	10
Viburnum villosum Sw.	+.1	1.1	1.2	1.2	+.1
Ilex macfadyenii (Walp.) Rehder	+.1	1.1	1.2	1.2	+.1
Solonia reflexa Urb.		+.1	+.r	+.r	—
Sapium erythrospermum (Griseb.) Muell. Arg.	—	—	+.r	—	+.r
Garrya fadyenii Hook.	—	+.1	+.r	+.r	+.r
Palicourea alpina (Sm.) DC.	+.r	—	—	+.1	—
Ageratina paucibracteata (Alain) King et Robins.	+.1	1.1	1.2	1.2	1.1
Clethra cubensis A. Rich.	—	+.1	+.1	—	+.1
Lyonia calycosa (Small) Urb.	—	+.r	—	—	+.r
Lyonia maestrensis Acuña and Roig	—	—	+.r	+.r	—
Cyrilla racemiflora L.	+.1	+.1	+.1	+.1	—
Critonia dalea (L.) DC.	—	1.1	1.1	1.1	—
Tibouchina longifolia (Vahl) Baill.	+.1	+.r	—	—	+.r
Trema cubensis Urb.	+.r	+.1	—	—	—

	1	2	3	4	5
Lobelia assurgens L.	+.r	–	–	+.r	–
Callicarpa ferruginea Sw.	+.1	+.1	+.1	1.1	+.1
Ascyrum hypericoides L.	+.1	1.2	–	–	–
Gesneria viridiflora (Dcne) Kuntze	+.1	+.1	+.r	+.r	–
Clidemia strigillosa (Sw.) DC.	–	–	–	+.1	+.2
Clidemia hirta (L.) C. Don	+.1	+.1	+.1	+.1	–
Miconia alternifolia Griseb.	–	–	+.1	+.1	–
Miconia acunae Borhidi	–	–	–	–	+.2
Ossaea muricata (Griseb.) Wr. ex Sam.	–	–	+.1	+.1	–
Vaccinium leonis Acuña and Roig	–	–	+.1	+.1	+.1
Vernonia parvuliceps Ekm.	–	+.1	+.2	–	–
Sapium jamaicense Sw.	+.1	–	–	–	–
Pteridium caudatum (L.) Max.	–	+.1	1.2	+.2	–
Eugenia rigida Berg	–	+.1	–	–	–
Myrcia splendens (Sw.) DC.	–	+.1	+.1	–	–
Hedyosmum grisebachii Solms	–	+.1	+.1	+.r	–
Rubus turquinensis Rydb.	–	–	–	+.2	+.2
Wigandia reflexa Brand	–	–	+.r	+.1	–
Purdiaea maestrensis Borhidi and Catasus	–	–	–	+.2	–
Rondeletia naguensis Britt. and Wils.	–	–	–	+.2	–
Graffenrieda rufescens Britt. and Wils.	–	+.1	–	+.1	–
Herb layer 10–80 cm high, cover %:	50	60	100	100	80
Dicranopteris flexuosa (Schrad.) Mett.	–	–	5.5	5.5	4.4
Nephrolepis biserrata (Sw.) Schott	2.2	2.3	–	–	–
Blechnum occidentale L.	1.1	1.2	–	–	–
Dennstaedtia adiantoides (H. and B.) Moore	–	–	+.1	–	+.1
Odontosoria aculeata (L.) J. Sm.	+.2	+.1	+.1	–	–
Odontosoria uncinella (Kunze) Fée	–	–	–	+.1	+.1
Coccocypselum × *lanceolatum* (Urb.) Borhidi	–	+.r	+.r	–	–
Dalbergaria cubensis (Urb.) Borhidi.	–	–	+.r	–	+.r
Desmodium barbatum (L.) Benth. and Oerst.	+.2	+.1	+.1	+.r	–
Pityrogramma sulphurea (Sw.) Max.	–	+.1	+.r	–	–
Coccocypselum herbaceum Aubl.	+.1	+.1	+.1	–	–
Habenaria monorrhiza (Sw.) Rchb. f.	+.r	+.r	–	–	–
Phaius tankervilliae (Banks) Blume	+.r	+.r	–	–	–
Hedyosmum grisebachii Solms	–	–	+.r	+.1	–
Lycopodium dichotomum Jacq.	1.1	1.2	–	–	–
Lycopodium cernuum L.	+.1	+.1	–	–	+.r
Panicum scoparium L.	1.1	1.2	–	–	+.r
Panicum boliviense Hack.	–	+.1	–	–	+.1
Rondeletia calophylla Standl. ex Britt.	–	–	+.1	+.1	–

Associations studied:

Hieronymo-Sloanetum curatellifoliae Borhidi ass. nova

This is the zonal serpentine rainforest community of the ranges Sierra de Nipe and Sierra del Cristal, formed by two tree layers, a rather dense shrub layer and a poor herb layer. The association is poor in treeferns, epiphytes and epiphyllous

liverworts. Table 140, exhibits five representative relevés made by Borhidi and collaborators in the Sierra de Nipe in September, 1975, and in the Sierra del Cristal in April, 1976. Type relevé: no. 3. Cayo Verde, Northern slope, in 700 m a.s.l., Sierra del Cristal, near Corea, made by Borhidi and Vales. Structure profile is shown on p. 397, Fig. 281.

Podocarpo-Bonnetietum cubensis Borhidi and Muñiz

This is the zonal serpentine rainforest community of the high plateaus of the Cuchillas de Moa and Toa. (Fig. 372) Characteristic species are *Bonnetia cubensis, Moacroton ekmanii, Tabebuia dubia, T. clementis, Podocarpus ekmanii, Pera ekmanii, Laplacea moaënsis, Purdiaea moënsis*, etc. A synthetic list of ten relevés made by Borhidi and Muñiz in Sierra de Moa, Sierra de Iberia, Rio Jaguani and Sierra de Maguey in February and March 1970 is found in column no. 15 of Table 25 (Appendix).

23.3.2 Alliance: ***Cyrillo-Pinion cubensis***
Borhidi and Muñiz in Borhidi et al. 1979 et hoc loco

Montane riverside forests on humid ferritic soils in the pine forest belt of the serpentine ranges of northern Oriente.

Characteristic species: *Cyrilla nipensis, Calyptronoma orientensis, Bactris cubensis, Senecio polyphlebius, S. rivalis, Hedyosmum crassifolium, Pachynathus reticulatus, Calyptranthes punctata, C. calyptrata, C. cardiophylla, C. monocarpa, Isachne leersioides, Litachne pauciflora, Ichnanthus nemorosus, Cladium restioides, Paepalanthus riparius,* etc.

Association studied:

Cyrillo nipensi-Pinetum cubensis Borhidi and Muiñiz ass. nova

The riparian riverside pineforest community of the montane belt in the serpentine ranges of Oriente. A synthetic list of five relevés made by Borhidi and Muñiz in the upland near the headwaters of Rio Toa, Sierra de Maguey, Cupeyal in February, 1970, is in column no. 14, of Table 25.

23.4 Order: CALYPTRONOMO-CYRILLETALIA
Borhidi in Borhidi et al. 1979 et hoc loco

Montane and submontane off-serpentine riverside forests of Cuba, irrigated by oxygen-rich freshwaters.

Characteristic species: *Calyptronoma* spp., *Cyrilla* spp., *Didymopanax morototoni, Isertia haenkeana, Senecio* spp., *Calophyllum* spp., *Calyptranthes* spp., *Myrcia* spp., *Mozartia* spp., *Hirtella americana, Alsophila* spp., *Cyathea minor, Pilea* spp., etc.

Table 140 Hyeronimo-Sloanetum curatellifoliae Borhidi ass. nova

Sample plots 30×30 m²	1.	2.	3.	4.	5.	C_5
High canopy layer: 18—25 m tall, cover	80	85	75	90	80	
Hyeronima nipensis Urb.	2.3	3.4	3.3	2.2	3.3	V
Sloanea curatellifolia Griseb.	3.3	1.1	1.2	1.1	1.2	V
Chionanthus domingensis Lam.	1.2	2.2	1.2	3.4	2.2	V
Podocarpus ekmanii Urb.	1.1	+.1	—	1.1	1.1	IV
Calophyllum utile Bisse	+.1	1.2	—	1.2	3.3	IV
Byrsonima coriacea R. Br.	2.2	1.1	2.2	1.1	2.2	V
Terminalia nipensis Alain	+.1	1.1	1.2	1.2	1.2	V
Myrsine coriacea (Sw.) R. Br.	2.2	1.2	1.2	2.2	1.2	V
Didymopanax morototoni (Aubl.) Dec. et Planch.	+.1	—	1.1	1.1	1.1	IV
Ocotea cuneata (Griseb.) Urb.	—	1.1	1.2	1.1	1.2	IV
Byrsonima orientensis Bisse	+.1	1.1	1.1	—	—	III
Matayba domingensis (DC.) Radlk.	1.1	1.1	—	—	+.1	III
Buchenavia capitata (Vahl.) Eichl.	—	1.1	—	—	1.1	II
Pithecellobium arboreum (L.) Urb.	—	1.1	—	1.1	—	II
Magnolia cubensis Urb.	+.1	+.1	—	—	—	II
Ocotea leucoxylon (Sw.) Mez	—	—	1.1	1.1	—	II
Micropholis polita (Griseb.) Pierre	—	—	1.1	+.1	—	II
Alchornea latifolia Sw.	—	1.2	—	2.2	—	II
Zanthoxylum cubense P. Wils.	—	—	1.1	—	1.1	II
Accidentally: *Guarea guidonia* (1), *Cupania glabra* (2), *Cupania americana* (4), *Chaetocarpus globosus* (5), *Guatteria moralesii* (1), *Ocotea floribunda* (5), *Licaria jamaicensis* (2), *Cinnamomum montanum* (3), *Guapira ophiticola* (3), *Manilkara albescens* (5)						
Low canopy layer: 6—12 m tall, cover %	30	40	35	20	25	
Hyeronima nipensis Urb.	+.1	+.1	+.1	+.1	+.1	V
Myrsine coriacea (Sw.) R. Br.	+.1	+.1	1.1	1.2	1.1	V
Coccoloba retusa Griseb.	1.1	1.2	+.1	+.1	+.1	V
Chrysophyllum argenteum Jacq.	1.1	1.1	+.1	+.1	+.1	V
Miconia serrulata (DC.) Naud.	+.1	1.1	+.1	+.1	+.1	V
Dipholis cubensis (Griseb.) Pierre	+.1	1.1	+.1	+.1	1.1	V
Byrsonima biflora Griseb.	+.1	+.1	+.1	+.1	—	IV
Ocotea ekmanii O. C. Schmidt	—	+.1	1.1	+.1	1.2	IV
Coccoloba costata Wr. in Sauv.	—	1.1	+.1	+.1	1.2	IV
Guatteria moralesii Urb.	1.1	1.2	+.1	—	1.1	IV
Bactris cubensis Burret	+.1	+.1	—	+.1	+.1	IV
Ocotea cuneata (Griseb.) Urb.	1.1	+.1	+.1	—	+.1	IV
Guettarda lindeniana A. Rich.	+.1	—	+.1	+.1	+.1	IV
Calophyllum utile Bisse	+.1	+.1	—	—	+.1	III
Byrsonima coriacea R. Br.	1.1	—	—	1.1	1.1	III
Byrsonima orientensis Bisse	+.1	1.1	+.1	—	—	III
Protium cubense (Rose) Urb.	—	—	+.1	+.1	+.1	III
Terminalia nipensis Alain	1.1	1.1	1.1	—	—	III
Talauma minor Urb. ssp. *oblongifolia* (León) Borhidi	—	—	+.1	+.1	1.2	III
Alsophila aquilina C. Chr.	+.1	+.1	—	—	+.1	III
Leucocroton wrightii Griseb.	—	—	1.1	+.1	+.1	III
Pilocarpus racemosus Vahl.	+.1	+.1	—	—	+.1	III
Miconia tetrandra (Sw.) D. Don	—	+.1	+.1	+.1	—	III
Simaruba laevis Griseb.	—	—	+.1	+.1	1.2	III

Sample plots 30×30 m²	1.	2.	3.	4.	5.	C_5
Alchornea latifolia Sw.	1.1	+.1	—	—	+.1	III
Illicium cubense A. C. Sm.	1.1	1.1	—	—	+.1	III
Podocarpus ekmanii Urb.	—	+.1	+.1	—	—	II
Pera ekmanii Urb.	—	—	+.1	+.1	—	II
Annona cristalensis (Alain) Borh. et Monc.	—	—	+.1	+.1	—	II
Ocotea leucoxylon (Sw.) Mez	+.1	—	—	—	+.1	II
Calycogonium grisebachii Triana	—	—	—	+.1	+.1	II
Wallenia laurifolia (Jacq.) Sw.	+.1	+.1	—	—	—	II
Pithecellobium obovale (A. Rich.) Wr. in Sauv. ssp. *pinetorum* (Britt.) Borhidi	+.1	+.1	—	—	—	II
Ditta myricoides Griseb.	—	—	+.1	+.1	—	II

Accidentally: *Buchenavia capitata* (2), *Pithecellobium cubense* (1), *Pithecellobium nipense* (5), *Pisonia macracantha* (4), *Pisonia byrsonimifolia* (3), *Henriettea fascicularis* (3), *Pachyanthus neglectus* (3), *Pachyanthus discolor* (2), *Miconia guianensis* (5), *Cameraria latifolia* (5), *Leucocroton cordifolius* (5).

Shrub layer: 1—3 m tall, cover %	40	30	50	20	10	
Dipholis cubensis (Griseb.) Pierre	1.2	1.1	2.2	+.1	+.1	V
Rauvolfia salicifolia Griseb.	+.1	1.1	1.2	+.1	+.1	V
Antirhea shaferi Urb.	+.1	+.1	+.1	+.1	+.1	V
Cestrum laurifolium L'Hérit.	1.2	+.1	1.1	+.1	—	IV
Savia cuneifolia Urb.	+.1	+.1	2.2	+.1	+.1	V
Protium cubense (Rose) Urb.	+.1	—	1.1	+.1	+.1	IV
Meriania leucantha Sw. ssp. *nana* (Naud.) Borhidi	+.1	1.1	+.1	+.1	—	IV
Mozartia gundlachii (Kr. and Urb.) Urb.	2.2	1.1	+.1	—	—	III
Phyllanthus subcarnosus Wr. ex Muell. Arg.	+.1	—	+.1	+.1	—	III
Terminalia nipensis Alain	+.1	1.2	—	—	+.1	III
Dendropanax nervosus (Urb. et Ekm.) A. C. Sm.	—	—	1.2	+.1	+.1	III
Allophylus cristalensis Lippold	—	—	1.1	+.1	+.1	III
Solanum cristalense Amsh.	—	—	1.2	+.1	+.1	III
Polygala oblongata (Britt.) Blake	—	+.1	1.2	+.1	—	III
Illicium cubense A. C. Sm.	1.1	1.2	+.1	—	—	III
Calyptranthes punctata Griseb.	+.2	+.2	+.1	—	—	III
Psychotria shaferi Urb.	—	+.1	+.1	+.1	—	III
Calycogonium lindenianum Naud.	+.1	+.1	—	—	—	II
Phyllanthus pachystylus Urb.	+.1	+.1	—	—	—	II
Solanum pachyneurum C. E. Schulz	+.1	+.1	—	—	—	II
Psidium balium Urb.	+.1	—	—	—	+.1	II
Ouratea revoluta (Wr. ex Griseb.) Engl.	1.1	1.2	—	—	—	II
Coussarea urbaniana Standl.	+.1	+.2	—	—	—	II
Rhamnidium nipense Urb.	+.1	+.1	—	—	—	II
Lasianthus lanceolatus (Griseb.) Urb.	+.1	—	—	+.1	—	II

Accidentally: *Myrsine cristalensis* (3), *Jacquinia robusta* (2), *Manilkara wrightiana* (4), *Chionanthus axilliflorus* (1), *Cameraria latifolia* (5), *Tabebuia shaferi* (2), *Tabebuia pachyphylla* (4), *Tabebuia simplicifolia* (3), *Pera orientensis* (3), *Alsophila aquilina* (5), *Psychotria graminifolia* (1), *Myrtus leiophloeus* (2), *Krokia odiolens* (4).

Herb layer: 30—100 cm tall, cover %	20	15	15	10	15	
Piper holguinianum Trel.	+.1	+.1	+.1	+.1	+.1	V
Lithachne pauciflora	+.1	+.2	+.1	+.2	+.2	V

Sample plots 30×30 m²	1.	2.	3.	4.	5.	C_5
Oplismenus hirtellus (L.) Beauv.	1.2	1.2	1.1	1.1	1.2	V
Ichnanthus mayarensis (Wr.) Hitchc.	1.1	1.1	1.2	+.1	+.2	V
Pharus latifolius L.	1.2	+.1	+.1	—	+.1	IV
Savia cuneifolia Urb.	+.1	+.1	+.1	+.1	—	IV
Sapium cubense Britt. et Wils.	1.1	+.1	+.1	—	—	III
Allophylus cristalensis Lippold	—	—	+.1	+.1	+.1	III
Panicum glutinosum Sw.	—	+.1	1.1	—	—	II
Hedyosmum grisebachii Solms	+.1	+.1	—	—	—	II
Polygala oblongata (Britt.) Blake	—	—	+.1	+.1	—	II
Gesneria pachyclada Urb.	—	—	+.1	—	+.1	II

Accidentally: *Eulophia alta* (2), *Malaxis uniflora* (5), *Lycopodium cernuum* (3), *Thelypteris totta* (1), *Asplenium erosum* (3), *Tectaria heracleifolia* (2), *Adiantum trapeziforme* (4), *Phyllanthus myrtilloides* (1), *Pilea mayarensis* (2), *Thelypteris pennata* (3), *Nephrolepis pectinata* (4), *Lindsaya stricta* (3).

Lianes; cover %	10	25	10	5	5	
Scleria pilosissima Britt.	+.1	1.1	+.2	+.1	1.2	V
Schradera cubensis Steyerm.	+.2	+.2	1.2	+.1	+.1	V
Marcgravia evenia Kr. et Urb.	1.1	1.2	1.1	+.1	+.1	V
Smilax domingensis L.	1.2	2.2	—	1.2	+.1	IV
Lasiacis sloanei (L.) Hitchc.	+.1	+.1	—	+.1	+.1	IV
Platygyne triandra Borhidi	+.2	1.1	—	—	1.1	III
Odontosoria uncinella (Ktze) Fée	+.1	2.3	—	+.2	—	III
Vanilla phaeantha Rchb.f.	+.1	+.1	—	—	—	II
Vanilla wrightii Rchb.f.	—	+.1	+.1	—	—	II
Salacia nipensis Britt.	+.1	+.1	—	—	—	II
Philodendron lacerum (Jacq.) Schott	1.1	—	—	+.1	—	II
Rajania nipensis Howard	+.1	+.1	—	—	—	II

Accidentally: *Dicranopteris flexuosa* (2), *Angadenia lindeniana* (3), *Banisteria laurifolia* (5), *Smilax balbisiana* (1), *Dioscorea tamoidea* (5).

Epiphytes; cover %	25	25	25	15	20	
Jacquiniella globosa (Jacq.) Schltr.	+.1	+.2	+.2	+.1	+.1	V
Stelis ophioglossoides (Jacq.) Sw.	+.1	+.1	+.1	1.1	1.2	V
Polypodium phyllitidis L.	1.1	1.1	1.1	+.1	+.1	V
Mecodium polyanthos (Sw.) Copel.	+.1	+.2	1.1	1.2	1.1	V
Trichomanes crispum L.	1.2	2.2	2.2	2.3	1.3	V
Vandenboschia scandens (L.) Copel.	2.2	1.1	2.2	+.1	+.1	V
Dinema cubincola (Borhidi) H. Dietr.	+.1	+.1	+.1	—	+.1	IV
Pleurothallis tribuloides (Sw.) Lindl.	+.2	+.2	+.1	—	+.1	IV
Meringium fucoides (Sw.) Copel.	1.1	1.2	1.1	—	2.2	IV
Hillia parasitica Jacq.	+.1	+.1	+.1	—	—	III
Dichaea hystricina Rchb.f.	—	—	+.1	+.1	+.1	III
Dilomilis oligophylla (Schltr.) Summerh.	—	—	+.1	+.1	+.1	III
Psychotria guadelupensis (DC.) Howard	—	—	—	+.1	+.1	II
Polystachya cubensis	+.1	—	+.1	—	—	II
Pleurothallis velaticaulis Rchb.f.	+.1	—	—	+.1	—	II
Elaphoglossum firmum (Mett.) Urb.	—	+.1	—	—	+.1	II
Feea rigida (Sw.) Copel.	—	+.1	—	+.1	—	II

Accidentally: *Didymoglossum kraussii* (2), *Mecodium abruptum* (3), *Vandenboschia capillacea* (2), *Lepanthes grisebachii* (2), *Epidendrum hioramii* (4), *Dichaea glauca* (1), *Elaphoglossum pusillum* (5), *Grammitis serrulatum* (1), *Grammitis shaferi* (3), *Hymenodium crinitum* (1).



Fig. 372 Sclerophyllous evergreen montane rainforests on serpentine and riverside scrub on the eastern slope of El Toldo at about 600 m a.s.l. (Photo: A. Borhidi)

23.4.1 Alliance: ***Calyptronomo-Cyrillion racemiflorae***
Borhidi in Borhidi et al. 1979 et hoc loco

Riverside broad-leaved, evergreen forests in Central and West Cuba.

Characteristic species: *Calyptronoma dulcis, C. intermedia, C. microcarpa, Calophyllum antillanum, C. antillanum* ssp. *rivularis, Dendropanax cuneifolius, Calyptranthes ferruginea, C. clementis, Pachyanthus angustifolius, Calyptropsidium sartorianum, Mitranthes ottonis, Alsophila myosuroides, Henriettea patrisiana,* etc.

Assocation studied:

Calyptronomo-Cyrilletum racemiflorae Borhidi and Capote

This is the riverside forest community of West-Cuba, mainly in the Sierra de los Organos range but descending also to the southern plain of the Province Pinar del Rio. The type relevé was made in the valley of Rio Frio, N orth Guane on crystalline slate rock.

23.4.2 Alliance: ***Calyptronomo clementis-Cyrillion racemiflorae***
Borhidi (1979) nom. nov.

Riverside humid, broad-leaved evergreen forest, mixed with "Manaca-palm" in the upper tree layer, occurring mainly in the Sierra Maestra range (Fig. 373).

Characteristic species: *Calyptronoma clementis, Bactris cubensis, Cyrilla racemiflora, Mozartia manacalensis, maestrensis, Rondeletia calophylla, Callophyllum antillanum* ssp. *rivulare, Chimarrhis cubensis, Phaius tankervilliae, Eugenia laeteviridis, E. maestrensis,* etc.

Associations studied:

Calyptronomo clementis-Cyrilletum racemiflorae Borhidi

24 Class: **RONDELETIO-GESNERIETEA**
Borhidi and Muñiz in Borhidi et al. (1979) in Borhidi and Capote 1984

Riverside evergreen scrub and suffrutescent vegetation, growing on the stony stream-deposits along the montane rivers of the mountain ranges in the Antilles.

Characteristic species and genera: *Rondeletia* spp., *Gesneria humilis* and other spp., *Exostema longiflorum* and other spp., *Buxus spp., Eugenia* spp., *Calyptranthes* spp., *Plinia* spp., *Aster* spp., *Ginoria americana* and spp., *Pilea* spp., *Heptanthus* spp., *Sapphoa rigidifolia, Phyllanthus* spp., *Erigeron bellioides* and other spp., *Chaptalia* spp., etc.

24.1 Order: RONDELETIO-GINORIETALIA
Borhidi in Borhidi et al. (1979) in Borhidi Capote 1984

Riverside off-serpentine evergreen scrubs and suffrutescent vegetation.

24.1.1 Alliance: ***Rondeletio microphyllae-Ginorion***
Borhidi and Capote in Borhidi et al. (1979) in Borhidi and Capote 1984

Riverside evergreen scrubs and suffrutescent vegetation in Central and West Cuba.

Characteristic species: *Rondeletia microphylla, R. peduncularis, R. pedicellaris, R. leonis, Ginoria americana, G. ginorioides, Exostema longiflorum* (Fig. 374), *Jussiaea decurrens, Aster burgessii, Cuphea lobelioides, Eugenia oligantha, Erigeron thrincioides, E. paucilobus, E. capillipes, Oldenlandia capillipes,* etc.



Fig. 373 "Manacal", the montane riverside palm gallery forest of the Moa range with *Calyptronoma clementis* ssp. *orientensis* Borhidi et Muñiz in the valley of the Anacleto river, Jaguani Reserve (Photo: A. Borhidi)



Fig. 374 Exostema longiflorum (Lamb.) R. and S. a characteristic subshrub of the riverside scrubs in Cuba (Photo: A. Borhidi)

Associations studied:

Rondeletio microphyllae-Gesnerietum humilis Borhidi in Borhidi and Capote 1984

This is a suffrutescent low plant community on the different (limestone, slate, sandstone) rocks continuously irrigated or flooded by the river stream and formed by creeping or decumbent dwarf shrubs in West Cuba. The association is poor in species, as illustrated in Table 141. The type relevé is no. 1, made in the Rio Mantua, (Pinar del Rio Province) in December, 1975, by Borhidi and Capote.

Eugenio-Cuphaeetum lobelioidis Borhidi in Borhidi and Capote, 1984

Suffrutescent riverside community mainly on limestone rocks, in the Sierra de los Organos. Five representative relévés made by Borhidi in 1975—1976, near Sumidero and Guane. Type relevé no. 3 (Table 142), at the Resolladero of the Guyaguateje river.

Exostemo-Ginorietum americanae Borhidi and Capote 1984

This is an evergreen riverside scrub association with two layers growing on limestone rocks of the Sierra del Rosario (Fig. 375) and perhaps in other limestone

Table 141 Rondeletio microphyllae-Gesnerietum Borhidi in Borhidi Capote 1984

	1	2	3	4	5
Cover %	50	55	60	45	40
Rondeletia microphylla Griseb.	2.3	2.3	2.2	2.2	1.2
Gesneria humilis L.	2.3	3.3	3.4	2.3	3.3
Erigeron thrincioides Griseb.	+.1	+.1	1.1	—	—
Oldenlandia capillipes Griseb.	+.1	—	—	+.2	—

Table 142 Eugenio-Cupheetum lobelioidis Borhidi in Borhidi and Capote 1984

	1	2	3	4	5
Cover %	40	45	50	35	45
Eugenia oligandra Urb.	1.3	2.3	2.3	+.2	2.3
Cuphea lobelioides Griseb.	2.3	2.2	2.3	2.2	2.2
Sauvagesia brownei Planch.	+.2	1.2	1.2	—	—
Pilea microphylla (L.) Liebm.	+.2	1.2	+.2	+.2	1.2
Pilea pubescens Liebm.	—	—	+.1	—	—
Anemia wrightii Baker	—	+.1	—	—	+.1
Erigeron hyoseroides Griseb.	—	—	+.1	—	—

mountains as well. Five representative relevés were made by Borhidi and Capote in different river valleys of the Sierra del Rosario near Soroa, San Diego de los Baños and Rangel in 1975 and 1976. Type relevé no. 1, (Table 143) was made in the valley of Rio San Diego in November, 1975.

24.2 Order: RONDELETIO-PURDIAEETALIA Borhidi in Borhidi et al. (1979) in Borhidi and Capote 1984

Riverside scrub vegetation on humid serpentine rocks of the mountains of Oriente (East Cuba).

Characteristic species: *Rondeletia pachyphylla, R. alaternoides* s.l. *Purdiaea* spp., *Leucocroton* spp., *Heptanthus* spp., *Pilea* spp., *Mozartia* spp., *Myrcia* spp., *Calyptranthes* spp., *Gundlachia* spp., *Schmidtottia* spp., *Chaptalia* spp., etc.

24.2.1 Alliance: ***Purdiaeo-Rondeletion pachyphyllae*** Borhidi in Borhidi et al. (1979) in Borhidi and Capote 1984

Riverside sclerophyllous evergreen scrub vegetation in the serpentine mountains of the northern part of Oriente, represented by a number of different communities composed of vicarious species of the same genera.



Fig. 375 Riverside evergreen scrub (*Exostemo-Ginorietum americanae* association) in the valley of Rio Los Palacios, Sierra del Rosario (Photo: A. Borhidi)

Table 143 Exostemo-Ginorietum americanae Borhidi and Capote 1984

	1	2	3	4	5
Shrub layer 1 m high cover %	50	60	60	55	45
Ginoria americana Jacq.	3.4	4.4	4.5	3.4	3.3
Mithranthes ottonis Berg	+.1	1.1	+.1	1.2	1.2
Exostema longiflorum (Lamb) R. and S.	1.2	1.1	—	1.2	+.2
Herb layer 30 cm high cover %	70	65	70	80	95
Rondeletia microphylla Griseb.	2.3	2.2	2.3	3.3	3.3
Gesneria humilis L.	3.3	2.3	2.3	3.4	4.4
Jussiaea decurrens (Walt.) DC.	+.1	—	—	+.1	—
Aster burgessii Britt.	—	—	+.2	—	+.1



Fig. 376 Pinguicula lingnicola Barnh. a peculiar epiphytic carnivorous plant of the montane rainforest of the Moa and Iberia ranges (Photo: A. Borhidi)

Characteristic species: *R. pachyphylla, R. shaferi, R. alaternoides, R. vacciniifolia, Calyptranthes monocarpa, C. moaensis, C. toaensis, C. pseudomoaensis, Leucocroton stenophyllus, L. acunae, L. obovatus, Purdiaea shaferi, P. ekmanii, P. moaënsis, P. velutina, Acrosynanthus revolutus, Oldenlandia polyphylla, Schmidtottia cubensis, S. monantha, S. uliginosa, Buxus foliosa, Exostema stenophyllum, Heptanthus cordifolius, H. shaferi, Chaptalia nipensis, C. shaferi, Phyllanthus chamaecristoides,* the epiphytic carnivorous *Pinguicula lignicola* (Fig. 376)



Fig. 377 Riverside evergreen scrub (*Leucocrotoni-Rondeletietum pachyphyllae* association) on the serpentine of the Nipe Mountains, at the Guayabo River (Photo: A. Borhidi)

Associations studied:

Exostemo-Leucocrotonetum stenophylli Borhidi in Borhidi and Capote 1984

This is the riverside serpentine scrub-community of the Sierra de Nipe (Fig. 377), formed by a dense shrub and a low dispersed herb layer, many lianes and few epiphytes. Five representative relevés were made by Borhidi in February, 1976 in the valleys of Rio Guaro, Rio Sojo, and Rio Piloto, in the Sierra de Nipe. The type relevé: no. 1, Table 144 made in the Rio Guaro above the waterfall.

Buxo foliosae-Acrosynanthetum revoluti
Borhidi and Muñiz in Borhidi and Capote 1984

This is the riverside serpentine scrub community in the montane rivers of the Moa range. The structure of the community is similar to that of the former association, but the lianes are poorly represented. The high participation of endemics is an outstanding feature. Five relevés were made by Borhidi and Muñiz in March, 1970 in the valley of the Rio Iberia about 550—600 m a.s.l. The type relevé is no. 1, (Table 145).

Table 144 Exostemo-Leucocrotonetum stenophylli Borhidi in Borhidi and Capote 1984

	1	2	3	4	5
Shrub layer: height: 1—2 m; cover %:	60	50	65	70	55
Leucocroton stenophyllus Urb.	2.3	2.2	2.3	3.3	2.2
Rondeletia pachyphylla Krug et Urb.	2.2	2.2	2.2	1.1	+.1
Calyptranthes monocarpa Urb.	—	—	—	+.2	+.1
Schmidtottia cubensis (Standl.) Urb.	—	—	—	1.1	1.1
Scolosanthus reticulatus Borhidi	+.1	1.1	—	—	—
Psychotria linearifolia Urb.	—	—	+.1	—	—
Brya hirsuta Borhidi	—	—	—	1.1	+.1
Calycogonium rosmarinifolium Griseb.	1.1	+.1	+.1	+.1	—
Ateramnus recurvus (Urb.) Rothm.	+.1	+.1	—	1.2	+.1
Gundlachia apiculata Britt. et Blake	—	+.2	—	—	—
Purdiaea nipensis M. Vict.	+.1	+.1	+.1	—	+.1
Clidemia rubrinervis Cogn.	+.1	—	—	+.1	—
Cassia shaferi Britt. et Wils.	—	+.1	—	—	—
Hypericum fasciculatum Lam.	+.2	1.2	1.2	—	+.2
Phyllanthus shaferi Urb.	+.2	—	+.1	+.1	—
Herb layer: height: 5—40 cm; cover %:	20	25	15	15	25
Exostema stenophyllum Britt.	1.1	1.2	+.2	+.2	1.1
Spaniopappus shaferi (Robins.) King et Robins.	+.1	+.r	—	—	—
Heptanthus cordifolius Britt. et Wils.	+.2	+.2	+.2	—	—
Chaptalia nipensis Urb.	+.r	+.1	—	+.1	+.r
Salvia cubensis Britt.	—	+.1	—	+.1	+.1
Paepalanthus rivularis Griseb.	1.2	2.2	1.2	1.2	2.2
Lianes:					
Platygyne triandra Borhidi	+.1	+.1	+.1	—	—
Serjania nipensis Urb.	—	—	+.1	+.1	+.1
Harnackia bisecta Urb.	—	—	—	+.1	+.r
Rajania linearis Howard	—	+.1	+.r	—	—
Epiphytes:					
Oncidium ghibertianum A. Rich.	—	—	—	+.1	—

24.2.2 Alliance: ***Gundlachio-Bryon subinermis*** Borhidi in Borhidi et al. 1979

Riverside scrubs pioneering on the sandbanks deposited by the lower sections the mountain rivers in Oriente.

Characteristic species: *Gundlachia lindeniana, G. cubana, G. apiculata, Brya subinermis, B. chrysogonii, Tabebuia rivularis, Ginoria montana, G. arborea,* etc.

Associations studied:

Gundlachio-Bryetum subinermis Borhidi and Muñiz in Borhidi et al. 1979

Table 145 Buxo foliosae-Acrosynanthetum revoluti Borhidi and Muñiz in Borhidi and Capote 1984

	1	2	3	4	5
Shrub layer: 1—2 m high; cover %	60	70	75	80	70
Buxus foliosa (Britt.) Urb.	2.3	3.3	3.4	2.3	1.2
Acrosynanthus revolutus Urb.	3.3	2.2	2.2	3.4	2.3
Rondeletia pachyphylla Kr. et Urb.	1.2	1.2	1.2	2.2	2.3
Calyptranthes pseudomoaensis Borhidi et Muñiz	—	+.2	+.2	—	—
Schmidtottia monantha Urb.	+.1	—	—	+.1	—
Purdiaea velutina Britt. et Wils.	1.1	1.2	—	1.1	1.2
P. moaensis M. Vict.	+.2	+.1	1.2	+.1	+.2
Moacroton ekmanii (Urb.) Croiz.	—	—	+.1	+.r	—
Psychotria moaensis Britt. et Wils.	+.1	+.1	—	—	+.1
Ateramnus recurvus (Urb.) Rothm.	+.1	+.2	+.2	1.2	+.1
Miconia moaensis Alain	+.1	—	—	+.1	—
Ossaea baracoensis Borhidi et Muñiz	—	—	+.1	—	+.1
Hypericum fasciculatum Lam.	+.1	+.2	1.2	1.2	1.2
Scolosanthus lucidus Britt.	+.2	+.2	—	—	+.2
Croton monogynus Urb.	+.1	—	—	—	+.r
Rondeletia vacciniifolia Urb.	—	—	—	1.2	+.r
Pithecellobium nipense Britt. et Wils.	—	—	1.1	—	—
Garcinia polyneura (Urb.) Borhidi	—	+.1	+.2	—	—
Herb layer: height: 5—40 cm; cover %	30	35	20	15	40
Paepalanthus rivularis Griseb.	2.3	2.3	2.2	1.2	2.3
Heptanthus shaferi Britt.	+.2	+.1	—	+.1	—
Chaptalia shaferi Britt.	+.1	+.r	+.r	+.r	+.1
Oldenlandia polyphylla Urb.	—	+.1	—	+.1	—
Mniochloa pulchella (Griseb.) Chase	—	—	—	+.2	—
Pilea fruticulosa Morton	+.2	—	+.1	+.2	2.2
Phyllanthus erythrinus Muell. Arg.	1.1	—	—	—	1.2
Lianes:					
Mikania alba Taylor	—	+.1	+.1	—	—
Epiphytes:					
Octadesmia oligophylla Schltr.	—	—	+.1	—	—
Pinguicula lignicola Barnh.	—	+.r	—	—	—

25 Class: **WEINMANNIO-CYRILLETEA** Knapp 1964

Cloud and mossy forests of the high mountain belts of the Antilles. They are rich in epiphytic micro-orchids, tree ferns and epiphytic and filmy ferns (e.g., *Polypodium, Microlepis, Grammitis, Hymenophyllum, Feea, Trichomanes, Elaphoglossum* species), in lycopodiaceas, in terrestrial, ramicolous and epiphyllous mosses and liverworts.

Characteristic species in Cuba: *Weinmannia pinnata, Cyrilla nipensis, Persea similis, P. anomala, Ocotea ekmanii, Cyathea arborea, C. balanocarpa, C. insignis, Nephelea pubescens, Dennstaedtia* spp., *Marattia alata, Gleichenia* spp., *Torralbasia lenticellata, Ternstroemia monticola, T. leonis,* ericaceas and melastomataceas, etc.

25.1 Order: WEINMANNIO-CYRILLETALIA Knapp 1964

With the same characteristics as the class.

25.1.1 Alliance: ***Cyrillo-Myrsinion*** Borhidi and Muñiz in Borhidi et al. 1979

Cloud forests of the Greater Antilles, in Cuba mainly occurring in the Sierra Maestra range between 1600 and 1900 m a.s.l. and by inversion also in the Gran Piedra and in the Loma del Gato in 1100—1200 m a.s.l.

Characteristic species: *Myrsine microphylla, Nectandra reticularis, Sapium maestrense, Ditta maestrensis, Torralbasia lenticellata, Garrya fadyenii, Hedyosmum cubense, H. nutans, Henriettea ekmanii, Tetrazygia elegans, Ternstroemia leonis, T. monticola, Miconia turquinensis, Ossaea maestrensis, Scolosanthus maestrensis,*

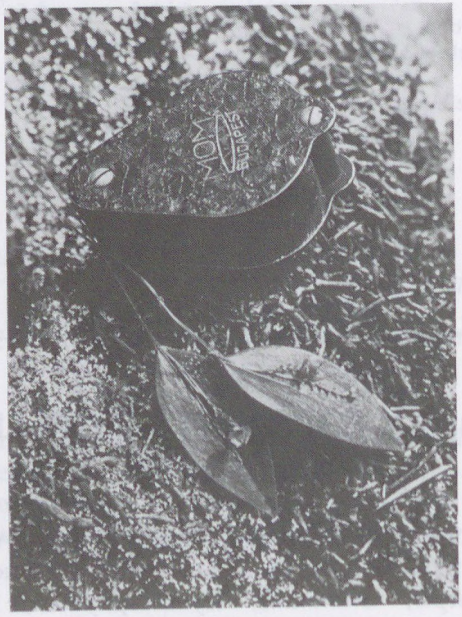


Fig. 378 Lepanthes ekmanii, one of the tiniest orchids of the Cuban flora, in the elfin forest of Pico Turquino (Photo: A. Borhidi)

Lepanthes spp. (Fig. 378), *Pleurothallis* spp., *Microlepanthes* spp., *Stelis* spp., and mosses, such as *Phyllogonium fulgens, Meteriopsis patula, Mettenothamnium reptans, Macromitrium* spp.,, *Hypnum polypterum, Pilotrichella flexilis, Rhizogonium spiniforme, Drepanolejeunea* spp., *Cololejeunea* spp., etc.

Associations studied:

Myrsino-Nectandretum reticularis Borhidi and Muñiz in Borhidi et al. 1974

This zonal cloud forest or elfin forest association of the highest level of the Sierra Maestra range, developed especially in the Turquino group between 1600 and 1900 m a.s.l. The characteristic species are the same as those of the alliance. The association is composed of a unique canopy level in which tree-ferns and microphyllous small evergreen trees are combined. The shrub layer is abundant and densely covered by mosses and hepatics even on the leaf-surfaces. Five representative relevés were made by Borhidi and Muñiz in the Turquino group in December 1969. The synthetic list of these relevés is column no. 22 in the Table 25 (Appendix).

26 Class: **MYRICO-BACCHARIDETEA** Knapp 1964

Subalpine, humid, microphyllous evergreen scrubs, thickets or elfin thickets between the zones of the cloud forests and paramos.

Characteristic genera: *Myrica, Baccharis, Lyonia, Vaccinium, Ilex*, etc.

26.1 Order: MYRICO-LYONIETALIA Knapp 1964 emend, Borhidi in Borhidi et al. 1979 et hoc loco

Microphyllous subalpine thickets or elfin thickets of the Greater Antilles.

26.1.1 Alliance: ***Ilici-Myricion*** Borhidi and Muñiz in Borhidi et al. 1979 et hoc loco

Elfin scrubs and thickets on the steep rocky slopes and cliffs in the elfin forest belt (in Cuba exclusively in the Turquino group, between 1800 and 2000 m a.s.l.).

Characteristic species: *Ilex turquinensis, I. nunezii, I. nannophylla, Lyonia calycosa, L. turquini, Peratanthe cubensis, Myrica cacuminis, Lobelia cacuminis, Micromeria bucheri, Salvia speirematoides, Rubus turquinensis, Vernonia praestans* var. *cacuminis, Agave pendentata, Juniperus saxicola, Ternstroemia monticola, Mitracarpus acunae, Eupatorium turquinense, Pleurothallis* spp. *Microlepanthes* spp.

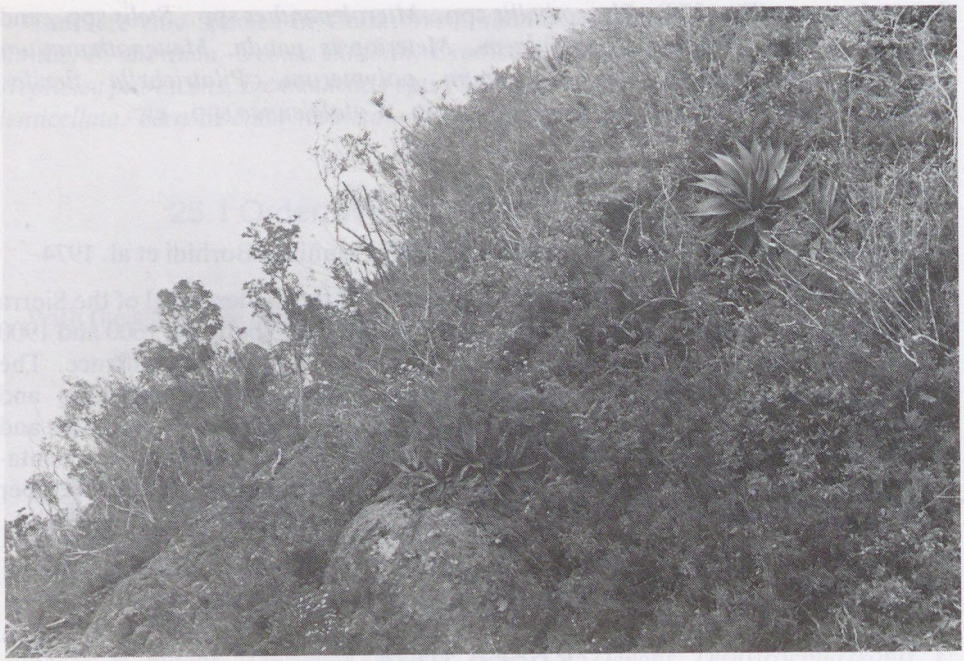


Fig. 379 The *Ilici-Myricetum cacuminis* elfin thicket community on the southern slope of Pico Turquino at 1950 m altitude. (Photo: A. Borhidi)

Associations studied:

Ilici turquinensi-Myricetum cacuminis Borhidi and Muñiz ass. nova

The elfin thicket association (Fig. 379) of the highest part of the Sierra Maestra. It is formed by a 2—3 m high, extremely dense shrub layer formed by microsclerophyllous evergreen bushes and small trees. The herb layer is scarcely developed and is sometimes formed by suffrutescent plants *(Ascyrum, Hypericum)* and by rosulate hemicryptophytes such as *Chaptalia turquinensis.*

Agavo pendentatae-Mitracarpetum acunae Borhidi and Muñiz ass. nova

Low elfin thicket association developing as a completely closed carpet on the steep, rocky, intensively insolated and rather dry southern slopes of the Turquino group, in the elfin forest belt. From the low shrub layer emerge the individuals of *Agave pendentata* (endemic of the Turquino Peak) and the shrubs, dwarf shrubs *(Mitracarpus acunae)* and creeping hemicryptophytes *(Peratanthe cubensis)* — all endemics are often densely interwined by the montane bamboo-like climber, *Chusquea abietifolia.* A combined synthetic list of the five relevés reperesenting the two associations of the alliance is found in Table 25. column no. 23. The relevés were made by Borhidi and Muñiz on the southern slopes and high ridge of the Pico Real—principal peak of Turquino group at about 1900—1990 m a.s.l.



Fig. 380 Siphocampylus glaber McVaugh, an endemic sub-shrub of the evergreen montane serpentine scrub of the Nipe Mountain (Photo: A. Borhidi)

27 Class: **CLUSIO-ILICETEA**
Borhidi and Muñiz in Borhidi et al. 1979

Semi-dry montane and elfin forests and thickets on serpentine rocks, replacing the cloud forests and elfin thickets of the non serpentine mountains in the serpentine ranges of the Greater Antilles, first of all in north-eastern Cuba. This vegetation type is formed by micro-sclerophyllous shrubs and small trees, with an extremely reduced participation or complete absence of tree-ferns, epiphytes, mosses and epiphyllous liverworts.

Characteristic genera: *Clusia, Ilex, Laplacea, Acrosynanthus, Calyptranthes, Buxus, Schmidtottia, Dasytropis, Phidiasia, Calycogonium, Pachyanthus, Ossaea, Miconia, Coccoloba, Feddea,* etc.

27.1 Order: CLUSIO-ILICETALIA
Borhidi and Muñiz in Borhidi et al. 1979

Semi-dry montane and elfin forests and thickets on serpentine rocks with an extremely high participation of endemic elements.

Characteristic species: *Clusia nipensis, C. monocarpa, C. callosa, C. alainii, C. moaënsis, Ilex moaënsis, I. shaferi, I. berteroi, I. hypaneura, I. subavenia,*

Schmidtottia sessiliflora, S. monticola, Laplacea moaënsis, L. benitoënsis, L. cristalensis, Acrosynanthus trachyophyllus, Phialanthus macrostemon, P. glaberrimus, Purdiaea microphylla, Siphocampylus glaber (Fig. 380), *Vaccinium shaferi, Myrica shaferi, Shaferocharis cubensis, Buxus crassifolia, B. retusa, B. historica, B. shaferi, Coccoloba nervosa, C. oligantha, Shafera cubensis, Feddea cubensis, Euphorbia munizii, Leucocroton moaënsis,* etc.

27.1.1 Alliance: ***Ilici-Laplaceion moaënsis***
Borhidi and Muñiz in Borhidi et al. 1979

Montane semidry sclerophyllous evergreen elfin forests and thickets in the serpentine highlands and mountains in the Sierra del Cristal, Cuchillas de Moa, Toa and Baracoa between 650—1300 m a.s.l.

Associations studied:

Ilici-Laplaceetum benitoensis Borhidi and Muñiz in Borhidi et al. 1979 et hoc loco

Semi-dry evergreen sclerophyllous low forest (elfin forest type) on the deeper latosols of the serpentine plateaus of Sierra de Iberia and Cupeyal.

Clusio-Ilicetum shaferi Borhidi and Muñiz in Borhidi et al. 1979 et hoc loco

Dry evergreen sclerophyllous elfin forests on the high serpentine ridges of shallow, rocky soils in the serpentine mountains of the Sierra de Moa, Cuchillas de Toa, Sierra de Iberia, etc.

A combined synthetic list of five relevés representing the two above associations, made by Borhidi and Muñiz, in March, 1970 can be found in Table 25 column no. 16 (Appendix).

According to Balátová-Tulácková and Garcia 1987, the list of the studied anthropic weed vegetation is the following:

Class: **PARTHENIO–DICHANTHIETEA ANNULATI** Bal.-Tul. 1987
Order: PARTHENIO–BIDENTETALIA PILOSAE Samek in Bal.-Tul. and Garcia 1987
Alliance: ***Parthenio–Bidention pilosae*** Samek 1971
Ass.: **Amarantho siponosi–Parthenietum hysterophori** Samek 1971
Order: DICHANTHIETALIA ANNULATI Bal.-Tul. 1987
Alliance: ***Dichanthion annulati*** Bal.-Tul. 1987
Ass.: **Hyparrhenietum rufae** Bal.-Tul. 1987
Centrosemo–Panicetum maximi Bal.-Tul. and Garcia 1987
Chamaesyci–Cynodontetum dactylonis Bal.-Tul. 1987
Sporoboletum indici Bal.-Tul. 1987
Axonopetum compressi Bal.-Tul. 1987
Brachiario–Dactyloctenietum aegyptii Bal.-Tul. 1987
Order: HYPTIDI–PASPALETALIA CONJUGATI Bal.-Tul. 1987
Alliance: ***Hyptido–Paspalion conjugati*** Bal.-Tul. 1987
Ass.: **Hyptido–Paspaletum conjugati** Bal.-Tul. and Urquiola 1987

Table 25 Synthetic phytosociologic table of Cuban woody communities
For the columns see pages 198—199

Abbreviations for life form types

A Giant trees (taller than 30 m), megaphanerophyte
B Tall trees (between 15—30 m), mesophanerophyte
C Small trees (between 5—15 m), mesophanerophyte
D Dwarf trees and tall shrubs (2—5 m) microphanerophyte
E Shrubs (0.5—2 m) nanophanerophyte
G Tall palms and rosulate trees (8—30 m), rosulate mesophanerophyte
H Small and dwarf palms and rosulate trees, rosulate microphanerophyte
I Woody epiphytes, phanerophytic epiphyte
J Woody lianes
K Trunk succulents, phanerophytic succulent
M Tree-sized herbs
N Tree-ferns
O Herbaceous perennials, hemicryptophyte
P Geophytes
Q Helo-hydatophytes
R Annuals, therophyte
T Herbaceous lianes
U Herbaceous, shade-tolerant and hygrophylous epiphytes
X Herbaceous drought-resistant epiphytes
V Subshrubs, chamaephyte
Y Dwarf or leaf-succulents, chamaephytic succulents

/2 macrophyllous plant
/3 mesophyllous plant
/4 notophyllous plant
/5 microphyllous plant
/6 nanophyllous plant
/7 leptophyllous plant
/8 aphyllous plant
! spinose and/or thorny plant

Note: the symbols are used in combinations, e.g.,
A/2 macrophyll megaphanerophyte,
E/7! spinose leptophyll shrub

Abbreviations for phytogeographic elements

a/ local endemics

a/1 endemics of Isle of Pines
a/2 endemics of the pine belt of Pinar del Rio
a/3 endemics of Cajalbana

a/4 endemics of the Sierra de Nipe
a/5 endemics of the Moa-Toa-Baracoa ranges
a/6 endemics of the Turquino Peak
a/7 endemics of the Sierra de Escambray
a/8 endemics of the limestone karsts of the Sierra Maestra
a/9 endemics of the Sierra de los Organos
a/10 endemics of the provinces Havanna and Matanzas
a/11 endemics of Las Villas province
a/12 endemics of Camagüey province
a/13 endemics of the serpentines of Holguin
a/14 endemics of the south-eastern dry coastal belt of Oriente

b/ regional endemics

b/1 endemics of the Isle of Pines and Pinar del Rio
b/2 endemics of the Nipe-Baracoa serpentine zone
b/3 endemics of the montane belts of Oriente
b/4 endemics of Central Cuba

c/ endemics of wider distribution

d: endemics of West Cuba
e: endemics of East Cuba
f: pan-Cuban endemics

d/ phytogeographical elements of the Caribbean

g: elements of the Greater Antilles
h: elements of the Antilles
i: elements of the Antilles and Bahamas
j: elements of the Bahamas and Cuba
k: elements of Cuba–Florida and SE-USA
l: North Caribbean elements
m: South Caribbean elements
n: pan-Caribbean elements

e/ tropical elements of wider distribution

o: elements of the Antilles and South America
p: Neotropical elements (Antilles+Central America+South America)
r: Pantropical elements

f/ other elements

s: American and extratropical elements
u: Cosmopolitan elements
v: Neotropical adventives
x: Paleotropical adventives

APPENDIX

Table 25 Synthetized phytosociologic table of the Cuban woody communities

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
T	r	*Abrus precatorius* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/7!	a/14	*Acacia Cowellii* (BRITT. et ROSE) LEÓN	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/7!	b/4	*A. daemon* EKM. & URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C/7!	r	*A. farnesiana* (L.) WILLD.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C/7!	m	*A. macracanthoides* BERT.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	g	*Acalypha glechomifolia* A. RICH.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/4	f	*A. membranacea* A. RICH.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
V	a/9	*A. mogotensis* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
V	c	*A. pendula* WR.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/7!	e	*Acidocroton oligostemon* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
H	n	*Acoelorraphe Wrightii* WENDL.	90	70	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
G!	f	*Gastrococos crispa* (MORALES) H. E. MOORE	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Q	r	*Acrostychum aureum* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Q	p	*A. danaifolium* LANSD. & FISCH.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	b/2	*Acrosynanthus latifolius* STANDL.	—	—	—	—	—	—	—	—	—	—	30	—	—	—	—	40	40	—	—	—
E/6	a/5	*A. minor* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	100	—	—	—
E/6	b/2	*A. revolutus* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—	—	—	—	—
D/4	a/5	*A. trachyphyllus* STANDL.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	100	—	—	—	—
C/5	h	*Adelia ricinella* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
P	c	*Adiantopsis asplenioides* MAX.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
P	g	*A. paupercula* (KUNTZE) FÉE	—	—	—	—	—	—	—	—	—	—	40	—	—	—	—	40	40	60	—	—
P	o	*A. pedata* (HOOK.) MOORE	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
P	m	*Adiantum cristatum* L.	—	—	—	—	—	—	—	—	60	—	—	—	—	—	50	—	—	—	—	—
P	h	*A. deltoideum* SW.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
P	P	*A. fragile* SW.	—	—	—	30	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
P	p	*A. latifolium* LAM.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	30
O	l	*A. melanoleucum* WILLD.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
P	o	*A. pulverulentum* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	60	40
P	f	*A. sericeum* EAT.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
P	p	*A. tenerum* SW.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
T	r	*Abrus precatorius* L.	–	–	–	–	–	–	–	40	40	40	–	–	–	–	–	–	–	–	–	–
E/7!	a/14	*Acacia Cowellii* (BRITT. et ROSE) LEÓN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	–
E/7!	b/4	*A. daemon* EKM. & URB.	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–
C/7!	r	*A. farnesiana* (L.) WILLD.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	60	60	30	40
C/7!	m	*A. macracanthoides* BERT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50	–
O	g	*Acalypha glechomifolia* A. RICH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
E/4	f	*A. membranacea* A. RICH.	–	–	–	–	–	–	40	40	–	40	–	–	–	–	–	–	–	–	–	–
V	a/9	*A. mogotensis* URB.	–	–	–	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	c	*A. pendula* WR.	–	–	–	–	–	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–
E/7!	e	*Acidocroton oligostemon* URB.	–	–	–	–	60	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–
H	n	*Acoelorraphe Wrightii* WENDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–	–	–	–
G!	f	*Gastrococos crispa* (MORALES) H. E. MOORE	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–	–	–	–	–
Q	r	*Acrostychum aureum* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	40	–	–	–
Q	p	*A. danaifolium* LANSD. & FISCH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–
D/5	b/2	*Acrosynanthus latifolius* STANDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	a/5	*A. minor* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
E/6	b/2	*A. revolutus* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	a/5	*A. trachyphyllus* STANDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	h	*Adelia ricinella* L.	–	–	–	80	100	60	100	100	100	100	–	–	–	–	–	–	80	–	90	30
P	c	*Adiantopsis asplenioides* MAX.	–	–	–	–	–	60	40	–	–	–	–	–	–	–	–	–	–	–	–	–
P	g	*A. paupercula* (KUNTZE) FÉE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P	o	*A. pedata* (HOOK.) MOORE	–	–	–	60	80	60	40	–	–	–	–	–	–	–	–	–	–	–	–	–
P	m	*Adiantum cristatum* L.	40	–	–	100	40	40	80	40	40	80	–	–	–	–	40	–	–	–	–	–
P	h	*A. deltoideum* SW.	–	–	–	40	–	100	100	–	–	–	–	–	–	–	–	–	–	–	40	30
P	P	*A. fragile* SW.	60	40	–	40	–	80	40	–	–	40	–	–	–	–	40	–	–	–	–	–
P	p	*A. latifolium* LAM.	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	l	*A. melanoleucum* WILLD.	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P	o	*A. pulverulentum* L.	60	60	–	–	–	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–
P	f	*A. sericeum* EAT.	–	–	–	–	60	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–
P	p	*A. tenerum* SW.	–	–	–	40	–	80	40	–	–	40	–	–	–	–	–	–	–	–	–	–

Table 25 Continued 2

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
P	o	*A. trapezioides* FÉE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
X	g	*Aechmea nudicaulis* (L.) GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	40	30	–	–	–	100	30
O	c	*Aeschynomene tenuis* GRISEB.	–	30	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
K!	a/14	*Agave albescens* TREL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
K!	a/13	*A. anomala* TREL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
K!	b/4	*A. Brittoniana* TREL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
K!	a/3	*A. cajalbanensis* ALVAREZ	–	–	–	–	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
K!	f	*A. Legrelliana* JACOBI	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
K!	a/6	*A. pendentata* TREL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
K!	b/2	*A. Shaferi* TREL.	–	–	–	–	–	–	–	–	100	–	–	–	–	–	–	–	–	–	–	–
K!	b/1	*A. tubulata* TREL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
K!	e	*A. Underwoodii* TREL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R	r	*Ageratum conyzoides* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R	l	*A. maritimum* HBK.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/5	f	*Albizzia cubana* BRITT. and WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/3	n	*Alchornea latifolia* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	–	–	–	–	100
C/3	p	*Alibertia edulis* (L. C. RICH.) A. RICH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	30
C/4	i	*Allophylus Cominia* (L.) SW.	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	a/8	*A. cubensis* BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/3	p	*A. racemosus* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–
N	p	*Alsophila aquilina* C. CHR.	–	–	–	–	–	30	36	–	–	–	30	90	–	100	100	100	–	–	100	50
N	n	*A. aspera* (L.) R. BR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	80
N	n	*A. myosuroides* LIEBM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50
N	e	*A. strigillosa* MAX.	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–
O	p	*Alternanthera ficoidea* (L.) R. BR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/6	k	*Alvaradoa amorphoides* LIEBM. ssp. *psilophylla* (URB.) CRONQ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6	b/3	*Alvardoa arborescens* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	40	–	40	–	40	80	–	–
D/3	n	*Amaouia corymbosa* HBK.	–	–	60	30	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Q	p	*Ammannia latifolia* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	k	*Ampelopsis arborea* (L.) RUSBG.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	m	*Amyris balsamifera* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
P	o	*A. trapezioides* FÉE	–	–	–	40	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–
X	g	*Aechmea nudicaulis* (L.) GRISEB.	40	–	–	40	40	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–
O	c	*Aeschynomene tenuis* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–
K!	a/14	*Agave albescens* TREL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
K!	a/13	*A. anomala* TREL.	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–
K!	b/4	*A. Brittoniana* TREL.	–	–	–	–	–	–	40	–	–	–	–	80	–	–	–	–	–	–	–	–
K!	a/3	*A. cajalbanensis* ALVAREZ	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
K!	f	*A. Legrelliana* JACOBI	–	–	–	–	–	–	–	–	–	–	80	–	–	–	–	–	–	–	–	–
K!	a/6	*A. pendentata* TREL.	–	–	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
K!	b/2	*A. Shaferi* TREL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
K!	b/1	*A. tubulata* TREL.	–	–	–	–	–	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–
K!	e	*A. Underwoodi* TREL.	–	–	–	–	100	–	–	–	–	–	–	–	–	–	–	–	–	–	90	60
R	r	*Ageratum conyzoides* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–
R	l	*A. maritimum* HBK.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	40	–	–	–
B/5	f	*Albizzia cubana* BRITT. & WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–
B/3	n	*Alchornea latifolia* SW.	60	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/3	p	*Alibertia edulis* (L. C. RICH.) A. RICH.	40	–	–	100	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–
C/4	i	*Allophylus Cominia* (L.) SW.	–	–	–	–	–	–	100	100	100	100	40	40	–	–	100	–	60	100	–	–
D/4	a/8	*A. cubensis* BHIDI. & MZ.	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/3	p	*A. racemosus* SW.	–	–	–	60	40	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–
N	p	*Alsophila aquilina* C. CHR.	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
N	n	*A. aspera* (L.) R. BR.	40	40	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–
N	n	*A. myosuroides* LIEBM.	80	40	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–	50
N	e	*A. strigillosa* MAX.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*Alternanthera ficoidea* (L.) R. BR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–
C/6	k	*Alvaradoa amorphoides* LIEBM. ssp. *psilophylla* (URB.) CRONQ.	–	–	–	–	–	–	–	60	40	–	–	–	–	–	–	–	–	–	–	–
D/6	b/3	*Alvardoa arborescens* GRISEB.	–	–	–	–	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/3	n	*Amaouia corymbosa* HBK.	60	40	–	100	–	–	40	40	40	80	–	–	–	–	80	–	–	–	–	–
Q	p	*Ammannia latifolia* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–
J	k	*Ampelopsis arborea* (L.) RUSBG.	–	–	–	–	–	–	–	40	–	60	–	–	–	–	–	–	–	–	–	–
D/5	m	*Amyris balsamifera* L.	–	–	–	–	40	40	40	100	100	100	–	–	–	–	–	–	10	40	–	–

Table 25 Continued 3

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
C/6	g	*A. diatrypa* SPRENG.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/4	f	*A. lineata* WR.	–	–	–	–	–	–	–	–	–	–	30	–	–	–	–	–	–	–	–	–
E/5	a/5	*A. stromatophylla* P. WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–
O	a/8	*Ancistranthus harpochiloides* (GRISEB.) LINDAU	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/4	p	*Andira inermis* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*Andropogon bicornis* L.	–	60	40	30	–	–	72	50	–	–	40	40	40	–	–	–	–	–	–	–
O	r	*A. brevifolius* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	c	*A. cubensis* HACK.	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	k	*A. gracilis* SPRENG.	81	70	100	100	60	100	100	100	100	100	90	100	80	–	–	–	60	80	–	–
O	p	*A. hirtiflorus* (NEES) KUNTH	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	f	*A. multinervosus* (NASH) HITCHC. & CHASE	81	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	f	*A. Nashianus* HITCHC.	–	–	–	–	–	60	100	70	50	80	–	–	–	–	–	–	–	–	–	–
O	x	*A. pertusus* (L.) WILLD.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	f	*A. Reedii* HITCHC. & EKM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	f	*A. Reinoldii* LEÓN	–	–	–	–	–	90	100	100	60	100	30	90	40	–	–	–	–	–	–	–
O	s	*A. virginius* L.	36	70	60	30	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*Anemia adiantifolia* (L.) SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
O	c	*A. cajalbanica* BHIDI. & MZ.	–	–	–	60	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	b/2	*A. coriacea* GRISEB. ssp. *coriacea*	–	–	–	–	–	100	–	–	100	100	–	–	–	–	–	–	–	60	–	–
O	a/5	*A. c.* ssp. *moaensis* BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	60	–	100	–	–	–	40	–	–	–
P	a/4	*A. nipensis* BENEDICT	–	–	–	–	–	50	–	–	30	30	–	–	–	–	–	–	–	40	–	–
O	g	*A. Underwoodiana* MAX.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	i	*Angadenia cubensis* LIPPOLD	45	60	40	60	40	30	81	40	50	60	–	–	–	–	–	–	–	40	–	–
J	f	*A. Lindeniana* (MUELL-ARG.) MIERS	–	–	–	–	–	–	–	–	–	–	50	30	60	–	–	80	40	–	–	–
O	n	*Angelonia angustifolia* BENTH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	g	*A. pilosella* KICKX	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	n	*Anguria pedata* (L.) JACQ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R	o	*Anisantherina hispidula* (MART.) PENN.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	f	*Annona bullata* (A. RICH.)	–	–	40	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/9	*A. cascarilloides* WR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
C/6	g	*A. diatrypa* SPRENG.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100
C/4	f	*A. lineata* WR.	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–
E/5	a/5	*A. stromatophylla* P. WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	a/8	*Ancistranthus harpochiloides* (GRISEB.) LINDAU	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/4	p	*Andira inermis* SW.	–	–	–	–	40	–	40	100	100	80	–	–	–	–	100	–	40	40	–	–
O	p	*Andropogon bicornis* L.	–	–	–	–	–	–	–	–	–	–	40	60	40	40	–	–	–	–	–	–
O	r	*A. brevifolius* SW.	–	–	–	–	–	–	–	–	–	–	–	60	–	40	40	–	–	–	–	–
O	c	*A. cubensis* HACK.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	k	*A. gracilis* SPRENG.	–	–	–	–	–	–	–	–	–	–	60	60	100	100	40	–	–	–	30	–
O	p	*A. hirtiflorus* (NEES) KUNTH	–	–	–	–	–	–	–	–	–	–	–	40	80	100	–	–	–	–	–	–
O	f	*A. multinervosus* (NASH) HITCHC. & CHASE	–	–	–	–	–	–	–	–	–	–	40	60	80	80	–	–	–	–	–	–
O	f	*A. Nashianus* HITCHC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	x	*A. pertusus* (L.) WILLD.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	40
O	f	*A. Reedii* HITCHC. & EKM.	–	–	–	–	–	–	–	–	–	–	40	60	80	100	–	–	–	–	–	–
O	f	*A. Reinoldii* LEÓN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	s	*A. virginius* L.	–	–	–	–	–	–	–	–	–	–	40	40	40	40	–	–	–	–	–	–
O	p	*Anemia adiantifolia* (L.) SW.	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–
O	c	*A. cajalbanica* BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–
O	b/2	*A. coriacea* GRISEB. ssp. *coriacea*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	a/5	*A. c.* ssp. *moaensis* BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P	a/4	*A. nipensis* BENEDICT	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	g	*A. Underwoodiana* MAX.	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	i	*Angadenia cubensis* LIPPOLD	–	–	–	–	40	40	40	–	–	–	80	60	100	60	40	–	–	40	30	–
J	f	*A. Lindeniana* (MUELL-ARG.) MIERS	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	n	*Angelonia angustifolia* BENTH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–
O	g	*A. pilosella* KICKX	–	–	–	–	–	–	–	–	–	–	–	40	100	40	40	–	–	–	–	–
T	n	*Anguria pedata* (L.) JACQ.	–	–	–	–	40	60	100	–	–	40	–	–	–	–	–	–	–	–	–	–
R	o	*Anisantherina hispidula* (MART.) PENN.	–	–	–	–	–	–	–	–	–	–	40	40	40	60	40	60	–	–	–	–
D/4	f	*Annona bullata* (A. RICH.)	–	–	–	–	–	–	–	–	–	–	60	40	40	40	40	–	–	–	–	–
E/5	a/9	*A. cascarilloides* WR.	–	–	–	–	–	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 25 Continued 4

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
C/3	m	*A. glabra* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/2	*A. sclerophylla* SAFFORD	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–	–
E/5	b/2	*Antirhea abbreviata* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	100	–	–	–
C/4	l	*A. lucida* (SW.) BENTH. & HOOK.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/5	*A. orbicularis* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–
B/4	b/2	*A. scrobiculata* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–
E/4	b/2	*A. Shaferi* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	60	–	–
D/5	f	*A. Urbaniana* WHITF	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	f	*Anthurium recusatum* SCHOTT	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	g	*A. scandens* (AUBL.) ENGL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
T	a/9	*A. venosum* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
I	p	*Antrophyum brasilianum* (DESV.) C. CHR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–
I	p	*A. lanceolatum* (L.) KAULF.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–
R	v	*Argemone maxicana* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	h	*Argythamnia candicans* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/14	*A. cubensis* BRITT. & WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	b/2	*Ariadne Shaferi* (STANDL.) URB.	–	–	–	–	–	40	–	–	70	–	–	30	60	40	30	40	100	100	–	–
R	h	*Aristida adscensionis* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	g	*A. calcicola* HITCHC. & EKM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	f	*A. curtifolia* HITCHC.	–	–	–	60	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	g	*A. Eggersii* HITCHC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	c	*A. erecta* HITCHC.	–	–	–	30	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	b/3	*A. laevigata* HITCHC. & EKM.	–	–	–	–	–	–	–	–	70	40	30	40	40	–	–	–	–	–	–	–
O	g	*A. neglecta* LEÓN	60	100	40	60	40	50	40	80	100	60	40	40	40	–	–	–	40	40	–	–
O	b/3	*Aristida Paradana* LEÓN	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	40	–	–	–
O	g	*A. refracta* GRISEB.	100	–	100	100	60	90	72	100	100	80	100	100	100	–	–	–	60	40	–	–
O	k	*A. spiciformis* ELL.	18	–	60	40	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–
O	n	*A. ternipes* CAV.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	i	*A. vilfifolia* HENR.	72	40	60	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	g	*Aristolochia bilabiata* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	b/3	*A. Lindeniana* DUTCH.	–	–	–	–	–	80	–	–	40	–	60	–	–	–	–	–	40	60	–	–

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
C/3	m	*A. glabra* L.	–	–	–	–	–	–	–	40	80	–	–	–	–	–	40	100	–	–	–	–
E/5	b/2	*A. sclerophylla* SAFFORD	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/2	*Antirhea abbreviata* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/4	l	*A. lucida* (SW.) BENTH. & HOOK.	–	–	–	–	–	–	–	100	80	60	40	–	–	–	–	–	60	40	40	70
E/5	a/5	*A. orbicularis* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/4	b/2	*A. scrobiculata* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/4	b/2	*A. Shaferi* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	f	*A. Urbaniana* WHITF	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–
T	f	*Anthurium recusatum* SCHOTT	–	–	–	40	60	60	60	–	–	–	–	–	–	–	–	–	–	–	–	–
T	g	*A. scandens* (AUBL.) ENGL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	a/9	*A. venosum* GRISEB.	–	–	–	–	–	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–
I	p	*Antrophyum brasilianum* (DESV.) C. CHR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
I	p	*A. lanceolatum* (L.) KAULF.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R	v	*Argemone maxicana* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–
E/5	h	*Argythamnia candicans* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	100	40	70
E/5	a/14	*A. cubensis* BRITT. & WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50	–
D/5	b/2	*Ariadne Shaferi* (STANDL.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R	h	*Aristida adscensionis* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	40
O	g	*A. calcicola* HITCHC. & EKM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
O	f	*A. curtifolia* HITCHC.	–	–	–	–	–	–	–	–	–	–	–	–	40	100	–	–	–	–	–	–
O	g	*A. Eggersii* HITCHC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	40
O	c	*A. erecta* HITCHC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	b/3	*A. laevigata* HITCHC. & EKM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	g	*A. neglecta* LEÓN	–	–	–	–	–	–	–	–	–	–	100	100	100	60	40	–	–	–	–	–
O	b/3	*Aristida Paradana* LEÓN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	g	*A. refracta* GRISEB.	–	–	–	–	–	–	–	–	–	–	60	100	100	100	–	–	–	–	–	–
O	k	*A. spiciformis* ELL.	–	–	–	–	–	–	–	–	–	–	40	–	40	40	40	–	–	–	–	–
O	n	*A. ternipes* CAV.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50	–
O	i	*A. vilfifolia* HENR.	–	–	–	–	–	–	–	–	–	–	–	–	100	100	–	–	–	–	–	–
T	g	*Aristolochia bilabiata* L.	–	–	–	–	–	–	–	–	–	–	80	–	–	–	–	–	–	–	–	–
T	b/3	*A. Lindeniana* DUTCH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 25 Continued 5

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
T	j	*A. passifloraefolia* A. RICH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	b/3	*A. peltata* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	f	*A. trigyna* A. RICH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	a/9	*Arthrostylidium angustifolium* NASH	–	–	–	–	–	–	–	–	50	–	–	30	40	100	60	–	40	60	40	40
J	i	*A. capillifolium* GRISEB.	–	–	–	–	–	–	–	–	–	–	30	40	–	–	30	80	400	–	–	30
J	b/3	*A. fimbriatum* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
J	m	*A. multispicatum* PILGER	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	60	–	–	–	–
J	b/2	*A. pinifolium* CATASUS	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	e	*A. Urbanii* PILGER	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*Arundinella Deppeana* NEES	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	k	*Ascyrum hypericoides* L.	–	–	30	–	–	–	36	–	–	40	30	–	–	–	–	–	–	–	–	–
O	p	*Asplenium abscissum* WILLD.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	r	*A. cuneatum* LAM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	n	*A. dentatum* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	g	*A. dimidiatum* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	40
O	h	*A. erosum* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	r	*A. formosum* WILLD.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*A. myriophyllum* (SW.) PRESL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	r	*A. pumilum* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
I	r	*A. serratum* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–
O	f	*A. venustum* UND. & MAX.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	f	*Ateleia apetala* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	n	*A. gummifera* var. *cubensis* (GRISEB.) MOHLBR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	e	*Auerodendron cubense* (BRITT. & WILS.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	k	*Ayenia euphrasifolia* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	c	*A. tenuicaulis* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	b/3	*A. velutina* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	g	*A. virgata* URB. & EKM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
T	j	*A. passifloraefolia* A. RICH.	–	–	–	–	–	–	–	–	–	–	40	80	60	100	–	–	–	–	–	–
T	b/3	*A. peltata* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	60
T	f	*A. trigyna* A. RICH.	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	a/9	*Arthrostylidium angustifolium* NASH	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	i	*A. capillifolium* GRISEB.	40	–	–	40	60	–	40	–	–	40	40	40	–	40	–	–	–	–	–	–
J	b/3	*A. fimbriatum* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	m	*A. multispicatum* PILGER	60	80	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	b/2	*A. pinifolium* CATASUS	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	e	*A. Urbanii* PILGER	–	–	–	–	–	–	10	–	–	–	–	80	–	–	–	–	–	–	–	–
O	p	*Arundinella Deppeana* NEES	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–	–
V	k	*Ascyrum hypericoides* L.	–	–	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*Asplenium abscissum* WILLD.	–	–	–	–	40	60	40	–	–	–	–	–	–	–	–	–	–	–	–	–
O	r	*A. cuneatum* LAM.	–	–	–	60	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	n	*A. dentatum* L.	–	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	g	*A. dimidiatum* SW.	–	–	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	h	*A. erosum* L.	40	–	–	40	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–
O	r	*A. formosum* WILLD.	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*A. myriophyllum* (SW.) PRESL	–	–	–	–	–	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–
O	r	*A. pumilum* SW.	–	–	–	–	40	60	40	–	–	–	–	–	–	–	–	–	–	–	–	–
I	r	*A. serratum* L.40	–	–	–	40	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	f	*A. venustum* UND. & MAX.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	f	*Ateleia apetala* GRISEB.	–	–	–	–	–	–	–	–	–	–	40	60	40	80	40	–	–	–	–	–
C/5	n	*A. gummifera* var. *cubensis* (GRISEB.) MOHLBR.	–	–	–	–	80	60	40	100	80	60	–	–	–	–	40	–	–	–	70	40
E/5	e	*Auerodendron cubense* (BRITT. & WILS.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–
V	k	*Ayenia euphrasifolia* GRISEB.	–	–	–	–	–	–	–	–	–	–	40	60	100	40	–	–	–	–	–	–
V	c	*A. tenuicaulis* URB.	–	–	–	–	–	–	–	–	–	–	–	40	60	40	–	–	–	–	–	–
V	b/3	*A. velutina* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
V	g	*A. virgata* URB. & EKM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50

Table 25 Continued 6

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
E/6	f	*Baccharis halimifolia* L. ssp. *angustior* DC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	b/3	*B. scoparioides* GRISEB.	–	–	–	–	–	80	100	90	30	100	90	100	40	–	–	–	–	–	–	40
E/7	b/2	*B. Shaferi* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	40	–	–
Q	l	*Bacopa Monnieri* PENN.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
G!	b/2	*Bactris cubensis* BURR.	–	–	–	–	–	–	100	–	40	–	–	60	40	80	100	–	–	–	100	–
E/5	j	*Banara reticulata* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	o	*Bauhinia cumanensis* HBK.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/4	l	*B. divaricata* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/3	n	*B. Jenningsii* P. WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	a/14	*Barleriola saturejoides* ssp. *Acunae* BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	o	*Bastardia bivalvis* (CAV.) HBK.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/2	*Befaria cubensis* GRISEB.	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	b/3	*Begonia cubensis* HASSK.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50
O	b/3	*B. cubincola* A. DC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	a/6	*B. lomensis* BRITT. & WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	b/3	*B. maestrensis* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60
V	g	*B. obliqua* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	b/2	*B. Wrightiana* A. DC.	–	–	–	–	–	–	–	–	–	–	–	–	–	80	40	–	–	–	80	–
C/5	f	*Behaimia cubensis* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6!	f	*Belairia mucronata* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/7!	b/3	*B. parvifolia* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/7!	f	*B. spinosa* A. RICH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6!	c	*B. ternata* URB. & GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6!	g	*Bellonia spinosa* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/4	g	*Beranardia dichotoma* (WILLD.) MUELL-ARG.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	h	*Besleria lutea* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
R	r	*Bidens cynapiifolia* HBK.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	g	*Bisgoeppertia scandens* (SPRENG.) URB.	–	–	–	–	–	60	54	40	30	100	90	100	40	–	–	–	100	60	–	–
O	p	*Blechnum occidentale* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
O	p	*B. polypodioides* (SW.) KUHN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
E/6	f	*Baccharis halimifolia* L. ssp. *angustior* DC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–
E/6	b/3	*B. scoparioides* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/7	b/2	*B. Shaferi* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Q	l	*Bacopa Monnieri* PENN.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–	–	–	–
G!	b/2	*Bactris cubensis* BURR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	j	*Banara reticulata* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	100	100	100	–	–	–	–	30	30
J	o	*Bauhinia cumanensis* HBK.	–	–	–	–	–	–	–	40	40	40	40	–	–	–	40	–	40	–	–	–
E/4	l	*B. divaricata* L.	–	–	–	–	–	–	–	60	100	40	–	–	–	–	–	–	80	100	–	–
E/3	n	*B. Jenningsii* P. WILS.	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–
V	a/14	*Barleriola saturejoides* ssp. *Acunae* BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	70
O	o	*Bastardia bivalvis* (CAV.) HBK.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	70
E/5	a/2	*Befaria cubensis* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	b/3	*Begonia cubensis* HASSK.	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	b/3	*B. cubincola* A. DC.	–	–	–	–	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	a/6	*B. lomensis* BRITT. & WILS.	–	100	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	b/3	*B. maestrensis* URB.	–	40	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	g	*B. obliqua* L.	60	–	–	60	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–
O	b/2	*B. Wrightiana* A. DC.	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	f	*Behaimia cubensis* GRISEB.	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	30
D/6!	f	*Belairia mucronata* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	60	80	100	–	–	–	40	30	30
D/7!	b/3	*B. parvifolia* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
D/7!	f	*B. spinosa* A. RICH.	–	–	–	–	–	–	–	40	40	–	–	40	–	–	–	–	–	–	–	–
D/6!	c	*B. ternata* URB. & GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	80	–	–
E/6!	g	*Bellonia spinosa* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	70	60
E/4	g	*Beranardia dichotoma* (WILLD.) MUELL-ARG.	–	–	–	–	100	–	100	40	40	–	–	–	–	–	–	–	–	–	60	80
V	h	*Besleria lutea* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R	r	*Bidens cynapiifolia* HBK.	–	–	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	g	*Bisgoeppertia scandens* (SPRENG.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*Blechnum occidentale* L.	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*B. polypodioides* (SW.) KUHN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 25 Continued 7

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
O	r	*B. serrulatum* A. RICH.	—	30	40	30	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	g	*B. Tuerckheimii* BRAUSE	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40
P	l	*Bletia purpurea* (LAM) DC.	—	30	40	—	—	60	63	—	30	—	40	80	40	40	60	60	40	60	—	—
O	n	*Bolbitis nicotianaefolia* (SW.) CHING	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	100	—
P	p	*Bomarea ovata* (CAV.) MIRB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C/3	c	*Bombacopsis cubensis* ROBINS.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/6	j	*Bonania cubana* A. RICH.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
B/4	a/5	*Bonnetia cubensis* (BRITT.) HOWARD	—	—	—	—	—	—	—	—	—	—	—	—	—	60	60	40	—	—	—	—
V	c	*Borreria eritrichoides* WR. & GRISEB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
V	a/10	*B. matanzasia* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	p	*B. ocimoides* (BURM. F.) DC.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	p	*B. spinosa* (L.) CHAM. & SCHLTD.	—	—	—	—	—	50	63	80	70	80	—	—	—	—	—	—	—	—	—	—
V	f	*B. thymocephala* GRISEB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/6	k	*Bourreria cassinifolia* (A. RICH.) GRISEB.	—	—	40	30	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/7	g	*B. divaricata* (DC.) DON	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/7	f	*B. microphylla* GRISEB.	—	—	—	—	—	—	—	—	30	—	—	—	—	—	—	—	—	80	—	—
E/7	a/5	*B. moaensis* BRITT.	—	—	—	—	—	—	—	—	—	—	30	—	—	—	—	—	—	—	—	—
D/5	l	*B. ovata* MIERS	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/6	f	*B. pauciflora* O. E. SCHULZ	—	—	—	—	—	—	—	—	60	40	60	—	—	—	—	—	40	100	—	—
D/6	a/2	*B. polyneura* O. E. SCHULZ	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/6	f	*B. setoso-hispida* O. E. SCHULZ	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C/4	h	*B. succulenta* JACQ.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C/5	e	*B. Taylorii* BRITT.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	p	*Bouteloua americana* (L.) SCRIBN.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
U	h	*Brachionidium Sherringii* ROLFE	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
U	i	*Broughtonia Lindenii* (LINDL.) DRESSL.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
U	f	*B. ortgiesiana* (RCHB. F.) DRESSL.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C/4	n	*Brunellia comocladifolia* HBK.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	50	—	—	—	—	100
E/4	c	*Brunfelsia nitida* BENTH.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/5	a/11	*B. nova*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C/6!	g	*Brya Ebenus* (L.) DC.	—	—	—	—	100	—	—	—	30	—	30	—	40	—	—	40	40	60	—	—

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
O	r	*B. serrulatum* A. RICH.	—	—	—	40	—	—	—	—	—	—	—	—	—	—	100	—	—	—	—	—
O	g	*B. Tuerckheimii* BRAUSE	—	40	100	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
P	l	*Bletia purpurea* (LAM) DC.	—	—	—	—	—	—	—	—	—	—	40	40	40	40	40	—	—	—	—	—
O	n	*Bolbitis nicotianaefolia* (SW.) CHING	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
P	p	*Bomarea ovata* (CAV.) MIRB.	—	—	—	40	—	60	40	—	—	—	—	—	—	—	—	—	—	—	—	—
C/3	c	*Bombacopsis cubensis* ROBINS.	—	—	—	—	—	100	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/6	j	*Bonania cubana* A. RICH.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	60	60
B/4	a/5	*Bonnetia cubensis* (BRITT.) HOWARD	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
V	c	*Borreria eritrichoides* WR. & GRISEB.	—	—	—	—	—	—	—	—	—	—	40	—	—	—	—	—	—	—	—	—
V	a/10	*B. matanzasia* URB.	—	—	—	—	—	—	—	—	—	—	40	—	—	—	—	—	—	—	—	—
O	p	*B. ocimoides* (BURM. F.) DC.	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—	—	—	—	—
O	p	*B. spinosa* (L.) CHAM. & SCHLTD.	—	—	—	—	—	—	—	—	—	—	—	60	40	60	40	—	—	—	—	—
V	f	*B. thymocephala* GRISEB.	—	—	—	—	—	—	—	—	—	—	—	60	100	80	—	—	—	—	—	—
D/6	k	*Bourreria cassinifolia* (A. RICH.) GRISEB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	30
E/7	g	*B. divaricata* (DC.) DON	—	—	—	—	—	—	—	—	—	—	40	100	60	—	—	—	—	—	—	—
E/7	f	*B. microphylla* GRISEB.	—	—	—	—	—	—	—	—	—	—	100	100	100	80	—	—	—	—	—	30
E/7	a/5	*B. moaensis* BRITT.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	l	*B. ovata* MIERS	—	—	—	—	—	—	—	60	60	80	—	40	—	—	—	—	60	—	—	—
E/6	f	*B. pauciflora* O. E. SCHULZ	—	—	—	—	—	—	—	—	—	—	—	—	—	60	—	—	—	—	—	30
D/6	a/2	*B. polyneura* O. E. SCHULZ	—	—	—	—	—	80	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/6	f	*B. setoso-hispida* O. E. SCHULZ	—	—	—	—	—	—	—	—	—	—	—	40	40	60	—	—	—	—	—	—
C/4	h	*B. succulenta* JACQ.	—	—	—	—	—	—	—	40	40	—	—	40	—	—	—	—	80	40	70	30
C/5	e	*B. Taylorii* BRITT.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	100	50
O	p	*Bouteloua americana* (L.) SCRIBN.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	30
U	h	*Brachionidium Sherringii* ROLFE	—	40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
U	i	*Broughtonia Lindenii* (LINDL.) DRESSL.	—	—	—	—	40	40	40	40	—	80	—	—	—	—	—	—	—	60	40	30
U	f	*B. ortgiesiana* (RCHB. F.) DRESSL.	—	—	—	—	—	—	—	60	40	—	—	—	—	—	—	—	—	—	—	—
C/4	n	*Brunellia comocladifolia* HBK.	—	80	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/4	c	*Brunfelsia nitida* BENTH.	—	—	—	—	—	—	—	—	—	—	40	—	—	—	—	—	—	—	—	—
E/5	a/11	*B. nova*	—	—	—	—	—	—	—	—	—	—	—	40	—	—	—	—	—	—	—	—
C/6!	g	*Brya Ebenus* (L.) DC.	—	—	—	—	—	—	—	—	—	—	100	100	100	60	—	—	—	—	30	40

Table 25 Continued 8

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
E/6!	a/5	*B. subinermis* LEÓN & ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–	–	40	–	–	–
B/5	o	*Buchenavia capitata* (VAHL) EICHL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–
O	p	*Buchnera longifolia* HBK.	–	30	40	30	–	30	–	–	30	–	–	–	–	–	–	–	–	–	–	–
B/5	l	*Bucida buceras* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–
C/6!	j	*B. spinosa* (NORTHR.) JENNINGS	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	c	*Bulbostylis setacea* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–
C/6	n	*Bumelia celastrina* HBK.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	g	*B. cubensis* GRISEB.	–	–	–	–	–	40	36	–	30	–	–	30	100	–	40	–	100	60	–	–
C/6!	g	*B. glomerata* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–
B/4	b/3	*B. jubilla* (EKM. & URB.) STEARN	–	–	–	–	–	–	–	–	–	–	–	–	60	100	–	–	–	80	40	–
B/5	l	*B. salicifolia* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	o	*Burmannia bicolor* MART.	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/3	*Bursera glauca* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–
E/5	j	*B. inaguensis* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/5	p	*B. Simaruba* (L.) SARG.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	b/2	*Buxus crassifolia* (BRITT.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–	–	–	–
E/5	b/2	*B. Ekmanii* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	–	–	–	–	–
E/5	b/4	*B. flaviramea* (BRITT.) MATHOU	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	a/5	*B. foliosa* (BRITT.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–
E/5	g	*B. glomerata* MUELL-ARG.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/10	*Buxus gonoclada* MUELL.-ARG.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/13	*B. heterophylla* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	a/5	*B. marginalis* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–
E/6	a/5	*B. revoluta* (BRITT.) MATHOU	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–
D/5	b/2	*B. Shaferi* (BRITT.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50	–	–	–	–	–
E/6	a/3	*B. Wrightii* MUELL.-ARG.	–	–	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/5	*Byrsonima biflora* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	90	100	40	–	–	–
D/5	a/5	*B. Bucherae* MOLD.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–
E/3	n	*B. crassifolia* (L.) HBK.	–	–	–	–	–	–	–	–	–	–	–	40	40	–	80	–	–	–	–	–
D/5	k	*B. cuneata* P. WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–
D/5	k	*B. lucida* (SW.) DC.	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–
D/6	b/2	*B. minutifolia* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
E/6!	a/5	*B. subinermis* LEÓN & ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/5	o	*Buchenavia capitata* (VAHL) EICHL.	–	–	–	80	–	–	–	–	40	40	–	–	–	–	60	–	40	40	–	–
O	p	*Buchnera longifolia* HBK.	–	–	–	–	–	–	–	–	–	–	40	60	80	40	40	–	–	–	–	–
B/5	l	*Bucida buceras* L.	–	–	–	–	–	–	–	–	40	40	–	–	–	–	40	100	–	100	–	–
C/6!	j	*B. spinosa* (NORTHR.) JENNINGS	–	–	–	–	–	–	–	–	40	–	40	–	–	–	–	–	–	40	–	–
O	c	*Bulbostylis setacea* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	40	40	–	–	–	–	–	–	–
C/6	n	*Bumelia celastrina* HBK.	–	–	–	–	–	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–
C/5	g	*B. cubensis* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50	–
C/6!	g	*B. glomerata* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–	–	–
B/4	b/3	*B. jubilla* (EKM. & URB.) STEARN	–	–	–	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/5	l	*B. salicifolia* L.	–	–	–	–	–	–	–	100	100	100	–	–	–	–	–	60	–	40	40	–
O	o	*Burmannia bicolor* MART.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/3	*Bursera glauca* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	70	90
E/5	j	*B. inaguensis* BRITT.	–	–	–	–	–	–	–	–	–	–	–	40	60	100	–	–	–	–	–	30
B/5	p	*B. Simaruba (L.)* SARG.	–	–	–	80	40	–	–	100	100	100	40	40	–	40	40	–	100	100	40	30
D/4	b/2	*Buxus crassifolia* (BRITT.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/2	*B. Ekmanii* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/4	*B. flaviramea* (BRITT.) MATHOU	–	–	–	–	–	–	–	–	–	–	60	40	–	–	–	–	–	–	–	–
E/6	a/5	*B. foliosa* (BRITT.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	g	*B. glomerata* MUELL-ARG.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100
E/5	a/10	*Buxus gonoclada* MUELL.-ARG.	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–
E/5	a/13	*B. heterophylla* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–
D/4	a/5	*B. marginalis* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	a/5	*B. revoluta* (BRITT.) MATHOU	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	b/2	*B. Shaferi* (BRITT.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	a/3	*B. Wrightii* MUELL.-ARG.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/5	*Byrsonima biflora* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	a/5	*B. Bucherae* MOLD.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/3	n	*B. crassifolia* (L.) HBK.	–	–	–	–	–	–	–	–	–	–	–	40	40	–	80	–	–	–	–	–
D/5	k	*B. cuneata* P. WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–
D/5	k	*B. lucida* (SW.) DC.	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–
D/6	b/2	*B. minutifolia* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 25 Continued 9

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
D/5	n	*B. spicata* (CAV.) L. C. RICH.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	60	—	—	—	—	—
E/5	b/1	*B. Wrightiana* URB. & NDZ.	81	60	40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
J!	f	*Byttneria microphylla* JACQ.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
J	f	*Banisteria pauciflora* HBK.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/6	j	*Caesalpinia bahamensis* LAM.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
J!	r	*C. Bonduc* (L.) ROXB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/7!	g	*C. glandulosa* BERT.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/5	a/5	*C. moaensis* BHIDI.	—	—	—	—	—	—	—	—	—	—	—	—	100	—	—	—	—	—	—	—
E/5	a/4	*C. nipensis* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	100	—	—
E/7!	k	*C. pauciflora* (GRISEB.) WR. & SAUV.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	b/3	*C. pinnata* (GRISEB.) WR.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/6	a/14	*C. subglauca* BRITT. & WILS.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C/5!	l	*C. vesicaria* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	c	*C. violacea* (MILL.) STANDL.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
P	l	*Calanthe mexicana* RCHB. F.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	50
E/7!	b/3	*Calliandra colletioides* GRISEB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C/5	j	*C. cubensis* (MACBR.) LEÓN	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/7!	b/2	*C. enervis* (BRITT.) ALAIN	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—	40	—	—	—	—
D/7	b/3	*C. orientalis* (BRITT. & ROSE) LEÓN	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/7!	f	*C. pauciflora* (A. RICH.) GRISEB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/5	b/3	*Callicarpa Bucheri* MOLD.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/4	a/6	*C. floccosa* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	30
E/4	b/3	*C. fulva* A. RICH.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	30	—	—	—	—	—
E/5	a/4	*C. lancifolia* MILLSP.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	100	—	—
E/5	a/4	*C. nova* 1.	—	—	—	—	—	—	—	—	30	—	—	—	—	—	—	—	—	—	—	—
E/5	a/14	*C. nova* 2.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/4	a/5	*C. oblanceolata* URB.	—	—	—	—	—	—	—	—	—	—	—	30	100	—	60	—	—	—	—	—
E/5	b/3	*C. resinosa* WR. & MOLD.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	30
B/4	h	*Calophyllum antillanum* STANDL.	—	—	—	30	—	—	—	—	—	—	—	—	—	100	100	—	—	—	100	30
T	n	*Calopogonium coeruleum* (BENTH.) HEMSL.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
D/5	n	*B. spicata* (CAV.) L. C. RICH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/1	*B. Wrightiana* URB. & NDZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–
J!	f	*Byttneria microphylla* JACQ.	–	–	–	–	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	f	*Banisteria pauciflora* HBK.	–	–	–	40	40	40	–	40	–	40	–	–	–	–	–	–	40	–	30	–
D/6	j	*Caesalpinia bahamensis* LAM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	60	40	–
J!	r	*C. Bonduc* (L.) ROXB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	40	30	–
E/7!	g	*C. glandulosa* BERT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
E/5	a/5	*C. moaensis* BHIDI.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/4	*C. nipensis* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/7!	k	*C. pauciflora* (GRISEB.) WR. & SAUV.	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	60	–	60	40
D/5	b/3	*C. pinnata* (GRISEB.) WR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	a/14	*C. subglauca* BRITT. & WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	40
C/5!	l	*C. vesicaria* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	40	40	–
D/5	c	*C. violacea* (MILL.) STANDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	40	–	–
P	l	*Calanthe mexicana* RCHB. F.	–	80	40	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/7!	b/3	*Calliandra colletioides* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	40
C/5	j	*C. cubensis* (MACBR.) LEÓN	–	–	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–
E/7!	b/2	*C. enervis* (BRITT.) ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/7	b/3	*C. orientalis* (BRITT. & ROSE) LEÓN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–
D/7!	f	*C. pauciflora* (A. RICH.) GRISEB.	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–
E/5	b/3	*Callicarpa Bucheri* MOLD.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50
E/4	a/6	*C. floccosa* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/4	b/3	*C. fulva* A. RICH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/4	*C. lancifolia* MILLSP.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/4	*C. nova* 1.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/14	*C. nova* 2.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–
D/4	a/5	*C. oblanceolata* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/3	*C. resinosa* WR. & MOLD.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/4	h	*Calophyllum antillanum* STANDL.	40	–	–	100	–	–	–	–	40	40	–	–	–	–	40	40	–	–	–	–
T	n	*Calopogonium coeruleum* (BENTH.) HEMSL.	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–

Table 25 Continued 10

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
B/4	p	*Calycophyllum candidissimum* (VAHL) DC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/4	b/2	*Calycogonium Grisebachii* TRIANA	–	–	–	–	–	–	–	–	–	–	–	30	–	–	70	–	–	–	–	–
E/6	b/2	*C. rosmarinifolium* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–	–
E/6	a/5	*C. moanum* BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	40	–	40	–	–	–	40	–	–	–
E/5	a/5	*C. Susannae* BHIDI.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	–	–	–	–	–
E/5	b/2	*Calycorectes Ekmanii* URB.	–	–	–	–	–	–	–	–	–	–	–	30	40	–	–	–	–	–	–	–
D/5	a/5	*Calyptranthes calyptrata* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	40	–
E/5	a/5	*C. cardiophyllum* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	–	–	–	40	–
D/5	a/9	*C. enneantha* WR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/2	*C. heterochora* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–
E/5	b/3	*C. leptoclada* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
D/5	a/7	*C. lomensis* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	b/1	*C. pinetorum* BRITT. & WILS.	54	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	a/5	*C. rostrata* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–
D/5	k	*C. syzygium* (L.) SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	50
G	b/3	*Calyptronoma Clementis* LEÓN	–	–	–	–	–	–	–	–	–	–	–	–	–	100	30	–	–	–	40	40
E/5	l	*Cameraria latifolia* L.	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	40	–	60	40	–
T	f	*Canavalia nitida* (CAV.) PIPER	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/4	k	*Canella Winterana* (L.) GAERTN. F.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R	p	*Caperonia palustris* (L.) ST. HIL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	p	*Capparis cynophallophora* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	g	*C. ferruginea* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	p	*C. flexuosa* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*Capraria biflora* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	r	*Capsicum frutescens* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–
A/3	o	*Carapa guianensis* AUBL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*Carex hamata* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/4	g	*Carpodiptera cubensis* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/4	f	*Casasia calophylla* A. RICH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/2	*C. jacquinioides* (GRISEB.) STANDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	100	–	–	–
D/5	b/2	*C. nigrescens* (GRISEB.) WR. ex URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
B/4	p	*Calycophyllum candidissimum* (VAHL) DC.	–	–	–	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/4	b/2	*Calycogonium Grisebachii* TRIANA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	b/2	*C. rosmarinifolium* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	a/5	*C. moanum* BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/5	*C. Susannae* BHIDI.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/2	*Calycorectes Ekmanii* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	a/5	*Calyptranthes calyptrata* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/5	*C. cardiophyllum* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	a/9	*C. enneantha* WR.	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/2	*C. heterochora* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/3	*C. leptoclada* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	a/7	*C. lomensis* URB.	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	b/1	*C. pinetorum* BRITT. & WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	a/5	*C. rostrata* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	k	*C. syzygium* (L.) SW.	40	–	–	–	–	–	–	40	–	60	–	–	–	–	–	–	–	40	–	–
G	b/3	*Calyptronoma Clementis* LEÓN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	l	*Cameraria latifolia* L.	–	–	–	–	–	–	–	40	40	40	–	–	–	–	–	–	40	–	–	40
T	f	*Canavalia nitida* (CAV.) PIPER	–	–	–	–	60	–	–	60	40	–	–	–	–	–	–	–	–	–	–	–
C/4	k	*Canella Winterana* (L.) GAERTN. F.	–	–	–	40	–	–	40	80	100	100	–	–	–	–	–	–	100	60	50	
R	p	*Caperonia palustris* (L.) ST. HIL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–
C/5	p	*Capparis cynophallophora* L.	–	–	–	–	40	40	–	100	60	–	–	–	–	–	–	–	80	100	60	60
C/5	g	*C. ferruginea* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	80
C/5	p	*C. flexuosa* L.	–	–	–	–	60	–	60	80	–	–	–	–	–	–	–	–	100	100	70	60
O	p	*Capraria biflora* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	40	–	30	30
E/5	r	*Capsicum frutescens* L.	–	–	–	–	–	–	–	40	60	40	–	–	–	–	–	–	60	–	30	30
A/3	o	*Carapa guianensis* AUBL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*Carex hamata* SW.	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/4	g	*Carpodiptera cubensis* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	–
B/4	f	*Casasia calophylla* A. RICH.	–	–	–	40	40	40	–	100	40	40	–	–	–	–	40	–	–	–	–	–
E/5	b/2	*C. jacquinioides* (GRISEB.) STANDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	b/2	*C. nigrescens* (GRISEB.) WR. ex URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 25 Continued 11

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
D/4	a/5	*C. n.* ssp. *moaensis* BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	80	–	–	–
E/5!	b/2	*Casearia aquifolia* WR. ex SAUV.	–	–	–	–	–	–	–	–	–	–	–	–	80	–	–	–	60	–	–	–
C/5	n	*C. arborea* (L. C. RICH.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	40	40	–	–	–	–	–
D/5!	a/4	*C. crassinervis* URB.	–	–	–	–	–	100	–	100	80	100	–	–	–	–	–	–	–	60	–	–
E/3!	a/14	*C. guantanamensis* M. VICT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	p	*C. guianensis* (AUBL.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/4	n	*C. hirsuta* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/5	*C. moanesis* M. VICT.	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–
E/6	b/2	*C. ophiticola* M. VICT.	–	–	–	–	–	–	–	–	–	–	30	–	40	–	–	–	60	–	–	–
D/5!	m	*C. spinescens* (SW.) GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/4	p	*C. sylvestris* SW.	–	–	30	30	–	–	–	–	–	–	–	–	–	40	–	–	–	–	80	–
C/5	f	*C. s.* var. *myricoides* GRISEB.	–	–	–	–	–	–	72	–	–	–	–	60	40	–	–	–	–	–	40	40
D/5	a/5	*Cassia Bucherae* (MOLD.) LEÓN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–	–	–
E/6	f	*C. chrysocarpa* DESV.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	n	*C. diphylla* L.	36	50	40	40	30	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/5	a/2	*C. Ekmaniana* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	n	*C. emarginata* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	n	*C. indecora* HBK.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
E/5	k	*C. ligustrina* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	i	*C. lineata* SW.	–	–	–	–	–	40	36	30	–	–	30	40	60	–	–	–	40	40	–	–
V	b/1	*C. minutiflora* LEÓN	–	50	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	a/12	*C. nova*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	n	*C. pilosa* L.	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*C. rotundifolia* PERS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	a/14	*C. scleroxyla* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/4	*C. Shaferi* BRITT. & WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–
D/6	b/3	*C. stenophylla* BENTH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/6	*C. turquini* (BRITT.) LEÓN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/5	j	*Cassine xylocarpa* VENT. var. *attenuata* (A. RICH.) KUNTZE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–
C/4	n	*Cassipourea guianensis* AUBL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	80	–
T	u	*Cassytha filiformis* L.	63	–	60	60	60	40	36	–	50	60	60	30	60	–	–	–	–	–	–	–

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
D/4	a/5	*C. n.* ssp. *moaensis* BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5!	b/2	*Casearia aquifolia* WR. ex SAUV.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	n	*C. arborea* (L. C. RICH.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–
D/5!	a/4	*C. crassinervis* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/3!	a/14	*C. guantanamensis* M. VICT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
D/4	p	*C. guianensis* (AUBL.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–	–
C/4	n	*C. hirsuta* SW.	–	–	–	–	40	40	60	100	80	100	40	–	–	–	40	–	40	–	–	–
E/5	a/5	*C. moanesis* M. VICT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	b/2	*C. ophiticola* M. VICT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5!	m	*C. spinescens* (SW.) GRISEB.	–	–	–	100	60	40	80	60	40	80	60	40	60	40	40	–	–	–	50	–
C/4	p	*C. sylvestris* SW.	–	–	–	60	–	–	40	80	60	60	–	–	–	–	60	–	–	–	–	–
C/5	f	*C. s.* var. *myricoides* GRISEB.	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	a/5	*Cassia Bucherae* (MOLD.) LEÓN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	f	*C. chrysocarpa* DESV.	–	–	–	–	40	–	–	40	60	40	–	80	40	40	–	–	–	–	30	30
O	n	*C. diphylla* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/5	a/2	*C. Ekmaniana* URB.	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–
C/5	n	*C. emarginata* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	40
D/5	n	*C. indecora* HBK.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–
E/5	k	*C. ligustrina* L.	–	–	–	–	–	–	–	–	40	40	–	–	–	–	–	–	–	100	–	–
E/6	i	*C. lineata* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	b/1	*C. minutiflora* LEÓN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	a/12	*C. nova*	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–
V	n	*C. pilosa* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*C. rotundifolia* PERS.	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–
C/5	a/14	*C. scleroxyla* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
E/5	a/4	*C. Shaferi* BRITT. & WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6	b/3	*C. stenophylla* BENTH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
E/5	a/6	*C. turquini* (BRITT.) LEÓN	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/5	j	*Cassine xylocarpa* VENT. var. *attenuata* (A. RICH.) KUNTZE	–	–	–	–	–	–	–	60	100	–	–	–	–	–	–	–	–	60	40	30
C/4	n	*Cassipourea guianensis* AUBL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	u	*Cassytha filiformis* L.	–	–	–	–	–	–	–	–	–	–	60	100	100	100	–	–	–	–	–	–

Table 25 Continued 12

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
E/6!	c	*Castela calcicola* (BRITT. & SMALL) URB. & EKM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6!	b/3	*C. Victorini* ACUNA & ROIG	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	b/3	*Catalpa brevipes* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/4	h	*C. punctata* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/7!	b/3	*Catesbaea flaviflora* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/7!	f	*C. holoacantha* Wr. ex GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
X	p	*Catopsis Berteroniana* (SCHULT.) MEZ	–	–	–	–	–	–	36	30	30	–	40	30	–	–	–	–	–	–	–	–
X	n	*C. floribunda* (BROGN.) L. B. SMITH	–	–	60	30	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
X	a/9	*C. montana* L. B. SMITH	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
X	n	*C. nitida* (HOOK.) GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
X	p	*C. sessiliflora* (R. & P.) MEZ	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
B/2	p	*Cecropia peltata* L.	–	–	30	30	–	–	–	–	–	–	–	–	–	40	100	–	–	–	60	–
B/4	p	*Cedrela mexicana* ROEM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–
A/3	r	*Ceiba pentandra* (L.) GAERTN.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J!	p	*Celtis iguanaea* (JACQ.) SARG.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/5	n	*C. trinervia* LAM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	p	*Centrosema virginianum* (L.) BENTH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	f	*C. v.* ssp. *angustifolium* HADAČ	–	–	30	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/3	u	*Cephalanthus occidentalis* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	a/9	*Ceratopyxis verbenacea* (GRISEB.) HOOK. F.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/2	*Cestrum buxoides* EKM.	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–	–	–	–
E/4	l	*C. diurnum* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/4	h	*C. laurifolium* L'HÉR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	70
E/5	b42	*C. pinetorum* BRITT.	–	–	–	–	–	–	–	–	60	–	40	–	–	–	–	–	–	40	–	–
V	b/1	*Chaetolepis cubensis* (A. RICH.) TRIANA	81	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R	k	*Chamaesyce adenoptera* (BERT.) MILLSP.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	n	*C. buxifolia* (LAM.) SMALL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	f	*C. camagüeyensis* MILLSP.	–	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	p	*Chamissoa altissima* (JACQ.) HBK.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
E/6!	c	*Castela calcicola* (BRITT. & SMALL) URB. & EKM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–
E/6!	b/3	*C. Victorini* ACUNA & ROIG	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60
D/5	b/3	*Catalpa brevipes* URB.	–	–	–	40	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/4	h	*C. punctata* GRISEB.	–	–	–	40	–	–	–	100	80	–	–	–	–	–	–	80	40	60	30	40
E/7!	b/3	*Catesbaea flaviflora* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50	–
E/7!	f	*C. holoacantha* Wr. ex GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	50	–
X	p	*Catopsis Berteroniana* (SCHULT.) MEZ	40	60	40	–	40	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–
X	n	*C. floribunda* (BROGN.) L. B. SMITH	40	–	–	–	40	40	40	–	40	–	–	–	–	–	40	–	–	40	–	–
X	a/9	*C. montana* L. B. SMITH	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–
X	n	*C. nitida* (HOOK.) GRISEB.	40	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
X	p	*C. sessiliflora* (R. & P.) MEZ	40	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/2	p	*Cecropia peltata* L.	–	–	–	80	60	–	40	100	100	100	–	–	–	–	–	–	60	–	–	–
B/4	p	*Cedrela mexicana* ROEM.	–	–	–	80	40	–	–	100	80	100	–	–	–	–	–	–	–	–	–	–
A/3	r	*Ceiba pentandra* (L.) GAERTN.	–	–	–	–	–	–	–	60	40	80	–	–	–	–	–	–	–	–	–	–
J!	p	*Celtis iguanaea* (JACQ.) SARG.	–	–	–	–	100	40	40	60	40	40	–	–	–	–	–	–	–	–	–	–
B/5	n	*C. trinervia* LAM.	–	–	–	40	60	60	100	40	60	100	–	–	–	–	–	–	–	–	–	–
T	p	*Centrosema virginianum* (L.) BENTH.	–	–	–	–	40	–	–	40	40	–	–	–	–	–	60	–	–	60	–	–
T	f	*C. v.* ssp. *angustifolium* HADAČ	–	–	–	–	–	–	–	–	–	–	80	40	100	80	–	–	–	–	40	40
C/3	u	*Cephalanthus occidentalis* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–	–	–	–
D/5	a/9	*Ceratopyxis verbenacea* (GRISEB.) HOOK. F.	–	–	–	–	–	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/2	*Cestrum buxoides* EKM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/4	l	*C. diurnum* L.	–	–	–	–	40	–	–	40	60	40	–	–	–	–	–	–	40	–	–	–
E/4	h	*C. laurifolium* L'HÉR.	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b42	*C. pinetorum* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	b/1	*Chaetolepis cubensis* (A. RICH.) TRIANA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R	k	*Chamaesyce adenoptera* (BERT.) MILLSP.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–
V	n	*C. buxifolia* (LAM.) SMALL	–	–	–	–	–	–	–	–	–	–	40	40	40	–	–	–	–	–	–	–
O	f	*C. camagüeyensis* MILLSP.	–	–	–	–	–	–	–	–	–	–	–	–	80	–	–	–	–	–	–	–
T	p	*Chamissoa altissima* (JACQ.) HBK.	–	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 25 Continued 13

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
O	l	*Chaptalia dentata* (L.) CASS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	e	*C. media* (GRISEB.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	80	–	–	–	–	–	–
O	g	*C. pumila* (SW.) FAWC.	–	–	–	–	–	50	81	30	40	–	–	–	–	–	–	–	–	–	–	–
O	a/7	*C. Rocana* BRITT. & WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	a/6	*C. turquinensis* BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	f	*Chascotheca neopeltandra* (GRISEB.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	g	*Cheilanthes Harrisii* MAX.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	p	*Chiococca alba* (L.) HITCHC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	b/2	*C. cubensis* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	60	40	40	–	–
J	h	*C. parvifolia* WULLSCHL. & GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/5	f	*Chione cubensis* A. RICH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6	f	*C. myrtifolia* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/5	p	*Chlorophora tinctoria* (L.) GAUD.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	n	*Chrysobalanus Icaco* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	m	*C. pellocarpus* MEYER.	45	–	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/4	h	*Chrysophyllum argenteum* JACQ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	a/11	*C. clarense* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	k	*C. oliviforme* L.	–	–	–	30	–	–	–	–	–	–	–	30	–	40	–	–	–	–	–	–
J	g	*Chusquea abietifolia* GRISEB.	–	–	–	–	–	–	–	–	–	–	40	30	–	–	60	–	–	–	–	30
J	r	*Cissampelos Pareira* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	l	*Cissus formosa* STANDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	p	*C. sicyoides* L. ssp. *sicyoides*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	p	*C. s.* ssp. *saxigena* BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	b/2	*C. subavenia* PLANCH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	–	–	–	–	–
J	o	*C. trifoliata* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/4	l	*Citharexylum caudatum* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	g	*C. discolor* TURCZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	h	*C. fruticosum* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Q	p	*Cladium jamaicense* CR.	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	p	*Clematis dioica* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J!	p	*Clerodendron aculeatum* (L.) SCHLECHTD.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Lf	Ge	No. of communities	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
		Number of relevés:	11	10	5	5	5	10	11	10	10	5	10	10	5	5	10	5	5	5	5	10
O	l	*Chaptalia dentata* (L.) CASS.	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	e	*C. media* (GRISEB.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–
O	g	*C. pumila* (SW.) FAWC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	a/7	*C. Rocana* BRITT. & WILS.	60	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–
O	a/6	*C. turquinensis* BHIDI. & MZ.	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	f	*Chascotheca neopeltandra* (GRISEB.) URB.	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–
O	g	*Cheilanthes Harrisii* MAX.	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	p	*Chiococca alba* (L.) HITCHC.	–	–	–	40	40	–	40	60	40	100	–	40	40	40	100	–	60	–	50	–
J	b/2	*C. cubensis* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	h	*C. parvifolia* WULLSCHL. & GRISEB.	–	–	–	–	–	–	–	60	40	–	–	–	–	–	–	–	–	–	–	–
B/5	f	*Chione cubensis* A. RICH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–
D/6	f	*C. myrtifolia* GRISEB.	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–
B/5	p	*Chlorophora tinctoria* (L.) GAUD.	–	–	–	–	–	–	–	40	40	40	–	–	–	–	–	–	40	–	–	–
E/5	n	*Chrysobalanus Icaco* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	60	80	–	–
E/5	m	*C. pellocarpus* MEYER.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–	–	–	–	–
C/4	h	*Chrysophyllum argenteum* JACQ.	–	–	–	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	a/11	*C. clarense* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–	–	–
C/5	k	*C. oliviforme* L.	–	–	–	–	40	–	40	100	100	80	40	–	–	–	80	–	80	100	30	–
J	g	*Chusquea abietifolia* GRISEB.	40	40	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	r	*Cissampelos Pareira* L.	–	–	–	–	60	40	100	–	–	–	–	40	60	40	–	–	–	–	30	50
J	l	*Cissus formosa* STANDL.	–	–	–	–	–	–	–	40	40	–	–	–	–	–	–	–	–	–	–	–
J	p	*C. sicyoides* L. ssp. *sicyoides*	–	–	–	80	–	–	–	60	60	100	–	–	–	–	–	–	60	–	–	–
J	p	*C. s.* ssp. *saxigena* BHIDI. & MZ.	–	–	–	–	80	60	100	–	–	–	–	–	–	–	–	–	–	40	–	–
J	b/2	*C. subavenia* PLANCH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	o	*C. trifoliata* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	60	50
B/4	l	*Citharexylum caudatum* L.	–	–	–	40	100	60	80	60	60	100	–	40	–	–	–	40	–	60	–	–
D/5	g	*C. discolor* TURCZ.	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	h	*C. fruticosum* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	70
Q	p	*Cladium jamaicense* CR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–	–	–	–
J	p	*Clematis dioica* L.	–	–	–	–	–	–	–	60	40	40	–	–	–	–	–	–	40	–	–	–
J!	p	*Clerodendron aculeatum* (L.) SCHLECHTD.	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	40	40	40	40	30

Table 25 Continued 14

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
D/5	c	*C. calcicola* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/5	a/8	*C. denticulatum* MOLD.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/3	f	*C. Lindenianum* A. RICH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–
E/4	b/2	*C. nipense* URB.	–	–	–	–	–	100	72	70	–	40	–	50	100	–	–	–	60	–	–	–
E/5	b/3	*Clethra cubensis* A. RICH.	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	40
D/5	b/3	*Cleyera nimanimae* (TUL.) KRUG & URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	–	–	–	–	90
E/4	p	*Clidemia capitellata* (BONPL.) D. DON	–	–	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/3	e	*C. capituliflora* Cogn.	–	–	–	–	–	30	81	–	–	–	–	–	–	–	–	–	–	–	–	–
E/3	g	*C. erythropogon* DC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–
E/3	p	*C. hirta* (L.) D. DON	–	–	80	30	–	–	–	–	–	–	60	–	60	–	–	60	–	–	–	30
E/4	f	*C. leucandra* WR. ex GRISEB.	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/4	g	*C. rubrinervis* GRISEB.	–	–	–	–	–	50	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/3	p	*C. strigillosa* (SW.) DC.	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	O	*Clitoria guianensis* (AUBL.) BENTH.	–	70	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	p	*C. rubiginosa* JUSS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	x	*C. ternatea* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	a/9	*Clusia Brittonii* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	a/5	*C. callosa* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	80	–	–	–	–
D/5	b/3	*C. Grisebachiana* (TR. & PL.) ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	40	50	–	–	–	–	–
D/4	m	*C. minor* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/5	*C. moaensis* BHIDI. et MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–
D/5	b/2	*C. monocarpa* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–
E/4	a/4	*C. nipensis* BHIDI. & MZ.	–	–	–	–	–	–	–	–	60	–	–	–	–	–	–	–	–	40	–	–
B/3	p	*C. rosea* JACQ.	–	–	–	–	–	–	–	–	–	–	40	40	–	40	60	–	–	–	100	30
E/4	b/2	*C. tetrastigma* VESQUE	–	–	–	–	–	–	–	–	–	–	–	30	–	–	30	–	–	–	–	40
O	p	*Coccocypselum guianense* (AUBL.) SCHUM.	–	30	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*C. herbaceum* AUBL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	–	–	–	–	30
D/7!	f	*Coccoloba armata* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	b/3	*C. benitoensis* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–
D/4	f	*C. praestans* BORHIDI	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
D/5	c	*C. calcicola* BRITT.	–	–	–	–	–	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–
B/5	a/8	*C. denticulatum* MOLD.	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/3	f	*C. Lindenianum* A. RICH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/4	b/2	*C. nipense* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/3	*Clethra cubensis* A. RICH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	b/3	*Cleyera nimanimae* (TUL.) KRUG & URB.	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/4	p	*Clidemia capitellata* (BONPL.) D. DON	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–
E/3	e	*C. capituliflora* Cogn.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/3	g	*C. erythropogon* DC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/3	p	*C. hirta* (L.) D. DON	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/4	f	*C. leucandra* WR. ex GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/4	g	*C. rubrinervis* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/3	p	*C. strigillosa* (SW.) DC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–	–	–	–	–
T	O	*Clitoria guianensis* (AUBL.) BENTH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	p	*C. rubiginosa* JUSS.	–	–	–	–	–	–	–	–	–	–	–	80	40	–	40	–	–	–	–	–
T	x	*C. ternatea* L.	–	–	–	–	–	–	–	–	–	–	60	60	40	40	–	–	40	40	40	–
D/5	a/9	*Clusia Brittonii* ALAIN	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	a/5	*C. callosa* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	b/3	*C. Grisebachiana* (TR. & PL.) ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	m	*C. minor* L.	–	–	–	40	–	–	40	–	–	–	60	40	–	–	100	–	–	–	–	–
E/5	a/5	*C. moaensis* BHIDI. et MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	b/2	*C. monocarpa* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/4	a/4	*C. nipensis* BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/3	p	*C. rosea* JACQ.	100	–	–	60	–	–	40	40	80	60	40	40	40	40	80	40	40	40	–	–
E/4	b/2	*C. tetrastigma* VESQUE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*Coccocypselum guianense* (AUBL.) SCHUM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–	–
O	p	*C. herbaceum* AUBL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/7!	f	*Coccoloba armata* GRISEB.	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–	–	–	40	–	–
D/5	b/3	*C. benitoensis* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	f	*C. praestans* BORHIDI	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 25 Continued 15

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
E/4	e	*C. Cowellii* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	h	*C. diversifolia* JACQ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6!	e	*C. geniculata* LINDAU	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/7!	f	*C. microphylla* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	b/2	*C. nervosa* ALAIN	–	–	–	–	–	–	–	–	–	40	40	–	–	–	–	–	–	40	–	–
E/5	b/2	*C. nipensis* URB.	–	–	–	–	–	–	–	–	–	–	30	–	80	–	–	–	100	40	–	–
E/5	j	*C. Northropiae* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	b/2	*C. oligantha* ALAIN	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–
D/4	c	*C. pallida* WR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	f	*C. praecox* WR. ex LIND.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5!	b/2	*C. reflexa* LINDAU	–	–	–	–	–	–	–	–	30	–	30	–	–	–	–	–	–	100	–	–
C/5	f	*C. retusa* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	40	–
E/5	b/2	*C. rufescens* WR.	–	–	–	–	–	–	–	–	–	–	–	30	–	–	–	–	–	–	–	–
E/3	b/2	*C. Shaferi* BRITT.	–	–	–	–	–	–	–	–	–	–	30	30	–	–	40	–	100	–	–	–
E/4	e	*C. Wrightii* LINDAU	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50	–	–	–	–	30
G	a/6	*Coccothrinax Acunana* LEÓN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
G	a/14	*C. Alexandri* LEÓN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
H	a/11	*C. clarensis* LEÓN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
G	a/8	*C. elegans* BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
H	g	*C. fragrans* BURR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
G	a/13	*C. Garciana* LEÓN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–
G	b/4	*C. litoralis* LEÓN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
H	f	*C. miraguama* (HBK.) BECC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
H	b/1	*C. m.* ssp. *arenicola* (LEÓN) BHIDI. & MZ.	–	70	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
G	a/14	*C. Munizii* BHIDI.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
H	a/12	*C. pseudorigida* LEÓN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
G	b/4	*C. Salvatoris* LEÓN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
G	a/3	*C. Yuraguana* (A. RICH.) LEÓN	–	–	–	100	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
H	a/5	*C. moaensis* BHIDI. et MZ.	–	–	–	–	–	–	–	–	–	–	50	–	–	–	–	–	–	–	–	–
G	b/2	*C. orientalis* (LEÓN) BHIDI et MZ.	–	–	–	–	–	100	81	90	100	100	–	30	100	–	–	–	–	–	–	–
G	b/1	*Colpothrinax Wrightii* GRISEB. & WENDL.	90	30	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
E/4	e	*C. Cowellii* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	100	60	–	–	–	–	–	–
D/4	h	*C. diversifolia* JACQ.	–	–	–	–	–	–	–	–	80	40	–	–	–	–	–	–	40	–	–	30
E/6!	e	*C. geniculata* LINDAU	–	–	–	–	–	–	–	–	–	–	–	60	80	100	–	–	–	–	–	–
D/7!	f	*C. microphylla* GRISEB.	–	–	–	–	–	–	–	–	–	–	60	40	–	40	–	–	–	–	–	–
E/6	b/2	*C. nervosa* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/2	*C. nipensis* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	j	*C. Northropiae* BRITT.	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–
E/6	b/2	*C. oligantha* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	c	*C. pallida* WR.	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–
D/5	f	*C. praecox* WR. ex LIND.	–	–	–	–	–	–	–	–	–	60	40	60	–	–	–	–	–	–	–	–
E/5!	b/2	*C. reflexa* LINDAU	–	–	–	–	–	–	–	–	–	–	–	–	–	80	–	–	–	–	–	–
C/5	f	*C. retusa* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/2	*C. rufescens* WR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/3	b/2	*C. Shaferi* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/4	e	*C. Wrightii* LINDAU	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
G	a/6	*Coccothrinax Acunana* LEÓN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
G	a/14	*C. Alexandri* LEÓN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	70
H	a/11	*C. clarensis* LEÓN	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–	–	–	–	–
G	a/8	*C. elegans* BHIDI. & MZ.	–	–	–	–	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
H	g	*C. fragrans* BURR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	70	–
G	a/13	*C. Garciana* LEÓN	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–	–	–	–	–	–
G	b/4	*C. litoralis* LEÓN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–
H	f	*C. miraguama* (HBK.) BECC.	–	–	–	–	–	–	60	–	–	–	100	40	40	–	–	–	–	–	–	–
H	b/1	*C. m.* ssp. *arenicola* (LEÓN) BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	80	–	–	–	–	–
G	a/14	*C. Munizii* BHIDI.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
H	a/12	*C. pseudorigida* LEÓN	–	–	–	–	–	–	–	–	–	–	–	–	100	–	–	–	–	–	–	–
G	b/4	*C. Salvatoris* LEÓN	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–
G	a/3	*C. Yuraguana* (A. RICH.) LEÓN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
H	a/5	*C. moaensis* BHIDI. et MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
G	b/2	*C. orientalis* (LEÓN) BHIDI et MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
G	b/1	*Colpothrinax Wrightii* GRISEB. & WENDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 25 Continued 16

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
C/3	n	*Clolubrina arborescens* (MILL.) SARG.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	k	*C. cubensis* (JACQ.) BROGN. ssp. *Ekmanii* (JOHNST.) BHIDI	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	n	*C. elliptica* (SW.) BRIZICK. & STEARN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/3	a/4	*C. glandulosa* PERS. ssp. *nipensis* (JOHNST.) BHIDI.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–
V	b/3	*Columnea cubensis* (URB.) BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	40
U	b/2	*C. tincta* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	80	–
O	o	*Commelina erecta* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–
T	p	*Commicarpus scandens* (L.) STANDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/3!	g	*Comocladia dentata* JACQ.	–	–	30	30	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5!	a/11	*C. intermedia* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/4	f	*Comocladia platyphylla* A. RICH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	o	*Comparettia falcata* POEPP. & ENDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	40	70	60	–	–	–	–
J	b/3	*Connarus reticulatus* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	r	*Conocarpus erecta* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/3	n	*Conostegia xalapensis* (BONPL.) D. DON	–	–	80	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
K!	a/14	*Consolea macracantha* (GRISEB.) BERG	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/4	f	*Copaifera hymenaefolia* MORIC	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–
G!	c	*Copernicia Brittonorum* LEÓN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
H!	a/12	*C. Cowellii* BRITT. & WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
H!	c	*C. Curtissii* BECC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
G!	c	*C. glabrescens* WENDL. & BECC.	–	–	40	30	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
H!	f	*C. macroglossa* WENDL. & BECC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
H!	e	*C. yarey* BURR.	–	–	–	–	–	–	–	–	–	30	–	–	–	–	–	–	–	–	–	–
O	x	*Corchorus hirsutus* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/5	*Cordia Acunae* (MOLD.) ALAIN	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–
B/5	p	*C. alliodora* (R. & P.) OKEN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/5	*C. baracoensis* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–
E/5	i	*C. Brittonii* (MILLSP.) MACBR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/4	n	*C. Collococca* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	b/3	*C. Curbeloi* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
C/3	n	*Clolubrina arborescens* (MILL.) SARG.	–	–	–	40	–	–	–	60	40	60	–	40	–	–	–	–	60	40	30	–
D/5	k	*C. cubensis* (JACQ.) BROGN. ssp. *Ekmanii* (JOHNST.) BHIDI	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
C/5	n	*C. elliptica* (SW.) BRIZICK. & STEARN	–	–	–	–	100	40	–	–	–	–	–	–	40	60	–	–	–	–	100	100
D/3	a/4	*C. glandulosa* PERS. ssp. *nipensis* (JOHNST.) BHIDI.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	b/3	*Columnea cubensis* (URB.) BRITT.	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	b/2	*C. tincta* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	o	*Commelina erecta* L.	–	–	–	60	–	–	60	–	60	100	–	–	–	–	–	–	–	–	–	–
T	p	*Commicarpus scandens* (L.) STANDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	90
E/3!	g	*Comocladia dentata* JACQ.	–	–	–	–	–	–	40	40	40	40	60	60	40	40	40	–	60	60	–	–
E/5!	a/11	*C. intermedia* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–
E/4	f	*Comocladia platyphylla* A. RICH.	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	o	*Comparettia falcata* POEPP. & ENDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	b/3	*Connarus reticulatus* GRISEB.	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	r	*Conocarpus erecta* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	60	–	–	–
D/3	n	*Conostegia xalapensis* (BONPL.) D. DON	–	–	–	–	–	40	–	–	–	–	–	–	–	–	100	–	–	–	–	–
K!	a/14	*Consolea macracantha* (GRISEB.) BERG	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100
B/4	f	*Copaifera hymenaefolia* MORIC—	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
G!	c	*Copernicia Brittonorum* LEÓN	–	–	–	–	–	–	–	60	40	–	–	–	–	–	–	–	–	–	–	–
H!	a/12	*C. Cowellii* BRITT. & WILS.	–	–	–	–	–	–	–	–	–	–	–	–	100	–	–	–	–	–	–	–
H!	c	*C. Curtissii* BECC.	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–
G!	c	*C. glabrescens* WENDL. & BECC.	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–
H!	f	*C. macroglossa* WENDL. & BECC.	–	–	–	–	–	–	–	–	–	–	100	80	100	60	–	–	–	–	–	–
H!	e	*C. yarey* BURR.	–	–	–	–	–	–	–	–	–	–	–	–	80	100	–	–	–	–	–	–
O	x	*Corchorus hirsutus* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	100
E/5	a/5	*Cordia Acunae* (MOLD.) ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/5	p	*C. alliodora* (R. & P.) OKEN	–	–	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
E/5	a/5	*C. baracoensis* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	i	*C. Brittonii* (MILLSP.) MACBR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	90
B/4	n	*C. Collococca* L.	–	–	–	80	40	–	40	–	40	60	–	–	–	–	–	–	–	–	–	–
D/5	b/3	*C. Curbeloi* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	90

Table 25 Continued 17

Lf	Ge	No. of communities Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
E/4	a/5	*C. Duartei* BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–
B/4	n	*C. Gerascanthus* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	l	*C. globosa* (JACQ.) HBK. ssp. *humilis* (JOHNST.) BHIDI.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	e	*C. Grisebachii* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/5	*C. iberica* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–
E/5	a/14	*C. leptoclada* URB. & BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	b/3	*C. leucosebestena* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	n	*C. Linnaei* STEARN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/3	*C. longipedunculata* (BRITT. & WILS.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60
E/5	a/5	*C. moensis* (MOLD.) ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–
B/5	h	*C. nitida* VAHL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/4	*C. pedunculosa* WR. ex GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–
C/4	a/14	*C. pulverulenta* (URB.) ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/3	p	*C. sebestena* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/4	a/5	*C. Shaferi* (BRITT.) ALAIN	–	–	–	–	–	–	–	–	–	40	–	–	40	–	–	–	–	–	–	–
E/5	h	*C. stenophylla* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/2	h	*C. sulcata* DC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	80	–
E/4	a/5	*C. Utermarkiana* BHIDI.	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	40	–	–	–
P	l	*Corymborchis forcipigera* (RCHB. F. L. O. WMS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*Crotalaria pumila* ORTEGA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R	r	*C. retusa* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6	h	*Croton betulinus* VAHL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	f	*C. Brittonianus* CARAB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	e	*C. camagüeyensis* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	b/1	*C. cerinus* MUELL.-ARG.	90	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/4	m	*C. corylifolius* LAM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	b/1	*C. craspedotrichus* GRISEB.	54	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/14	*C. excisus* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	g	*C. linearis* JACQ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
E/4	a/5	*C. Duartei* BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/4	n	*C. Gerascanthus* L.	–	–	–	40	40	40	40	100	100	100	–	–	–	–	–	–	80	60	50	30
E/5	l	*C. globosa* (JACQ.) HBK. ssp. *humilis* (JOHNST.) BHIDI.	–	–	–	–	–	–	–	60	40	60	100	80	40	–	–	–	100	40	80	50
E/6	e	*C. Grisebachii* URB.	–	–	–	–	–	–	–	–	–	–	–	–	80	60	–	–	–	–	–	–
E/5	a/5	*C. iberica* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/14	*C. leptoclada* URB. & BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50	30
D/4	b/3	*C. leucosebestena* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	90	50
D/4	n	*C. Linnaei* STEARN	–	–	–	–	–	–	–	–	–	–	–	40	40	–	–	–	–	–	–	–
E/5	b/3	*C. longipedunculata* (BRITT. & WILS.) URB. –	100	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/5	*C. moensis* (MOLD.) ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/5	h	*C. nitida* VAHL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–
E/5	a/4	*C. pedunculosa* WR. ex GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/4	a/14	*C. pulverulenta* (URB.) ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	–
C/3	p	*C. sebestena* L.	–	–	–	–	–	–	–	40	60	40	–	–	–	–	–	–	60	–	–	–
E/4	a/5	*C. Shaferi* (BRITT.) ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	h	*C. stenophylla* ALAIN	–	–	–	–	–	–	–	–	60	–	–	–	–	–	–	–	–	80	–	–
B/2	h	*C. sulcata* DC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/4	a/5	*C. Utermarkiana* BHIDI.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P	l	*Corymborchis forcipigera* (RCHB. F.) L. O. WMS.	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*Crotalaria pumila* ORTEGA	–	–	–	–	–	–	–	40	40	–	–	–	–	–	–	40	–	40	–	–
R	r	*C. retusa* L.	–	–	–	–	–	–	–	–	–	–	40	40	–	–	–	–	–	–	–	–
D/6	h	*Croton betulinus* VAHL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
E/6	f	*C. Brittonianus* CARAB.	–	–	–	–	–	–	–	–	–	–	–	–	40	60	–	–	–	–	–	–
E/6	e	*C. camagüeyensis* URB.	–	–	–	–	–	–	–	–	–	–	–	40	40	–	–	–	–	–	–	–
V	b/1	*C. cerinus* MUELL.-ARG.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/4	m	*C. corylifolius* LAM.	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	b/1	*C. craspedotrichus* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/14	*C. excisus* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
E/5	g	*C. linearis* JACQ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60

Table 25 Continued 18

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
E/6	f	*C. litoralis* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	i	*C. lucidus* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	a/5	*C. monogynus* URB.	–	–	–	–	–	–	–	–	–	–	100	–	–	–	–	–	–	–	–	–
E/5	e	*C. myricifolius* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	g	*C. nummulariifolius* A. RICH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6	h	*C. origanifolius* LAM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	j	*C. rosmarinoides* MILLSP.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	f	*C. Sagraeanus* MUELL.-ARG.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	e	*C. stenophyllus* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	e	*C. vaccinioides* L. C. RICH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/2	*Croton viminalis* GRISEB	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	60	–	–	–
U	o	*Cranichis muscosa* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–
C/4	p	*Crescentia Cujete* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P	c	*Crinum erubescens* AIT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V!	j	*Crossopetalum aquifolium* (GRISEB.) HITCHC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6!	a/14	*C. pungens* (WR.) ROTHM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6!	n	*C. Rhacoma* CR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6!	b/2	*C. tenuifolium* (URB.) ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–
J	f	*Cuervea integrifolia* (A. RICH.) A. C. SMITH	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/3	m	*Cupania americana* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–
B/4	n	*C. glabra* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	g	*Cuphea Melanium* (L.) R. BR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	b/1	*C. pseudosilene* GRISEB.	36	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/3	p	*Curatella americana* L.	–	80	40	30	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
N	e	*Cyathea araneosa* MAX.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–
N	p	*C. arborea* (L.) J. SMITH	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	90
N	e	*C. balanocarpa* EAT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60
N	e	*C. cubensis* UNDERW.	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	30
N	g	*C. furfuracea* BAK.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
N	g	*C. minor* EAT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	80	30

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
E/6	f	*C. litoralis* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	30	—
E/5	i	*C. lucidus* L.	—	—	—	60	—	—	40	60	40	—	—	—	—	—	40	—	100	40	100	70
E/6	a/5	*C. monogynus* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/5	e	*C. myricifolius* GRISEB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	50	40
V	g	*C. nummulariifolius* A. RICH.	—	—	—	—	—	—	—	—	—	—	100	100	100	100	—	—	—	—	—	—
D/6	h	*C. origanifolius* LAM.	—	—	—	—	—	—	—	—	—	—	100	80	100	60	—	—	—	—	—	—
E/6	j	*C. rosmarinoides* MILLSP.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	70	60
E/5	f	*C. Sagraeanus* MUELL.-ARG.	—	—	—	—	—	—	—	—	—	—	60	40	100	40	—	—	—	—	—	—
E/5	e	*C. stenophyllus* GRISEB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	30	90
E/6	e	*C. vaccinioides* L. C. RICH.	—	—	—	—	—	—	60	—	—	—	—	—	—	—	—	—	—	—	—	—
E/5	b/2	*Croton viminalis* GRISEB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
U	o	*Cranichis muscosa* SW.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C/4	p	*Crescentia Cujete* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	100	60	—	—	—
P	c	*Crinum erubescens* AIT.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—	—	—
V!	j	*Crossopetalum aquifolium* (GRISEB.) HITCHC.	—	—	—	—	—	—	—	—	—	—	40	40	60	100	—	—	—	—	50	70
E/6!	a/14	*C. pungens* (WR.) ROTHM.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	70
D/6!	n	*C. Rhacoma* CR.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—
E/6!	b/2	*C. tenuifolium* (URB.) ALAIN	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
J	f	*Cuervea integrifolia* (A. RICH.) A. C. SMITH	—	—	—	—	—	80	—	—	—	—	—	—	—	—	—	—	—	—	—	—
B/3	m	*Cupania americana* L.	—	—	—	80	—	—	—	—	—	60	—	—	—	—	—	—	—	—	—	—
B/4	n	*C. glabra* SW.	—	—	—	100	—	—	—	40	60	80	—	—	—	—	80	—	60	—	—	—
O	g	*Cuphea Melanium* (L.) R. BR.	—	—	—	—	—	—	—	—	—	—	—	40	40	40	—	—	—	—	—	—
O	b/1	*C. pseudosilene* GRISEB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/3	p	*Curatella americana* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—	—	—	—
N	e	*Cyathea araneosa* MAX.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
N	p	*C. arborea* (L.) J. SMITH	80	40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
N	e	*C. balanocarpa* EAT.	90	80	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
N	e	*C. cubensis* UNDERW.	40	60	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
N	g	*C. furfuracea* BAK.	—	—	40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
N	g	*C. minor* EAT.	—	40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Table 25 Continued 19

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
N	g	*C. tenera* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	–	–	–	–	–
J	n	*Cydista diversifolia* (HBK.) MIERS	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
K/8!	p	*Cylindropuntia hystrix* (GRISEB.) ARECES	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	j	*Cynanchum caribaeum* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	n	*C. cubense* (GRISEB.) WOODS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	i	*C. Eggersii* (SCHLTR.) ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	g	*C. ephedroides* (GRISEB.) ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	f	*C. graminifolium* (GRISEB.) ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–
T	f	*C. ophiticolum* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–
T	b/2	*C. orientense* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–	–	–	–
T	f	*C. penicillatum* (GRISEB.) ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	f	*C. Sauvallei* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	c	*C. savannarum* ALAIN	80	60	40	40	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R	l	*Cynoctonum Mitreola* (L.) BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	b/2	*Cyrilla cubensis* P. WILS.	–	–	–	–	–	–	–	–	30	–	50	30	100	–	60	100	40	60	–	–
C/5	b/2	*C. c.* ssp. *nipensis* (URB.) BHIDI.	–	–	–	–	–	–	–	–	–	–	–	–	–	100	50	–	–	–	–	–
B/4	n	*C. racemiflora* L.	18	–	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	r	*Cyperus articulatus* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	r	*Cyperus haspan* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	x	*C. Iria* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*C. odoratus* L. var. *acicularis* (SCHRAD.) ONEILL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	h	*C. unifolius* BOECKL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	p	*Dalbergia Brownei* (JACQ.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/4	r	*D. Ecastophyllum* (L.) TAUB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	p	*Dalechampia scandens* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	p	*Danaea elliptica* J. SMITH	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	30
V	g	*D. jamaicensis* UNDERW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
V	g	*D. Wrightii* UNDERW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–
E/5	a/7	*Daphnopsis Alainii* NEVLING	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
N	g	*C. tenera* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	n	*Cydista diversifolia* (HBK.) MIERS	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	50	–
K/8!	p	*Cylindropuntia hystrix* (GRISEB.) ARECES	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
T	j	*Cynanchum caribaeum* ALAIN	–	–	–	–	–	60	–	–	–	40	40	40	40	–	–	–	–	–	–	–
T	n	*C. cubense* (GRISEB.) WOODS.	–	–	–	–	–	–	40	–	–	–	–	–	–	–	60	–	–	–	–	–
T	i	*C. Eggersii* (SCHLTR.) ALAIN	–	–	–	–	–	–	–	–	–	–	–	60	40	40	–	–	–	30	50	–
T	g	*C. ephedroides* (GRISEB.) ALAIN	–	–	–	40	100	60	40	–	–	–	–	–	–	–	–	–	–	–	–	–
T	f	*C. graminifolium* (GRISEB.) ALAIN	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–
T	f	*C. ophiticolum* ALAIN	–	–	–	–	–	–	–	–	–	–	60	100	100	60	–	–	–	–	–	–
T	b/2	*C. orientense* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	f	*C. penicillatum* (GRISEB.) ALAIN	–	–	–	–	–	40	60	–	–	–	–	–	–	–	–	–	–	–	–	–
T	f	*C. Sauvallei* ALAIN	–	–	–	–	–	40	60	–	–	–	–	–	–	–	–	–	–	–	–	–
T	c	*C. savannarum* ALAIN	–	–	–	–	40	40	100	–	–	–	–	–	–	–	–	–	–	–	–	–
R	l	*Cynoctonum Mitreola* (L.) BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	b/2	*Cyrilla cubensis* P. WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–
C/5	b/2	*C. b.* ssp. *nipensis* (URB.) BHIDI.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/4	n	*C. racemiflora* L.	100	80	40	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–
O	r	*Cyperus articulatus* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–
O	r	*Cyperus haspan* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–
O	x	*C. Iria* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–
O	p	*C. odoratus* L. var. *acicularis* (SCHRAD.) ONEILL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	80	–	–	–	–
O	h	*C. unifolius* BOECKL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–
J	p	*Dalbergia Brownei* (JACQ.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–
C/4	r	*D. Ecastophyllum* (L.) TAUB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	60	–	30
J	p	*Dalechampia scandens* L.	–	–	–	–	–	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–
V	p	*Danaea elliptica* J. SMITH	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	g	*D. jamaicensis* UNDERW.	–	80	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	g	*D. Wrightii* UNDERW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/7	*Daphnopsis Alainii* NEVLING	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–

Table 25 Continued 20

Lf	Ge	No. of communities Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
D/5	b/4	*D. cuneata* RADIX.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/2	*D. Guacacoa* WR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/4	*D. oblongifolia* BRITT. & WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	p	*Davilla multiflora* (DC.) ST. HIL.	–	20	80	30	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	l	*Declieuxia chiococcoides* HBK. ssp. *mexicana* (DC.) BHIDI.	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V!	f	*Deherainia cubensis* (RADLK.) MEZ	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/8!	f	*Dendrocereus nudiflorus* (ENGELM.) BRITT. & ROSE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/3	p	*Dendropanax arboreus* (L.) DEC. & PL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	40
I	i	*Dendropemon emarginatus* (SW.) STEUD.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
I	g	*Dendropemon psilobotrys* (DC.) V. TIEGH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
I	i	*D. purpureus* (L.) KRUG & URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
I	e	*Dendrophthora buxifolia* (LAM.) EICHL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	–	40	–	–	40
I	b/2	*D. constricta* (WR. ex GRISEB.) EICHL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–
I	e	*D. cubensis* EICHL.	–	–	–	–	–	–	–	–	–	–	–	–	–	80	40	–	40	–	–	60
I	g	*D. cupressoides* (MACF.) EICHL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60
I	g	*D. domingensis* (SPRENG.) EICHL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
I	e	*D. Epiviscum* (GRISEB.) EICHL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
I	f	*D. glauca* (GRISEB.) EICHL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
I	b/3	*D. grandifolia* EICHL.	–	–	–	–	–	–	–	–	30	–	–	–	–	–	–	–	–	–	–	–
I	b/3	*D. serpyllifolia* (GRISEB.) KRUG & URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	–	–	–	–	40
I	b/3	*D. tetrastachya* (WR. ex GRISEB.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–
J	p	*Dennstaedtia adiantoides* (H. & B.) MOORE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–
J	p	*D. cicutaria* (SW.) MOORE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50
J	p	*D. cornuta* (KAULF.) MOORE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	p	*D. ordinata* (KAULF.) MOORE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	p	*D. rubiginosa* (KAULF.) MOORE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
D/5	b/4	*D. cuneata* RADIX.	–	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/2	*D. Guacacoa* WR.	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/4	*D. oblongifolia* BRITT. & WILS.	–	–	–	–	–	–	–	–	–	–	–	80	40	–	–	–	–	–	–	–
J	p	*Davilla multiflora* (DC.) ST. HIL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–	–	–	–	–
O	l	*Declieuxia chiococcoides* HBK. ssp. *mexicana* (DC.) BHIDI.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V!	f	*Deherainia cubensis* (RADLK.) MEZ	–	–	–	–	–	40	–	–	–	–	40	–	–	–	–	–	–	–	–	–
D/8!	f	*Dendrocereus nudiflorus* (ENGELM.) BRITT. & ROSE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	70
C/3	p	*Dendropanax arboreus* (L.) DEC. & PL.	80	–	–	100	40	60	100	40	–	60	–	–	–	–	–	–	–	–	–	–
I	i	*Dendropemon emarginatus* (SW.) STEUD.	–	–	–	40	40	–	40	–	–	–	–	40	40	40	40	40	40	40	–	–
I	g	*Dendropemon psilobotrys* (DC.) V. TIEGH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	30
I	i	*D. purpureus* (L.) KRUG & URB.	–	–	–	–	–	–	60	40	40	40	–	–	40	40	40	60	40	60	60	50
I	e	*Dendrophthora buxifolia* (LAM.) EICHL.	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
I	b/2	*D. constricta* (WR. ex GRISEB.) EICHL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
I	e	*D. cubensis* EICHL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
I	g	*D. cupressoides* (MACF.) EICHL.	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
I	g	*D. domingensis* (SPRENG.) EICHL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
I	e	*D. Epiviscum* (GRISEB.) EICHL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
I	f	*D. glauca* (GRISEB.) EICHL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	40	–	–
I	b/3	*D. grandifolia* EICHL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
I	b/3	*D. serpyllifolia* (GRISEB.) KRUG & URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
I	b/3	*D. tetrastachya* (WR. ex GRISEB.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	p	*Dennstaedtia adiantoides* (H. & B.) MOORE	–	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	p	*D. cicutaria* (SW.) MOORE	–	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	p	*D. cornuta* (KAULF.) MOORE	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	p	*D. ordinata* (KAULF.) MOORE	–	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	p	*D. rubiginosa* (KAULF.) MOORE	–	100	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 25 Continued 21

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
O	p	*Desmodium affine SCHLECHTD.*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	*p*	*D. axillare* (SW.) DC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*D. barbatum* (L.) BENTH. & OERST.	–	50	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*D. canum* (GMEL.) SCH. & THELL.	–	–	30	30	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	l	*Dichaea glauca* (SW.) LINDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
U	h	*D. hystricina* RCHB. F.	–	–	–	–	–	–	–	–	–	–	–	–	–	100	90	–	40	–	40	60
O	r	*Dichondra micrantha* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/2	p	*Didymopanax morototoni* (AUBL.) DEC. & PL.	..	30	–	–	–	–	36	–	–	–	–	–	–	60	100	–	–	–	100	40
U	g	*Dilomilis elata* (BENTH.) SUMMERH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50	–	40	–	–	40
U	g	*D. montana* (SW.) SUMMERH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	40	–	–	–	100
U	b/2	*D. oligophylla* (SCHLTR.) SUMMERH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	80	–	–	–	–
V	o	*Diodia apiculata* (WILLD.) K. SCHUM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–
O	g	*D. simplex* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R	p	*D. teres* WALT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	e	*Dioscorea cubensis* KNUTH	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	p	*D. polygonoides* H. & B.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	l	*Diospyros anisandra* BLAKE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	g	*D. caribaea* (A. DC.) STANDL.	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	40	–	80	–	–
D/5	i	*D. crassinervis* (KRUG & URB.) STANDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6!	f	*D. Grisebachii* (HIERN.) STANDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	g	*D. tetrasperma* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
N	g	*Diplazium aemulum* UNDERW. & MAX.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	70
N	p	*D. grandifolium* (SW.) SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	80	–
N	m	*D. striatum* (L.) PRESL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50
N	g	*D. unilobum* (POIR.) HIERON.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	40
N	g	*D. Urbanii* (C. CHR.) CHR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	f	*Distictis gnaphalantha* (A. RICH.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	g	*D. lactiflora* (VAHL) DC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	g	*Ditta myricoides* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	60	30	–	–	–	–	80
E/5	r	*Dodonaea viscosa* BENTH.	–	40	40	30	40	40	100	60	40	40	40	60	60	–	–	–	–	60	–	–

Lf	Ge	No. of communities / Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
O	p	*Desmodium affine SCHLECHTD.*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	*60*	–	–	–	–	–
O	*p*	*D. axillare* (SW.) DC.	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*D. barbatum* (L.) BENTH. & OERST.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*D. canum* (GMEL.) SCH. & THELL.	–	–	–	–	40	–	–	–	40	40	40	60	40	40	–	–	–	–	–	–
U	l	*Dichaea glauca* (SW.) LINDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	h	*D. hystricina* RCHB. F.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	r	*Dichondra micrantha* URB.	–	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/2	p	*Didymopanax morototoni* (AUBL.) DEC. & PL.	60	–	–	80	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–
U	g	*Dilomilis elata* (BENTH.) SUMMERH.	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	g	*D. montana* (SW.) SUMMERH.	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	b/2	*D. oligophylla* (SCHLTR.) SUMMERH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	o	*Diodia apiculata* (WILLD.) K. SCHUM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	g	*D. simplex* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–
R	p	*D. teres* WALT.	–	–	–	–	–	–	–	–	–	–	40	40	40	40	40	–	–	–	–	–
T	e	*Dioscorea cubensis* KNUTH	40	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–
T	p	*D. polygonoides* H. & B.	–	–	–	40	80	–	40	–	–	–	–	–	40	40	–	–	–	–	–	–
D/5	l	*Diospyros anisandra* BLAKE	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–
C/5	g	*D. caribaea* (A. DC.) STANDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	i	*D. crassinervis* (KRUG & URB.) STANDL.	–	–	–	–	–	40	60	100	80	60	100	80	100	100	40	–	–	60	–	–
D/6!	f	*D. Grisebachii* (HIERN.) STANDL.	–	–	–	–	–	–	–	40	–	60	40	–	–	80	–	–	–	80	90	30
C/5	g	*D. tetrasperma* SW.	–	–	–	–	–	–	–	60	40	–	–	–	–	–	–	–	–	–	–	–
N	g	*Diplazium aemulum* UNDERW. & MAX.	60	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
N	p	*D. grandifolium* (SW.) SW.	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
N	m	*D. striatum* (L.) PRESL	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
N	g	*D. unilobum* (POIR.) HIERON.	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
N	g	*D. Urbanii* (C. CHR.) CHR.	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	f	*Distictis gnaphalantha* (A. RICH.) URB.	–	–	–	–	60	–	100	–	–	–	–	–	–	–	–	–	–	–	40	30
J	g	*D. lactiflora* (VAHL) DC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	80	–	–
D/5	g	*Ditta myricoides* GRISEB.	–	60	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	r	*Dodonaea viscosa* BENTH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–

Table 25 Continued 22

Lf	Ge	No. of communities Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
C/6	e	*Doerpfeldia cubensis* (BRITT.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
J	p	*Doliocarpus dentatus* (AUBL.) STANDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	g	*Domingoa haematochila* (RCHB. F.) CARAB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P	p	*Doryopteris pedata* (L.) FÉE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
N	a/5	*Dracaena cubensis* M. VICT.	–	–	–	–	–	–	–	–	–	–	–	–	100	–	–	–	–	–	–	–
P	h	*Dryopteris deltoidea* (SW.) KUNTZE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
P	r	*D. dentata* (FORSK.) C. CHR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–
P	r	*D. effusa* (SW.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P	a/7	*D. Leonina* MORTON	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P	f	*D. lonchodes* (EET.) KUNTZE	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	40	–
P	p	*D. oligophylla* MAXON	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	70
P	r	*D. patens* (SW.) KUNTZE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–
P	p	*D. reptans* (GMEL.) C. CHR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P	h	*Dryopteris resinifera* (GMEL.) MORTON	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P	p	*D. reticulata* (L.) URB.	–	–	60	–	–	–	–	–	–	–	–	40	–	–	60	–	–	–	60	–
P	g	*D. scalpturoides* (FÉE) C. CHR.	–	–	–	–	–	–	–	–	–	–	–	40	–	60	–	–	–	–	40	–
P	g	*D. serra* (SW.) KUNTZE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P	p	*D. tetragona* (SW.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	r	*Drymaria cordata* (L.) WILLD. ex R. & S.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/4	h	*Drypetes alba* POIT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/4	l	*D. lateriflora* (SW.) KRUG & URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5!	j	*D. mucronata* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6!	f	*Duranta Fletcheriana* MOLD.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	r	*D. repens* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	p	*Echites umbellata* JACQ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	f	*E. u.* ssp. *crassipes* (A. RICH.) BHIDI.	–	–	40	80	40	–	36	–	30	40	40	–	30	–	–	–	–	–	–	–
B/4	l	*Ehretia tinifolia* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/4	a/9	*Ekmanianthe actinophylla* (GRISEB.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	a/5	*Ekmanochloa aristata* EKM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
C/6	e	*Doerpfeldia cubensis* (BRITT.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	70
J	p	*Doliocarpus dentatus* (AUBL.) STANDL.	–	–	–	60	–	–	–	–	–	–	–	–	–	–	100	–	–	–	–	–
U	g	*Domingoa haematochila* (RCHB. F.) CARAB.	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P	p	*Doryopteris pedata* (L.) FÉE	–	–	–	60	60	–	80	–	–	–	–	–	–	–	–	–	–	–	–	–
N	a/5	*Dracaena cubensis* M. VICT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P	h	*Dryopteris deltoidea* (SW.) KUNTZE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P	r	*D. dentata* (FORSK.) C. CHR.	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P	p	*D. effusa* (SW.) URB.	80	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–
P	a/7	*D. Leonina* MORTON	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P	f	*D. lonchodes* (EET.) KUNTZE	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–
P	p	*D. oligophylla* MAXON	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P	r	*D. patens* (SW.) KUNTZE	60	–	–	80	40	–	40	40	40	80	–	–	–	–	60	40	–	–	–	–
P	p	*D. reptans* (GMEL.) C. CHR.	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P	h	*Dryopteris resinifera* (GMEL.) MORTON	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P	p	*D. reticulata* (L.) URB.	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P	g	*D. scalpturoides* (FÉE) C. CHR.	60	–	–	–	–	40	40	–	–	60	–	–	–	–	–	–	–	–	–	–
P	g	*D. serra* (SW.) KUNTZE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P	p	*D. tetragona* (SW.) URB.	–	–	–	40	–	40	–	–	–	–	–	–	–	40	–	–	–	–	–	–
O	r	*Drymaria cordata* (L.) WILLD. ex R. & S.	–	–	–	–	40	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–
B/4	h	*Drypetes alba* POIT.	–	–	–	–	60	–	–	40	–	60	–	–	–	–	–	–	–	–	–	–
C/4	l	*D. lateriflora* (SW.) KRUG & URB.	–	–	–	–	–	–	–	–	–	60	–	–	–	–	–	–	–	–	–	–
D/5!	j	*D. mucronata* GRISEB.	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	40	–	70
D/6!	f	*Duranta Fletcheriana* MOLD.	40	60	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	r	*D. repens* L.	–	–	–	–	60	–	40	60	–	–	–	–	–	–	–	–	–	–	40	30
T	p	*Echites umbellata* JACQ.	–	–	–	–	40	–	40	–	–	–	–	–	–	–	40	–	80	40	60	90
T	f	*E. u.* ssp. *crassipes* (A. RICH.) BHIDI.	–	–	–	–	–	–	–	–	–	–	40	80	100	80	–	–	–	–	–	–
B/4	l	*Ehretia tinifolia* L.	–	–	–	–	–	–	–	–	40	40	–	–	–	–	–	–	–	–	–	–
B/4	a/9	*Ekmanianthe actinophylla* (GRISEB.) URB.	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	a/5	*Ekmanochloa aristata* EKM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 25 Continued 23

Lf	Ge	No. of communities Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
D/4	a/6	*Elaeagia cubensis* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	n	*Elaphoglossum crinitum* (L.) CHR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	80	30
U	g	*E. Eggersii* (BAK.) C. CHR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	80
U	p	*E. firmum* (METT.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	40	–	–	40	70
U	p	*E. glabellum* J. SMITH	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
U	r	*E. hirtum* (SW.) C. CHR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	p	*E. longifolium* JACQ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
U	p	*E. rigidum* (AUBL.) ALST.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–
U	n	*E. Wrightii* (METT.) MOORE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	–	–	–	40	–
Q	l	*Eleocharis cellulosa* TORR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Q	p	*E. interstincta* (VAHL) R. & S.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*E. minima* KUNTH	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	n	*Elleanthus capitatus* (R. BR.) RCHB. F.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60
U	o	*E. linifolius* (PRESL)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	70	–	–	–	100	30
O	e	*Elytraria cubana* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	f	*E. planifolia* LEONARD	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Q	c	*Enhydra sessilis* (SW.) DC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	l	*Epidendrum Acunae* DRESSL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	p	*E. anceps* JACQ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P	p	*E. atropurpureum* WILLD.	–	–	–	–	–	–	–	–	70	40	50	–	–	–	–	60	40	60	–	–
U	l	*E. Boothianum* LINDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	f	*E. brevifolium* JENNINGS	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P	p	*E. cochleatum* L.	–	–	–	–	–	–	–	–	40	40	80	–	–	–	–	–	40	40	–	30
U	p	*E. difforme* JACQ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	p	*E. diffusum* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	p	*E. fragrans* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	40
U	i	*E. fucatum* LINDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	a/5	*E. Hiorami* ACUÑA & ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	60	–	–	–	–
U	o	*E. ionosmum* LINDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	80	–	–
U	b/2	*E. neoporpax* AMES	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	–	–	–	–	–
P	p	*E. nocturnum* JACQ.	–	–	–	–	–	–	–	–	40	–	60	–	–	40	80	–	–	40	–	–
U	p	*E. oncidioides* LINDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
D/4	a/6	*Elaeagia cubensis* BRITT.	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	n	*Elaphoglossum crinitum* (L.) CHR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	g	*E. Eggersii* (BAK.) C. CHR.	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	p	*E. firmum* (METT.) URB.	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	p	*E. glabellum* J. SMITH	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	r	*E. hirtum* (SW.) C. CHR.	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	p	*E. longifolium* JACQ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	p	*E. rigidum* (AUBL.) ALST.	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	n	*E. Wrightii* (METT.) MOORE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Q	l	*Eleocharis cellulosa* TORR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–
Q	p	*E. interstincta* (VAHL) R. & S.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	80	–	–	–	–
O	p	*E. minima* KUNTH	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–
U	n	*Elleanthus capitatus* (R. BR.) RCHB. F.	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	o	*E. linifolius* (PRESL)	60	80	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	e	*Elytraria cubana* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	100	60	–	–	–	–	–	–
O	f	*E. planifolia* LEONARD	–	–	–	–	–	–	–	–	–	–	–	40	–	40	–	–	–	–	–	–
Q	c	*Enhydra sessilis* (SW.) DC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	40	–	–	–
U	l	*Epidendrum Acunae* DRESSL.	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	60	–	–	–	–
U	p	*E. anceps* JACQ.	–	–	–	–	40	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–
P	p	*E. atropurpureum* WILLD.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	l	*E. Boothianum* LINDL.	–	–	–	40	–	–	40	–	40	60	–	–	–	–	–	–	–	–	–	–
U	f	*E. brevifolium* JENNINGS	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–
P	p	*E. cochleatum* L.	40	40	40	40	80	40	40	40	–	60	–	40	40	40	40	40	–	40	–	–
U	p	*E. difforme* JACQ.	–	–	–	–	60	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	p	*E. diffusum* SW.	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	p	*E. fragrans* SW.	40	–	–	40	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–
U	i	*E. fucatum* LINDL.	–	–	–	–	–	60	100	40	60	–	–	–	–	–	–	40	–	40	–	–
U	a/5	*E. Hiorami* ACUÑA & ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	o	*E. ionosmum* LINDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	b/2	*E. neoporpax* AMES	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P	p	*E. nocturnum* JACQ.	40	60	40	40	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–
U	p	*E. oncidioides* LINDL.	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 25 Continued 24

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
U	f	*E. oxypetalum* LINDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	a/1	*E. pallidiflorum* HOOK.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	f	*E. phoeniceum* LINDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	f	*E. plicatum* LINDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	l	*E. cubincola* BHIDI.	–	–	–	–	–	–	–	–	–	–	–	–	–	100	100	–	–	–	80	100
U	n	*E. repens* COGN.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	p	*E. rigidum* JACQ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	g	*E. serrulatum* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	l	*E. teretifolium* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	60	60	–	–	–	40	50
U	o	*E. vespa* VELL.	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	40	40
R	x	*Eragrostis ciliaris* (L.) LINK	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	g	*E. cubensis* HITCHC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	k	*Eragrostis Elliottii* S. WATS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R	x	*E. tenella* (L.) BEAUV.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	c	*Eriochloa setosa* (A. RICH.) HITCHC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	n	*Eriosema crinitum* (HBK.) G. DON	–	50	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	l	*Erithalis fruticosa* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	g	*E. f.* ssp. *vacciniifolia* (GRISEB.) BHIDI.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/5	f	*Erythrina cubensis* WR. ex SAUV.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	f	*Erythroxylon alaternifolium* A. RICH.	–	–	–	40	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	i	*E. confusum* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	b/2	*E. coriaceum* BRITT. & WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–
C/5	f	*E. havanense* JACQ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	f	*E. longipes* O. E. SCHULZ	–	–	–	–	–	–	–	–	–	–	60	30	40	–	50	80	40	60	–	–
D/7	g	*E. minutifolium* GRISEB.	–	–	–	–	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	b/2	*E. pedicellare* (GRISEB.) O. E. SCHULZ	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	80	–	–
D/4	g	*E. Roigii* BRITT. et WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/6	g	*E. rotundifolium* LUNAN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/7!	f	*E. spinescens* A. RICH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	f	*Espadaea amoena* A. RICH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	b/2	*Eugenia acrantha* URB.	–	–	–	–	–	40	–	–	–	–	40	80	–	40	50	–	–	40	–	–
E/6	f	*E. asperifolia* BERG	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
U	f	*E. oxypetalum* LINDL.	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–
U	a/1	*E. pallidiflorum* HOOK.	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–
U	f	*E. phoeniceum* LINDL.	–	–	–	–	–	–	–	–	–	–	–	40	40	40	40	40	–	60	–	–
U	f	*E. plicatum* LINDL.	–	–	–	–	–	–	40	40	40	40	40	40	40	60	40	40	40	40	40	40
U	l	*E. cubincola* BHIDI.	–	100	100	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	n	*E. repens* COGN.	–	40	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	p	*E. rigidum* JACQ.	–	–	–	–	40	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–
U	g	*E. serrulatum* SW.	–	40	–	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	l	*E. teretifolium* SW.	40	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	o	*E. vespa* VELL.	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R	x	*Eragrostis ciliaris* (L.) LINK	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	60
O	g	*E. cubensis* HITCHC.	–	–	–	–	–	–	–	–	–	–	60	80	100	100	–	–	–	–	–	–
O	k	*Eragrostis Elliottii* S. WATS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–
R	x	*E. tenella* (L.) BEAUV.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	30
O	c	*Eriochloa setosa* (A. RICH.) HITCHC.	–	–	–	–	–	–	–	–	–	–	–	80	100	60	–	–	–	–	–	–
V	n	*Eriosema crinitum* (HBK.) G. DON	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	l	*Erithalis fruticosa* L.	–	–	–	–	–	–	–	40	60	–	–	–	–	–	–	–	–	80	100	100
E/6	g	*E. f.* ssp. *vacciniifolia* (GRISEB.) BHIDI.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	80
B/5	f	*Erythrina cubensis* WR. ex SAUV.	–	–	–	–	60	80	–	–	–	–	–	–	–	–	–	–	40	60	–	–
D/5	f	*Erythroxylon alaternifolium* A. RICH.	–	–	–	–	–	–	80	–	40	–	100	40	40	40	40	–	–	60	–	–
C/5	i	*E. confusum* BRITT.	–	–	–	40	–	–	60	100	100	100	–	40	–	–	–	100	60	40	40	30
C/5	b/2	*E. coriaceum* BRITT. & WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	f	*E. havanense* JACQ.	–	–	–	60	40	80	40	40	–	40	40	–	–	–	–	–	–	–	–	–
D/5	f	*E. longipes* O. E. SCHULZ	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
D/7	g	*E. minutifolium* GRISEB.	–	–	–	–	–	–	–	–	–	–	100	100	100	60	–	–	–	–	60	30
E/6	b/2	*E. pedicellare* (GRISEB.) O. E. SCHULZ	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100
D/4	g	*E. Roigii* BRITT. et WILS.	–	–	–	–	–	–	–	60	80	–	–	–	–	–	–	–	–	–	–	–
C/6	g	*E. rotundifolium* LUNAN	–	–	–	–	60	–	–	80	40	–	40	40	40	40	–	–	80	100	70	70
D/7!	f	*E. spinescens* A. RICH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
C/5	f	*Espadaea amoena* A. RICH.	–	–	–	40	–	–	–	–	–	80	–	–	–	–	–	–	–	–	–	–
D/5	b/2	*Eugenia acrantha* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	f	*E. asperifolia* BERG	–	–	–	–	40	–	40	–	–	–	–	40	–	–	–	–	–	–	–	–

Table 25 Continued 25

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
D/5	k	*E. axillaris* (SW.) WILLD.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/9	*E. banderensis* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	f	*E. camarioca* WR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	a/4	*E. canapuensis* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–
D/6	a/11	*E. clarensis* BRITT. et WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/7	f	*E. Cowellii* BRITT. & WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6	f	*E. cyphophloea* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/4	b/2	*E. Fadyenii* KRUG & URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–
D/5	c	*E. farameoides* A. RICH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	a/9	*E. galeata* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	b/2	*E. Grisebachii* KRUG & URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–
D/4	b/3	*E. laeteviridis* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	40
C/5	o	*E. ligustrina* (SW.) WILLD.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	b/3	*E. lomensis* BRITT. & WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	a/6	*E. maestrensis* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50
C/5	k	*E. maleolens* POIR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	f	*E. melanadenia* KRUG & URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/7	a/4	*E. mensurensis* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–
E/6	f	*E. mucronata* BERG	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	b/3	*E. nematopoda* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	e	*E. papayoensis* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	30
D/5	b/2	*E. pinetorum* URB.	–	–	–	–	–	40	81	–	70	40	90	40	100	40	–	40	40	60	–	–
E/5	o	*E. punicifolia* (HBK.) DC.	36	60	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	c	*E. Ramoniana* URB.	–	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	b/3	*E. revoluta* BERG	–	–	–	–	–	–	–	–	–	–	–	30	–	–	–	–	–	40	–	50
C/5	k	*E. rhombea* (BERG) KRUG & URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	b/1	*E. rigidifolia* A. RICH.	–	–	–	40	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	b/4	*E. rigidula* BRITT. & WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6	c	*E. Sauvallei* KRUG & URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	f	*E. scaphophylla* WR.	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	40	40	–	–	–
E/5	b/2	*E. stenoxypha* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–
E/6	a/11	*E. subdisticha* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
D/5	k	*E. axillaris* (SW.) WILLD.	—	—	—	60	40	40	40	80	100	100	40	—	—	—	60	—	100	40	40	30
E/5	a/9	*E. banderensis* URB.	—	—	—	—	—	60	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	f	*E. camarioca* WR.	—	—	—	—	—	—	—	—	—	—	60	40	100	100	—	—	—	—	—	—
C/5	a/4	*E. canapuensis* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/6	a/11	*E. clarensis* BRITT. et WILS.	—	—	—	—	—	—	—	—	—	—	—	80	—	—	—	—	—	—	—	—
E/7	f	*E. Cowellii* BRITT. & WILS.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	60	100
D/6	f	*E. cyphophloea* GRISEB.	—	—	—	—	—	—	40	—	—	—	—	—	—	—	—	—	—	—	—	—
C/4	b/2	*E. Fadyenii* KRUG & URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	c	*E. farameoides* A. RICH.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	100	—	—	—	—	—
D/5	a/9	*E. galeata* URB.	—	—	—	—	—	100	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	b/2	*E. Grisebachii* KRUG & URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/4	b/3	*E. laeteviridis* URB.	—	40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C/5	o	*E. ligustrina* (SW.) WILLD.	—	—	—	—	—	—	—	—	40	60	—	—	—	—	—	—	—	100	—	—
D/4	b/3	*E. lomensis* BRITT. & WILS.	—	40	60	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C/5	a/6	*E. maestrensis* URB.	—	100	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C/5	k	*E. maleolens* POIR.	—	—	—	40	80	40	40	100	100	80	80	40	40	40	60	—	100	100	90	30
E/5	f	*E. melanadenia* KRUG & URB.	—	—	—	—	—	—	—	—	—	—	100	40	100	60	—	—	—	—	—	—
E/7	a/4	*E. mensurensis* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/6	f	*E. mucronata* BERG	—	—	—	—	—	—	60	—	—	—	—	—	—	—	—	—	—	—	—	—
C/5	b/3	*E. nematopoda* URB.	—	—	—	—	40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/6	e	*E. papayoensis* URB.	—	—	—	—	40	—	40	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	b/2	*E. pinetorum* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/5	o	*E. punicifolia* (HBK.) DC.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	100	—	—	—	—	—
E/5	c	*E. Ramoniana* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—	—	—	—
E/6	b/3	*E. revoluta* BERG	—	—	—	—	—	—	—	—	—	—	—	—	40	40	—	—	—	—	—	—
C/5	k	*E. rhombea* (BERG) KRUG & URB.	—	—	—	—	—	—	—	60	40	40	40	40	—	—	40	—	40	60	—	30
E/6	b/1	*E. rigidifolia* A. RICH.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/6	b/4	*E. rigidula* BRITT. & WILS.	—	—	—	—	—	—	60	—	—	—	—	—	—	—	—	—	—	—	—	—
D/6	c	*E. Sauvallei* KRUG & URB.	—	—	—	—	—	—	—	—	—	—	40	—	—	—	—	—	—	—	—	—
E/6	f	*E. scaphophylla* WR.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/5	b/2	*E. stenoxypha* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/6	a/11	*E. subdisticha* URB.	—	—	—	—	—	—	—	—	—	—	—	40	—	—	—	—	—	—	—	—

Table 25 Continued 26

Lf	Ge	No. of communities Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
E/6	f	*E. tuberculata* (HBK.) DC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/7	b/2	*E. vitis-idaea* WR. ex SAUV.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–
E/5	b/2	*Eupatorium ayapanoides* GRISEB.	–	–	–	–	–	–	–	–	–	–	50	80	–	–	–	–	40	–	–	–
D/5	b/3	*E. bullescens* ROBINS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	k	*E. capillifolium* (LAM.) SMALL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/3	*E. carsticola* BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/5	*E. grandiceps* WR. ex SAUV.	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–
V	a/3	*E. Grisebachianum* ALAIN	–	–	–	40	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	p	*Eupatorium havanense* HBK.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
E/5	b/3	*E. helianthemoides* ROBINS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	a/6	*E. hidrodes* ROBINS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
V	b/2	*E. hygrophilum* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	60	50	–	–	–	–	–
E/5	e	*E. hypoleucum* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	a/7	*E. iodostylum* ROBINS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/3	*E. lantanifolium* GRISEB.	–	–	–	–	–	–	–	–	–	–	60	–	40	–	30	–	40	40	–	–
D/4	b/3	*E. libanoticum* SCH.-BIP.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
E/5	b/3	*E. maestrense* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/4	*E. nipense* ROBINS.	–	–	–	–	–	–	–	–	80	–	–	–	–	–	–	–	–	40	–	–
E/5	p	*E. odoratum* L.	–	–	–	–	–	–	–	–	–	–	30	40	–	–	–	–	–	–	–	–
D/5	a/6	*E. paucibracteatum* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	b/2	*E. polystictum* URB.	–	–	–	–	–	100	100	100	90	100	100	100	100	–	–	–	–	40	–	–
E/4	f	*E. pseudo-dalea* (DC.) MAZA & MOL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
J	b/2	*E. rhexioides* ROBINS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	–	–	–	–	–
V	b/2	*E. Shaferi* ROBINS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–
E/6	h	*E. sinuatum* LAM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/6	*E. turquinense* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	k	*E. villosum* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	b/3	*Euphorbia Helenae* URB.	–	–	–	–	–	–	–	–	–	100	100	–	40	–	30	–	40	40	–	–
D/4	b/2	*E. H.* ssp. *grandifolia* BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	30	–	–	–	–
E/6	a/5	*E. Munizii* BHIDI.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–
E/6	b/2	*E. podocarpifolia* URB.	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	80	–	–
G	h	*Euterpe globosa* GAERTN.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	40

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
E/6	f	*E. tuberculata* (HBK.) DC.	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–
E/7	b/2	*E. vitis-idaea* WR. ex SAUV.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/2	*Eupatorium ayapanoides* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	b/3	*E. bullescens* ROBINS.	–	80	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	k	*E. capillifolium* (LAM.) SMALL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–
E/5	b/3	*E. carsticola* BHIDI. & MZ.	–	–	–	–	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/5	*E. grandiceps* WR. ex SAUV.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	a/3	*E. Grisebachianum* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	p	*Eupatorium havanense* HBK.	–	–	–	40	40	–	–	60	–	–	–	–	–	–	–	40	40	–	–	–
E/5	b/3	*E. helianthemoides* ROBINS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–
D/5	a/6	*E. hidrodes* ROBINS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	b/2	*E. hygrophilum* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	e	*E. hypoleucum* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	40	80	–	–	–	–	–	–	–
V	a/7	*E. iodostylum* ROBINS.	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/3	*E. lantanifolium* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	b/3	*E. libanoticum* SCH.-BIP.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/3	*E. maestrense* URB.	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/4	*E. nipense* ROBINS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	p	*E. odoratum* L.	–	–	–	–	40	40	40	40	–	–	–	–	–	–	–	–	–	40	–	–
D/5	a/6	*E. paucibracteatum* ALAIN	–	100	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	b/2	*E. polystictum* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/4	f	*E. pseudo-dalea* (DC.) MAZA & MOL.	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	b/2	*E. rhexioides* ROBINS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	b/2	*E. Shaferi* ROBINS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	h	*E. sinuatum* LAM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	50
E/5	a/6	*E. turquinense* ALAIN	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	k	*E. villosum* SW.	–	–	–	–	40	40	40	–	–	–	60	80	60	60	–	–	–	–	50	–
D/5	b/3	*Euphorbia Helenae* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	b/2	*E. H.* ssp. *grandifolia* BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	a/5	*E. Munizii* BHIDI.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	b/2	*E. podocarpifolia* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
G	h	*Euterpe globosa* GAERTN.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 25 Continued 27

Lf	Ge	No. of communities Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
V	i	*Evolvulus arbuscula* POIR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	j	*E. Bracei* HOUSE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	k	*E. Grisebachii* PETER.	36	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	f	*E. minimus* v. OESTR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*E. sericeus* SW.	–	90	40	–	40	30	–	40	–	–	–	–	–	–	–	–	–	40	–	–
C/5	l	*Exostema caribaeum* (JACQ.) R. & S.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	f	*E. Valenzuelae* A. RICH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	b/2	*E. purpureum* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	100	100	–	–
C/4	f	*E. rotundatum* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/7!	g	*E. spinosum* (Le VAVASS.) KRUG & URB.	–	–	–	–	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	e	*E. velutinum* STANDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/4	l	*Exothea paniculata* (JUSS.) RADLK.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/4	p	*Faramea occidentalis* (L.) A. RICH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	80	–
J	a/5	*Feddea cubensis* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–
C/4	k	*Ficus aurea* NUTT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/4	g	*F. Berteroi* WARB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
B/3	c	*F. Combsii* WARB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/4	h	*F. crassinervis* WILLD.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	i	*F. perforata* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	h	*F. citrifolia* MILL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/4	f	*F. maxima* MILL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/4	g	*F. velutina* (H. & B.) WILLD.	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	100	–
R	r	*Fimbristylis cymosa* R. BR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/3	l	*Forchammeria trifoliata* RADLK.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	h	*Forestiera rhamnifolia* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	h	*F. segregata* (JACQ.) KRUG & URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	g	*Forsteronia corymbosa* (JACQ.) G. MEY.	–	–	–	–	–	–	–	–	–	–	–	30	–	–	–	–	–	40	–	–
B/5	a/11	*Fraxinus caroliniana* MILL. ssp. *cubensis* (GRISEB.) BHIDI.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/3	g	*Freziera Grisebachii* KRUG & URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
V	i	*Evolvulus arbuscula* POIR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50	30
O	j	*E. Bracei* HOUSE	–	–	–	–	–	–	–	–	–	–	–	40	40	60	40	–	–	–	–	–
O	k	*E. Grisebachii* PETER.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	f	*E. minimus* v. OESTR.	–	–	–	–	–	–	–	–	–	–	–	40	60	40	–	–	–	–	–	–
O	p	*E. sericeus* SW.	–	–	–	–	–	–	–	–	–	–	–	40	100	100	–	–	–	–	–	–
C/5	l	*Exostema caribaeum* (JACQ.) R. & S.	–	–	–	–	–	–	–	40	60	–	–	–	–	40	–	–	80	60	60	80
D/5	f	*E. Valenzuelae* A. RICH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–
D/5	b/2	*E. purpureum* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/4	f	*E. rotundatum* GRISEB.	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–
D/7!	g	*E. spinosum* (Le VAVASS.) KRUG & URB.	–	–	–	–	–	–	–	–	–	–	60	40	80	60	–	–	–	–	70	50
D/5	e	*E. velutinum* STANDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
B/4	l	*Exothea paniculata* (JUSS.) RADLK.	–	–	–	40	–	–	–	–	60	100	–	–	–	–	40	–	–	–	–	–
C/4	p	*Faramea occidentalis* (L.) A. RICH.	40	–	–	80	–	60	40	40	–	60	–	–	–	–	60	–	–	–	–	–
J	a/5	*Feddea cubensis* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/4	k	*Ficus aurea* NUTT.	–	–	–	80	80	40	100	40	40	–	–	–	–	–	–	40	40	60	50	30
B/4	g	*F. Berteroi* WARB.	–	–	–	100	60	–	–	–	–	–	–	–	–	–	–	–	–	–	30	30
B/3	c	*F. Combsii* WARB.	–	–	–	–	–	–	–	60	80	–	–	–	–	–	–	–	–	–	–	–
B/4	h	*F. crassinervis* WILLD.	–	–	–	–	–	–	100	100	100	100	–	–	–	–	–	–	40	–	–	–
C/5	i	*F. perforata* L.	–	–	–	–	100	40	80	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	h	*F. citrifolia* MILL.	–	–	–	–	80	–	40	40	40	–	–	–	–	–	–	–	–	100	70	60
B/4	f	*F. maxima* MILL.	–	–	–	–	–	–	–	40	80	–	–	–	–	–	–	60	–	–	–	–
B/4	g	*F. velutina* (H. & B.) WILLD.	–	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R	r	*Fimbristylis cymosa* R. BR.	–	–	–	–	–	–	–	–	–	–	–	40	40	–	40	–	–	–	–	–
C/3	l	*Forchammeria trifoliata* RADLK.	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–
C/5	h	*Forestiera rhamnifolia* GRISEB.	–	–	–	–	–	–	–	40	40	60	40	–	–	–	40	–	60	40	–	–
C/5	h	*F. segregata* (JACQ.) KRUG & URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	80
J	g	*Forsteronia corymbosa* (JACQ.) G. MEY.	–	–	–	–	100	40	60	40	–	40	–	–	–	–	40	–	–	60	–	–
B/5	a/11	*Fraxinus caroliniana* MILL. ssp. *cubensis* (GRISEB.) BHIDI.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–
C/3	g	*Freziera Grisebachii* KRUG & URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 25 Continued 28

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
O	r	*Fuirena umbellata* ROTTB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
K!	g	*Furcraea hexapetala* (JACQ.) URB.	–	–	–	30	30	–	–	–	–	–	–	30	–	–	–	–	–	–	–	–
T	b/2	*Galactia brachyodon* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	60	–	–	–	–
T	c	*G. Combsii* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	b/3	*G. cuneata* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	h	*G. dubia* DC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	b/2	*G. Earlei* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–
T	f	*G. galactioides* (GRISEB.) HITCHC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	a/14	*G. maisiana* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	a/14	*G. minutifolia* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	k	*G. parvifolia* A. RICH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	b/2	*G. revoluta* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–
T	b/2	*G. rudolphioides* (GRISEB.) BENTH. & HOOK.	–	–	–	–	–	100	72	60	60	100	50	40	100	–	–	–	–	60	–	–
T	f	*G. savannarum* BRITT.	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	k	*G. spiciformis* TORR. & GRAY	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	p	*G. striata* (JACQ.) URB.	–	–	40	40	30	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	l	*Garrya Fadyenii* HOOK.	–	–	–	–	–	–	–	–	–	–	30	–	–	–	30	40	–	–	–	90
G	a/9	*Gaussia princeps* WENDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/3	p	*Genipa americana* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	a/5	*Gesneria acuminata* URB. ssp. *obovata* (MORT.) BHIDI.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–
V	a/9	*G. celsioides* (GRISEB.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/3	*G. ferruginea* (WR. ex SAUV.) URB.	–	–	–	30	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/3	*G. heterochroa* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
E/5	a/8	*G. h.* ssp. *nova*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/4	*G. nipensis* BRITT. & WILS.	–	–	–	–	–	–	–	–	30	–	–	–	–	–	–	–	–	–	–	–
E/4	b/2	*G. Norlindii* URB.	–	–	–	–	–	–	–	–	–	–	40	30	–	–	–	–	–	–	–	–
E/4	a/5	*G. nova*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–
D/4	b/3	*G. viridifolia* (DCNE.) KUNTZE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60
E/5	a/6	*Ginoria montana* BRITT. & WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
O	r	*Fuirena umbellata* ROTTB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–
K!	g	*Furcraea hexapetala* (JACQ.) URB.	–	–	–	–	–	–	–	–	–	–	40	80	40	40	–	–	–	–	–	–
T	b/2	*Galactia brachyodon* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	c	*G. Combsii* URB.	–	–	–	–	–	–	–	–	–	–	40	40	–	–	–	–	–	–	–	–
T	b/3	*G. cuneata* ALAIN	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	40	30
T	h	*G. dubia* DC.	–	–	–	–	–	–	–	40	60	60	40	–	–	–	–	–	–	–	–	–
T	b/2	*G. Earlei* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	f	*G. galactioides* (GRISEB.) HITCHC.	–	–	–	–	–	–	–	–	–	–	–	80	100	60	–	–	–	–	–	–
T	a/14	*G. maisiana* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
T	a/14	*G. minutifolia* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60
T	k	*G. parvifolia* A. RICH.	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	30	30
T	b/2	*G. revoluta* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	b/2	*G. rudolphioides* (GRISEB.) BENTH. & HOOK.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	f	*G. savannarum* BRITT.	–	–	–	–	–	–	–	–	–	–	100	60	40	100	40	–	–	–	–	–
T	k	*G. spiciformis* TORR. & GRAY	–	–	–	–	–	–	–	40	40	40	80	–	60	40	40	–	60	–	–	–
T	p	*G. striata* (JACQ.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	l	*Garrya Fadyenii* HOOK.	80	100	100	–	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–
G	a/9	*Gaussia princeps* WENDL.	–	–	–	–	–	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/3	p	*Genipa americana* L.	–	–	–	–	–	–	–	40	60	80	–	–	–	–	40	–	–	–	–	–
V	a/5	*Gesneria acuminata* URB. ssp. *obovata* (MORT.) BHIDI.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	a/9	*G. celsioides* (GRISEB.) URB.	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/3	*G. ferruginea* (WR. ex SAUV.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/3	*G. heterochroa* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/8	*G. h.* ssp. *nova*	–	–	–	–	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/4	*G. nipensis* BRITT. & WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/4	b/2	*G. Norlindii* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/4	a/5	*G. nova*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	b/3	*G. viridifolia* (DCNE.) KUNTZE	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/6	*Ginoria montana* BRITT. & WILS.	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 25 Continued 29

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
J	p	*Gleichenia bifida* (WILLD.) SPRENG.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100
J	p	*G. flexuosa* (SCHRAD.) METT.	–	–	60	40	–	–	–	–	–	–	–	30	40	–	90	40	–	–	–	30
J	f	*G. Leonis* (MAX.) C. CHR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	–	–	–	–	40
J	l	*G. palmata* (SCHAFFN.) MOORE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	p	*G. pectinata* (WILLD.) PRESL	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	40
O	l	*Gnaphalium attenuatum* DC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5!	b/2	*Gochnatia attenuata* (BRITT.) JERVIS & ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–
E/6!	a/14	*G. calcicola* (BRITT.) JERVIS & ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6!	b/4	*G. Cowellii* (BRITT.) JERVIS & ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/5	*G. crassifolia* (BRITT.) JERVIS & ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	100	–	–
E/6!	b/2	*G. cubensis* (CARAB.) JERVIS & ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	80	–	–
E/6!	a/14	*G. maisiana* (LEÓN) JERVIS & ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/7!	a/12	*G. parvifolia* (BRITT.) JERVIS & ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6!	b/2	*G. recurva* (BRITT.) JERVIS & ALAIN	–	–	–	–	–	–	–	–	–	–	90	–	60	–	–	40	60	–	–	–
R	a/2	*Goerziella minima* (STANDL.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/4	h	*Gomidesia Lindeniana* BERG	–	–	–	–	–	–	–	–	–	–	–	60	–	–	70	–	–	–	–	90
D/3	g	*Gonzalaguinia brachyantha* (A. RICH.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	80	–
D/4	b/1	*G. Sagraeana* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/4	n	*G. panamensis* (CAV.) SCHUM. ex MART.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	a/10	*Gossypianthus Jacquianus* EKM. & SÜSSGTH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	m	*Gossypiospermum eriophorum* (WR.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	l	*Gouania lupuloides* (L.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	p	*G. polygama* (JACQ.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/5	*Graffenrieda cordifolia* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–
D/5	a/6	*G. rufescens* BRITT. & WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60
E/5	i	*Grimmeodendron eglandulosum* (A. RICH.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Lf	Ge	No. of communities / Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
J	p	*Gleichenia bifida* (WILLD.) SPRENG.	80	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	p	*G. flexuosa* (SCHRAD.) METT.	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	f	*G. Leonis* (MAX.) C. CHR.	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	l	*G. palmata* (SCHAFFN.) MOORE	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	p	*G. pectinata* (WILLD.) PRESL	–	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	l	*Gnaphalium attenuatum* DC.	–	60	–	–	–	–	–	–	–	–	–	40	40	40	40	–	–	–	–	–
E/5!	b/2	*Gochnatia attenuata* (BRITT.) JERVIS & ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6!	a/14	*G. calcicola* (BRITT.) JERVIS & ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6!	b/4	*G. Cowellii* (BRITT.) JERVIS & ALAIN	–	–	–	–	–	–	–	–	–	–	–	60	80	–	–	–	–	–	–	–
E/5	a/5	*G. crassifolia* (BRITT.) JERVIS & ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6!	b/2	*G. cubensis* (CARAB.) JERVIS & ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6!	a/14	*G. maisiana* (LEÓN) JERVIS & ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	90
E/7!	a/12	*G. parvifolia* (BRITT.) JERVIS & ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	80	–	–	–	–	–	–
E/6!	b/2	*G. recurva* (BRITT.) JERVIS & ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R	a/2	*Goerziella minima* (STANDL.) URB.	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–
C/4	h	*Gomidesia Lindeniana* BERG	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/3	g	*Gonzalaguinia brachyantha* (A. RICH.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	b/1	*G. Sagraeana* URB.	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/4	n	*G. panamensis* (CAV.) SCHUM. ex MART.	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–
V	a/10	*Gossypianthus Jacquianus* EKM. & SÜSSGTH.	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–
D/5	m	*Gossypiospermum eriophorum* (WR.) URB.	–	–	–	–	–	–	–	40	40	40	–	–	–	–	–	–	–	60	–	–
J	l	*Gouania lupuloides* (L.) URB.	–	–	–	–	–	–	–	40	60	100	–	–	–	–	–	–	–	–	–	–
J	p	*G. polygama* (JACQ.) URB.	–	–	–	60	40	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–
E/5	a/5	*Graffenrieda cordifolia* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	a/6	*G. rufescens* BRITT. & WILS.	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	i	*Grimmeodendron eglandulosum* (A. RICH.) URB.	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	50	50

Table 25 Continued 30

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
C/5	p	*Guaiacum officinale* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/5	l	*G. sanctum* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/3	o	*Guarea guidonia* (L.) SLEUMER	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	80	–
B/5	g	*Guatteria Blainii* (GRISEB.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	80	60	–	–	–	–	40
B/4	b/3	*G. Moralesii* (MAZA) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
B/4	p	*Guazuma ulmifolia* LAM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	f	*Guettarda brevipodis* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	c	*G. calcicola* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/4	f	*G. calyptrata* A. RICH.	–	–	30	40	–	70	–	30	50	80	–	–	–	–	–	–	–	–	–	–
E/5	a/12	*G. camagüeyensis* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	a/11	*G. clarensis* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/3	l	*G. Combsii* URB.	–	–	–	30	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	a/14	*G. Coxiana* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/4	b/2	*G. crassipes* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–	–	–	–	–	–
D/6	b/3	*G. cueroensis* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/7!	f	*G. echinodendron* WR. ex SAUV.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	n	*G. elliptica* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	b/2	*G. ferruginea* WR. ex GRISEB.	–	–	–	–	–	–	36	30	–	60	100	30	100	30	40	60	100	80	–	–
D/5	g	*G. Lindeniana* A. RICH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/3	b/2	*G. macrocarpa* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	b/2	*G. monocarpa* URB.	–	–	–	–	–	30	–	–	100	60	60	60	–	–	30	40	–	60	–	–
D/4	a/12	*G. Munizii* BHIDI.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/7	f	*G. rigida* A. RICH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/4	l	*G. scabra* (L.) LAM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/3	*G. Shaferi* STANDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–
C/4	a/7	*G. Urbanii* EKM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/4	g	*G. Valenzuelena* A. RICH.	–	–	30	40	40	–	–	36	–	–	–	30	–	40	50	40	–	–	–	–
E/6	b/2	*Gundlachia cubana* BRITT. & BLAKE	–	–	–	–	–	–	–	–	–	–	–	30	–	100	–	40	–	–	–	–
X	g	*Guzmania erythrolepis* BROGN.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	70
X	n	*G. lingulata* (L.) MEZ	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	60	50
X	m	*G. monostachya* (L.) RUSHBY ex MEZ	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–
C/5	l	*Gyminda latifolia* (SW.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
C/5	p	*Guaiacum officinale* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	70
B/5	l	*G. sanctum* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	40	–	–
B/3	o	*Guarea guidonia* (L.) SLEUMER	40	–	–	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/5	g	*Guatteria Blainii* (GRISEB.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/4	b/3	*G. Moralesii* (MAZA) URB.	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/4	p	*Guazuma ulmifolia* LAM.	–	–	–	–	–	–	60	60	100	–	–	–	–	–	–	40	60	–	–	–
C/5	f	*Guettarda brevinodis* URB.	–	–	–	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	c	*G. calcicola* BRITT.	–	–	–	–	–	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/4	f	*G. calyptrata* A. RICH.	–	–	–	–	60	–	–	40	40	40	100	40	60	40	40	–	60	40	30	–
E/5	a/12	*G. camagüeyensis* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	100	–	–	–	–	–	–	–
E/6	a/11	*G. clarensis* BRITT.	–	–	–	–	–	–	–	–	–	–	–	100	–	–	–	–	–	–	–	–
B/3	l	*G. Combsii* URB.	–	–	–	–	–	–	–	80	60	–	–	–	–	–	–	–	40	60	–	–
E/6	a/14	*G. Coxiana* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	100
E/4	b/2	*G. crassipes* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6	b/3	*G. cueroensis* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	100
E/7!	f	*G. echinodendron* WR. ex SAUV.	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–	–	–	–	–	–
C/5	n	*G. elliptica* SW.	–	–	–	–	–	–	–	60	80	100	–	–	–	–	40	–	80	40	70	–
C/5	b/2	*G. ferruginea* WR. ex GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	g	*G. Lindeniana* A. RICH.	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–
C/3	b/2	*G. macrocarpa* GRISEB.	–	–	–	–	–	–	–	–	40	30	–	–	–	–	–	–	–	–	–	–
C/5	b/2	*G. monocarpa* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	a/12	*G. Munizii* BHIDI.	–	–	–	–	–	–	40	–	–	40	–	–	–	–	–	–	–	–	–	–
D/7	f	*G. rigida* A. RICH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50
C/4	l	*G. scabra* (L.) LAM.	–	–	–	–	–	–	–	–	–	–	40	60	60	60	40	–	–	40	–	–
E/5	b/3	*G. Shaferi* STANDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–	–	–
C/4	a/7	*G. Urbanii* EKM.	–	–	–	–	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–
C/4	g	*G. Valenzuelena* A. RICH.	–	–	–	–	40	–	–	–	–	–	–	–	–	–	40	–	–	–	30	–
E/6	b/2	*Gundlachia cubana* BRITT. & BLAKE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
X	g	*Guzmania erythrolepis* BROGN.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
X	n	*G. lingulata* (L.) MEZ	60	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
X	m	*G. monostachya* (L.) RUSHBY ex MEZ	80	–	–	60	40	40	60	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	l	*Gyminda latifolia* (SW.) URB.	–	–	–	–	–	–	–	40	80	40	–	–	–	–	40	–	–	100	–	–

Table 25 Continued 31

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
D/6	a/14	*G. orbicularis* BHIDI. & MZ.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C/4	l	*Gymnanthes lucida* SW.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
P	l	*Habenaria alata* HOOK.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
P	f	*H. bicornis* LINDL.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—
P	o	*H. monorrhiza* (SW.) RCHB. F.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	30	—	—	—	40	30
C/5	l	*Haematoxylon campechianum* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C/4	b/2	*Haenianthus variifolius* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	60	—	—	—	—
D/3	p	*Hamelia patens* JACQ.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
J	a/4	*Harnackia bisecta* URB.	—	—	—	—	—	—	36	—	—	—	—	—	—	—	—	—	—	40	—	—
D/6	f	*Harpalyce cubensis* GRISEB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	a/11	*H. macrocarpa* BRITT. & WILS.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/5	c	*H. suberosa* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/6	b/2	*H. villosa* BRITT. & WILS.	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—	—	40	—	40	—
K/8!	f	*Harrisia eriophora* (PFEIFF.) BRITT.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
K/8!	b/3	*H. Fernowii* BRITT.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C/4	f	*Hebestigma cubense* (HBK.) URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/4	b/2	*Hedyosmum crassifolium* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	60	—	—	—	—	—	—
E/5	a/6	*H. cubense* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/3	e	*H. Grisebachii* SOLMS	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—	—	—	50
E/5	a/5	*H. subintegrum* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—	—	—
M	h	*Heliconia caribaea* LAM.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	80	—
D/3	h	*Helicteres jamaicensis* JACQ.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/5	i	*H. semitriloba* BERT.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	f	*H. trapezifolia* A. RICH.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	b/3	*Helietta glaucescens* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
R	g	*Heliotropium antillanum* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
V	g	*H. humifusum* HBK.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/7	h	*H. microphyllum* SW.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
R	p	*H. procumbens* MILL.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/6	n	*H. ternatum* VAHL	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	p	*Hemionitis palmata* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—

Lf	Ge	No. of communities / Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
D/6	a/14	*G. orbicularis* BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
C/4	l	*Gymnanthes lucida* SW.	–	–	–	100	60	80	100	60	40	60	–	–	–	–	–	40	100	100	100	90
P	l	*Habenaria alata* HOOK.	–	–	–	–	–	–	–	–	–	–	–	40	40	–	–	–	–	–	–	–
P	f	*H. bicornis* LINDL.	40	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–
P	o	*H. monorrhiza* (SW.) RCHB. F.	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	l	*Haematoxylon campechianum* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–
C/4	b/2	*Haenianthus variifolius* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/3	p	*Hamelia patens* JACQ.	–	–	–	–	60	80	40	80	40	40	–	–	–	–	–	–	40	100	–	–
J	a/4	*Harnackia bisecta* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6	f	*Harpalyce cubensis* GRISEB.	–	–	–	–	–	–	–	–	–	–	40	40	–	–	–	–	–	–	–	–
D/5	a/11	*H. macrocarpa* BRITT. & WILS.	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–
E/5	c	*H. suberosa* URB.	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–	–	–	–	–	–
D/6	b/2	*H. villosa* BRITT. & WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
K/8!	f	*Harrisia eriophora* (PFEIFF.) BRITT.	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	60	–	–
K/8!	b/3	*H. Fernowii* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	80
C/4	f	*Hebestigma cubense* (HBK.) URB.	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	60	–	–	–
E/4	b/2	*Hedyosmum crassifolium* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/6	*H. cubense* URB.	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/3	e	*H. Grisebachii* SOLMS	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/5	*H. subintegrum* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
M	h	*Heliconia caribaea* LAM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/3	h	*Helicteres jamaicensis* JACQ.	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–
E/5	i	*H. semitriloba* BERT.	–	–	–	–	–	–	–	40	40	–	–	40	60	100	–	–	–	–	60	30
D/5	f	*H. trapezifolia* A. RICH.	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–
D/5	b/3	*Helietta glaucescens* URB.	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R	g	*Heliotropium antillanum* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–
V	g	*H. humifusum* HBK.	–	–	–	–	–	–	–	–	–	–	100	60	100	40	–	–	–	–	–	–
E/7	h	*H. microphyllum* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
R	p	*H. procumbens* MILL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–
E/6	n	*H. ternatum* VAHL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	100
O	p	*Hemionitis palmata* L.	–	–	–	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 25 Continued 32

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
N	l	*Hemitelia horrida* (L.) R. BR.	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–	40	60
H	a/5	*Hemithrinax rivularis* LEÓN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–
H	a/5	*Hemithrinax savannarum* LEÓN	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	40	–	–	–
C/6!	e	*Henoonia Brittonii* (SMALL) MONACH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/5	*Henriettea Acunae* (ALAIN) ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–
C/4	a/6	*H. Ekmanii* (URB.) ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/3	b/1	*H. patrisiana* DC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/14	*Heppiella cubensis* MORTON	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	a/4	*Heptanthus cordifolius* BRITT.	–	–	–	–	–	40	–	–	30	–	–	–	–	–	–	–	–	40	–	–
O	b/2	*H. lobatus* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	40	–	–	–
O	b/1	*H. ranunculoides* GRISEB.	–	–	–	80	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	a/5	*H. Shaferi* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	40	–
R	r	*Herissantia crispa* (L.) MEDIK.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	b/1	*Herpyza grandiflora* (GRISEB.) WR.	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	l	*Heteropteris laurifolia* (L.) JUSS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	g	*Heterotrichum umbellatum* (MILL.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	70
O	l	*Hibiscus costatus* A. RICH.	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	g	*H. cryptocarpus* A. RICH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/3	g	*H. elatus* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
I	p	*Hillia parasitica* JACQ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	40
I	l	*H. tetrandra* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	60	40	–	–	–	100	30
C/5	p	*Hippomane mancinella* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	n	*Hirtella triandra* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	80	–	–
X	g	*Hohenbergia penduliflora* (A. RICH.) MEZ	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	40
U	g	*Homalopetalum vomeriforme* (SW.) FAWC. & RENDLE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6!	g	*Hybanthus havanensis* JACQ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*Hydocotyle umbellata* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/4	b/2	*Hyeronima nipensis* URB.	–	–	–	–	–	–	–	–	–	–	–	60	–	60	100	–	–	–	–	–
U	p	*Hymenophyllum abruptum* HOOK.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50	80	–	–	40	100
U	p	*H. crispum* HBK.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50

Lf	Ge	No. of communities / Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
N	l	*Hemitelia horrida* (L.) R. BR.	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
H	a/5	*Hemithrinax rivularis* LEÓN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
H	a/5	*Hemithrinax savannarum* LEÓN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/6!	e	*Henoonia Brittonii* (SMALL) MONACH.	–	–	–	–	–	–	–	–	–	–	–	40	40	80	–	–	–	–	50	30
E/5	a/5	*Henriettea Acunae* (ALAIN) ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/4	a/6	*H. Ekmanii* (URB.) ALAIN	–	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/3	b/1	*H. patrisiana* DC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–	–
E/5	a/14	*Heppiella cubensis* MORTON	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
O	a/4	*Heptanthus cordifolius* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	b/2	*H. lobatus* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	b/1	*H. ranunculoides* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	a/5	*H. Shaferi* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R	r	*Herissantia crispa* (L.) MEDIK.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50	40
O	b/1	*Herpyza grandiflora* (GRISEB.) WR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	l	*Heteropteris laurifolia* (L.) JUSS.	–	–	–	60	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	g	*Heterotrichum umbellatum* (MILL.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	l	*Hibiscus costatus* A. RICH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	80	–	–	–	–	–
D/5	g	*H. cryptocarpus* A. RICH.	–	–	–	–	40	–	–	60	60	–	–	–	–	–	–	–	–	–	30	30
B/3	g	*H. elatus* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	40	–	–	–
I	p	*Hillia parasitica* JACQ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
I	l	*H. tetrandra* SW.	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	p	*Hippomane mancinella* L.	–	–	–	–	–	–	–	60	40	–	–	–	–	–	–	–	80	40	–	–
D/4	n	*Hirtella triandra* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
X	g	*Hohenbergia penduliflora* (A. RICH.) MEZ	40	–	–	60	80	60	80	40	–	–	–	–	–	–	–	–	–	–	–	40
U	g	*Homalopetalum vomeriforme* (SW.) FAWC. & RENDLE	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6!	g	*Hybanthus havanensis* JACQ.	–	–	–	–	–	–	–	–	–	–	40	40	40	80	–	–	–	–	30	40
O	p	*Hydocotyle umbellata* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–	–	–	–
C/4	b/2	*Hyeronima nipensis* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	p	*Hymenophyllum abruptum* HOOK.	40	100	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	p	*H. crispum* HBK.	–	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 25 Continued 33

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
U	r	*H. fucoides* SW.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	50
U	r	*H. polyanthos* SW.	—	—	—	—	—	—	—	—	—	—	—	—	—	60	—	—	—	—	80	100
U	p	*H. sericeum* SW.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—	—	—	40
D/5	h	*Hypelate trifoliata* SW.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/4	b/1	*Hyperbaena columbica* (EICHL.) MIERS	—	—	—	60	40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C/5	f	*H. cubensis* (GRISEB.) URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
J	o	*H. domingensis* (DC.) BENTH.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C/3	a/5	*H. longiuscula* (MIERS) ssp. *Clementis* (MOLD.) BHIDI.	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—	—	—	—	60	—
D/4	a/5	*H. obovata* URB.	—	—	—	—	—	—	—	—	—	—	40	30	—	—	—	—	—	—	—	—
D/5	f	*H. racemosa* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
V	k	*Hypericum fasciculatum* LAM.	—	—	40	40	—	—	36	30	—	—	—	30	—	—	—	40	40	—	—	—
V	f	*H. styphelioides* A. RICH.	45	—	100	80	40	30	—	—	30	—	100	30	80	—	—	60	60	—	—	—
O	b/1	*Hyptis actinocephala* GRISEB.	—	30	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	f	*H. minutifolia* GRISEB.	—	40	—	—	—	—	54	—	—	—	—	—	—	—	—	—	—	—	—	—
O	f	*Ichnanthus mayarensis* (WR.) HITCHC.	—	—	30	30	40	100	36	30	80	30	—	—	—	—	—	—	—	40	—	—
O	h	*I. pallens* (SW.) MUNRO	—	—	—	30	—	—	—	—	—	—	—	—	—	—	80	—	—	—	100	100
D/5	g	*Ilex Berteroi* LOES.	—	—	—	—	—	—	—	—	—	—	—	—	—	80	40	100	—	—	—	—
D/5	k	*I. Cassine* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	a/7	*I. Clementis* BRITT. & WILS.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/5	b/3	*I. cubana* LOES.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	b/5	*I. hypaneura* LOES.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40
C/5	h	*I. Macfadyenii* (WALP.) RENDER	—	—	—	—	—	40	45	—	40	—	50	90	—	—	60	—	—	40	—	—
E/7	a/6	*I. nanophylla* BHIDI. & MZ.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	60	40	100
E/6	a/5	*I. moana* BHIDI. & MZ.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/6	a/6	*I. Nunezii* BHIDI.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	30	—	—	—	—	—
D/6	a/5	*I. Shaferi* BRITT. & WILS.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/6	a/6	*I. turquinensis* ALAIN	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	80	—	—	—	—
E/5	a/5	*I. Victorinii* ALAIN	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	b/2	*Illicium cubense* A. C. SMITH	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—	—	—
O	p	*Imperata brasiliensis* TRIN.	—	60	40	30	—	—	—	—	—	—	—	—	—	—	60	100	—	—	—	40

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
U	r	*H. fucoides* SW.	100	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	r	*H. polyanthos* SW.	80	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	p	*H. sericeum* SW.	–	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	h	*Hypelate trifoliata* SW.	–	–	–	–	–	–	–	100	40	100	–	–	–	–	–	–	40	100	40	–
D/4	b/1	*Hyperbaena columbica* (EICHL.) MIERS	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	f	*H. cubensis* (GRISEB.) URB.	–	–	–	40	80	–	–	80	–	–	–	–	–	–	–	–	–	–	–	–
J	o	*H. domingensis* (DC.) BENTH.	–	–	–	80	–	–	–	–	–	60	–	–	–	–	–	–	–	–	–	–
C/3	a/5	*H. longiuscula* (MIERS) ssp. *Clementis* (MOLD.) BHIDI.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	a/5	*H. obovata* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	f	*H. racemosa* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–
V	k	*Hypericum fasciculatum* LAM.	–	–	40	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–
V	f	*H. styphelioides* A. RICH.	40	–	–	–	–	–	–	–	–	–	40	–	–	–	80	–	–	–	–	–
O	b/1	*Hyptis actinocephala* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	f	*H. minutifolia* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–
O	f	*Ichnanthus mayarensis* (WR.) HITCHC.	–	–	–	–	–	–	–	40	–	40	100	80	100	100	60	–	–	–	–	–
O	h	*I. pallens* (SW.) MUNRO	100	–	–	–	–	–	40	–	–	–	–	–	–	–	40	–	–	–	–	–
D/5	g	*Ilex Berteroi* LOES.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	k	*I. Cassine* L.	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	60	–	–	–	–
D/5	a/7	*I. Clementis* BRITT. & WILS.	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/3	*I. cubana* LOES.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	b/5	*I. hypaneura* LOES.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	h	*I. Macfadyenii* (WALP.) RENDER	–	40	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/7	a/6	*I. nanophylla* BHIDI. & MZ.	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	a/5	*I. moana* BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	a/6	*I. Nunezii* BHIDI.	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6	a/5	*I. Shaferi* BRITT. & WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6	a/6	*I. turquinensis* ALAIN	–	100	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/5	*I. Victorinii* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	b/2	*Illicium cubense* A. C. SMITH	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*Imperata brasiliensis* TRIN.	–	–	–	–	–	–	–	–	–	–	–	40	40	60	40	–	–	–	–	–

Table 25 Continued 34

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
O	p	*I. contracta* (HBK.) HITCHC.	–	–	–	–	–	60	100	30	–	–	–	–	–	–	–	–	–	–	–	–
U	p	*Ionopsis utricularioides* (SW.) LINDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	r	*Ipomoea acuminata* (VAHL) R. & S.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	r	*I. asarifolia* (DESR.) R. & S.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	m	*I. Cavanillesii* R. & S.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	j	*I. Carolina* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	f	*I. C.* ssp. *ophiticola* BHIDI. & MZ.	–	–	–	–	–	30	100	80	50	60	30	50	40	–	–	–	40	60	–	–
T	a/9	*I. fuchsioides* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	k	*I. microdactyla* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	k	*I. tenuissima* CHOISY	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	f	*Isachne leersioides* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–	–	–	–	–	–
U	p	*Isochilus linearis* (JACQ.) R. BR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60
C/3	m	*Ixora ferrea* (JACQ.) BENTH.	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	100	40
C/5	b/3	*Jacaranda arborea* URB.	–	–	–	–	–	–	–	–	–	–	30	30	40	–	70	100	80	100	–	–
C/6	j	*J. coerulea* (L.) GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–	–	–
E/7	e	*J. Cowellii* BRITT. & WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	l	*Jacquemontia jamaicensis* (JACQ.) HALL. F.	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–
T	p	*J. nodiflora* (DESV.) G. DON	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	c	*J. serpyllifolia* (HBK.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	g	*J. verticillata* (L.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6!	f	*Jacquinia aculeata* (L.) MEZ	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/5	*J. Acunana* BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–
E/6!	h	*J. Berterii* SPRENG.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/6!	f	*J. brevifolia* (GRISEB.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6!	c	*J. brunnescens* URB.	–	–	–	–	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6!	b/2	*J. robusta* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	40	–	–
D/5!	b/2	*J. Roigii* P. WILS.	–	–	–	–	–	–	–	–	–	–	30	–	60	–	–	–	–	–	–	–
D/6!	e	*J. Shaferi* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–
E/6!	g	*J. stenophylla* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5!	b/3	*J. verticillaris* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
O	p	*I. contracta* (HBK.) HITCHC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	p	*Ionopsis utricularioides* (SW.) LINDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	80	–	–
T	r	*Ipomoea acuminata* (VAHL) R. & S.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	40	–	–
T	r	*I. asarifolia* (DESR.) R. & S.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–
T	m	*I. Cavanillesii* R. & S.	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–
T	j	*I. Carolina* L.	–	–	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	30	30
T	f	*I. C.* ssp. *ophiticola* BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	40	60	40	60	–	–	–	–	–	–
T	a/9	*I. fuchsioides* GRISEB.	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	k	*I. microdactyla* GRISEB.	–	–	–	–	–	–	–	–	–	–	40	40	80	60	–	–	–	–	30	30
T	k	*I. tenuissima* CHOISY	–	–	–	–	–	–	–	–	–	–	–	40	60	40	–	–	–	40	–	–
O	f	*Isachne leersioides* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	p	*Isochilus linearis* (JACQ.) R. BR.	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/3	m	*Ixora ferrea* (JACQ.) BENTH.	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	b/3	*Jacaranda arborea* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/6	j	*J. coerulea* (L.) GRISEB.	–	–	–	–	–	–	40	40	40	–	–	–	–	–	40	40	–	–	30	30
E/7	e	*J. Cowellii* BRITT. & WILS.	–	–	–	–	–	–	–	–	–	–	–	80	60	100	–	–	–	–	–	–
T	l	*Jacquemontia jamaicensis* (JACQ.) HALL. F.	–	–	–	–	–	40	–	60	40	–	80	40	40	40	40	–	100	100	60	70
T	p	*J. nodiflora* (DESV.) G. DON	–	–	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	30	50
T	c	*J. serpyllifolia* (HBK.) URB.	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	30	–
T	g	*J. verticillata* (L.) URB.	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–	–	–	–	–	–
D/6!	f	*Jacquinia aculeata* (L.) MEZ	–	–	–	–	–	–	40	40	40	40	–	–	–	–	40	–	–	80	–	50
E/5	a/5	*J. Acunana* BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6!	h	*J. Berterii* SPRENG.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	90
C/6!	f	*J. brevifolia* (GRISEB.) URB.	–	–	–	–	–	–	–	–	–	–	80	40	–	–	–	–	–	–	–	50
E/6!	c	*J. brunnescens* URB.	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–
D/6!	b/2	*J. robusta* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5!	b/2	*J. Roigii* P. WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6!	e	*J. Shaferi* URB.	–	–	–	–	–	–	–	–	–	–	–	–	100	60	–	–	–	–	–	–
E/6!	g	*J. stenophylla* URB.	–	–	–	–	–	–	–	–	–	–	–	80	40	–	–	–	–	–	40	30
E/5!	b/3	*J. verticillaris* URB.	–	–	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 25 Continued 35

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
U	p	*Jacquiniella globosa* (JACQ.) SCHLTR.	–	–	–	–	–	–	–	–	–	–	–	–	–	80	100	80	–	–	100	40
V	b/1	*Jatropha angustifolia* GRISEB.	36	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R	p	*J. gossypifolia* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	p	*J. integerrima* JACQ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	h	*Juniperus lucayana* BRITT.	–	–	–	–	–	–	–	–	30	–	–	–	–	–	30	–	–	–	–	–
D/5	a/6	*J. saxicola* BRITT. & WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	f	*Justicia Alainii* STEARN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	a/1	*Kalmiella aggregata* SMALL	18	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	a/1	*K. simulata* BRITT. & WILS.	18	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	a/11	*Karwinskia oblongifolia* (BRITT. & WILS.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	a/12	*K. orbiculata* (BRITT. & WILS.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*Kosteletzkyia pentasperma* (BERT.) GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	l	*Krugiodendron ferreum* (VAHL) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	f	*K. mogoticola* BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	c	*Lachnorhiza piloselloides* A. RICH.	90	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	g	*Laelia Lyonsii* (LINDL.) L. O. WMS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	80	–
C/5	g	*Laetia Thamnia* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6	a/4	*Lagetta pauciflora* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–
E/5	h	*Lantana arida* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	p	*L. camara* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	g	*L. insularis* MOLD.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	p	*L. involucrata* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/7	a/14	*L. parvifolia* DESF.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/4	l	*L. reticulata* PERS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/5	b/3	*Laplacea angustifolia* (BRITT. & WILS.) O. C. SCHM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100
D/5	a/5	*L. benitoensis* (BRITT. & WILS.) O. C. SCHMIDT	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	100	–	–	–	–

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
U	p	*Jacquiniella globosa* (JACQ.) SCHLTR.	60	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	b/1	*Jatropha angustifolia* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R	p	*J. gossypifolia* L.	–	–	–	–	–	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	p	*J. integerrima* JACQ.	–	–	–	–	40	–	–	–	60	–	–	–	–	–	40	–	–	–	–	–
D/5	h	*Juniperus lucayana* BRITT.	–	–	–	–	–	–	–	–	40	–	–	–	–	–	40	–	–	40	–	–
D/5	a/6	*J. saxicola* BRITT. & WILS.	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	f	*Justicia Alainii* STEARN	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	40	–	–	–
V	a/i	*Kalmiella aggregata* SMALL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	a/1	*K. simulata* BRITT. & WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	a/11	*Karwinskia oblongifolia* (BRITT. & WILS.) URB.	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–
E/6	a/12	*K. orbiculata* (BRITT. & WILS.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–	–	–	–
O	p	*Kosteletzkyia pentasperma* (BERT.) GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–
C/5	l	*Krugiodendron ferreum* (VAHL) URB.	–	–	–	–	40	40	–	–	80	40	–	–	–	–	40	–	40	60	–	–
E/5	f	*K. mogoticola* BHIDI. & MZ.	–	–	–	–	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	c	*Lachnorhiza piloselloides* A. RICH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	g	*Laelia Lyonsii* (LINDL.) L. O. WMS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	g	*Laetia Thamnia* L.	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–
D/6	a/4	*Lagetta pauciflora* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	h	*Lantana arida* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50
E/5	p	*L. camara* L.	–	–	–	–	–	–	–	40	40	40	–	–	–	–	40	–	–	–	–	–
E/5	g	*L. insularis* MOLD.	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	p	*L. involucrata* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	100	–	90	50
E/7	a/14	*L. parvifolia* DESF.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
E/4	l	*L. reticulata* PERS.	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–
B/5	b/3	*Laplacea angustifolia* (BRITT. & WILS.) O. C. SCHMIDT	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	a/5	*L. benitoensis* (BRITT. & WILS.) O. C. SCHMIDT	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 25 Continued 36

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
C/4	a/5	*Laplacea moaensis* M. VICT.	–	–	–	–	–	–	–	–	–	–	40	40	–	–	70	–	–	–	–	–
J	p	*Lasiacis divaricata* (L.) HITCHC.	–	–	30	30	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	30
D/4	g	*Lasianthus lanceolatus* (GRISEB.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	100
C/4	j	*Lasiocroton bahamensis* PAX & HOFFM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R	r	*Laurentia longiflora* (L.) PETERM.	–	–	–	30	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P	l	*Leiphaimos parasitica* CHAM. & SCHLECHTD.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
K/8!	g	*Lemairocereus hystrix* (HAW.) BRITT. & ROSE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	h	*Leochilus labiatus* (SW.) KUNTZE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–
U	a/6	*Lepanthes blepharantha* SCHLTR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	g	*L. brevipetala* FAWC. & RENDLE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	a/6	*L. Ekmanii* SCHLTR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	a/6	*L. fractiflexa* AMES & SCHWEINF.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	g	*L. fulva* LINDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	b/3	*L. Lindmaniana* SCHLTR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	–	–	–	–	–
U	g	*L. microlepanthes* (GRISEB.) AMES	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	a/6	*L. ovata* AMES & SCHWEINF.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	a/6	*L. pergracilis* SCHLTR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	a/6	*L. turquinoensis* SCHLTR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
K/8!	a/9	*Leptocereus assurgens* (WR.) BRITT. & ROSE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*Leptocoryphium lanatum* (HBK.) NEES	63	90	100	40	–	70	–	70	40	100	40	60	60	–	–	–	–	–	–	–
T	a/3	*Lescaillea equisetiformis* GRISEB.	–	–	–	60	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/4	b/4	*Leucocroton havanensis* BORHIDI	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/7!	f	*L. microphyllus* (A. RICH.) PAX & HOFFM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	a/5	*L. moaensis* BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	–	–	–	–	–
E/4	a/5	*L. pachyphyllus* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–
D/3	e	*L. virens* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	g	*Liabum crispum* SCH.-BIP.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–
O	b/3	*L. Wrightii* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
C/4	a/5	*Laplacea moaensis* M. VICT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	p	*Lasiacis divaricata* (L.) HITCHC.	40	–	–	40	–	–	80	–	40	40	40	60	–	–	60	–	60	–	–	–
D/4	g	*Lasianthus lanceolatus* (GRISEB.) URB.	80	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/4	j	*Lasiocroton bahamensis* PAX & HOFFM.	–	–	–	–	–	–	–	–	–	–	40	40	60	–	–	–	–	–	50	40
R	r	*Laurentia longiflora* (L.) PETERM.	–	–	–	40	–	–	–	–	40	40	–	40	–	–	40	–	–	–	–	–
P	l	*Leiphaimos parasitica* CHAM. & SCHLECHTD.	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	40	–	–
K/8!	g	*Lemairocereus hystrix* (HAW.) BRITT. & ROSE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	100
U	h	*Leochilus labiatus* (SW.) KUNTZE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	a/6	*Lepanthes blepharantha* SCHLTR.	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	g	*L. brevipetala* FAWC. & RENDLE	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	a/6	*L. Ekmanii* SCHLTR.	–	100	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	a/6	*L. fractiflexa* AMES & SCHWEINF.	–	40	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	g	*L. fulva* LINDL.	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	b/3	*L. Lindmaniana* SCHLTR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	g	*L. microlepanthes* (GRISEB.) AMES	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	a/6	*L. ovata* AMES & SCHWEINF.	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	a/6	*L. pergracilis* SCHLTR.	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	a/6	*L. turquinoensis* SCHLTR.	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
K/8!	a/9	*Leptocereus assurgens* (WR.) BRITT. & ROSE	–	–	–	–	–	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*Leptocoryphium lanatum* (HBK.) NEES	–	–	–	–	–	–	–	–	–	–	40	40	60	80	40	–	–	–	–	–
T	a/3	*Lescaillea equisetiformis* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/4	b/4	*Leucocroton havanensis* BORHIDI	–	–	–	–	–	–	–	–	–	–	100	–	–	–	–	–	–	–	–	–
E/7!	f	*L. microphyllus* (A. RICH.) PAX & HOFFM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	80	73	30
D/4	a/5	*L. moaensis* BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/4	a/5	*L. pachyphyllus* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/3	e	*L. virens* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–
O	g	*Liabum crispum* SCH.-BIP.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	b/3	*L. Wrightii* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 25 Continued 37

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
O	p	*Lindsaya qudrangularis* (SW.) RADDI	—	—	—	—	—	—	—	—	—	—	—	—	—	—	50	60	—	—	—	—
C/5	b/2	*Linociera cubensis* (P. WILS.) URB.	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—	40	60	—	—	—
B/4	l	*L. domingensis* (LAM.) KNOBL.	—	—	—	—	—	—	—	—	—	—	—	60	—	100	100	—	—	—	40	50
B/5	g	*L. ligustrina* SW.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	b/2	*Linodendron aronifolium* GRISEB.	—	—	—	—	—	—	—		30	60	100	70	—	—	40	—	—	—	—	—
P	p	*Liparis elata* LINDL.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	60	30
O	b/3	*Lisianthus glandulosus* A. RICH.	—	—	—	—	—	—	—	—	—	—	—	60	—	—	—	—	—	—	—	60
O	b/1	*L. silenifolius* (GRISEB.) URB.	—	—	40	40	40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
V	g	*Lobelia assurgens* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	50
V	a/6	*L. cacuminis* BRITT. & WILS.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
V	b/2	*L. oxyphylla* URB.	—	—	—	—	—	—	—	—	50	—	—	30	—	—	—	—	—	40	—	—
B/5	g	*Lonchocarpus longipes* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
B/4	p	*L. pentaphyllus* (POIR.) DC.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
B/4	h	*L. sericeus* (POIR.) DC. var. *glabrescens* BENTH.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
N	p	*Lophosoria quadripinnata* (GMEL.) C. CHR.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	30
D/4	p	*Lopimia malacophylla* NEES & MART.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
B/3	p	*Luehea speciosa* WILLD.	—	—	—	30	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C/5	a/6	*Lunania cubensis* TURCZ.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40
E/5	b/3	*L. divaricata* BENTH.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
V	r	*Lycopodium cernuum* L.	—	—	40	—	—	—	—	—	—	—	—	40	—	100	40	—	—	—	—	100
V	u	*L. clavatum* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
V	p	*L. dichotomum* JACQ.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40
U	n	*L. funiforme* CHAM.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	80	60
V	p	*L. linifolium* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	100	40
V	r	*L. meridionale* UNDERW. & LLOYD	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—	—	—
V	h	*L. montanum* UNDERW. & LLYOD	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
V	p	*L. reflexum* LAM.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	50
V	r	*L. serratum* THUNB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
V	p	*L. taxifolium* SW.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
J	f	*Lygodium cubense* HBK.	—	30	100	40	60	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Lf	Ge	No. of communities / Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
O	p	*Lindsaya qudrangularis* (SW.) RADDI	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	b/2	*Linociera cubensis* (P. WILS.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/4	l	*L. domingensis* (LAM.) KNOBL.	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/5	g	*L. ligustrina* SW.	–	–	–	–	–	–	–	40	40	40	–	–	–	–	–	–	40	100	50	–
D/5	b/2	*Linodendron aronifolium* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P	p	*Liparis elata* LINDL.	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	b/3	*Lisianthus glandulosus* A. RICH.	–	80	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	b/1	*L. silenifolius* (GRISEB.) URB.	–	–	–	–	–	40	–	–	–	–	–	–	–	–	60	–	–	–	–	–
V	g	*Lobelia assurgens* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	a/6	*L. cacuminis* BRITT. & WILS.	–	60	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	b/2	*L. oxyphylla* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/5	g	*Lonchocarpus longipes* URB.	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/4	p	*L. pentaphyllus* (POIR.) DC.	–	–	–	80	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–
B/4	h	*L. sericeus* (POIR.) DC. var. *glabrescens* BENTH.	–	–	–	–	–	–	–	–	60	–	–	–	–	–	–	–	–	–	–	–
N	p	*Lophosoria quadripinnata* (GMEL.) C. CHR.	–	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	p	*Lopimia malacophylla* NEES & MART.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–	–
B/3	p	*Luehea speciosa* WILLD.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	40	–	–	–
C/5	a/6	*Lunania cubensis* TURCZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/3	*L. divaricata* BENTH.	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	r	*Lycopodium cernuum* L.	40	80	40	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–
V	u	*L. clavatum* L.	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	p	*L. dichotomum* JACQ.	–	40	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	n	*L. funiforme* CHAM.	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	p	*L. linifolium* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	r	*L. meridionale* UNDERW. & LLOYD	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	h	*L. montanum* UNDERW. & LLYOD	40	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	p	*L. reflexum* LAM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	r	*L. serratum* THUNB.	–	60	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	p	*L. taxifolium* SW.	60	60	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	f	*Lygodium cubense* HBK.	–	–	–	–	–	–	60	–	–	–	40	80	40	40	60	–	–	–	–	–

Table 25 Continued 38

Lf	Ge	No. of communities Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
J	g	*L. volubile* SW. var. *Wrightii* EAT.	–	–	–	–	–	–	–	–	–	–	30	50	40	–	50	–	–	–	–	–
D/5	a/6	*Lyonia calycosa* (SMALL) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/2	*L. glandulosa* (A. RICH.) GRISEB.	–	–	–	–	–	30	–	–	–	–	40	80	–	–	50	100	–	–	–	–
E/5	b/2	*L. latifolia* (A. RICH.) GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	50	100	–	–	–
D/5	b/2	*L. macrophylla* (BRITT.) EKM. and URB.	–	–	–	–	–	100	36	80	80	100	–	30	80	–	–	–	–	–	–	–
E/6	b/2	*L. myrsinaefolia* (A. RICH.) URB.	–	–	–	–	–	–	–	–	60	–	–	40	–	–	40	–	–	–	–	–
E/6	b/1	*L. myrtilloides* GRISEB.	–	30	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/4	*L. nipensis* URB.	–	–	–	–	–	30	–	–	–	–	–	–	–	–	–	–	–	80	–	–
E/5	b/2	*L. oblongata* URB.	–	–	–	–	–	–	–	–	–	–	50	–	–	–	–	–	–	–	–	–
E/5	b/3	*L. turquinii* (SMALL) EKM. ex URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/1	*L. vaccinioides* (SMALL) ACUÑA and ROIG	36	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6	l	*Lysiloma bahamensis* BENTH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/6	i	*L. latisiliqua* (L.) BENTH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	b/2	*Machaerina cubensis* (KÜK.) KOY.	–	–	–	–	–	–	–	–	–	–	40	–	40	–	–	40	80	80	–	–
O	h	*M. restioides* (SW.) VAHL	–	–	–	–	–	–	–	–	–	–	–	30	–	100	40	–	–	–	–	–
D/7!	f	*Machaonia dumosa* BHIDI and FNDEZ.	–	–	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/7!	e	*M. nipensis* BHIDI. and FNDEZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–
E/6!	f	*M. pauciflora* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/4	e	*Magnolia cubensis* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50	–	–	–	–	90
P	b/3	*Malaxis pusilla* AMES and SCHWEINF.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	–	–	–	–	–
P	k	*M. unifolia* MICHX.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
E/5!	a/8	*Malpighia Acunana* BHIDI. and MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5!	h	*M. angustifolia* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6!	g	*M. aquifolia* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	g	*M. biflora* POIR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5!	g	*M. Cnide* SPRENG.	–	–	–	–	–	–	–	–	–	–	100	–	80	–	–	60	40	40	–	–
E/5!	c	*M. cubensis* HBK.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6!	h	*M. horrida* SMALL	–	–	–	–	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6!	l	*M. incana* MILL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6!	a/12	*M. nova*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Lf	Ge	No. of communities / Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
J	g	*L. volubile* SW. var. *Wrightii* EAT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	a/6	*Lyonia calycosa* (SMALL) URB.	–	100	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/2	*L. glandulosa* (A. RICH.) GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/2	*L. latifolia* (A. RICH.) GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	b/2	*L. macrophylla* (BRITT.) EKM. & URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	b/2	*L. myrsinaefolia* (A. RICH.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	b/1	*L. myrtilloides* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–
E/5	a/4	*L. nipensis* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/2	*L. oblongata* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/3	*L. turquinii* (SMALL) EKM. ex URB.	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/1	*L. vaccinioides* (SMALL) ACUÑA & ROIG	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6	l	*Lysiloma bahamensis* BENTH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	80	–	–
B/6	i	*L. latisiliqua* (L.) BENTH.	–	–	–	–	–	–	–	40	40	–	–	–	–	–	–	–	–	–	–	30
O	b/2	*Machaerina cubensis* (KÜK.) KOY.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	h	*M. restioides* (SW.) VAHL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/7!	f	*Machaonia dumosa* BHIDI & FNDEZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/7!	e	*M. nipensis* BHIDI & FNDEZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6!	f	*M. pauciflora* URB.	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/4	e	*Magnolia cubensis* URB.	100	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P	b/3	*Malaxis pusilla* AMES & SCHWEINF.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P	k	*M. unifolia* MICHX.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5!	a/8	*Malpighia Acunana* BHIDI. & MZ.	–	–	–	–	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5!	h	*M. angustifolia* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50	40
E/6!	g	*M. aquifolia* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	30
E/5	g	*M. biflora* POIR.	–	–	–	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5!	g	*M. Cnide* SPRENG.	–	–	–	–	–	–	–	–	–	–	–	–	40	40	–	–	–	–	–	–
E/5!	c	*M. cubensis* HBK.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–
D/6!	h	*M. horrida* SMALL	–	–	–	–	–	–	–	–	–	–	80	–	–	–	–	–	–	–	–	–
E/6!	l	*M. incana* MILL.	–	–	–	–	–	–	–	–	–	–	–	–	–	40	80	–	–	–	60	–
E/6!	a/12	*M. nova*	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–

Table 25 Continued 39

Lf	Ge	No. of communities Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
E/6!	f	*M. nummulariifolia* NDZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6!	h	*M. pallens* SMALL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5!	a/9	*M. Roigiana* BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5!	b/2	*M. setosa* SPRENG.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	40	–	–	–
D/5	p	*Malvaviscus arboreus* CAV.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	p	*M. a.* ssp. *Sagraeanus* (A. RICH.) HADAČ	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Y/8!	g	*Mamillaria prolifera* (MILL.) HAW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	b/3	*Manettia lygustoides* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–	–	40	–	–
C/5	f	*Manilkara Jaimiquii* (WR. ex GRISEB.) DUBARD	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	f	*M. J.* ssp. *Wrightiana* CRONQ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	b/2	*M. mayarensis* (EKM. ex URB.) CRONQ.	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	60	–	–
V	p	*Marattia alata* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
J	a/9	*Marcgravia calcicola* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	b/3	*M. evenia* KRUG & URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	80	80	80	–	–	100	–
J	g	*M. oligandra* WR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	80
J	g	*M. rectiflora* TR. & PL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
J	f	*Margaritaria scandens* (GRISEB.) MUELL.-ARG.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	g	*Marsdenia clausa* R. BR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	g	*M. linearis* DCNE.	–	–	–	–	–	–	–	–	–	–	30	–	–	–	–	–	40	40	–	–
B/4	h	*Mastichodendron foetidissimum* (JACQ.) CRONQ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	l	*Matayba apetala* (MACF.) RADLK.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	40	40	–	–	–
B/5	h	*M. domingensis* (DC.) RADLK.	–	–	–	–	–	–	–	–	–	–	–	–	–	100	100	–	–	–	40	50
T	a/6	*Matelea bicolor* (BRITT. & WILS.) WOODS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60
T	a/6	*M. Ekmanii* (URB.) WOODS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
T	b/1	*M. oblongata* (GRISEB.) WOODS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	h	*Maxillaria conferta* (GRISEB.) SCHWEINE.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	100

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
E/6!	f	*M. nummulariifolia* NDZ.	–	–	–	–	–	–	–	–	–	–	60	60	80	60	–	–	–	–	–	–
E/6!	h	*M. pallens* SMALL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	60	50	40
E/5!	a/9	*M. Roigiana* BHIDI. & MZ.	–	–	–	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5!	b/2	*M. setosa* SPRENG.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	p	*Malvaviscus arboreus* CAV.	–	–	–	–	60	–	–	40	100	–	–	–	–	–	–	–	–	–	–	–
D/5	p	*M. a.* ssp. *Sagraeanus* (A. RICH.) HADAČ	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
Y/8!	g	*Mamillaria prolifera* (MILL.) HAW.	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	b/3	*Manettia lygustoides* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	f	*Manilkara Jaimiquii* (WR. ex GRISEB.) DUBARD	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–
C/5	f	*M. J.* ssp. *Wrightiana* CRONQ.	–	–	–	–	–	–	–	–	–	40	40	–	40	–	–	–	40	–	–	–
C/5	b/2	*M. mayarensis* (EKM. ex URB.) CRONQ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	p	*Marattia alata* SW.	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	a/9	*Marcgravia calcicola* BRITT.	–	–	–	–	–	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	b/3	*M. evenia* KRUG & URB.	–	80	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	g	*M. oligandra* WR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	g	*M. rectiflora* TR. & PL.	40	–	–	60	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	f	*Margaritaria scandens* (GRISEB.) MUELL.-ARG.	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–
J	g	*Marsdenia clausa* R. BR.	–	–	–	–	–	–	–	40	40	–	–	–	–	–	40	100	40	40	–	–
J	g	*M. linearis* DCNE.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/4	h	*Mastichodendron foetidissimum* (JACQ.) CRONQ.	–	–	–	60	–	–	–	100	100	100	–	–	–	–	–	–	60	–	–	–
C/5	l	*Matayba apetala* (MACF.) RADLK.	40	–	–	40	–	–	–	–	–	–	40	–	–	–	80	–	–	–	–	–
B/5	h	*M. domingensis* (DC.) RADLK.	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	a/6	*Matelea bicolor* (BRITT. & WILS.) WOODS.	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	a/6	*M. Ekmanii* (URB.) WOODS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	b/1	*M. oblongata* (GRISEB.) WOODS.	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	h	*Maxillaria conferta* (GRISEB.) SCHWEINE.	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 25 Continued 40

Lf	Ge	No. of communities Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
U	p	*M. purpurea* (SPRENG.) AMES & CORRELL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	40
U	p	*M. rufescens* LINDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	60
D/6	i	*Maytenus buxifolia* (A. RICH.) GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6	a/14	*Maytenus buxifolia* ssp. *cochlearifolius* (GRISEB.) BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6	b/2	*M. b.* ssp. *serpentini* BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	40	–	–
D/5	a/6	*M. splendens* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
E/6	b/1	*Mazaea phialanthoides* (GRISEB.) KRUG & URB.	–	–	–	100	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	c	*M. tinifolia* (GRISEB.) ALAIN	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/4	g	*Mecranium amygdalinum* (DESV.) WR. ex SAUV.	–	–	–	–	–	–	–	–	–	–	–	60	40	–	–	–	–	–	40	30
C/3	f	*M. haemanthum* TRIANA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	g	*M. purpurascens* (SW.) TRIANA	–	–	–	–	–	–	–	–	–	–	–	60	–	60	–	–	–	–	–	–
D/5	e	*Meliosma oppositifolia* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
Y/8!	a/14	*Melocactus Acunae* LEÓN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Y/8!	a/14	*M. Harlowii* (BRITT. & ROSE) LEÓN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Y/8!	a/10	*M. matanzanus* LEÓN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	a/14	*Melochia obovata* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	m	*M. parvifolia* HBK.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	b/1	*M. savannarum* BRITT.	29	90	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	p	*M. tomentosa* L.	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–
V	p	*M. villosa* (MILL.) FAWC. & RENDLE	–	–	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	p	*Melothria guadelupensis* (SPRENG.) COGN.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	e	*Meriania leucantha* SW. ssp. *nana* (NAUD.) BHIDI.	–	–	–	–	–	–	–	–	–	–	–	–	–	80	–	–	–	–	–	70
T	l	*Merremia aegyptica* (L.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	p	*M. cissioides* (LAM.) HALL. F.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	f	*Mesechitea rosea* (A. DC.) MIERS	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	o	*Mesosetum loliiforme* (HOCHST.) CHASE	100	80	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
U	p	*M. purpurea* (SPRENG.) AMES & CORRELL	30	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	p	*M. rufescens* LINDL.	40	–	–	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6	i	*Maytenus buxifolia* (A. RICH.) GRISEB.	–	–	–	–	–	40	–	–	–	–	100	60	–	100	40	–	40	–	100	–
D/6	a/14	*Maytenus buxifolia* ssp. *cochlearifolius* (GRISEB.) BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	90
D/6	b/2	*M. b.* ssp. *serpentini* BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–	–	–	–
D/5	a/6	*M. splendens* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	b/1	*Mazaea phialanthoides* (GRISEB.) KRUG & URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	c	*M. tinifolia* (GRISEB.) ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/4	g	*Mecranium amygdalinum* (DESV.) WR. ex SAUV.	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/3	f	*M. haemanthum* TRIANA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–	–	–	–	–
C/5	g	*M. purpurascens* (SW.) TRIANA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	e	*Meliosma oppositifolia* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Y/8!	a/14	*Melocactus Acunae* LEÓN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	70
Y/8!	a/14	*M. Harlowii* (BRITT. & ROSE) LEÓN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	–
Y/8!	a/10	*M. matanzanus* LEÓN	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–
V	a/14	*Melochia obovata* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	–
V	m	*M. parvifolia* HBK.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	–
E/6	b/1	*M. savannarum* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–
E/5	p	*M. tomentosa* L.	–	–	–	–	–	–	–	–	–	–	40	40	40	40	–	–	–	–	30	50
V	p	*M. villosa* (MILL.) FAWC. & RENDLE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–
T	p	*Melothria guadelupensis* (SPRENG.) COGN.	–	–	–	–	40	60	60	–	–	–	–	–	–	–	–	–	–	–	40	50
D/5	e	*Meriania leucantha* SW. ssp. *nana* (NAUD.) BHIDI.	40	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	l	*Merremia aegyptica* (L.) URB.	–	–	–	–	60	–	40	–	–	–	–	–	–	–	60	–	–	–	–	–
T	p	*M. cissioides* (LAM.) HALL. F.	–	–	–	–	–	–	–	–	–	–	40	40	40	–	–	–	–	–	–	–
T	f	*Mesechitea rosea* (A. DC.) MIERS	–	–	–	–	–	–	–	–	–	–	100	60	100	100	–	–	–	40	80	40
O	o	*Mesosetum loliiforme* (HOCHST.) CHASE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 25 Continued 41

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
B/5	l	*Metopium Brownei* (JACQ.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	k	*M. toxiferum* (L.) KRUG & URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	b/2	*M. venosum* (GRISEB.) ENGL.	–	–	–	–	–	30	–	–	50	40	30	–	40	–	30	60	40	60	–	–
E/5	a/6	*Mettenia cordifolia* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
C/5	g	*M. globosa* (SW.) GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	40
E/5	a/5	*M. oblongata* ALAIN	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–	–	–	–	–
D/4	p	*Miconia albicans* (SW.) TRIANA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	b/3	*M. alternifolia* (GRISEB.) ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	80	–	–	–	40
E/5	b/1	*M. androsaemifolia* GRISEB.	54	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/4	b/2	*M. baracoensis* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	70	40	40	–	–	–
D/4	b/2	*M. cerasiflora* URB.	–	–	–	–	–	–	–	–	–	–	40	50	–	–	–	40	80	40	–	–
D/3	g	*M. cubensis* WR. ex GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	m	*M. delicatula* A. RICH.	45	80	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/3	p	*M. dodecandra* (DESV.) COGN.	–	–	–	–	–	–	–	–	–	–	–	30	–	–	–	–	–	–	80	80
C/2	g	*M. elata* (SW.) DC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	30
D/4	p	*M. ibaguensis* (BONPL.) TRIANA	–	–	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/2	p	*M. impetiolaris* (SW.) D. DON.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/3	p	*M. laevigata* (L.) DC.	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–
D/5	a/5	*M. lenticellata* ALAIN	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–
B/3	m	*M. mirabilis* (AUBL.) L. O. WMS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–
D/5	b/2	*M. moensis* (BRITT.) ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	40	30	–	–	–	–	–
D/5	a/6	*M. Nystroemii* EKM. ex URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/3	a/6	*M. plumeriaefolia* BRITT. & WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
C/3	p	*M. prasina* (SW.) DC.	–	–	40	30	–	–	–	–	–	–	–	–	–	–	50	–	–	–	60	–
D/3	p	*M. punctata* (DESV.) D. DON	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	90
E/3	b/3	*M. rufa* (GRISEB.) TRIANA	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–
C/2	p	*M. serrulata* (DC.) NAUD.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	40
D/5	a/5	*M. Shaferi* COGN.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–
B/3	h	*M. tetrandra* (SW.) D. DON	–	–	–	–	–	–	–	–	–	–	–	50	–	–	40	–	–	–	60	–
D/4	a/6	*M. turquinensis* URB. & EKM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	a/5	*M. uninervis* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	40	–	–	–
G	b/1	*Microcycas calocoma* (MIQX.) DC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
B/5	l	*Metopium Brownei* (JACQ.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	100	–	–
D/4	k	*M. toxiferum* (L.) KRUG & URB.	–	–	–	–	–	–	–	–	–	–	–	–	40	100	–	–	–	–	–	–
D/5	b/2	*M. venosum* (GRISEB.) ENGL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/6	*Mettenia cordifolia* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	g	*M. globosa* (SW.) GRISEB.	–	–	–	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/5	*M. oblongata* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	p	*Miconia albicans* (SW.) TRIANA	80	–	–	–	–	–	100	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	b/3	*M. alternifolia* (GRISEB.) ALAIN	–	80	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/1	*M. androsaemifolia* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/4	b/2	*M. baracoensis* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	b/2	*M. cerasiflora* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/3	g	*M. cubensis* WR. ex GRISEB.	60	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	m	*M. delicatula* A. RICH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–	–	–	–	–
C/3	p	*M. dodecandra* (DESV.) COGN.	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/2	g	*M. elata* (SW.) DC.	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	p	*M. ibaguensis* (BONPL.) TRIANA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–	–	–	–	–
C/2	p	*M. impetiolaris* (SW.) D. DON.	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/3	p	*M. laevigata* (L.) DC.	80	–	–	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	a/5	*M. lenticellata* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/3	m	*M. mirabilis* (AUBL.) L. O. WMS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	b/2	*M. moensis* (BRITT.) ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	a/6	*M. Nystroemii* EKM. ex URB.	–	60	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/3	a/6	*M. plumeriaefolia* BRITT. & WILS.	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/3	p	*M. prasina* (SW.) DC.	80	–	–	80	–	–	–	–	–	–	–	–	–	–	100	–	–	60	–	–
D/3	p	*M. punctata* (DESV.) D. DON	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/3	b/3	*M. rufa* (GRISEB.) TRIANA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/2	p	*M. serrulata* (DC.) NAUD.	60	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–
D/5	a/5	*M. Shaferi* COGN.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/3	h	*M. tetrandra* (SW.) D. DON	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	a/6	*M. turquinensis* URB. & EKM.	–	100	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	a/5	*M. uninervis* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
G	b/1	*Microcycas calocoma* (MIQ.) DC.	–	–	–	–	–	40	–	–	–	–	–	–	–	–	60	–	–	–	–	–

Table 25 Continued 42

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
T	b/3	*Mikania alba* TAYLOR	–	–	–	–	–	–	–	–	–	–	–	–	–	60	40	–	–	–	40	70
T	k	*M. cordifolia* (L.) WILLD.	–	–	–	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	m	*M. hastata* (L.) WILLD.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	f	*M. ranunculifolia* A. RICH.	–	–	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J!	a/5	*Mimosa Ekmanii* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–
E/7!	e	*M. fagaracantha* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	a/6	*Mitracarpus Acunae* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	b/1	*M. glabrescens* (GRISEB.) URB.	–	–	40	80	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	f	*M. squarrosus* CHAM. & SCHLTD.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R	b/2	*M. tenuis* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–
R	p	*M. villosus* (SW.) DC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	a/5	*Mniochloa pulchella* (GRISEB.) CHASE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–
D/3	a/5	*Moacroton Ekmanii* (URB.) CROIZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50	–	–	–	–	–
D/5	a/4	*M. lanceolatus* ALAIN var. *ellipticus* BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–
E/6	a/5	*M. Leonis* CROIZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–
D/5	a/10	*M. revolutus* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/5	*M. tetramerus* BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–
T	r	*Momordica charantia* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	a/5	*Morinda moaensis* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	40	–	40	100	100	–	–	–
J	n	*M. royoc* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	f	*Mouriri acuta* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	f	*M. rostrata* URB.	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–
E/5	l	*Myginda Uragoga* JACQ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	b/3	*Myrcia Gundlachii* KRUG & URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	60	50	–	–	–	–	–
D/6!	b/2	*M. retivenia* (WR.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–	–
E/6	a/5	*M. Susannae* BHIDI.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–
C/5	k	*Myrcianthes fragrans* (SW.) MC. VAUGH	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	o	*Myrciaria floribunda* (WEST.) ex WILLD.) BERG	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6	a/6	*Myrica cacuminis* BRITT. & WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	k	*M. cerifera* L.	–	–	100	40	40	–	–	–	–	–	30	–	–	–	–	–	–	40	–	–

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
T	b/3	*Mikania alba* TAYLOR	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	k	*M. cordifolia* (L.) WILLD.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	m	*M. hastata* (L.) WILLD.	–	–	–	–	–	–	–	40	40	40	–	–	–	–	–	100	–	–	–	–
T	f	*M. ranunculifolia* A. RICH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–	–
J!	a/5	*Mimosa Ekmanii* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/7!	e	*M. fagaracantha* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–	–	–	–
V	a/6	*Mitracarpus Acunae* ALAIN	–	–	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	b/1	*M. glabrescens* (GRISEB.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–
O	f	*M. squarrosus* CHAM. & SCHLTD.	–	–	–	–	–	–	–	–	–	–	40	80	80	40	–	–	–	–	–	–
R	b/2	*M. tenuis* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R	p	*M. villosus* (SW.) DC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
O	a/5	*Mniochloa pulchella* (GRISEB.) CHASE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/3	a/5	*Moacroton Ekmanii* (URB.) CROIZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	a/4	*M. lanceolatus* ALAIN var. *ellipticus* BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	a/5	*M. Leonis* CROIZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	a/10	*M. revolutus* ALAIN	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–	–	–	–	–	–
E/5	a/5	*M. tetramerus* BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	r	*Momordica charantia* L.	–	–	–	–	40	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–
J	a/5	*Morinda moaensis* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	n	*M. royoc* L.	–	–	–	–	–	–	–	–	–	–	40	60	40	40	40	80	100	40	50	–
D/5	f	*Mouriri acuta* GRISEB.	–	–	–	60	–	–	–	–	–	–	–	–	–	–	80	–	–	–	–	–
D/5	f	*M. rostrata* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	l	*Myginda Uragoga* JACQ.	–	–	–	–	–	40	–	40	60	40	–	–	–	–	40	–	40	40	–	–
D/4	b/3	*Myrcia Gundlachii* KRUG & URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6!	b/2	*M. retivenia* (WR.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	a/5	*M. Susannae* BHIDI.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	k	*Myrcianthes fragrans* (SW.) MC. VAUGH	–	–	–	–	–	60	–	–	–	–	–	–	–	–	–	–	–	40	–	–
C/5	o	*Myrciaria floribunda* (WEST.) ex WILLD.) BERG	–	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6	a/6	*Myrica cacuminis* BRITT. & WILS.	–	40	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	k	*M. cerifera* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–	–	100	–	–

Table 25 Continued 43

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
D/5	b/3	*M. punctata* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	50
D/6	b/2	*M. Shaferi* URB. & BRITT.	–	–	–	–	–	30	–	–	–	–	–	30	–	–	30	60	80	40	–	–
B/5	p	*Myrsine coriacea* (R. & P.) LAM.	–	–	–	–	–	30	36	–	–	–	–	50	–	–	–	–	–	–	–	100
D/6	a/6	*M. microphylla* (BRITT. & WILS.) ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	p	*M. punctata* (AUBL.) STEARN	–	–	–	–	–	–	–	–	–	–	30	40	–	40	70	–	–	–	–	–
D/5	f	*Myrtus anomala* BURR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	f	*M. bahamensis* (KIAERSK.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	b/2	*M. Ekmanii* URB.	–	–	–	–	–	70	–	–	40	–	–	–	–	–	–	–	–	60	–	–
E/5	a/10	*M. matanzasia* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/7	a/14	*M. oonophylla* (URB.) BURR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/5	*M. ophiticola* (BRITT. & WILS.) ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	80	–	–	–	40	–	–	–
B/3	h	*Nectandra antillana* MEISSN.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	80	–
B/4	l	*N. coriacea* (SW.) GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	a/6	*N. reticularis* BRITT. & WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6	e	*Neea Shaferi* STANDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Y/8!	a/13	*Neobesseya cubensis* (BRITT. & ROSE) HESTER	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	j	*Neobracea angustifolia* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6	b/2	*N. Ekmanii* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–
E/5	a/7	*N. Howardii* WOODS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/8	*N. Susannina* BHIDI.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	f	*N. Valenzuelana* (A. RICH.) URB.	–	–	–	40	100	–	–	–	–	–	80	40	40	–	30	40	100	60	–	–
O	r	*Nephrolepis biserrata* (SW.) SCHOTT	–	–	–	–	–	–	–	–	–	–	–	–	–	60	30	60	–	–	–	30
O	r	*N. exaltata* (L.) SCHOTT	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
O	p	*N. rivularis* (VAHL) METT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/7	f	*Notodon Roigii* BRITT. & WILS.	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	80	–	–	–
E/7	e	*N. savannarum* BRITT. & WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/2	p	*Ochroma pyramidalis* (CAV.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–
C/5	a/5	*Ocotea Bucheri* ROIG & ACUÑA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	–	–	–	–	–

Lf	Ge	No. of communities / Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
D/5	b/3	*M. punctata* GRISEB.	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6	b/2	*M. Shaferi* URB. & BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/5	p	*Myrsine coriacea* (R. & P.) LAM.	100	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6	a/6	*M. microphylla* (BRITT. & WILS.) ALAIN	–	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	p	*M. punctata* (AUBL.) STEARN	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	80	–	–
D/5	f	*Myrtus anomala* BURR.	–	–	–	–	–	–	–	–	–	–	40	100	100	60	–	–	–	–	–	–
E/5	f	*M. bahamensis* (KIAERSK.) URB.	–	–	–	–	–	–	–	–	–	–	60	–	40	60	–	–	–	–	50	–
D/5	b/2	*M. Ekmanii* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/10	*M. matanzasia* URB.	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–
D/7	a/14	*M. oonophylla* (URB.) BURR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	70
E/5	a/5	*M. ophiticola* (BRITT. & WILS.) ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/3	h	*Nectandra antillana* MEISSN.	40	–	–	80	–	–	–	–	40	40	–	–	–	–	–	–	–	40	–	–
B/4	l	*N. coriacea* (SW.) GRISEB.	–	–	–	60	80	40	100	100	60	60	60	–	–	–	40	–	–	100	70	60
C/5	a/6	*N. reticularis* BRITT. & WILS.	–	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6	e	*Neea Shaferi* STANDL.	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	50	80
Y/8!	a/13	*Neobesseya cubensis* (BRITT. & ROSE) HESTER	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–
D/5	j	*Neobracea angustifolia* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–
D/6	b/2	*N. Ekmanii* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/7	*N. Howardii* WOODS.	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/8	*N. Susannina* BHIDI.	–	–	–	–	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	f	*N. Valenzuelana* (A. RICH.) URB.	–	–	–	–	–	–	–	–	–	–	80	100	60	100	–	–	–	–	–	–
O	r	*Nephrolepis biserrata* (SW.) SCHOTT	40	–	–	–	–	–	–	40	–	40	–	–	–	–	40	40	–	–	–	–
O	r	*N. exaltata* (L.) SCHOTT	40	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*N. rivularis* (VAHL) METT.	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/7	f	*Notodon Roigii* BRITT. & WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/7	e	*N. savannarum* BRITT. & WILS.	–	–	–	–	–	–	–	–	–	–	–	–	100	80	–	–	–	–	–	–
B/2	p	*Ochroma pyramidalis* (CAV.) URB.	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	a/5	*Ocotea Bucheri* ROIG & ACUÑA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 25 Continued 44

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
B/4	g	*O. cuneata* (GRISEB.) URB.	—	—	—	—	—	30	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C/5	e	*O. Ekmanii* O. C., SCHMIDT	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
B/4	p	*O. floribunda* (SW.) MEZ	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—	—	—	30
B/3	h	*Ocotea leucoxylon* (SW.) MEZ	—	—	—	—	—	—	—	—	—	—	—	—	—	80	80	—	—	—	60	80
J	h	*Odontosoria aculeata* (L.) J. SMITH	—	—	—	—	—	50	72	30	50	—	40	60	40	40	90	—	—	40	—	100
J	h	*O. uncinella* (KUNTZE) FÉE	—	—	—	—	—	—	—	—	—	—	—	40	—	100	50	60	—	—	—	100
J	b/1	*O. Wrightiana* MAXON	—	30	100	40	30	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	h	*Oleandra articulata* (SW.) PRESL	—	—	—	—	—	—	—	—	—	—	—	—	—	80	30	—	—	—	40	—
O	p	*Olyra latifolia* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—
J	m	*Omphalea diandra* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	100	—
C/3	a/9	*O. hypoleuca* GRISEB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/3	f	*O. trichotoma* MUELL.-ARG.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
U	p	*Oncidium guttatum* RCHB. F.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
U	l	*O. sphacelatum* LINDL.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
U	k	*O. variegatum* SW.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	r	*Oplismenus Burmannii* (RETZ) BEAUV.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	30
O	p	*O. hirtellus* (L.) BEAUV.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	60	80
E/7!	c	*Oplonia nannophylla* (URB.) STEARN	—	—	—	—	30	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/6!	a/9	*O. purpurascens* (GRISEB.) STEARN	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/6!	h	*O. cubensis* BHIDI.	—	—	—	—	—	—	—	—	60	60	90	—	—	—	—	40	80	—	—	—
E/6!	f	*O. tetrasticha* (WR. ex GRISEB.) STEARN	—	—	—	—	60	—	—	—	—	—	30	—	—	—	—	—	—	—	—	—
K/8!	l	*Opuntia Dillenii* (KER.-GAWL.) HAW.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
P	u	*Osmunda regalis* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/5	a/4	*Ossaea Acunae* ALAIN	—	—	—	—	—	—	—	—	30	—	—	—	—	—	—	—	—	40	—	—
E/6	a/5	*O. baracoensis* BHIDI. & MZ.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—	—	—
D/5	a/6	*O. brachystemon* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/5	b/2	*O. Ekmanii* URB.	—	—	—	—	—	—	—	—	30	—	—	—	—	—	—	60	—	—	—	—
E/4	a/5	*O. granulata* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—	—	—	—
E/5	e	*O. lanata* (NAUD.) WR. ex SAUV.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40
E/6	g	*O. microphylla* (SW.) WR. ex SAUV.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	30
E/6	a/5	*O. moaensis* ALAIN	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	40	—	—	—

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
B/4	g	*O. cuneata* (GRISEB.) URB.	100	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	e	*O. Ekmanii* O. C., SCHMIDT	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/4	p	*O. floribunda* (SW.) MEZ	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/3	h	*Ocotea leucoxylon* (SW.) MEZ	60	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	h	*Odontosoria aculeata* (L.) J. SMITH	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	h	*O. uncinella* (KUNTZE) FÉE	60	60	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	b/1	*O. Wrightiana* MAXON	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	h	*Oleandra articulata* (SW.) PRESL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*Olyra latifolia* L.	–	–	–	80	–	–	–	40	40	40	40	–	–	–	–	–	–	–	–	–
J	m	*Omphalea diandra* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/3	a/9	*O. hypoleuca* GRISEB.	–	–	–	–	–	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/3	f	*O. trichotoma* MUELL.-ARG.	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	40	100	–	–
U	p	*Oncidium guttatum* RCHB. F.	–	–	–	30	40	–	–	30	30	40	–	–	–	–	–	–	–	–	–	–
U	l	*O. sphacelatum* LINDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–
U	k	*O. variegatum* SW.	–	–	–	–	–	–	–	–	–	–	–	40	40	40	–	–	–	–	40	–
O	r	*Oplismenus Burmannii* (RETZ) BEAUV.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*O. hirtellus* (L.) BEAUV.	100	40	–	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/7!	c	*Oplonia nannophylla* (URB.) STEARN	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–
E/6!	a/9	*O. purpurascens* (GRISEB.) STEARN	–	–	–	–	–	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6!	h	*O. cubensis* BHIDI.	–	–	–	–	–	–	–	–	–	–	–	–	60	100	–	–	–	–	50	–
E/6!	f	*O. tetrasticha* (WR. ex GRISEB.) STEARN	–	–	–	–	100	–	–	–	–	–	40	40	–	–	–	–	–	–	100	100
K/8!	l	*Opuntia Dillenii* (KER.-GAWL.) HAW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	40	30	70
P	u	*Osmunda regalis* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–
E/5	a/4	*Ossaea Acunae* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	a/5	*O. baracoensis* BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	a/6	*O. brachystemon* URB.	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/2	*O. Ekmanii* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/4	a/5	*O. granulata* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	e	*O. lanata* (NAUD.) WR. ex SAUV.	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	g	*O. microphylla* (SW.) WR. ex SAUV.	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	a/5	*O. moaensis* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 25 Continued 45

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
D/5	b/3	*O. muricata* (GRISEB.) WR. ex SAUV.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	50
E/5	b/2	*O. navasensis* BRITT. & WILS.	—	—	—	—	—	—	—	—	—	—	—	70	60	—	40	—	40	—	—	—
E/6	a/4	*O. nipensis* BRITT. & WILS.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	60	—	—
D/5	e	*O. Ottoschmidtii* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	80
E/5	b/2	*O. pauciflora* (NAUD.) URB.	—	—	—	—	—	30	36	—	—	—	50	40	100	—	—	—	40	40	—	—
D/4	b/2	*O. rufescens* (GRISEB.) WR. ex SAUV.	—	—	—	—	—	—	—	—	—	—	—	—	—	100	80	—	—	—	—	—
D/5	a/6	*O. turquinensis* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	60
E/6	a/5	*O. Vazquezii* BHIDI. & MZ.	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—	—	—	—	—
E/7!	g	*Ottoschmidtia dorsiventralis* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C/5	f	*Ottoschulzia cubensis* (WR.) URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/5	b/1	*Ouratea elliptica (A. RICH.) MAZA*	*54*	*40*	*40*	*80*	*60*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5!	g	*O. ilicifolia* (DC.) BAILL.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/4	l	*O. nitida* (SW.) ENGL.	—	—	40	40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	g	*O. striata* (V. STIEGH.) URB.	—	—	—	—	—	100	36	60	40	60	80	40	100	—	—	—	—	40	—	—
O	b/1	*Oxalis pinetorum* URB.	—	—	40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C/5	g	*Oxandra lanceolata* (SW.) BAILL.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—
B/3	h	*O. laurifolia* (SW.) A. RICH.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	100	—
V	b/2	*Paepalanthus Brittonii* MOLD.	—	—	—	—	—	40	—	—	—	—	—	—	40	—	—	—	60	—	—	—
V	b/2	*P. pungens* GRISEB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	80	—	—	—	—
V	a/5	*P. riparius* MOLD.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	60	—	—	—	—
V	b/1	*P. seslerioides* GRISEB.	100	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/4	b/1	*Pachyanthus cubensis* A. RICH.	54	30	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C/4	a/1	*P. longifolius* JENNINGS	36	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	b/2	*P. mayarensis* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	80	—	—
E/5	a/5	*P. moaensis* BHIDI. & MZ.	—	—	—	—	—	—	—	—	—	—	—	—	60	—	—	40	60	—	—	—
D/5	b/2	*P. oleifolius* GRISEB.	—	—	—	—	—	—	—	—	—	—	30	—	—	—	—	—	—	—	—	—
D/4	b/1	*P. Poiretii* GRISEB.	—	—	100	40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/4	b/2	*P. reticulatus* BRITT. & WILS.	—	—	—	—	—	50	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/4	a/5	*P. rigidus* ALAIN	—	—	—	—	—	—	—	—	—	—	—	—	—	—	30	—	—	—	—	—
C/4	g	*Palicourea alpina* (SW.) DC.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	80
C/3	m	*P. barbinervis* DC.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	80	—

Lf	Ge	No. of communities / Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
D/5	b/3	*O. muricata* (GRISEB.) WR. ex SAUV.	—	60	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/5	b/2	*O. navasensis* BRITT. & WILS.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/6	a/4	*O. nipensis* BRITT. & WILS.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	e	*O. Ottoschmidtii* URB.	80	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/5	b/2	*O. pauciflora* (NAUD.) URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/4	b/2	*O. rufescens* (GRISEB.) WR. ex SAUV.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	a/6	*O. turquinensis* URB.	—	80	40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/6	a/5	*O. Vazquezii* BHIDI. & MZ.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/7!	g	*Ottoschmidtia dorsiventralis* URB.	—	—	—	—	—	—	—	—	—	—	60	40	—	—	—	—	—	—	—	—
C/5	f	*Ottoschulzia cubensis* (WR.) URB.	—	—	—	—	40	—	—	40	—	40	—	—	—	—	—	—	—	—	—	—
E/5	b/1	*Ouratea elliptica* (A. RICH.) MAZA	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5!	g	*O. ilicifolia* (DC.) BAILL.	—	—	—	—	—	—	—	60	40	40	100	100	100	100	—	—	—	40	30	—
D/4	l	*O. nitida* (SW.) ENGL.	—	—	—	—	—	—	—	—	—	—	—	40	—	—	100	—	—	—	—	—
D/5	g	*O. striata* (V. STIEGH.) URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	b/1	*Oxalis pinetorum* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C/5	g	*Oxandra lanceolata* (SW.) BAILL.	—	—	—	100	60	60	40	60	100	100	—	—	—	—	—	—	80	40	30	—
B/3	h	*O. laurifolia* (SW.) A. RICH.	—	—	—	100	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
V	b/2	*Paepalanthus Brittonii* MOLD.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
V	b/2	*P. pungens* GRISEB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
V	a/5	*P. riparius* MOLD.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
V	b/1	*P. seslerioides* GRISEB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/4	b/1	*Pachyanthus cubensis* A. RICH.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C/4	a/1	*P. longifolius* JENNINGS	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	b/2	*P. mayarensis* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/5	a/5	*P. moaensis* BHIDI. & MZ.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	b/2	*P. oleifolius* GRISEB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/4	b/1	*P. Poiretii* GRISEB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—	—	—	—
D/4	b/2	*P. reticulatus* BRITT. & WILS.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/4	a/5	*P. rigidus* ALAIN	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C/4	g	*Palicourea alpina* (SW.) DC.	60	60	40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C/3	m	*P. barbinervis* DC.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Table 25 Continued 46

Lf	Ge	No. of communities Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
D/4	p	*Palicourea crocea* (SW.) R. & S.	—	—	—	—	—	—	—	—	—	—	—	—	—	40	50	—	—	—	100	—
D/3	h	*P. domingensis* (JACQ.) DC.	—	—	—	—	—	—	—	—	—	—	—	—	—	60	—	—	—	—	40	30
O	l	*Panicum aciculare* DESV.	—	80	80	30	40	—	72	—	—	—	—	—	—	—	40	—	—	60	—	—
O	g	*P. acuminatum* SW.	—	90	60	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	l	*P. albo-marginatum* NASH	45	80	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	l	*P. arenicoloides* ASHE	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—	—	—	—	—	—
O	k	*P. auburne* ASHE	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	p	*P. boliviense* HACK.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	j	*P. coerulescens* HACK.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	k	*P. chrysopsidifolium* NASH	40	40	80	40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	k	*P. erectifolium* NASH	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	p	*P. fasciculatum* SW.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	i	*P. fusiforme* HITCHC.	—	—	—	—	—	—	63	—	—	—	—	—	—	—	—	—	—	—	—	—
O	p	*P. glutinosum* SW.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	30	—	—	—	—	30
O	l	*P. lancearium* TRIN.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	k	*P. longiligulatum* NASH	81	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	k	*P. scoparium* LAM.	—	—	—	—	—	—	54	—	—	—	70	70	—	—	—	—	40	40	—	30
O	p	*P. Sellowii* NEES	—	—	—	40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	p	*P. stenodes* GRISEB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	l	*P. strigosum* MUHL.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	k	*P. virgatum* L. ssp. *cubense* (GRISEB.) BHIDI.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	l	*P. xalapense* HBK.	—	—	—	—	—	—	—	72	—	—	—	—	—	—	—	—	—	—	—	30
D/4	l	*Parathesis cubana* (A. DC.) MOLT. & MAZA	—	—	40	40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	a/4	*Paspalum Alainii* LEÓN	—	—	—	—	—	—	45	—	—	—	—	—	—	—	—	—	—	—	—	—
O	g	*P. breve* CHASE	—	—	—	—	—	30	—	—	100	—	—	—	—	—	—	—	—	—	—	—
O	l	*P. caespitosum* FLÜGGE	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	h	*P. laxum* LAM.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	p	*P. paniculatum* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	g	*P. rupestre* TRIN.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	r	*P. vaginatum* SW.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Lf	Ge	No. of communities / Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
D/4	p	*Palicourea crocea* (SW.) R. & S.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–	–
D/3	h	*P. domingensis* (JACQ.) DC.	100	–	–	100	–	80	100	40	–	100	–	–	–	–	40	–	–	–	–	–
O	l	*Panicum aciculare* DESV.	–	–	–	–	–	–	–	–	–	–	40	40	60	80	40	–	–	–	–	–
O	g	*P. acuminatum* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	l	*P. albo-marginatum* NASH	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–
O	l	*P. arenicoloides* ASHE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	k	*P. auburne* ASHE	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–
O	p	*P. boliviense* HACK.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–	–	–	–
O	j	*P. coerulescens* HACK.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	80	40	–	–	–	–
O	k	*P. chrysopsidifolium* NASH	–	–	–	–	–	–	–	–	–	–	–	60	80	–	–	–	–	–	–	–
O	k	*P. erectifolium* NASH	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–
O	p	*P. fasciculatum* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	60	30
O	l	*P. fusiforme* HITCHC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*P. glutinosum* SW.	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	l	*P. lancearium* TRIN.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	60	–	–	–	–
O	k	*P. longiligulatum* NASH	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	k	*P. scoparium* LAM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*P. Sellowii* NEES	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*P. stenodes* GRISEB.	–	–	–	–	–	–	–	–	–	–	40	–	–	–	60	–	–	40	40	30
O	l	*P. strigosum* MUHL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–
O	k	*P. virgatum* L. ssp. *cubense* (GRISEB.) BHIDI.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–	–	–	–
O	l	*P. xalapense* HBK.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	l	*Parathesis cubana* (A. DC.) MOLT. & MAZA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–
O	a/4	*Paspalum Alainii* LEÓN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	g	*P. breve* CHASE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	l	*P. caespitosum* FLÜGGE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–
O	h	*P. laxum* LAM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	30
O	p	*P. paniculatum* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	60	–	–	–
O	g	*P. rupestre* TRIN.	–	–	–	–	–	–	–	–	–	–	100	80	100	60	–	–	–	–	30	–
O	r	*P. vaginatum* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	80	–	–	–	–

Table 25 Continued 47

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
T	f	*Passiflora cubensis* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50
T	i	*P. cuprea* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	f	*P. foetida* L. ssp. *polyadena* (GRISEB.) BHIDI.	–	–	–	–	–	30	36	30	–	–	–	–	40	–	–	–	–	40	–	–
T	l	*P. multiflora* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	a/4	*P. nipensis* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–
T	g	*P. penduliflora* BERT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	80	–
T	p	*P. rubra* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	b/3	*P. santiagana* (KILLIP) BHIDI.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	p	*P. sexflora* JUSS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50
T	p	*P. suberosa* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	p	*Paullinia pinnata* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	a/9	*Pavonia achanioides* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	e	*P. heterostemon* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R	b/4	*Pectis havanensis* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	pp	*Peltapteris peltata* (SW.) MORTON	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	40
C/7	j	*Peltophorum adnatum* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*Peperomia alata* RUIZ. & PAV.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	e	*P. cubensis* DC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*P. galioides* HBK.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*P. glabella* (SW.) A. DIETR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
U	b/3	*P. Grisebachii* C. DC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	m	*P. hernandiaefolia* (VAHL) A. DIETR.	–	–	–	–	–	–	–	–	–	–	–	–	–	60	50	–	–	–	40	60
O	f	*P. hirta* C. DC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	m	*P. maculosa* (L.) HOOK.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	30
O	m	*P. magnoliaefolia* (JACQ.) A. DIETR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50	–	–	–	100	100
O	b/3	*P. oblanceolata* TREL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–
O	f	*P. pseudo-peireskiaefolia* C. DC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
V	m	*P. qudrangularis* (THOMPS.) A. DIETR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	p	*P. rotundifolia* (L.) HBK.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	60
V	h	*P. verticillata* (L.) A. DIETR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/4	j	*Pera bumeliaefolia* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
T	f	*Passiflora cubensis* URB.	–	–	–	–	–	–	–	–	–	–	100	100	40	60	–	–	–	40	–	–
T	i	*P. cuprea* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	40
J	f	*P. foetida* L. ssp. *polyadena* (GRISEB.) BHIDI.	–	–	–	40	40	40	40	–	–	–	40	60	80	60	–	–	–	–	–	–
T	l	*P. multiflora* L.	–	–	–	–	–	–	60	60	–	–	–	–	–	–	–	–	–	–	40	–
T	a/4	*P. nipensis* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	g	*P. penduliflora* BERT.	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	30	–
T	p	*P. rubra* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
T	b/3	*P. santiagana* (KILLIP) BHIDI.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50	90
T	p	*P. sexflora* JUSS.	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	p	*P. suberosa* L.	–	–	–	40	60	40	40	40	40	40	60	60	40	40	40	–	80	–	40	30
J	p	*Paullinia pinnata* L.	–	–	–	60	40	–	–	40	–	60	–	–	–	–	–	–	–	–	–	–
V	a/9	*Pavonia achanioides* GRISEB.	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	e	*P. heterostemon* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
R	b/4	*Pectis havanensis* URB.	–	–	–	–	–	–	–	–	–	–	40	40	–	–	–	–	–	–	–	–
U	pp	*Peltapteris peltata* (SW.) MORTON	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/7	j	*Peltophorum adnatum* GRISEB.	–	–	–	–	40	–	40	40	60	40	40	–	–	–	–	–	80	–	–	
O	p	*Peperomia alata* RUIZ. & PAV.	–	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	e	*P. cubensis* DC.	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*P. galioides* HBK.	–	60	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*P. glabella* (SW.) A. DIETR.	40	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	b/3	*P. Grisebachii* C. DC.	–	80	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	m	*P. hernandiaefolia* (VAHL) A. DIETR.	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	f	*P. hirta* C. DC.	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	m	*P. maculosa* (L.) HOOK.	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	m	*P. magnoliaefolia* (JACQ.) A. DIETR.	60	40	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	b/3	*P. oblanceolata* TREL.	–	–	–	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	f	*P. pseudo-peireskiaefolia* C. DC.	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	m	*P. qudrangularis* (THOMPS.) A. DIETR.	–	–	–	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	p	*P. rotundifolia* (L.) HBK.	80	–	–	60	60	40	60	–	–	–	–	–	–	–	–	–	–	–	–	–
V	h	*P. verticillata* (L.) A. DIETR.	–	–	–	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/4	j	*Pera bumeliaefolia* GRISEB.	–	–	–	–	–	–	–	–	60	80	40	–	40	40	40	–	–	–	–	–

Table 25 Continued 48

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
B/5	b/2	*P. Ekmanii* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	100	40	—	—	—	—
B/4	b/3	*P. orientensis* BHIDI.	—	—	—	—	—	—	—	—	—	—	—	—	—	40	50	—	—	80	40	40
C/5	b/2	*P. polylepis* URB.	—	—	—	—	—	—	—	—	—	—	—	—	60	—	—	—	—	—	—	—
V	a/6	*Peratanthe cubensis* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
B/4	b/3	*Persea anomala* BRITT. & WILS.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40
C/5	e	*P. hypoleuca* (A. RICH.) MEZ	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40
B/5	h	*Petitia domingensis* JACQ.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C/5	g	*P. Urbanii* EKM.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
J	l	*Petraea volubilis* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	n	*Phaeospharion persicariaefolium* (DC.) CLARKE	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	100	—
P	x	*Phaius Tankervilliae* (BANKS) BLUME	—	—	—	—	—	—	—	—	—	—	40	60	—	80	50	—	40	40	40	50
T	a/3	*Phania cajalbanica* BHIDI. & MZ.	—	—	—	100	40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
T	c	*P. matricarioides* (SPRENG.) GRISEB.	—	—	40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	p	*Pharus glaber* HBK.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	60	—
O	p	*P. latifolius* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—	—	40	—
V	f	*Phenax asper* WEBB	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/6	b/3	*Phialanthus ellipticus* URB.	—	—	—	—	—	—	—	—	50	40	—	—	—	—	—	—	—	40	—	—
D/6	b/2	*P. oblongatus* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	80	—	—	—
D/6	b/4	*P. resinifluus* GRISEB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/5	b/2	*Phidiasia Lindavii* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—	—	—
T	h	*Philodendron angustatum* SCHOTT	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	30
T	c	*P. Clementis* WR.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
T	g	*P. hederaceum* (JACQ.) SCHOTT	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
T	g	*P. lacerum* (JACQ.) SCHOTT	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	60	—
T	a/9	*P. Urbanianum* KRAUSE	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
B/4	g	*Phoebe montana* (SW.) GRISEB.	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—	—	—	80	40
I	m	*Phoradendron racemosum* (AUBL.) KRUG & URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	30	—	—	—	—	—
I	h	*P. Randiae* (BELLO) BRITT.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
I	a/11	*P. zapatanum* TREL.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	h	*Phyla strigulosa* MART. & GAL.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
B/5	b/2	*P. Ekmanii* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/4	b/3	*P. orientensis* BHIDI.	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	b/2	*P. polylepis* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	a/6	*Peratanthe cubensis* URB.	–	100	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/4	b/3	*Persea anomala* BRITT. & WILS.	–	100	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	e	*P. hypoleuca* (A. RICH.) MEZ	40	60	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/5	h	*Petitia domingensis* JACQ.	–	–	–	–	–	–	–	40	100	80	–	40	–	40	–	–	–	80	–	–
C/5	g	*P. Urbanii* EKM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
J	l	*Petraea volubilis* L.	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	40	–	–
O	n	*Phaeospharion persicariaefolium* (DC.) CLARKE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P	x	*Phaius Tankervilliae* (BANKS) BLUME	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	a/3	*Phania cajalbanica* BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	c	*P. matricarioides* (SPRENG.) GRISEB.	–	–	–	–	–	–	–	–	–	40	–	–	–	40	–	–	–	–	–	–
O	p	*Pharus glaber* HBK.	60	–	–	60	–	–	60	–	40	60	–	–	–	–	40	–	–	–	–	–
O	p	*P. latifolius* L.	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–
V	f	*Phenax asper* WEBB	–	–	–	–	–	40	60	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6	b/3	*Phialanthus ellipticus* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6	b/2	*P. oblongatus* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6	b/4	*P. resinifluus* GRISEB.	–	–	–	–	–	–	80	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/2	*Phidiasia Lindavii* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	h	*Philodendron angustatum* SCHOTT	40	–	–	40	40	40	40	40	40	40	–	–	–	–	–	40	–	40	–	–
T	c	*P. Clementis* WR.	–	–	–	–	–	–	80	–	–	–	–	–	–	–	–	–	–	–	–	–
T	g	*P. hederaceum* (JACQ.) SCHOTT	–	–	–	–	–	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–
T	g	*P. lacerum* (JACQ.) SCHOTT	–	–	–	60	80	60	100	40	–	–	–	–	–	–	–	–	–	40	–	–
T	a/9	*P. Urbanianum* KRAUSE	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/4	g	*Phoebe montana* (SW.) GRISEB.	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
I	m	*Phoradendron racemosum* (AUBL.) KRUG & URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
I	h	*P. Randiae* (BELLO) BRITT.	–	–	–	–	–	–	–	–	–	–	–	40	60	60	–	–	–	60	60	70
I	a/11	*P. zapatanum* TREL.	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	40	–	–
O	h	*Phyla strigulosa* MART. & GAL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	30	–

Table 25 Continued 49

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
E/7	k	*Phyllanthus angustifolius* (SW.) SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/7	b/2	*P. chamaecristoides* URB. ssp. *baracoensis* (URB.) WEBST.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–	–	–	–
E/5	a/5	*P. chryseus* HOWARD	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	40	–	–	–
D/5	a/5	*P. cinctus* URB.	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–
E/6	a/5	*P. comosus* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–	–	–
E/5	a/3	*P. comptus* WEBST.	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	c	*P. discolor* POEPP.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/8	i	*P. Epiphyllanthus* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/8	b/3	*P. E.* ssp. *dilatatus* (MUELL.-ARG.) WEBST.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/2	*P. excisus* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50	–	–	–	–	–
E/6	b/2	*P. incrustatus* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	40	–	–	–	–
V	b/1	*P. junceus* MUELL.-ARG.	18	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
V	g	*P. Lindenianus* BAILL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	a/5	*P. myrtilloides* GRISEB. ssp. *erythrinus* (MUELL.-ARG.) WEBST.	–	–	–	–	–	–	–	–	–	–	–	30	100	–	30	–	40	–	–	–
E/7	a/4	*P. m.* ssp. *Shaferi* (URB.) WEBST.	–	–	–	–	–	40	81	–	40	–	–	–	–	–	–	–	–	60	–	–
E/7	f	*P. orbicularis* HBK.	–	–	–	–	80	–	–	–	30	–	50	–	–	–	–	–	80	–	–	–
E/7	b/2	*P. pachystylus* URB.	–	–	–	–	–	–	–	–	–	–	–	30	40	–	–	–	–	–	–	–
E/6	a/3	*P.* × *pallidus* WR. ex GRISEB.	–	–	–	30	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	a/1	*P. Selbyi* BRITT. & WILS.	90	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	p	*Phyllostylon brasiliensis* CAP.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	h	*Picramnia pentandra* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	j	*Picrodendron macrocarpum* (A. RICH.) BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/7!	e	*Pictetia marginata* SAUV.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	80	–	–
V	a/9	*Pilea abbreviata* URB. & EKM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	a/9	*P. affinis* MORTON	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	e	*P. cellulosa* (SPRENG.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	a/7	*P. clarana* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	a/7	*Pilea Clementis* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
E/7	k	*Phyllanthus angustifolius* (SW.) SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
E/7	b/2	*P. chamaecristoides* URB. ssp. *baracoensis* (URB.) WEBST.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/5	*P. chryseus* HOWARD	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	a/5	*P. cinctus* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	a/5	*P. comosus* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/3	*P. comptus* WEBST.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	c	*P. discolor* POEPP.	–	–	–	–	–	–	40	–	–	–	100	40	–	–	–	–	–	–	–	–
D/8	i	*P. Epiphyllanthus* L.	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–
D/8	b/3	*P. E.* ssp. *dilatatus* (MUELL.-ARG.) WEBST.	–	–	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/2	*P. excisus* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	b/2	*P. incrustatus* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	b/1	*P. junceus* MUELL.-ARG.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	g	*P. Lindenianus* BAILL.	–	–	–	–	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	a/5	*P. myrtilloides* GRISEB. ssp. *erythrinus* (MUELL.-ARG.) WEBST.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/7	a/4	*P. m.* ssp. *Shaferi* (URB.) WEBST.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/7	f	*P. orbicularis* HBK.	–	–	–	–	–	–	–	–	–	–	100	80	60	80	–	–	–	–	–	–
E/7	b/2	*P. pachystylus* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	a/3	*P.* × *pallidus* WR. ex GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	a/1	*P. Selbyi* BRITT. & WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	p	*Phyllostylon brasiliensis* CAP.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
C/5	h	*Picramnia pentandra* SW.	–	–	–	100	60	60	60	80	40	40	–	–	–	–	–	–	–	40	30	30
C/5	j	*Picrodendron macrocarpum* (A. RICH.) BRITT.	–	–	–	–	–	–	–	100	60	–	–	–	–	–	–	–	–	100	100	60
E/7!	e	*Pictetia marginata* SAUV.	–	–	–	–	–	–	–	–	–	–	–	40	40	80	–	–	–	–	30	60
V	a/9	*Pilea abbreviata* URB. & EKM.	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	a/9	*P. affinis* MORTON	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	e	*P. cellulosa* (SPRENG.) URB.	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	a/7	*P. clarana* URB.	40	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	a/7	*Pilea Clementis* BRITT.	80	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 25 Continued 50

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
O	b/3	*P. crenata* BRITT. & WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–	–	–	–	100	–
O	b/3	*P. Forsythiana* var. *robustior* WEDD.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	a/9	*P. hemisphaerica* URB. & EKM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	e	*P. intermedia* (WEBB) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	a/9	*P. lurida* WR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	a/4	*P. mayarensis* MORTON	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	80	–	–
V	g	*P. micromeriaefolia* BRITT. & WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R	p	*P. microphylla* (L.) LIEBM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–
O	a/5	*P. moaensis* BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–
O	b/3	*P. obtusangula* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*P. pumileoides* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	g	*P. repens* (SW.) WEDD.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50
R	a/9	*P. simplex* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	b/2	*P. spathulata* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–
V	h	*P. trianthemoides* (SW.) LINDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	a/8	*P. uninervis* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
K/8!	e	*Pilosocereus Brooksianus* (VAMP.) BYL. & ROW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/4	a/5	*Pimenta odiolens* (URB.) BURR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–
B/4	k	*Pinus caribaea* MORELET ssp. *caribaea*	63	60	100	100	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/5	b/2	*P. cubensis* GRISEB.	–	–	–	–	–	100	100	100	100	100	100	100	100	60	50	40	–	–	–	–
B/4	b/1	*P. tropicalis* MORELET	100	90	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/3	f	*Piper aduncum* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	40	–
D/4	f	*P. articulatum* A. RICH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–
E/4	b/3	*P. holguinianum* TREL.	–	–	–	–	–	–	–	–	–	–	–	40	–	–	40	–	–	–	–	–
E/3	r	*P. umbellatum* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	l	*Piqueria laxiflora* ROB. & SEAN.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R	p	*Piriqueta cistoides* (L.) MEY.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/2	*P. cubensis* BRITT. & WILS.	–	–	–	–	–	–	–	–	–	–	30	30	60	–	–	40	60	–	–	–
E/6	f	*Piscidia cubensis* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	f	*P. havanensis* (BRITT. & WILS.) URB. & EKM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
O	b/3	*P. crenata* BRITT. & WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	b/3	*P. Forsythiana* var. *robustior* WEDD.	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	a/9	*P. hemisphaerica* URB. & EKM.	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	e	*P. intermedia* (WEBB) URB.	40	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–
O	a/9	*P. lurida* WR.	–	–	–	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	a/4	*P. mayarensis* MORTON	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	g	*P. micromeriaefolia* BRITT. & WILS.	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R	p	*P. microphylla* (L.) LIEBM.	–	–	–	80	60	60	100	40	–	–	–	–	–	–	–	–	–	–	–	–
O	a/5	*P. moaensis* BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	b/3	*P. obtusangula* URB.	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*P. pumileoides* URB.	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–
O	g	*P. repens* (SW.) WEDD.	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R	a/9	*P. simplex* URB.	–	–	–	–	–	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	b/2	*P. spathulata* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	h	*P. trianthemoides* (SW.) LINDL.	–	–	–	–	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
V	a/8	*P. uninervis* GRISEB.	–	–	–	40	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
K/8!	e	*Pilosocereus Brooksianus* (VAMP.) BYL. & ROW.	–	–	–	–	40	–	40	–	–	–	–	–	–	–	–	–	–	–	–	90
C/4	a/5	*Pimenta odiolens* (URB.) BURR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/4	k	*Pinus caribaea* MORELET ssp. *caribaea*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/5	b/2	*P. cubensis* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/4	b/1	*P. tropicalis* MORELET	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/3	f	*Piper aduncum* L.	60	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	f	*P. articulatum* A. RICH.	40	–	–	–	–	–	–	60	40	40	–	–	–	–	–	–	–	–	–	–
E/4	b/3	*P. holguinianum* TREL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/3	r	*P. umbellatum* L.	60	–	–	40	40	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–
O	l	*Piqueria laxiflora* ROB. & SEAN.	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R	p	*Piriqueta cistoides* (L.) MEY.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–
E/5	b/2	*P. cubensis* BRITT. & WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	f	*Piscidia cubensis* URB.	–	–	–	–	–	–	–	–	–	–	40	40	80	40	–	–	–	–	–	–
D/5	f	*P. havanensis* (BRITT. & WILS.) URB. & EKM.	–	–	–	–	–	–	–	40	40	–	–	–	–	–	–	–	–	–	–	–

Table 25 Continued 51

Lf	Ge	No. of communities / Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
C/4	n	*P. piscipula* (L.) SARG.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5!	r	*Pisonia aculeata* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	b/1	*P. petiolaris* HEIMERL & EKM.	—	—	—	100	40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	k	*P. rotundata* GRISEB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
P	b/3	*Pitcairnia cubensis* (MEZ) L. B. SMITH	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
B/6	l	*Pithecellobium arboreum* (L.) URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C/5!	x	*P. dulce* (RCHB.) BENTH.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/6	a/13	*P. glaucum* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/7!	j	*P. hystrix (A. RICH.) BENTH.*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C/5!	*g*	*P. lentiscifolium* (A. RICH.) WR.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/7	b/2	*P. nipense* BRITT.	—	—	—	—	—	—	—	—	—	—	—	—	—	60	60	80	—	—	—	—
B/5	f	*P. obovale* (A. RICH.) WR. ex SAUV.	—	—	—	—	—	—	—	—	—	—	—	30	—	40	40	—	—	—	40	—
D/7	g	*P. oppositifolium* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/7!	e	*P. prehensile* (WR.) BENTH.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
J	p	*Pithecoctenium echinatum* (AUBL.) K. SCHUM.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	r	*Pityrogramma calomelanos* (L.) LINK	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40
O	g	*P. Eggersii* (C. CHR.) MAXON	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
J	f	*Platygyne hexandra* (JACQ.) MUELL.-ARG.	—	—	—	30	40	—	—	—	—	—	30	—	—	—	—	—	—	—	—	—
J	a/5	*P. obovata* BHIDI.	—	—	—	—	—	—	—	—	—	—	—	60	40	50	—	—	—	—	—	—
J	e	*P. parvifolia* ALAIN	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
J	b/2	*P. triandra* BHIDI.	—	—	—	—	—	—	—	—	40	—	—	—	—	—	—	—	—	—	40	—
U	e	*Pleurothallis confusa* FAWC. & RENDLE	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	30
U	p	*P. gelida* LINDL.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40
U	e	*P. Grisebachiana* COGN.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	30
U	b/3	*P. hymenantha* LINDL.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	30	—	—	—	—	—
U	g	*P. longilabris* LINDL.	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—	—	—	60	—
U	a/6	*P. obliquipetala* ACUNA & SCHWEINF.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
U	g	*P. obovata* LINDL.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40
U	b/3	*Pleurothallis parvula* AMES & SCHWEINF.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
C/4	n	*P. piscipula* (L.) SARG.	—	—	—	—	—	—	—	40	—	—	—	—	—	—	40	—	—	40	—	—
D/5!	r	*Pisonia aculeata* L.	—	—	—	40	60	40	60	80	100	40	—	—	—	—	40	100	100	—	—	—
D/5	b/1	*P. petiolaris* HEIMERL. & EKM.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	k	*P. rotundata* GRISEB.	—	—	—	—	40	—	—	40	40	—	—	60	40	40	40	—	—	—	—	—
P	b/3	*Pitcairnia cubensis* (MEZ) L. B. SMITH	—	—	—	—	40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
B/6	l	*Pithecellobium arboreum* (L.) URB.	—	—	—	60	60	40	100	100	60	100	40	—	—	—	60	—	—	100	—	—
C/5!	x	*P. dulce* (RCHB.) BENTH.	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—	—	—	—	—
D/6	a/13	*P. glaucum* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—	—	—	—	—
E/7!	j	*P. hystrix* (A. RICH.) BENTH.	—	—	—	—	—	—	—	—	—	—	—	40	—	—	—	—	—	40	60	30
C/5!	g	*P. lentiscifolium* (A. RICH.) WR.	—	—	—	—	—	—	—	—	40	—	—	—	—	—	—	80	60	40	30	—
D/7	b/2	*P. nipense* BRITT.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
B/5	f	*P. obovale* (A. RICH.) WR. ex SAUV.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	100	—	—	—	—	—
D/7	g	*P. oppositifolium* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—
E/7!	e	*P. prehensile* (WR.) BENTH.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—
J	p	*Pithecoctenium echinatum* (AUBL.) K. SCHUM.	—	—	—	40	40	40	60	40	40	40	—	—	—	—	40	40	40	—	—	—
O	r	*Pityrogramma calomelanos* (L.) LINK	40	—	—	40	100	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	g	*P. Eggersii* (C. CHR.) MAXON	—	—	—	—	—	—	—	40	—	—	—	—	—	—	—	—	—	—	—	—
J	f	*Platygyne hexandra* (JACQ.) MUELL.-ARG.	—	—	—	80	100	40	100	80	60	100	60	60	—	—	40	—	40	60	30	30
J	a/5	*P. obovata* BHIDI.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
J	e	*P. parvifolia* ALAIN	—	—	—	—	—	—	—	—	—	—	—	—	100	100	—	—	—	—	—	—
J	b/2	*P. triandra* BHIDI.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
U	e	*Pleurothallis confusa* FAWC. & RENDLE	60	80	100	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
U	p	*P. gelida* LINDL.	40	60	100	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
U	e	*P. Grisebachiana* COGN.	40	40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
U	b/3	*P. hymenantha* LINDL.	—	40	40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
U	g	*P. longilabris* LINDL.	—	40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
U	a/6	*P. obliquipetala* ACUNA & SCHWEINF.	—	—	60	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
U	g	*P. obovata* LINDL.	—	—	—	40	100	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
U	b/3	*Pleurothallis parvula* AMES & SCHWEINF.	—	—	40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Table 25 Continued 52

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
U	m	*P. quadrifolia* (LLAVE & LEX) LINDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50	–	–	–	100	100
U	g	*P. sertularioides* (SW.) SPRENG.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	b/3	*P. Shaferi* AMES	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	80	–
U	m	*P. testifolia* (SW.) LINDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	e	*P. tribuloides* (SW.) LINDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
U	m	*P. velaticaulis* RCHB. F.	–	–	–	–	–	–	–	–	–	–	–	–	–	40	50	–	–	–	40	40
U	h	*P. Wilsonii* LINDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	40	40
U	b/3	*P. Wrightii* RCHB. F.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/3	*Plinia dermatodes* URB.	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	b/2	*P. punctata* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–
O	l	*Pluchea rosea* (L.) GODFREY	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	p	*Plumbago scandens* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/3	f	*Plumeria nipensis* BRITT.	–	–	–	–	–	90	–	–	60	–	–	60	30	40	40	50	80	40	–	–
D/4	b/3	*P. lanata* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/3	h	*P. emarginata* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	b/3	*P. stenophylla* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/3	f	*P. trinitensis* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	i	*P. tuberculata* LODD.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6	b/2	*Podocarpus Ekmanii* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	60	80	40	–	–	–	–
P	p	*Pogonia macrophylla* LINDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	50
J	p	*Poiretia scandens* VENT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*Polybotrya cervina* (L.) KAULF.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–
C/5	f	*Polygala cuneata* (GRISEB.) BLAKE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/7	e	*P. guantanamana* BLAKE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6	a/11	*P. g.* ssp. *clarensis* BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R	p	*P. leptocaulis* TORR. & GRAY	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R	p	*P. longicaulis* HBK.	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	f	*P. montana* (BRITT.) BLAKE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6	j	*P. oblongata* (BRITT.) BLAKE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	80	–	–	–	–
R	p	*P. paniculata* L.	–	–	–	–	–	–	–	–	–	–	40	60	–	–	40	40	–	–	–	–
V	f	*P. saginoides* GRISEB.	–	–	40	–	–	40	–	40	60	60	–	–	–	–	–	–	–	40	–	–
R	j	*P. spathulata* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
U	m	*P. quadrifolia* (LLAVE & LEX) LINDL.	40	60	100	80	60		—	40	—	—	—	—	—	—	—	—	—	—	—	—
U	g	*P. sertularioides* (SW.) SPRENG.	—	—	—	40	40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
U	b/3	*P. Shaferi* AMES	—	—	—	60	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
U	m	*P. testifolia* (SW.) LINDL.	—	—	40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
U	e	*P. tribuloides* (SW.) LINDL.	60	60	40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
U	m	*P. velaticaulis* RCHB. F.	—	40	100	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
U	h	*P. Wilsonii* LINDL.	60	40	40	40	—	—	80	40	—	—	—	—	—	—	—	—	—	—	—	—
U	b/3	*P. Wrightii* RCHB. F.	—	100	60	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/5	a/3	*Plinia dermatodes* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	b/2	*P. punctata* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	l	*Pluchea rosea* (L.) GODFREY	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—	—	—
T	p	*Plumbago scandens* L.	—	—	—	40	40	—	40	40	40	40	—	—	—	—	40	—	60	—	—	—
D/3	f	*Plumeria nipensis* BRITT.	—	—	—	—	—	—	—	—	—	—	—	40	40	40	40	—	—	—	—	—
D/4	b/3	*P. lanata* BRITT.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	60
D/3	h	*P. emarginata* GRISEB.	—	—	—	—	80	100	100	60	40	40	60	100	100	60	40	—	60	100	30	—
D/5	b/3	*P. stenophylla* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	30
D/3	f	*P. trinitensis* BRITT.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	60	40
D/4	i	*P. tuberculata* LODD.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—	40
D/6	b/2	*Podocarpus Ekmanii* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
P	p	*Pogonia macrophylla* LINDL.	—	40	40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
J	p	*Poiretia scandens* VENT.	—	—	—	—	—	—	40	—	—	—	—	—	—	—	—	—	—	—	—	—
O	p	*Polybotrya cervina* (L.) KAULF.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C/5	f	*Polygala cuneata* (GRISEB.) BLAKE	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	60	100	70
D/7	e	*P. guantanamana* BLAKE	—	—	—	—	—	—	—	—	—	—	—	—	40	80	—	—	—	—	50	90
D/6	a/11	*P. g.* ssp. *clarensis* BHIDI. & MZ.	—	—	—	—	—	—	—	—	—	—	—	40	—	—	—	—	—	40	—	—
R	p	*P. leptocaulis* TORR. & GRAY	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
R	p	*P. longicaulis* HBK.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	f	*P. montana* (BRITT.) BLAKE	—	—	—	60	80	—	60	—	40	—	—	—	—	—	—	—	—	—	—	—
D/6	j	*P. oblongata* (BRITT.) BLAKE	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
R	p	*P. paniculata* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
V	f	*P. saginoides* GRISEB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	60	100	40	—	—	—
R	j	*P. spathulata* GRISEB.	—	—	—	—	—	—	60	—	—	—	—	—	—	—	—	—	—	—	—	—

Table 25 Continued 53

Lf	Ge	No. of communities Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
O	b/1	*P. squamifolia* WR.	45	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R	b/1	*P. uncinata* WR.	36	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	e	*P. Wrightii* CHOD.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P	p	*Polypodium angustifolium* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	p	*P. astrolepis* LIEBM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	70
P	p	*P. aureum* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	30
P	p	*P. chnoodes* SPRENG.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60
P	n	*P. costatum* KUNTZE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–
U	r	*P. duale* MAXON	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	100	–	–	100	60
U	b/3	*P. flexuosum* MAXON	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–
U	f	*P. funiculum* FÉE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–
P	g	*P. gladiatum* KUNTZE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–
U	p	*P. heterophyllum* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
P	p	*P. loriceum* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
U	r	*P. lycopodioides* L.	–	–	–	–	–	–	–	–	50	–	–	–	–	–	90	–	–	–	40	60
U	p	*P. phyllitidis* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	40	50	–	–	–	80	30
U	p	*P. piloselloides* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	60	60	–	–	–	80	90
U	p	*P. polypodioides* (L.) WATT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	p	*P. plumula* H. & B. ex WILLD.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	g	*P. Shaferi* MAXON	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–
U	a/6	*P. turquinum* MAXON	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P	g	*P. vexatum* EAT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	p	*Polystachya extinctoria* RCHB. F. in WALP.	–	–	–	–	–	–	–	–	–	–	–	40	–	40	70	–	–	–	–	–
Q	p	*Pontederia lanceolata* NUTT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P	h	*Ponthieva petiolata* LINDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–
P	p	*P. racemosa* (WALT.) MOHR	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
E/3	f	*Portlandia daphnoides* GRAHAM	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*Portulaca pilosa* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5!	f	*Pouteria aristata* (BRITT. & WILS.) BAEHNI	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/4	l	*P. domingensis* (GAERTN. F.) BAEHNI	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Lf	Ge	No. of communities / Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
O	b/1	*P. squamifolia* WR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R	b/1	*P. uncinata* WR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	e	*P. Wrightii* CHOD.	–	–	–	–	–	–	–	–	–	–	–	40	60	60	–	–	–	40	–	–
P	p	*Polypodium angustifolium* SW.	60	–	–	40	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–
U	p	*P. astrolepis* LIEBM.	–	100	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P	p	*P. aureum* L.	40	–	–	–	40	40	80	–	–	–	–	40	–	–	–	–	–	–	–	–
P	p	*P. chnoodes* SPRENG.	–	40	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P	n	*P. costatum* KUNTZE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	r	*P. duale* MAXON	–	100	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	b/3	*P. flexuosum* MAXON	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	f	*P. funiculum* FÉE	40	–	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P	g	*P. gladiatum* KUNTZE	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	p	*P. heterophyllum* L.	40	–	–	–	80	40	100	40	40	40	–	–	–	–	–	–	–	40	–	–
P	p	*P. loriceum* L.	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	r	*P. lycopodioides* L.	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	p	*P. phyllitidis* L.	100	40	–	80	60	40	–	–	–	–	–	–	–	–	–	40	–	–	–	–
U	p	*P. piloselloides* L.	100	100	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	p	*P. polypodioides* (L.) WATT.	–	–	–	60	80	–	40	40	–	–	–	–	–	–	–	60	–	40	–	–
U	p	*P. plumula* H. & B. ex WILLD.	80	–	–	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	g	*P. Shaferi* MAXON	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	a/6	*P. turquinum* MAXON	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	
P	g	*P. vexatum* EAT.	–	–	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	p	*Polystachya extinctoria* RCHB. F. in WALP.	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	40	–	–	–	–
Q	p	*Pontederia lanceolata* NUTT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–
P	h	*Ponthieva petiolata* LINDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P	p	*P. racemosa* (WALT.) MOHR	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/3	f	*Portlandia daphnoides* GRAHAM	–	–	–	40	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*Portulaca pilosa* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	30
C/5!	f	*Pouteria aristata* (BRITT. & WILS.) BAEHNI	–	–	–	–	–	–	–	40	–	60	–	–	–	–	–	–	–	40	–	–
C/4	l	*P. domingensis* (GAERTN. F.) BAEHNI	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	60	100	–	–

Table 25 Continued 54

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
P	p	*Prescottia stachyoides* (SW.) LINDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	70
D/5	o	*Prockia crucis* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Q	s	*Proserpinaca palustris* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/4	b/2	*Protium fragrans* (ROSE) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	40	50	40	40	–	–	–
B/5	f	*Prunus myrtifolia* (L.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/3	l	*P. occidentalis* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–	40	–
B/3	b/1	*Pseudobombax ellipticum* (HBK.) DUGAND.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5!	b/3	*Pseudocarpidium avicennioides* (A. RICH.) MILLSP.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5!	b/4	*P. multidens* (URB.) MOLD.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5!	j	*P. Wrightii MILLSP.*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/4	*l*	*Pseudolmedia spuria* (SW.) GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/3	*Psidium cymosum* URB.	–	–	–	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/4	p	*P. guajava* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	f	*P. parvifolium* GRISEB.	–	–	–	–	–	–	–	–	40	40	30	40	100	–	–	–	40	100	40	–
D/5	b/1	*P. salutare* (HBK.) BERG	–	–	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	a/9	*P. vicentinum* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	r	*Psilotum nudum* (L.) GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	h	*Psychotria Brownei* SPRENG.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–
D/4	f	*P. Clementis* BRITT.	–	–	–	–	–	–	–	–	–	–	–	30	–	–	40	–	–	–	40	–
D/5	g	*P. ebracteata* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6	b/2	*P. graminifolia* URB.	–	–	–	–	–	–	–	–	30	–	60	–	–	–	30	–	–	–	–	–
C/3	l	*P. grandis* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–
E/4	h	*P. horizontalis* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	b/2	*P. Lopezii* ACUÑA & ROIG	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–
D/4	a/7	*P. Martii* ACUÑA & ROIG	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/5	*P. Moralesii* BRITT & WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	80	–	–	–	–
E/4	n	*P. nervosa* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	h	*P. nutans* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/4	p	*P. patens* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–
I	h	*P. pendula* JACQ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	40

Lf	Ge	No. of communities / Number of relevés:	21 5	22 5	23 5	24 5	25 5	26 5	27 5	28 5	29 5	30 5	31 5	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 10	40 10
P	p	*Prescottia stachyoides* (SW.) LINDL.	60	60	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	o	*Prockia crucis* L.	–	–	–	–	–	–	100	–	60	40	–	–	–	–	40	–	–	–	–	–
Q	s	*Proserpinaca palustris* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	80	–	–	–	–
B/4	b/2	*Protium fragrans* (ROSE) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/5	f	*Prunus myrtifolia* (L.) URB.	–	–	–	–	–	–	–	–	–	60	–	–	–	–	–	–	–	–	–	–
B/3	l	*P. occidentalis* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/3	b/1	*Pseudobombax ellipticum* (HBK.) DUGAND.	–	–	–	–	–	–	–	80	–	–	–	–	–	–	–	–	–	–	–	–
D/5!	b/3	*Pseudocarpidium avicennioides* (A. RICH.) MILLSP.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	100
D/5!	b/4	*P. multidens* (URB.) MOLD.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	100
C/5!	j	*P. Wrightii* MILLSP.	–	–	–	–	–	–	–	–	40	60	100	100	60	80	–	–	–	60	60	–
B/4	l	*Pseudolmedia spuria* (SW.) GRISEB.	–	–	–	60	–	–	–	40	–	100	–	–	–	–	40	–	–	–	–	–
E/5	a/3	*Psidium cymosum* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/4	p	*P. guajava* L.	5–	–	–	–	–	–	40	–	40	60	–	40	40	–	40	–	40	–	–	–
D/5	f	*P. parvifolium* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	40	40	40	–	–	–	–	–	–
D/5	b/1	*P. salutare* (HBK.) BERG	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–	–
E/6	a/9	*P. vicentinum* URB.	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	r	*Psilotum nudum* (L.) GRISEB.	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–
D/4	h	*Psychotria Brownei* SPRENG.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	f	*P. Clementis* BRITT.	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	g	*P. ebracteata* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–	–
D/6	b/2	*P. graminifolia* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/3	l	*P. grandis* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/4	h	*P. horizontalis* SW.	–	–	–	–	40	–	–	–	40	–	–	–	–	–	100	40	–	–	–	–
D/5	b/2	*P. Lopezii* ACUÑA & ROIG	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	a/7	*P. Martii* ACUÑA & ROIG	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/5	*P. Moralesii* BRITT & WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/4	n	*P. nervosa* SW.	–	–	–	–	40	–	–	40	100	40	–	–	–	–	–	–	40	60	–	–
D/5	h	*P. nutans* SW.	–	–	–	60	100	40	40	40	40	60	–	40	–	–	40	40	–	40	–	–
E/4	p	*P. patens* SW.	40	–	–	–	–	–	–	40	60	60	–	–	–	–	–	–	–	–	–	–
I	h	*P. pendula* JACQ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 25 Continued 55

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
D/5	g	*P. revoluta* DC.	36	—	—	40	60	30	—	—	40	40	80	—	40	—	40	—	—	60	—	50
D/5	b/2	*P. rufovaginata* SW.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	80	—	—
D/5	b/2	*P. thelophora* URB.	—	—	—	—	—	—	—	—	—	—	—	40	60	—	—	60	—	40	—	—
E/3	b/2	*P. Van-Hermannii* ACUÑA & ROIG	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—	—	—	60	—
O	p	*Pteridium caudatum* (L.) MAXON	—	—	40	60	40	100	100	90	100	100	90	90	100	40	60	—	—	40	—	—
V	b/3	*Pteris Clementis* MORTON	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
V	p	*P. grandifolia* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
V	u	*P. longifolia* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	o	*Pterocaulon alopecuroideum* (LAM.) DC.	—	—	—	—	—	—	36	30	—	—	—	—	—	—	—	—	40	40	—	—
D/5	b/1	*Purdiaea cubensis* (A. RICH.) PLANCH.	—	30	40	100	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/4	b/2	*P. moaensis* M. VICT.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	70	—	—	—	—	—
E/5	b/2	*P. nipensis* M. VICT & LEÓN	—	—	—	—	—	—	—	—	40	—	—	—	—	—	—	—	40	60	—	—
E/5	a/4	*P. parvifolia* (M. VICT.) THOMAS	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—
E/4	b/3	*P. stenopetala* GRISEB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	80	—	—	—
D/4	b/2	*P. velutina* BRITT. & WILS.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	80	—	—	—
B/5	a/2	*Quercus oleoides* CHAM. & SCHLTD. ssp. *Sagraeana* (C. H. MUELL.) BHIDI.	—	—	80	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
T	g	*Rajania angustifolia* SW.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
T	b/2	*R. baracoensis* KNUTH	—	—	—	—	—	30	81	—	—	60	60	40	60	60	60	80	40	40	—	—
T	c	*R. Ekmanii* KNUTH	—	—	—	40	60	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
T	a/4	*R. Howardii* ALAIN	—	—	—	—	—	60	—	—	—	60	—	—	—	—	—	—	—	—	—	—
T	a/4	*R. nipensis* HOWARD	—	—	—	—	—	—	—	—	50	—	—	—	—	—	—	—	—	60	—	—
T	b/2	*R. tenuiflora* KNUTH	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—
T	f	*R. Wrightii* ULINE ex KNUTH	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/6!	n	*Randia aculeata* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/7!	f	*R. spinifex* (R. & S.) STANDL.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	c	*Rauvolfia cubana* A. DC.	—	—	40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C/4	h	*R. nitida* JACQ.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	b/2	*R. salicifolia* GRISEB.	—	—	—	—	—	—	—	—	—	—	60	40	80	—	40	100	40	60	—	—
E/5	n	*R. tetraphylla* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Lf	Ge	No. of communities Number of relevés:	21 5	22 5	23 5	24 5	25 5	26 5	27 5	28 5	29 5	30 5	31 5	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 10	40 10
D/5	g	*P. revoluta* DC.	–	–	–	–	–	–	–	–	–	–	80	40	40	100	40	–	–	40	–	–
D/5	b/2	*P. rufovaginata* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	b/2	*P. thelophora* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/3	b/2	*P. Van-Hermannii* ACUÑA & ROIG	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*Pteridium caudatum* (L.) MAXON	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–	–
V	b/3	*Pteris Clementis* MORTON	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	p	*P. grandifolia* L.	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–
V	u	*P. longifolia* L.	–	–	–	–	–	–	–	40	40	–	–	–	–	–	–	–	–	–	–	–
O	o	*Pterocaulon alopecuroideum* (LAM.) DC.	–	–	–	–	–	–	–	–	–	–	–	40	40	40	–	–	–	–	–	–
D/5	b/1	*Purdiaea cubensis* (A. RICH.) PLANCH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	b/2	*P. moaensis* M. VICT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/2	*P. nipensis* M. VICT & LEÓN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/4	*P. parvifolia* (M. VICT.) THOMAS	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/4	b/3	*P. stenopetala* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	b/2	*P. velutina* BRITT. & WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/5	a/2	*Quercus oleoides* CHAM. & SCHLTD. ssp. *Sagraeana* (C. H. MUELL.) BHIDI.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–	–	–	–	–
T	g	*Rajania angustifolia* SW.	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–
T	b/2	*R. baracoensis* KNUTH	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	c	*R. Ekmanii* KNUTH	–	–	–	–	–	80	–	–	–	–	–	–	–	–	40	–	–	–	–	–
T	a/4	*R. Howardii* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	a/4	*R. nipensis* HOWARD	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	b/2	*R. tenuiflora* KNUTH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	f	*R. Wrightii* ULINE ex KNUTH	–	–	–	–	–	–	100	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6!	n	*Randia aculeata* L.	–	–	–	–	–	–	–	100	60	40	40	40	40	80	40	–	–	40	100	40
D/7!	f	*R. spinifex* (R. & S.) STANDL.	–	–	–	–	80	–	–	–	–	–	100	60	100	100	–	–	–	40	100	100
D/5	c	*Rauvolfia cubana* A. DC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–
C/4	h	*R. nitida* JACQ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	40	–	–
D/5	b/2	*R. salicifolia* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	n	*R. tetraphylla* L.	–	–	–	–	–	–	–	40	40	40	–	–	–	–	40	–	60	60	–	–

Table 25 Continued 56

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
D/5	b/2	*Ravenia Ekmanii* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–
D/5	g	*R. spectabilis* (LINDL.) PLANCH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	m	*Reichenbachianthus emarginatus* GARAY	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–
E/6	a/12	*Reynosia camagüeyensis* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/7!	f	*R. mucronata* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/7!	a/14	*R. m.* ssp. *azulensis* BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/7	*Rhamnidium potrerilloanum* BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5!	c	*Rheedia brevipes* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6!	f	*R. fruticosa* WR.	–	–	–	–	60	–	–	–	–	–	70	–	–	–	–	–	40	60	–	–
E/6!	a/5	*R. polyneura* URB.	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	60	–	–	–	–
D/5!	b/2	*R. revoluta* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	60	–	–	–
E/6!	e	*R. ruscifolia* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	60	–	–
U	p	*Rhipidopteris peltata* (SW.) SCHOTT	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	100	40
X	p	*Rhipsalis cassutha* GAERT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	k	*Rhus Copallina* L. var. *leucantha* DC.	–	–	60	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	x	*Rhynchelitrum roseum* (NEES) STAPF & HUBB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	a/4	*Rhynchosia nipensis* URB.	–	–	–	–	–	80	–	–	–	40	–	–	–	–	–	–	–	–	–	–
O	g	*Rhynchospora aristata* BOECKL. var. *brevifolia* KÜK.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50
O	a/5	*R. Bucherorum* LEÓN	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–	–	–	–	–	–
O	c	*R. cephalotoides* (L.) VAHL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	b/2	*R. cernua* GRISEB.	–	–	–	–	–	100	–	80	30	100	90	40	80	–	–	60	80	60	–	–
O	g	*R. cubensis* A. RICH.	–	–	–	40	40	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–
O	r	*R. cyperoides* (SW.) MART.	–	–	40	–	–	–	–	–	–	–	–	–	60	–	–	–	–	–	–	–
O	c	*R. diodon* (NEES) BOECKL.	–	–	100	40	–	90	–	80	100	40	100	40	40	–	40	–	40	30	–	–
O	h	*R. elongata* BOECKL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100
O	p	*R. globosa* (HBK.) R. & S.	90	60	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	i	*R. Lindeniana* GRISEB. var. *bahamensis* (BRITT.) GALE	–	–	–	–	–	40	–	50	–	–	40	50	80	–	–	–	60	40	–	–
O	g	*R. marisculus* NEES	–	–	–	–	–	–	–	–	–	–	40	60	–	100	–	–	40	60	–	–

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
D/5	b/2	*Ravenia Ekmanii* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	g	*R. spectabilis* (LINDL.) PLANCH.	—	—	—	—	—	—	—	—	—	60	—	—	—	—	—	—	—	40	—	—
U	m	*Reichenbachianthus emarginatus* GARAY	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/6	a/12	*Reynosia camagüeyensis* BRITT.	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—	—	—	—	—	—
D/7!	f	*R. mucronata* GRISEB.	—	—	—	—	—	—	—	—	—	40	—	—	—	—	—	—	40	60	—	—
D/7!	a/14	*R. m.* ssp. *azulensis* BHIDI. & MZ.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	50
E/5	a/7	*Rhamnidium potrerilloanum* BHIDI. & MZ.	40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5!	c	*Rheedia brevipes* BRITT.	—	—	—	—	—	—	—	—	—	—	40	—	—	—	—	—	—	—	—	—
D/6!	f	*R. fruticosa* WR.	—	—	—	—	—	—	—	—	—	—	80	60	60	80	—	—	—	—	—	—
E/6!	a/5	*R. polyneura* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5!	b/2	*R. revoluta* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/6!	e	*R. ruscifolia* GRISEB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
U	p	*Rhipidopteris peltata* (SW.) SCHOTT	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
X	p	*Rhipsalis cassutha* GAERT.	—	—	—	—	40	60	80	—	—	—	—	—	—	—	40	—	—	—	—	—
D/5	k	*Rhus Copallina* L. var. *leucantha* DC.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—	—	—	—
O	x	*Rhynchelitrum roseum* (NEES) STAPF & HUBB.	—	—	—	—	—	—	—	—	—	—	80	60	60	40	40	—	—	—	—	—
T	a/4	*Rhynchosia nipensis* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	g	*Rhynchospora aristata* BOECKL. var. *brevifolia* KÜK.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	a/5	*R. Bucherorum* LEÓN	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	c	*R. cephalotoides* (L.) VAHL	—	—	—	—	—	—	—	—	—	—	—	—	—	—	60	—	—	—	—	—
O	b/2	*R. cernua* GRISEB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	g	*R. cubensis* A. RICH.	—	—	—	—	—	—	—	—	—	—	60	—	—	—	80	—	—	—	—	—
O	r	*R. cyperoides* (SW.) MART.	—	—	—	—	—	—	—	—	—	—	—	—	60	40	60	40	—	60	—	—
O	c	*R. diodon* (NEES) BOECKL.	—	—	—	—	—	—	—	—	—	—	40	60	40	40	40	—	—	—	—	—
O	h	*R. elongata* BOECKL.	80	80	40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	p	*R. globosa* (HBK.) R. & S.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	60	—	—	—	—	—
O	i	*R. Lindeniana* GRISEB. var. *bahamensis* (BRITT.) GALE	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	g	*R. marisculus* NEES	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Table 25 Continued 57

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
O	k	*R. miliacea* (LAM.) GRAY	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	a/4	*R. nipensis* BRITT.	—	—	—	—	—	80	—	40	—	—	—	—	—	—	—	—	—	60	—	—
O	b/2	*R. pruinosa* GRISEB.	—	—	—	—	—	30	—	—	40	40	30	30	100	—	100	100	100	40	—	—
O	b/2	*R. Shaferi* BRITT.	—	—	—	—	—	—	—	40	—	—	—	40	60	—	—	100	100	60	—	—
O	l	*R. stellata* (LAM.) GRISEB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	p	*R. tenuis* LINK	—	—	—	100	100	100	—	100	80	100	90	80	40	—	—	—	60	100	—	—
Q	e	*R. triflora* VAHL	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/4	a/14	*Rhytidophyllum Acunae* MORTON	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/5	b/3	*R. intermedium* URB. & EKM.	—	—	—	—	—	—	—	—	—	—	—	40	—	—	—	—	—	—	—	—
E/3	a/8	*R. mogoticola* BHIDI. & MZ.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/4	a/9	*R. rupincola* (URB.) MORTON	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/3	b/3	*R. villosulum* (URB.) MORTON	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	60	—
O	f	*Richardia muricata* (GRISEB.) ROBINS.	—	40	40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/7!	h	*Rochefortia acanthophora* (DC.) GRISEB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/7!	f	*R. cubensis* BRITT. & WILS.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5!	a/14	*R. oblongata* URB. & EKM.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/6!	a/14	*R. stellata* BRITT. & WILS.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/6	a/14	*Rondeletia baracoensis* BRITT.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/4	g	*R. brachycarpa* (GRISEB.) WR. ex SAUV.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/5	a/12	*R. camagüeyensis* STANDL.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/6	f	*R. camarioca* WR. ex SAUV.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/4	b/2	*R. canellaefolia* BRITT.	—	—	—	—	—	—	—	—	40	—	—	—	—	—	—	—	—	40	—	—
D/5	c	*R. correifolia* GRISEB.	27	90	100	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/6	a/13	*R. holguinensis* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/7	b/3	*R. hypoleuca* GRISEB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/7	b/3	*R. ingrata* STANDL.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/4	a/6	*R. intermixta* BRITT.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	a/3	*Rondeletia Lindeniana* A. RICH.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/6	a/3	*R. longibracteata* ALAIN	—	—	—	40	60	—	—	—	—	—	—	—	—	—	—	—	—	—	100	—
E/6	a/9	*R. microphylla* GRISEB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/5	a/5	*R. moaensis* ALAIN	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—	—	—

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
O	k	*R. miliacea* (LAM.) GRAY	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	80	–	–	–	–
O	a/4	*R. nipensis* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	b/2	*R. pruinosa* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	b/2	*R. Shaferi* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	l	*R. stellata* (LAM.) GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–	–	–	–
O	p	*R. tenuis* LINK	–	–	–	–	–	–	–	–	–	–	100	100	60	100	40	–	–	–	–	–
Q	e	*R. triflora* VAHL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–
E/4	a/14	*Rhytidophyllum Acunae* MORTON	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
E/5	b/3	*R. intermedium* URB. & EKM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–
E/3	a/8	*R. mogoticola* BHIDI. & MZ.	–	–	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/4	a/9	*R. rupincola* (URB.) MORTON	–	–	–	–	–	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/3	b/3	*R. villosulum* (URB.) MORTON	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	f	*Richardia muricata* (GRISEB.) ROBINS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/7!	h	*Rochefortia acanthophora* (DC.) GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–
E/7!	f	*R. cubensis* BRITT. & WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
D/5!	a/14	*R. oblongata* URB. & EKM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50	–
D/6!	a/14	*R. stellata* BRITT. & WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	70
D/6	a/14	*Rondeletia baracoensis* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
D/4	g	*R. brachycarpa* (GRISEB.) WR. ex SAUV.	–	–	–	–	–	–	40	–	–	–	100	–	–	–	–	–	–	–	–	–
E/5	a/12	*R. camagüeyensis* STANDL.	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–
E/6	f	*R. camarioca* WR. ex SAUV.	–	–	–	–	–	–	–	–	–	–	60	100	40	–	–	–	–	–	–	–
D/4	b/2	*R. canellaefolia* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	c	*R. correifolia* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–
E/6	a/13	*R. holguinensis* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–
E/7	b/3	*R. hypoleuca* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
D/7	b/3	*R. ingrata* STANDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60
D/4	a/6	*R. intermixta* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	a/3	*Rondeletia Lindeniana* A. RICH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	a/3	*R. longibracteata* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	a/9	*R. microphylla* GRISEB.	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/5	*R. moaensis* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 25 Continued 58

Lf	Ge	No. of communities Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
D/5	b/2	*R. myrtacea* STANDL.	—	—	—	—	—	40	—	—	50	—	—	30	40	—	—	—	—	40	—	—
E/6	a/12	*R. nova*	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/5	c	*R. odorata* JACQ.	—	—	60	40	40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/5	b/3	*R. pachyphylla* KRUG & URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	100	—	—	40	40	—	—
E/7	b/2	*R. plicatula* URB.	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—	—	60	—	—	—
E/6	a/13	*R. Shaferi* URB. & BRITT.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/4	b/2	*R. stellata* (GRISEB.) WR. ex SAUV.	—	—	—	—	—	—	—	—	—	—	—	—	100	—	—	40	100	—	—	—
E/6	a/5	*R. Vazquezi* BHIDI. & MZ.	—	—	—	—	—	—	—	—	—	—	40	30	—	—	60	—	—	—	—	—
E/6	f	*R. venosa* WR. ex GRISEB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—	—
J	p	*Rourea glabra* HBK.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
G	k	*Roystonea regia* (HBK.) COOK.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—
E/5!	a/6	*Rubus turquinensis* RYOB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
G	f	*Sabal Japa* WR.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
G	f	*S. parviflora* BECC.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	g	*Sachsia polycephala* GRISEB.	36	90	40	80	100	30	—	40	40	—	60	—	—	—	—	—	—	—	—	—
Q	n	*Sagittaria lancifolia* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
B/4	c	*Salix caroliniana* MICHX.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	b/2	*Salvia cubensis* BRITT.	—	—	—	—	—	—	—	—	30	—	—	—	—	—	—	—	—	60	—	—
R	p	*S. riparia* KUNTH	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/4	b/3	*S. speirematoides* WR. ex SAUV.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	60
B/5	x	*Samanea Saman* (JACQ.) BENTH.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	f	*Samyda macrantha* P. WILS.	—	—	—	—	—	—	54	30	40	—	—	—	—	—	—	—	—	40	—	—
E/6	b/3	*S. minutifolia* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/5	b/3	*Sapium erythrospermum* (GRISEB.) MUELL.-ARG.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	60
D/5	c	*S. leucogynum* WR. ex GRISEB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
B/3	g	*S. jamaicense* SW.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/5	a/6	*S. maestrense* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
V	g	*Sauvagesia Brownei* (SW.) BRIQ.	54	—	40	—	—	50	72	—	—	—	—	—	60	—	—	—	—	—	—	—
E/7	a/6	*Satureja Bucheri* (P. WILS.) URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/6	a/3	*Sauvallella immarginata* (WR.) RYDB.	—	—	—	40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
D/5	b/2	*R. myrtacea* STANDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	a/12	*R. nova*	–	–	–	–	–	–	–	–	–	–	–	–	80	–	–	–	–	–	–	–
E/5	c	*R. odorata* JACQ.	–	–	–	–	–	60	80	–	–	–	100	60	–	–	80	–	–	–	–	–
E/5	b/3	*R. pachyphylla* KRUG & URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/7	b/2	*R. plicatula* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	a/13	*R. Shaferi* URB. & BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–
D/4	b/2	*R. stellata* (GRISEB.) WR. ex SAUV.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	a/5	*R. Vazquezi* BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	f	*R. venosa* WR. ex GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	p	*Rourea glabra* HBK.	–	–	–	60	–	–	–	80	–	–	–	–	–	–	–	–	–	–	–	–
G	k	*Roystonea regia* (HBK.) COOK.	–	–	–	100	40	40	40	100	100	100	40	–	–	–	–	60	–	–	–	–
E/5!	a/6	*Rubus turquinensis* RYOB.	–	80	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
G	f	*Sabal Japa* WR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–
G	f	*S. parviflora* BECC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–	100	–	–
O	g	*Sachsia polycephala* GRISEB.	–	–	–	–	–	–	–	–	–	–	100	100	100	60	40	–	–	–	–	–
Q	n	*Sagittaria lancifolia* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–
B/4	c	*Salix caroliniana* MICHX.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	40	–	–
D/5	b/2	*Salvia cubensis* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R	p	*S. riparia* KUNTH	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–
D/4	b/3	*S. speirematoides* WR. ex SAUV.	–	80	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/5	x	*Samanea Saman* (JACQ.) BENTH.	–	–	–	–	–	–	–	–	–	80	–	–	–	–	–	–	–	–	–	–
D/5	f	*Samyda macrantha* P. WILS.	–	–	–	–	–	–	–	–	–	–	–	60	40	60	40	–	–	–	–	–
E/6	b/3	*S. minutifolia* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
E/5	b/3	*Sapium erythrospermum* (GRISEB.) MUELL.-ARG.	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	c	*S. leucogynum* WR. ex GRISEB.	–	–	–	–	–	40	60	–	–	–	–	–	–	–	–	–	–	–	–	–
B/3	g	*S. jamaicense* SW.	–	–	–	60	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–
E/5	a/6	*S. maestrense* URB.	–	80	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	g	*Sauvagesia Brownei* (SW.) BRIQ.	–	–	–	–	–	–	–	–	–	–	–	40	40	40	40	–	–	–	–	–
E/7	a/6	*Satureja Bucheri* (P. WILS.) URB.	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	a/3	*Sauvallella immarginata* (WR.) RYDB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 25 Continued 59

Lf	Ge	No. of communities Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
E/5	k	*Savia bahamensis* BRITT.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/5	f	*S. clusiifolia* GRISEB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	g	*S. erythroxyloides* GRISEB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C/5	h	*S. sessiliflora* (SW.) WILLD.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/5	b/2	*Scaevola Wrightii* (GRISEB.) MAZA	—	—	—	—	—	—	—	—	—	40	90	—	—	40	—	—	—	—	—	—
E/8	g	*Schaefferia ephedroides* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	k	*S. frutescens* JACQ.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
P	p	*Schizaea Poeppigiana* STURM	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	60	—	—	—	—
D/5	b/2	*Schmidtottia elliptica* (BRITT.) URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—	—
E/5	b/2	*S. involucrata* (VERH.) ALAIN	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	100	—	—	—
E/5	a/5	*S. multiflora* URB.	—	—	—	—	—	—	—	—	—	—	—	30	—	—	—	—	—	—	—	—
E/5	b/2	*S. sessiliflora* (BRITT.) URB. ssp. *Shaferi* (STANDL.) BHIDI.	—	—	—	—	—	—	—	—	—	—	—	100	—	—	40	—	—	—	—	—
C/5	k	*Schoepfia chrysophylloides* (A. RICH.) PLANCH.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	a/5	*S. cubensis* BRITT. & WILS.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	60	—	—	—	—
D/6	a/6	*S. stenophylla* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
J	o	*Schradera cephalocarpa* GRISEB.	—	—	—	—	—	—	—	—	—	—	—	—	—	100	60	100	—	—	100	—
J	a/6	*S. cubensis* STEYERM.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
R	p	*Schultesia guianensis* (AUBL.) MALME	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	k	*Scleria ciliata* MICHX.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	h	*S. cubensis* BOECKL.	—	—	—	40	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—
O	k	*S. Georgiana* CORE	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—
O	r	*S. lithosperma* (L.) SW.	—	—	—	40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	p	*S. melaleuca* CHAM. & SCHLTD.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
J	b/2	*S. pilosissima* BRITT.	—	—	—	—	—	50	—	—	50	—	—	40	40	100	70	—	—	60	80	—
O	h	*Scleria scindens* NEES	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40
J	p	*S. secans* (L.) URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	30	—	—	—	60	30
O	p	*S. verticillata* MUHL.	36	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/7!	b	*Scolosanthus maisianus* BHIDI.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/6!	a/6	*S. maestrensis* ALAIN	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40
D/6!	b/3	*S. lucidus* BRITT.	—	—	—	—	—	—	—	—	—	—	30	30	—	—	—	60	60	—	—	—

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
E/5	k	*Savia bahamensis* BRITT.	–	–	–	–	40	40	–	80	100	40	–	–	–	–	40	–	–	100	40	30
E/5	f	*S. clusiifolia* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	70	30
D/5	g	*S. erythroxyloides* GRISEB.	–	–	–	–	100	40	–	–	40	–	–	–	–	–	–	–	–	40	40	30
C/5	h	*S. sessiliflora* (SW.) WILLD.	–	–	–	–	60	60	100	100	100	100	–	–	–	–	–	–	–	–	–	–
E/5	b/2	*Scaevola Wrightii* (GRISEB.) MAZA	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/8	g	*Schaefferia ephedroides* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
D/5	k	*S. frutescens* JACQ.	–	–	–	40	80	60	100	–	60	–	–	–	–	–	40	–	–	–	30	30
P	p	*Schizaea Poeppigiana* STURM	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	b/2	*Schmidtottia elliptica* (BRITT.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/2	*S. involucrata* (VERH.) ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/5	*S. multiflora* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/2	*S. sessiliflora* (BRITT.) URB. ssp. *Shaferi* (STANDL.) BHIDI.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	k	*Schoepfia chrysophylloides* (A. RICH.) PLANCH.	–	–	–	40	60	40	–	60	100	40	–	–	–	–	40	–	–	80	30	–
D/5	a/5	*S. cubensis* BRITT. & WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6	a/6	*S. stenophylla* URB.	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	o	*Schradera cephalocarpa* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	a/6	*S. cubensis* STEYERM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R	p	*Schultesia guianensis* (AUBL.) MALME	–	–	–	–	–	–	–	–	–	–	–	60	40	40	–	–	–	–	–	–
O	k	*Scleria ciliata* MICHX.	–	–	–	–	–	–	–	–	–	–	–	40	40	–	–	–	–	–	–	–
O	h	*S. cubensis* BOECKL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	k	*S. Georgiana* CORE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	r	*S. lithosperma* (L.) SW.	40	–	–	–	–	–	40	–	–	–	100	60	40	40	40	–	–	–	50	30
O	p	*S. melaleuca* CHAM. & SCHLTD.	–	–	–	–	–	–	–	–	–	–	60	–	–	40	40	–	–	–	–	–
J	b/2	*S. pilosissima* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	h	*Scleria scindens* NEES	40	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	p	*S. secans* (L.) URB.	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*S. verticillata* MUHL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/7!	j	*Scolosanthus maisianus* BHIDI.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50
E/6!	a/6	*S. maestrensis* ALAIN	–	80	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6!	b/3	*S. lucidus* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 25 Continued 60

Lf	Ge	No. of communities Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
D/7!	b/3	*S. hirsutus* BHIDI.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R	p	*Scoparia dulcis* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	k	*Scutellaria havanensis* JACQ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R	o	*Sebastiania corniculata* (VAHL) PAX	–	–	40	–	–	–	36	–	–	–	–	–	–	–	–	–	–	40	–	–
J	f	*Securidaca elliptica* TURCZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	40	50	–	–	–	–	–
J	g	*S. virgata* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/7!	i	*Securinega Acidoton* (L.) FAWC. & RENDLE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	h	*Selaginella albonitens* SPRENG.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–
V	g	*S. confusa* SPRING.	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–	–	40
V	g	*S. cordifolia* (DESV.) SPRING.	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	60	30
V	g	*S. serpens* SPRENG.	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	40
V	g	*S. stolonifera* (SW.) SPRENG.	–	–	40	40	–	50	–	–	40	–	30	40	40	–	–	–	40	40	–	80
K/8!	g	*Selenicereus grandiflorus* (L.) BRITT. & ROSE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
K/8!	g	*S. Urbanianus* (GURKE & WEING.) BRITT. & ROSE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–
E/4	a/5	*Senecio biseriatus* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–
E/5	a/5	*S. cubensis* GREENM.	–	–	–	–	–	–	–	–	–	–	–	30	40	–	–	–	–	–	–	–
V	b/2	*S. leucolepis* GREENM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–	–	–
E/5	a/5	*S. moaensis* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–
E/4	a/5	*S. pachypodus* GREENM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–
D/3	g	*S. plumbeus* GREENM.	–	–	–	–	–	30	–	–	40	40	40	60	40	40	30	40	40	40	–	–
D/3	b/2	*S. polyphlebius* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–	–	–	–	–	–
D/3	b/2	*S. rivalis* GREENM.	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–	–	–	–	–	–
E/5	b/2	*S. subsquarrosus* GREENM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	80	–	–
E/5	b/2	*S. trichotomus* GREENM.	–	–	–	–	–	–	–	–	–	–	80	–	–	–	–	–	–	60	–	–
J	g	*S. trineurus* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	b/3	*Serjania crassinervis* RADLK.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	m	*S. diversifolia* (JACQ.) RADLK.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–
J	a/4	*S. nipensis* URB.	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	40	–	–
H	j	*Setaria distantiflora* (A. RICH.) PILGER	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
D/7!	b/3	*S. hirsutus* BHIDI.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–
R	p	*Scoparia dulcis* L.	–	–	–	–	–	–	–	–	–	–	40	40	40	40	40	40	–	–	–	–
O	k	*Scutellaria havanensis* JACQ.	–	–	–	–	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–
R	o	*Sebastiania corniculata* (VAHL) PAX	–	–	–	–	–	–	–	–	–	–	–	40	60	40	40	–	–	–	–	–
J	f	*Securidaca elliptica* TURCZ.	–	–	–	40	–	–	40	80	40	–	–	–	–	–	–	–	–	100	–	–
J	g	*S. virgata* SW.	–	–	–	–	40	80	–	–	–	–	–	40	40	40	40	–	–	–	–	–
E/7!	i	*Securinega Acidoton* (L.) FAWC. & RENDLE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	40	40
V	h	*Selaginella albonitens* SPRENG.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	g	*S. confusa* SPRING.	–	80	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	g	*S. cordifolia* (DESV.) SPRING.	–	100	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	g	*S. serpens* SPRENG.	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	g	*S. stolonifera* (SW.) SPRENG.	60	–	–	40	–	–	60	–	–	–	100	40	40	40	60	40	–	–	–	–
K/8!	g	*Selenicereus grandiflorus* (L.) BRITT. & ROSE	–	–	–	–	–	60	40	–	–	40	–	–	–	–	40	–	40	100	30	30
K/8!	g	*S. Urbanianus* (GURKE & WEING.) BRITT. & ROSE	–	–	–	–	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/4	a/5	*Senecio biseriatus* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/5	*S. cubensis* GREENM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	b/2	*S. leucolepis* GREENM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/5	*S. moaensis* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/4	a/5	*S. pachypodus* GREENM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/3	g	*S. plumbeus* GREENM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/3	b/2	*S. polyphlebius* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/3	b/2	*S. rivalis* GREENM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/2	*S. subsquarrosus* GREENM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/2	*S. trichotomus* GREENM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	g	*S. trineurus* GRISEB.	–	–	–	–	–	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–
J	b/3	*Serjania crassinervis* RADLK.	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	60	30
J	m	*S. diversifolia* (JACQ.) RADLK.	40	–	–	–	80	40	100	80	60	40	100	40	40	40	40	–	40	100	–	–
J	a/4	*S. nipensis* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
H	j	*Setaria distantiflora* (A. RICH.) PILGER	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	30

Table 25 Continued 61

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
R	p	*S. geniculata* (LAM.) BEAUV.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*S. setosa* (SW.) BEAUV.	–	–	–	30	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*S. tenax* (L. C. RICH.) DESV.	–	–	–	–	–	–	36	–	–	40	–	–	–	–	–	–	–	–	–	–
E/3	a/5	*Shafera platyphylla* GREENM.	–	–	–	–	–	–	–	–	–	–	–	70	–	–	30	–	–	–	–	–
E/5	a/5	*Shaferocharis multiflora* BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–
R	m	*Sida acuminata* DC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	r	*S. cordifolia* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	n	*S. jamaicensis* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	r	*S. linifolia* CAV.	+5	30	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/9	*Siemensia pendula* (WR. ex GRISEB.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	l	*Simaruba glauca* DC. var. *latifolia* CRONQ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/3	f	*S. laevis* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	a/5	*Siphocampylus glaber* MCVAUGH	–	–	–	–	–	–	–	–	30	–	–	–	–	–	–	–	–	40	–	–
V	a/5	*S. subglaber* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–
V	b/3	*S. undulatus* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/3	b/3	*Sloanea curatellifolia* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	–	–	–	80	–
J	g	*Smilax Balbisiana* KUNTH	–	–	–	–	–	40	–	–	40	–	30	30	–	–	–	–	–	60	–	–
J!	k	*S. havanensis* JACQ.	–	–	40	30	40	70	90	40	50	80	30	30	–	–	–	–	–	40	–	–
J	l	*S. lanceolata* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	40	–	100	40
J	k	*S. laurifolia* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	g	*S. populnea* KUNTH	–	–	–	–	–	–	–	–	–	–	–	30	60	–	–	–	–	–	–	–
J	g	*Solandra longiflora* TUSS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6!	g	*Solanum aculeatum* (JACQ.) O. E. SCHULZ	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/3	h	*S. antillarum* O. E. SCHULZ	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5!	*l*	*S. bahamense* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/3	r	*Solanum erianthum* D. DON	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/4	b/2	*S. gundlachii* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
E/5	g	*S. havanense* JACQ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	a/5	*S. moense* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–

Lf	Ge	No. of communities / Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
R	p	*S. geniculata* (LAM.) BEAUV.	—	—	—	—	—	—	—	—	—	—	80	60	40	40	40	—	—	—	—	—
O	p	*S. setosa* (SW.) BEAUV.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—	—	—	
O	p	*S. tenax* (L. C. RICH.) DESV.	—	—	—	—	—	—	—	—	—	—	80	40	40	40	40	—	—	—	—	—
E/3	a/5	*Shafera platyphylla* GREENM.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/5	a/5	*Shaferocharis multiflora* BHIDI. & MZ.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
R	m	*Sida acuminata* DC.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—	50
O	r	*S. cordifolia* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	30
O	n	*S. jamaicensis* L.	—	—	—	—	—	—	—	60	—	—	—	—	—	—	—	—	—	40	—	—
O	r	*S. linifolia* CAV.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/5	a/9	*Siemensia pendula* (WR. ex GRISEB.) URB.	—	—	—	—	—	80	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C/5	l	*Simaruba glauca* DC. var. *latifolia* CRONQ.	—	—	—	—	—	—	—	—	—	—	—	40	60	80	—	—	—	—	—	—
C/3	f	*S. laevis* GRISEB.	—	—	—	—	—	—	—	60	—	—	—	—	—	—	—	—	—	—	—	—
V	a/5	*Siphocampylus glaber* MCVAUGH	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
V	a/5	*S. subglaber* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
V	b/3	*S. undulatus* URB.	—	—	—	—	60	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
B/3	b/3	*Sloanea curatellifolia* GRISEB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
J	g	*Smilax Balbisiana* KUNTH	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
J!	k	*S. havanensis* JACQ.	—	—	—	40	80	60	100	—	—	—	100	80	100	40	60	40	60	60	70	100
J	l	*S. lanceolata* L.	40	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—	—	—	—
J	k	*S. laurifolia* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—	—	—
J	g	*S. populnea* KUNTH.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—
J	g	Solandra longiflora TUSS.	—	—	—	—	—	80	60	40	—	60	—	—	—	—	—	—	60	—	—	—
E/6!	g	*Solanum aculeatum* (JACQ.) O. E. SCHULZ	—	—	—	—	—	—	—	—	—	—	40	60	80	100	—	—	—	—	—	70
D/3	h	*S. antillarum* O. E. SCHULZ	—	—	40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/5!	l	*S. bahamense* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	100	40	30	30
D/3	r	*Solanum erianthum* D. DON	—	—	—	—	—	—	—	40	40	—	—	—	—	—	—	—	—	—	—	—
C/4	b/2	*S. gundlachii* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/5	g	*S. havanense* JACQ.	—	—	—	—	—	—	—	—	—	40	—	—	—	—	—	—	40	—	—	—
D/5	a/5	*S. moense* BRITT.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Table 25 Continued 62

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
O	l	*Solidago sempervirens* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/4	a/6	*Solonia reflexa* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40
O	o	*Sorghastrum stipoides* (HBK.) NASH	—	40	60	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
H	a/9	*Spathelia Brittonii* P. WILS.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	a/4	*S. cubensis* P. WILS.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	100	—	—
D/6	b/2	*S. pinetorum* M. VICT.	—	—	—	—	—	—	—	—	30	—	40	—	—	80	100	—	—	—	40	—
D/5	a/5	*S. subintegra* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	30	40	—	—	—	—
D/5	a/5	*S. vernicosa* PLANCH.	—	—	—	—	—	—	—	—	—	40	50	—	—	—	—	—	—	—	—	—
D/5	b/2	*S. Wrightii* M. VICT.	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—	60	—	—	—	—
R	r	*Spigelia Anthelmia* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—
V	c	*Spilanthes pauciceps* (GRISEB.) BLAKE	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
P	k	*Spiranthes cranichioides* (GRISEB.) COGN.	—	—	—	—	—	—	—	—	—	—	40	—	—	—	—	—	—	—	—	—
P	o	*S. elata* (SW.) L. C. RICH.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	50
P	l	*S. tortilis* (SW.) L. C. RICH.	36	—	—	—	—	—	—	—	—	—	40	30	—	—	—	40	—	—	—	30
D/4	b/2	*Spirotecoma apiculata* (BRITT.) ALAIN	—	—	—	—	—	—	—	—	—	—	50	50	100	—	—	40	80	60	—	—
C/5	a/13	*S. holguinensis* (BRITT.) ALAIN	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	b/3	*S. spiralis* (WR. ex GRISEB.) PICHON	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	p	*Sporobolus indicus* (L.) R. BR.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
J	n	*Stegnosperma cubense* A. RICH.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	e	*Stenandrium crenatum* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	j	*S. droseroides* NEES	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	f	*S. ovatum* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
U	a/6	*Stelis aprica* LINDL. in HOOK.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
U	p	*S. ophioglossoides* (JACQ.) SW.	—	—	—	—	—	—	—	—	—	—	—	—	—	60	50	—	—	—	—	40
J	a/14	*Stigmaphyllon coccolobaefolium* ALAIN	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
J	g	*S. diversifolium* (KUNTH) JUSS.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
J	b/3	*S. lineare* WR.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—
J	a/4	*S. nipense* ALAIN	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—
J	h	*S. periplocifolium* (DESF.) JUSS.	—	—	—	—	—	90	100	80	80	100	—	—	—	—	—	—	—	—	—	—
J	i	*S. Sagraeanum* JUSS.	—	—	—	80	60	50	50	50	60	60	50	40	—	—	—	—	—	—	—	—
J	e	*S. sericeum* WR.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Lf	Ge	No. of communities / Number of relevés:	21 / 11	22 / 10	23 / 5	24 / 5	25 / 5	26 / 10	27 / 11	28 / 10	29 / 10	30 / 5	31 / 10	32 / 10	33 / 5	34 / 5	35 / 10	36 / 5	37 / 5	38 / 5	39 / 5	40 / 10
O	l	*Solidago sempervirens* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–
D/4	a/6	*Solonia reflexa* URB.	–	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	o	*Sorghastrum stipoides* (HBK.) NASH	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–
H	a/9	*Spathelia Brittonii* P. WILS.	–	–	–	–	–	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	a/4	*S. cubensis* P. WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6	b/2	*S. pinetorum* M. VICT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	a/5	*S. subintegra* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	a/5	*S. vernicosa* PLANCH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	b/2	*S. Wrightii* M. VICT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R	r	*Spigelia Anthelmia* L.	–	–	–	–	–	–	–	–	–	–	–	40	–	40	–	–	–	–	–	–
V	c	*Spilanthes pauciceps* (GRISEB.) BLAKE	–	–	–	–	–	–	80	–	–	–	–	–	–	–	–	–	–	–	–	–
P	k	*Spiranthes cranichioides* (GRISEB.) COGN.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P	o	*S. elata* (SW.) L. C. RICH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P	l	*S. tortilis* (SW.) L. C. RICH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–
D/4	b/2	*Spirotecoma apiculata* (BRITT.) ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	a/13	*S. holguinensis* (BRITT.) ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–
D/5	b/3	*S. spiralis* (WR. ex GRISEB.) PICHON	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	90	70
O	p	*Sporobolus indicus* (L.) R. BR.	–	–	–	–	–	–	–	–	–	–	–	40	40	–	40	–	100	100	–	–
J	n	*Stegnosperma cubense* A. RICH.	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–
O	e	*Stenandrium crenatum* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
O	j	*S. droseroides* NEES	–	–	–	–	–	–	–	–	–	–	40	80	40	60	–	–	–	–	–	–
O	f	*S. ovatum* URB.	–	–	–	–	–	–	–	–	–	–	40	–	60	–	–	–	–	–	–	–
U	a/6	*Stelis aprica* LINDL. in HOOK.	–	100	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	p	*S. ophioglossoides* (JACQ.) SW.	–	100	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	a/14	*Stigmaphyllon coccolobaefolium* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60
J	g	*S. diversifolium* (KUNTH) JUSS.	–	–	–	–	–	80	–	–	–	–	100	100	60	40	40	–	80	100	60	30
J	b/3	*S. lineare* WR.	–	–	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	a/4	*S. nipense* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	h	*S. periplocifolium* (DESF.) JUSS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	i	*S. Sagraeanum* JUSS.	–	–	–	–	60	–	–	40	–	60	60	40	100	80	40	–	80	40	70	30
J	e	*S. sericeum* WR.	–	–	–	–	–	–	–	–	–	–	–	40	–	40	–	–	–	–	50	50

Table 25 Continued 63

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
E/5	f	*Strempeliopsis strempelioides* (GRISEB.) K. SCHUM.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/6	l	*Strumpfia maritima* JACQ.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5!	g	*Strychnos Grayi* GRISEB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	p	*Stylosanthes hamata* (L.) TANB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C/5	k	*Swietenia mahagoni* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—
D/5	a/6	*Symplocos Leonis* BRITT. & WILS.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C/5	b/3	*S. Lindeniana* KRUG & URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	50
J	h	*Symphysia alainii* (ACUÑA) BERAZ.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	60	—	—	—	—
C/4!	b/3	*Synapsis ilicifolia* GRISEB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	a/1	*Syngonium insulare* (MOLD.)	72	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/4	a/8	*Tabebuia bibracteolata* GRISEB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/4	g	*T. angustata* BRITT.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/4	a/5	*T. Clementis* ALAIN	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	80	—	—	—	—
B43	b/3	*T. dubia* (WR. ex SAUV.) BRITT. & SEIBERT	—	—	—	—	—	—	—	—	—	—	40	30	—	40	70	40	—	80	—	—
D/5	b/2	*T. elegans* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	40	—	—	—
E/5	b/2	*T. gracilipes* ALAIN	—	—	—	—	—	—	—	—	—	—	—	—	—	40	30	—	—	—	—	—
D/4	b/3	*T. hypoleuca* (WR. ex SAUV.) URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	30
E/5	b/1	*T. lepidophylla* (A. RICH.) GREENM.	90	40	100	40	40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/5	j	*T. lepidota* (HBK.) BRITT.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	a/3	*T. leptopoda* URB.	—	—	—	40	40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	— —
E/6	b/3	*T. libanensis* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	a/5	*T. linearis* ALAIN	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	80	—	—	—
E/4	b/2	*T. litoralis* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	80	—	—	40	—	—	—
E/4	b/2	*T. moaensis* BRITT.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	60	—
D/6	f	*T. myrtifolia* (GRISEB.) BRITT.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/4	b/2	*Tabebuia nipensis* URB.	—	—	—	—	—	—	—	—	—	—	60	30	—	—	—	—	—	40	—	—
C/5	b/2	*T. oligolepis* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	90
D/3	b/2	*T. pinetorum* BRITT.	—	—	—	—	—	—	—	—	—	—	60	—	40	—	—	—	—	—	—	—
E/5	a/4	*T. pulverulenta* URB.	—	—	—	—	—	—	—	—	40	—	—	—	—	—	—	—	—	40	—	—

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
E/5	f	*Strempeliopsis strempelioides* (GRISEB.) K. SCHUM.	–	–	–	40	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	l	*Strumpfia maritima* JACQ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
D/5!	g	*Strychnos Grayi* GRISEB.	–	–	–	–	–	–	–	60	60	–	–	–	–	–	–	40	–	–	–	–
O	p	*Stylosanthes hamata* (L.) TANB.	–	–	–	–	–	–	–	–	–	–	–	60	40	40	–	–	–	–	–	30
C/5	k	*Swietenia mahagoni* L.	–	–	–	100	60	40	40	40	60	60	–	40	–	–	–	40	40	100	30	30
D/5	a/6	*Symplocos Leonis* BRITT. & WILS.	–	40	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	b/3	*S. Lindeniana* KRUG & URB.	–	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	h	*Symphysia alainii* (ACUÑA) BERAZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/4!	b/3	*Synapsis ilicifolia* GRISEB.	–	–	–	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	a/1	*Syngonium insulare* (MOLD.)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	a/8	*Tabebuia bibracteolata* GRISEB.	–	–	–	–	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	g	*T. angustata* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	100	40	–	–
D/4	a/5	*T. Clementis* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B43	b/3	*T. dubia* (WR. ex SAUV.) BRITT. & SEIBERT	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	b/2	*T. elegans* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/2	*T. gracilipes* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	b/3	*T. hypoleuca* (WR. ex SAUV.) URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/1	*T. lepidophylla* (A. RICH.) GREENM.	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–
E/5	j	*T. lepidota* (HBK.) BRITT.	–	–	–	–	–	–	–	–	–	–	100	100	40	–	–	–	–	–	–	–
D/5	a/3	*T. leptopoda* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	b/3	*T. libanensis* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
D/5	a/5	*T. linearis* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/4	b/2	*T. litoralis* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/4	b/2	*T. moaensis* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6	f	*T. myrtifolia* (GRISEB.) BRITT.	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	40	90	40
D/4	b/2	*Tabebuia nipensis* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	b/2	*T. oligolepis* URB.	–	80	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/3	b/2	*T. pinetorum* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/4	*T. pulverulenta* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 25 Continued 64

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
D/5	c	*T. Sauvallei* BRITT.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
B/4	f3	*T. Shaferi* BRITT.	—	—	—	—	—	40	—	—	—	—	—	—	—	—	30	—	—	—	—	—
E/5	b/2	*T. simplicifolia* CARAB. ex ALAIN	—	—	—	—	—	—	—	—	30	—	30	—	—	—	—	—	60	80	—	—
E/5	e	*T. trachycarpa* (GRISEB.) K. SCHUM.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/4	b/3	*T. turquinensis* ALAIN	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C/4	f	*Tabernaemontana amblyocarpa* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C/3	a/5	*Talauma minor* URB. ssp. *oblongifolia* (LEÓN) BHIDI.	—	—	—	—	—	—	—	—	—	—	—	—	—	80	30	—	—	—	60	—
D/4	f	*Tapura cubensis* (POEPP. & ENDL.) GRISEB.	—	—	—	—	—	—	—	—	—	—	—	—	—	80	100	100	—	—	—	—
E/5	p	*Tecoma stans* (L.) HBK.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	g	*Tectaria cicutaria* (L.) COPEL.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—
O	l	*T. heracleifolia* (WILLD.) UNDERW.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	30
O	p	*T. incisa* CAV.	—	—	40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	a/14	*Tephrosia Clementis* ALAIN	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	k	*T. corallicola* (SMALL) LEÓN	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	a/14	*T. villosa* BHIDI. & MZ.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	b/3	*Terebraria apiculata* BRITT. & STANDL.) ALAIN	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
B/4	f	*Terminalia eryostachya* (A. RICH.)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	30
C/4	f	*T. intermedia* (A. RICH.) URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	b/2	*T. nipensis* ALAIN	—	—	—	—	—	—	—	—	30	—	—	—	—	60	40	—	—	40	—	—
C/4	b/2	*T. orientensis* MONACH.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	40	40	—	—	—
D/5	f	*Ternstroemia parviflora* KRUG & URB.	—	—	—	60	80	40	—	—	—	—	—	—	—	—	—	—	—	40	—	—
D/5	h	*T. peduncularis* DC.	—	—	—	40	40	40	—	50	—	60	—	—	—	—	—	—	—	—	40	100
J	p	*Tetracera volubilis* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
P	f	*Tetramicra erosa* CARAB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—	—
P	f	*T. eulophiae* RCHB. F.	72	20	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C/3	k	*Tetrazygia bicolor* (MILL.) COGN.	—	30	60	—	—	40	45	—	—	—	—	—	—	—	40	100	40	40	40	—
E/4	a/3	*T. coriacea* URB.	—	—	—	100	40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	b/3	*T. elaegans* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
P	x	*Thelypteris palustris* SALISB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
P	h	*T. pennata* (POIR.) MORTON	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	30

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
D/5	c	*T. Sauvallei* BRITT.	–	–	–	–	–	40	100	–	–	–	–	–	–	–	–	–	–	–	–	–
B/4	f3	*T. Shaferi* BRITT.	40	–	–	–	–	–	–	100	40	80	–	–	–	–	–	–	–	–	–	–
E/5	b/2	*T. simplicifolia* CARAB. ex ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–	–	–
E/5	e	*T. trachycarpa* (GRISEB.) K. SCHUM.	–	–	–	–	–	–	–	–	–	–	–	40	100	100	–	–	–	–	60	40
D/4	b/3	*T. turquinensis* ALAIN	–	80	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/4	f	*Tabernaemontana amblyocarpa* URB.	–	–	–	–	40	–	60	40	60	60	40	40	40	40	40	60	100	–	–	–
C/3	a/5	*Talauma minor* URB. ssp. *oblongifolia* (LEÓN) BHIDI.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	f	*Tapura cubensis* (POEPP. & ENDL.) GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	p	*Tecoma stans* (L.) HBK.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	40	60	30
O	g	*Tectaria cicutaria* (L.) COPEL.	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	l	*T. heracleifolia* (WILLD.) UNDERW.	60	–	–	100	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–
O	p	*T. incisa* CAV.	–	–	–	80	–	–	–	–	–	–	–	–	–	–	40	–	–	40	–	–
O	a/14	*Tephrosia Clementis* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	–
O	k	*T. corallicola* (SMALL) LEÓN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	–
O	a/14	*T. villosa* BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
D/5	b/3	*Terebraria apiculata* BRITT. & STANDL.) ALAIN	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/4	f	*Terminalia eryostachya* (A. RICH.)	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
C/4	f	*T. intermedia* (A. RICH.) URB.	–	–	–	–	–	40	60	60	60	–	–	40	40	40	40	–	–	60	–	–
D/5	b/2	*T. nipensis* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/4	b/2	*T. orientensis* MONACH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	f	*Ternstroemia parviflora* KRUG & URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	h	*T. peduncularis* DC.	40	100	40	–	–	–	60	–	40	60	40	80	40	60	40	–	–	60	30	30
J	p	*Tetracera volubilis* L.	–	–	–	–	–	–	–	–	–	40	–	–	–	–	60	–	–	–	–	–
P	f	*Tetramicra erosa* CARAB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P	f	*T. eulophiae* RCHB. F.	–	–	–	–	–	–	–	–	–	–	80	40	60	40	40	–	–	–	–	–
C/3	k	*Tetrazygia bicolor* (MILL.) COGN.	40	–	–	–	–	–	–	–	60	–	–	–	–	–	100	–	–	60	–	–
E/4	a/3	*T. coriacea* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	b/3	*T. elaegans* URB.	–	80	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P	x	*Thelypteris palustris* SALISB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–
P	h	*T. pennata* (POIR.) MORTON	60	100	40	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 25 Continued 65

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
P	g	*T. sclerophylla* (POEPP. & SPRENG.) MORTON	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/4	r	*Thespesia populnea* (L.) SOLAND.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	f	*Thouinia hypoleuca* BHIDI.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	f	*T. pseudopunctata* LIPPOLD	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/5	a/14	*T. Leonis* ALAIN	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/3	a/9	*T. rotundata* WR. in SAUX	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C/4	g	*T. trifoliata* POIT.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
G	f	*Thrinax radiata* LODD.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
H	c	*T. Morrisii* WENDL.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
R	j	*Thymopsis thymoides* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/4	p	*Tibouchina longifolia* (VAHL) BAILL.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40
X	l	*Tillandsia argentea* GRISEB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
X	n	*T. Balbisiana* SCHULT.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
X	n	*T. bulbosa* HOOK.	—	—	40	30	30	30	—	—	30	40	—	—	—	—	40	—	40	40	—	—
X	z	*T. capitata* GRISEB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
X	g	*T. canescens* SW.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
X	m	*T. caribaea* SW.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	30
X	l	*T. circinnata* SCHLTD.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
X	m	*T. compacta* GRISEB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	30
X	l	*T. excelsa* GRISEB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40
X	n	*T. fasciculata* SW.	—	—	40	—	—	70	45	90	70	60	30	40	—	—	—	—	40	40	40	40
X	l	*T. festucoides* BROGN. & MEZ	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
X	n	*T. fleuxuosa* SW.	—	—	40	30	30	—	—	—	—	—	—	—	—	—	—	—	40	40	—	—
X	g	*T. Hotteana* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	50
X	n	*T. juncea* (RUIZ & PAV.) POIR.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
X	g	*T. Lescaillei* WR.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40
X	n	*Tillandsia polystachya* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
X	n	*T. pruinosa* SW.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	60	—	—	—	—
X	p	*T. recurvata* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
X	n	*T. tenuifolia* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
X	p	*T. usneoides* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	40	—	—	—	50
X	n	*T. Valenzueleana* A. RICH.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	60	40	—	—	40	30

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
P	g	*T. sclerophylla* (POEPP. & SPRENG.) MORTON	–	–	–	–	–	–	–	–	–	60	–	–	–	–	–	–	–	–	–	–
D/4	r	*Thespesia populnea* (L.) SOLAND.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–
D/5	f	*Thouinia hypoleuca* BHIDI.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
D/5	f	*T. pseudopunctata* LIPPOLD	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	70	100
E/5	a/14	*T. Leonis* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
D/3	a/9	*T. rotundata* WR. in SAUV.	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/4	g	*T. trifoliata* POIT.	–	–	–	–	60	40	100	–	–	40	40	–	–	–	–	–	40	–	–	–
G	f	*Thrinax radiata* LODD.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	100	–	–	–
H	c	*T. Morrisii* WENDL.	–	–	–	–	–	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–
R	j	*Thymopsis thymoides* URB.	–	–	–	–	–	–	–	–	–	–	–	40	60	80	–	–	–	–	–	–
E/4	p	*Tibouchina longifolia* (VAHL) BAILL.	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
X	l	*Tillandsia argentea* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	30
X	n	*T. Balbisiana* SCHULT.	–	–	–	–	–	–	100	–	40	40	40	100	40	40	40	60	40	–	50	–
X	n	*T. bulbosa* HOOK.	–	–	–	–	40	60	40	–	40	–	40	40	80	40	40	–	–	40	30	60
X	z	*T. capitata* GRISEB.	–	–	–	–	–	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–
X	g	*T. canescens* SW.	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–
X	m	*T. caribaea* SW.	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
X	l	*T. circinnata* SCHLTD.	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	30	30
X	m	*T. compacta* GRISEB.	–	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
X	l	*T. excelsa* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
X	n	*T. fasciculata* SW.	40	–	–	60	80	80	100	40	40	40	–	–	–	–	40	80	80	80	60	30
X	l	*T. festucoides* BROGN. & MEZ	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	40	40	60	30	–
X	n	*T. fleuxuosa* SW.	–	–	–	40	40	40	40	–	–	–	40	100	40	60	60	40	100	60	50	40
X	g	*T. Hotteana* URB.	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
X	n	*T. juncea* (RUIZ & PAV.) POIR.	–	–	–	–	–	–	60	40	60	40	–	–	–	–	–	100	–	60	–	–
X	g	*T. Lescaillei* WR.	–	40	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
X	n	*Tillandsia polystachya* L.	–	–	–	40	–	80	40	40	40	40	–	–	–	–	40	–	–	40	40	–
X	n	*T. pruinosa* SW.	40	–	–	40	60	40	–	–	–	–	–	–	–	–	–	–	–	–	40	30
X	p	*T. recurvata* L.	–	–	–	–	80	40	60	40	40	40	40	40	60	40	40	–	–	60	70	90
X	n	*T. tenuifolia* L.	–	–	–	–	60	60	–	40	40	–	–	–	–	–	40	–	–	–	–	–
X	p	*T. usneoides* L.	60	100	–	60	80	80	60	40	–	–	–	–	–	–	–	100	40	40	30	30
X	n	*T. Valenzueleana* A. RICH.	40	–	–	60	60	60	40	40	40	40	–	–	–	–	–	40	–	–	30	–

Table 25 Continued 66

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
D/3	b/3	*Tocoyena cubensis* BRITT. & STANDL.	—	—	—	—	—	—	—	—	—	—	—	—	—	100	—	—	—	—	40	—
D/5	g	*Torralbasia cuneifolia* (WR.) KRUG & URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	100
C/5	k	*Torrubia longifolia* (HEIMERL) BRITT.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	j	*T. obtusata* (JACQ.) BRITT.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	b/3	*T. rufescens* (GRISEB.) BRITT.	—	—	—	—	—	—	—	—	—	—	60	30	—	—	70	—	—	60	—	—
J	p	*Tournefortia bicolor* SW.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	80	30
D/3	l	*T. glabra* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
J	p	*T. hirsutissima* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
J	i	*T. polyochros* SPRENG.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/5	b/3	*T. stenophylla* URB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
J	p	*T. volubilis* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	o	*Trachypogon filifolius* (HACK.) HITCHC.	45	90	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
J	p	*Tragia volubilis* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	i	*Trema Lamarckiana* (R. & S.) BLUME	—	—	—	—	—	—	—	—	—	—	60	30	—	—	40	—	40	40	—	40
D/5	p	*T. micrantha* (L.) BLUME	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	p	*Trichilia glabra* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
B/5	p	*T. hirta* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
U	p	*Trichomanes alatum* SW.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
U	p	*T. arbuscula* DESV.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
U	p	*T. capillaceum* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	30
U	p	*T. crispum* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
U	p	*T. hymenophylloides* V. d. BOSCH.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	50
U	p	*T. osmundioides* DC.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—
U	r	*T. rigidum* SW.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	—	—	—	—	30
U	l	*T. scandens* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	30	—	—	—	60	100
U	m	*Trichopilia fragrans* (LINDL.) RCHB. F.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40
J	p	*Trichostigma octandrum* (L.) WALT.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
J	g	*Triopteris jamaicensis* L.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
J	g	*T. j.* var. *ovata* (CAV.) NDZ.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
J	g	*T. rigida* SW.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	g	*Tripogon spicatus* (NEES) EKM.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/5	p	*Triumfetta semitriloba* JACQ.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
D/3	b/3	*Tocoyena cubensis* BRITT. & STANDL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	g	*Torralbasia cuneifolia* (WR.) KRUG & URB.	–	100	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	k	*Torrubia longifolia* (HEIMERL) BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
D/5	j	*T. obtusata* (JACQ.) BRITT.	–	–	–	–	80	–	40	80	40	40	40	40	60	40	40	–	40	60	40	30
D/5	b/3	*T. rufescens* (GRISEB.) BRITT.	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	p	*Tournefortia bicolor* SW.	40	–	–	–	–	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–
D/3	l	*T. glabra* L.	40	–	–	40	40	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–
J	p	*T. hirsutissima* L.	–	–	–	–	–	–	–	40	–	40	–	–	–	–	40	–	–	40	–	–
J	i	*T. polyochros* SPRENG.	–	–	–	–	60	40	40	–	–	–	–	–	–	–	–	–	–	–	30	30
E/5	b/3	*T. stenophylla* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	30
J	p	*T. volubilis* L.	–	–	–	–	60	–	40	–	–	–	–	–	–	–	–	–	–	40	70	30
O	o	*Trachypogon filifolius* (HACK.) HITCHC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	p	*Tragia volubilis* L.	–	–	–	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	30	30
D/5	i	*Trema Lamarckiana* (R. & S.) BLUME	40	–	–	–	40	–	40	–	–	–	–	–	–	–	–	–	–	80	50	30
D/5	p	*T. micrantha* (L.) BLUME	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	80	–
D/5	p	*Trichilia glabra* L.	–	–	–	80	100	80	100	80	–	–	–	–	–	–	–	–	–	60	–	–
B/5	p	*T. hirta* L.	–	–	–	–	–	–	40	100	60	100	100	–	–	–	–	–	40	–	–	–
U	p	*Trichomanes alatum* SW.	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	p	*T. arbuscula* DESV.	–	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	p	*T. capillaceum* L.	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	p	*T. crispum* L.	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	p	*T. hymenophylloides* V. d. BOSCH.	–	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	p	*T. osmundioides* DC.	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	r	*T. rigidum* SW.	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	l	*T. scandens* L.	40	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
U	m	*Trichopilia fragrans* (LINDL.) RCHB. F.	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	p	*Trichostigma octandrum* (L.) WALT.	–	–	–	60	80	40	80	40	40	40	–	–	–	–	–	–	–	40	30	–
J	g	*Triopteris jamaicensis* L.	–	–	–	–	–	–	–	–	–	–	–	–	100	40	–	–	–	–	–	–
J	g	*T. j.* var. *ovata* (CAV.) NDZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	90
J	g	*T. rigida* SW.	–	–	–	–	–	80	40	–	40	40	–	40	–	–	40	–	40	100	100	–
O	g	*Tripogon spicatus* (NEES) EKM.	–	–	–	–	–	–	–	–	–	–	–	40	60	–	–	–	–	–	–	–
E/5	p	*Triumfetta semitriloba* JACQ.	–	–	–	–	40	40	40	40	40	40	–	–	–	–	–	–	–	–	–	–

Table 25 Continued 67

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
E/5	n	*Trixis radialis* (L.) KUNTZE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	p	*Turbina corymbosa* (L.) RAF.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	p	*Turnera diffusa* WILLD.	–	–	–	–	–	30	–	60	30	–	–	–	40	–	–	–	–	100	–	–
E/5	p	*T. ulmifolia* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	h	*Urechites lutea* (L.) BRITT.	–	–	40	30	40	–	30	–	30	–	40	30	–	–	–	–	–	–	–	–
O	r	*Urena lobata* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–
D/3	p	*Urera baccifera* (L.) GAUD.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	b/2	*Vaccinium Alainii* ACUÑA & ROIG	–	–	–	–	–	–	–	–	–	–	80	90	40	–	–	40	–	–	–	–
E/6	b/2	*V. cubense* (A. RICH.) GRISEB.	–	–	–	–	–	50	45	30	40	60	–	–	–	–	–	–	–	–	–	–
E/6	b/1	*V. c.* ssp. *Ramonii* (GRISEB.) BHIDI.	–	–	80	100	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	a/6	*V. Leonis* ACUÑA & ROIG	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	b/3	*Vanilla claviculata* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–
T	h	*V. Dilleniana* CORR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	k	*V. phaeantha* RCHB. F.	–	–	–	–	–	–	–	–	30	–	–	–	–	–	–	–	–	60	–	–
T	o	*V. Wrightii* RCHB. F.	–	–	–	–	–	–	–	–	30	–	–	–	–	80	50	–	–	40	80	–
O	h	*Verbesina alata* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	f	*Vernonia angustissima* WR. ex EKM.	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–
E/5	a/5	*V. calida* GLEAS.	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–	–	–	–	–
E/6	b/2	*V. calophylla* GLEAS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–
E/5	c	*V. cubensis* GRISEB.	–	30	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/3	*V. c.* ssp. *cajalbanica* (EKM. ex URB.) BHIDI.	–	–	–	40	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	f	*V. gnaphaliifolia* A. RICH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	b/3	*V. hieracioides* GRISEB.	–	–	–	–	–	30	–	–	50	–	–	40	40	–	–	–	40	40	–	–
E/5	f	*V. inaequiserrata* SCH.-BIP.	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–
E/5	f	*V. menthaefolia* (POEPP. & SPRENG.) LESS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/5	*V. moaensis* ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	60	–	–	–
E/5	a/8	*V. nova*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	b/3	*V. parvuliceps* EKM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
E/6	b/2	*V. pineticola* GLEAS.	–	–	–	–	–	–	–	–	–	–	40	30	–	–	–	–	–	–	–	–

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
E/5	n	*Trixis radialis* (L.) KUNTZE	—	—	—	—	80	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
J	p	*Turbina corymbosa* (L.) RAF.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	40	60	30	—
V	p	*Turnera diffusa* WILLD.	—	—	—	—	—	—	—	—	—	—	80	40	60	40	—	—	—	—	40	90
E/5	p	*T. ulmifolia* L.	—	—	—	—	—	—	—	40	40	40	40	—	—	—	40	—	40	—	—	—
T	h	*Urechites lutea* (L.) BRITT.	—	—	—	—	—	—	—	—	—	—	40	60	60	40	40	60	100	80	60	40
O	r	*Urena lobata* L.	—	—	—	40	—	—	—	—	—	—	—	—	—	—	60	80	80	40	—	—
D/3	p	*Urera baccifera* (L.) GAUD.	—	—	—	60	—	—	40	—	40	—	—	—	—	—	—	—	—	—	—	—
E/6	b/2	*Vaccinium Alainii* ACUÑA & ROIG	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/6	b/2	*V. cubense* (A. RICH.) GRISEB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/6	b/1	*V. c.* ssp. *Ramonii* (GRISEB.) BHIDI.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	a/6	*V. Leonis* ACUÑA & ROIG	—	60	100	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
T	b/3	*Vanilla claviculata* SW.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
T	h	*V. Dilleniana* CORR.	—	—	—	—	—	40	60	40	40	60	40	40	60	60	40	—	—	—	30	30
T	k	*V. phaeantha* RCHB. F.	—	—	—	—	—	—	—	40	—	60	—	—	—	—	—	—	—	40	—	—
T	o	*V. Wrightii* RCHB. F.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	h	*Verbesina alata* L.	—	—	—	—	—	—	—	—	—	—	40	40	40	40	40	—	—	—	—	—
V	f	*Vernonia angustissima* WR. ex EKM.	—	—	—	—	—	—	—	—	—	—	—	—	—	80	—	—	—	—	—	—
E/5	a/5	*V. calida* GLEAS.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/6	b/2	*V. calophylla* GLEAS.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/5	c	*V. cubensis* GRISEB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/5	a/3	*V. c.* ssp. *cajalbanica* (EKM. ex URB.) BHIDI.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
O	f	*V. gnaphaliifolia* A. RICH.	—	—	—	60	40	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	b/3	*V. hieracioides* GRISEB.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/5	f	*V. inaequiserrata* SCH.-BIP.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/5	f	*V. menthaefolia* (POEPP. & SPRENG.) LESS.	—	—	—	40	40	—	—	—	—	—	—	—	—	60	—	—	—	—	—	—
E/5	a/5	*V. moaensis* ALAIN	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/5	a/8	*V. nova*	—	—	—	—	100	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
D/5	b/3	*V. parvuliceps* EKM.	—	100	100	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E/6	b/2	*V. pineticola* GLEAS.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Table 25 Continued 68

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
E/4	a/7	*Vermonia potrerilloana* EKM. & URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/6	*V. praestans* EKM. ex URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
E/5	a/6	*V. p.* var. *cacuminis* BHIDI. & MZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/3	*V. Sagraeana* DC.	–	–	–	–	–	–	–	–	–	–	–	30	–	–	–	–	–	–	–	–
E/5	b/2	*V. segregata* GLEAS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	60	–	–	–	–
E/5	b/2	*V. semitalis* GLEAS.	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	40	–	–	–
E/4	a/4	*V. Urbaniana* EKM. ex URB.	–	–	–	–	–	90	100	100	50	100	–	–	–	–	–	–	–	–	–	–
E/4	a/3	*V. Valenzuelana* A. RICH.	–	–	–	60	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/3	*V. Wrightii* SCH.-BIP.	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–	–	–	–	–	–
D/5	g	*Viburnum villosum* SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	r	*Vigna luteola* (JACQ.) BENTH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/4	g	*Vitex divaricata* SW. ssp. *cubensis* (URB.) BHIDI.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	p	*Vitis tiliaefolia* H. & B. ex R. & S.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
X	m	*Vriesea capituligera* (GRISEB.) SM. & PITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50	50
X	a/9	*V. dissitiflora* (WR.) MEZ	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
X	m	*V. incurva* (GRISEB.) READ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
X	m	*V. macrostachys* (BELLO) MEZ	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
X	m	*V. sanguinolenta* COGN. & MARCHAL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100
X	g	*V. Sintenisii* (BAKER) SM. & PITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	40
D/4	f	*Wallenia bumelioides* (GRISEB.) MEZ	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	g	*W. laurifolia* (JACQ.) SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	p	*Waltheria indica* L.	–	–	–	–	–	–	90	40	–	–	–	–	–	–	–	–	–	–	–	–
O	g	*Wedelia gracilis* L. C. RICH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	f	*W. rugosa* GREENM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/6	p	*Weinmannia pinnata* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30	–	–	–	–	100
E/5	r	*Wissadula periplocifolia* (L.) PRESL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5!	r	*Ximenia americana* L.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/4	o	*Xylopia aromatica* (LAM.) MART.	–	40	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Lf	Ge	No. of communities Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
E/4	a/7	*Vermonia potrerilloana* EKM. & URB.	40	–	–	–	–	–	80	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/6	*V. praestans* EKM. ex URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	a/6	*V. p.* var. *cacuminis* BHIDI. & MZ.	–	40	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/3	*V. Sagraeana* DC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/2	*V. segregata* GLEAS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/2	*V. semitalis* GLEAS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/4	a/4	*V. Urbaniana* EKM. ex URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/4	a/3	*V. Valenzuelana* A. RICH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	b/3	*V. Wrightii* SCH.-BIP.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5	g	*Viburnum villosum* SW.	–	100	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T	r	*Vigna luteola* (JACQ.) BENTH.	–	–	–	40	–	–	40	–	40	–	–	–	–	–	–	–	–	40	40	–
E/4	g	*Vitex divaricata* SW. ssp. *cubensis* (URB.) BHIDI.	–	–	–	–	–	60	–	–	–	–	–	–	–	–	–	–	–	40	–	–
J	p	*Vitis tiliaefolia* H. & B. ex R. & S.	–	–	–	40	–	–	–	40	40	–	–	–	–	–	–	40	–	–	–	–
X	m	*Vriesea capituligera* (GRISEB.) SM. & PITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
X	a/9	*V. dissitiflora* (WR.) MEZ	–	–	–	–	–	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–
X	m	*V. incurva* (GRISEB.) READ.	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
X	m	*V. macrostachys* (BELLO) MEZ	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
X	m	*V. sanguinolenta* COGN. & MARCHAL	–	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
X	g	*V. Sintenisii* (BAKER) SM. & PITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/4	f	*Wallenia bumelioides* (GRISEB.) MEZ	–	–	–	–	–	–	–	–	40	40	–	–	–	–	–	40	–	–	–	–
D/4	g	*W. laurifolia* (JACQ.) SW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	40	80	–	–
O	p	*Waltheria indica* L.	–	–	–	–	–	–	–	–	–	–	40	40	60	80	–	–	–	–	40	30
O	g	*Wedelia gracilis* L. C. RICH.	–	–	–	–	–	–	–	–	–	–	–	–	40	40	–	–	–	–	–	–
V	f	*W. rugosa* GREENM.	–	–	–	–	–	–	–	–	–	–	40	40	40	40	40	–	–	–	–	–
C/6	p	*Weinmannia pinnata* L.	–	80	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	r	*Wissadula periplocifolia* (L.) PRESL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	30
D/5!	r	*Ximenia americana* L.	–	–	–	–	–	–	–	–	40	40	–	–	–	–	–	–	–	60	–	30
C/4	o	*Xylopia aromatica* (LAM.) MART.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–	–	–	–	–

Table 25 Continued 69

Lf	Ge	No. of communities / Number of relevés:	1 11	2 10	3 5	4 5	5 5	6 10	7 11	8 10	9 10	10 5	11 10	12 10	13 5	14 5	15 10	16 5	17 5	18 5	19 5	20 10
B/5	f	*Xylopia obtusifolia* (DC.) RICH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	b/2	*X. Roigii* P. WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50	–	–	–	–	–
C/5!	h	*Xylosma buxifolium* A. GRAY	–	–	–	–	–	–	–	–	50	–	50	–	60	–	–	–	–	60	–	–
E/5!	e	*X. infestum* GRISEB.	–	–	–	–	–	–	–	–	–	–	30	–	–	–	–	–	–	–	–	–
E/7!	b/1	*X. Shaferi* (P. WILS.) HOWARD	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	b/1	*Xyris grandiceps* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	a/1	*X. longibracteata* BRITT. & WILS.	36	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	j	*Zamia angustifolia* JACQ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	g	*Z. latifoliolata* PRESL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	f	*Z. pygmaea* SIMS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	a/1	*Z. silicea* BRITT.	29	70	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/7!	a/3	*Zanthoxylum dumosum* A. RICH.	–	–	–	–	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5!	k	*Z. coriaceum* A. RICH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
B/5!	i	*Z. cubense* P. WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–
E/6!	f	*Z. ramoni* BEURTON	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–
B/4	p	*Z. elephantiasis* MACF.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/6!	p	*Z. fagara* (L.) SARG.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5	k	*Z. flavum* VAHL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5!	b/2	*Z. lomincolum* (URB.) ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	40	–	–	–
B/4!	p	*Z. martinicense* (LAM.) DC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–
E/7!	e	*Z. nannophyllum* (URB.) ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5!	g	*Z. pimpinelloides* (LAM.) DC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	f	*Z. pistacifolium* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/6!	m	*Z. spinifex* (JACQ.) DC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6	f	*Z. taediosum* A. RICH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
J	g	*Zeugites americana* WILLD.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50
D/5!	f	*Zizyphus havanensis* HBK.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6!	a/14	*Z. h.* ssp. *bullatus* (URB.) BHIDI.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/3	g	*Z. rhodoxylon* URB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	r	*Zornia diphylla* (L.) PERS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/3	m	*Zuelania guidonia* (SW.) BRITT. & MILLSP.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Lf	Ge	No. of communities / Number of relevés:	21 11	22 10	23 5	24 5	25 5	26 10	27 11	28 10	29 10	30 5	31 10	32 10	33 5	34 5	35 10	36 5	37 5	38 5	39 5	40 10
B/5	f	*Xylopia obtusifolia* (DC.) RICH.	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–
C/5	b/2	*X. Roigii* P. WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C/5!	h	*Xylosma buxifolium* A. GRAY	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5!	e	*X. infestum* GRISEB.	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/7!	b/1	*X. Shaferi* (P. WILS.) HOWARD	–	–	–	–	–	–	–	40	40	–	–	–	–	–	–	–	–	40	–	–
O	b/1	*Xyris grandiceps* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–
O	a/1	*X. longibracteata* BRITT. & WILS.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–
V	j	*Zamia angustifolia* JACQ.	–	–	–	–	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
V	g	*Z. latifoliolata* PRESL	–	–	–	60	40	40	60	–	40	–	–	–	–	–	–	–	–	40	–	–
V	f	*Z. pygmaea* SIMS.	–	–	–	–	–	–	–	–	–	–	60	80	–	–	80	–	–	–	–	–
V	a/1	*Z. silicea* BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/7!	a/3	*Zanthoxylum dumosum* A. RICH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D/5!	k	*Z. coriaceum* A. RICH.	–	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/5!	i	*Z. cubense* P. WILS.	–	–	–	80	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/6!	f	*Z. ramoni* BEURTON	–	–	–	–	–	–	–	–	–	–	100	40	60	100	–	–	–	–	–	–
B/4	p	*Z. elephantiasis* MACF.	–	–	–	–	–	–	40	40	–	100	–	–	–	–	–	–	–	–	–	–
C/6!	p	*Z. fagara* (L.) SARG.	–	–	–	–	–	–	–	40	100	40	40	40	40	40	40	–	100	100	40	–
C/5	k	*Z. flavum* VAHL	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50
D/5!	b/2	*Z. lomincolum* (URB.) ALAIN	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B/4!	p	*Z. martinicense* (LAM.) DC.	40	–	–	100	–	–	40	–	–	60	–	–	–	–	–	–	–	–	–	–
E/7!	e	*Z. nannophyllum* (URB.) ALAIN	–	–	–	–	–	–	–	–	–	–	–	*40*	–	*100*	–	–	–	–	–	–
D/5!	g	*Z. pimpinelloides* (LAM.) DC.	–	–	–	–	100	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–
E/5	f	*Z. pistacifolium* GRISEB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
D/6!	m	*Z. spinifex* (JACQ.) DC.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50
E/6	f	*Z. taediosum* A. RICH.	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–
J	g	*Zeugites americana* WILLD.	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50
D/5!	f	*Zizyphus havanensis* HBK.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	30	40
E/6!	a/14	*Z. h.* ssp. *bullatus* (URB.) BHIDI.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	70
B/3	g	*Z. rhodoxylon* URB.	–	–	–	*100*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
O	r	*Zornia diphylla* (L.) PERS.	–	–	–	–	–	–	–	–	–	–	–	40	40	40	–	–	–	–	–	–
E/3	m	*Zuelania guidonia* (SW.) BRITT. & MILLSP.	–	–	–	–	40	–	–	–	100	100	100	–	–	–	–	–	–	–	–	–

Table 25 Continued 70

No. of communities	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Number of relevés:	11	10	5	5	5	10	11	10	10	5	10	10	5	5	10	5	5	5	5	10
Acroporium ancistrostegium (SULL.) Crum.et STEERE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
A. pungens (HEDW.) BROTH.	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	100
Adelothecium bogotense (HPE) MITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
Barbula cruegeri SORID.	–	–	–	–	–	40	–	–	40	100	–	60	–	–	–	–	–	–	40	–
B. subulifolia SULL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–
Brachythecium stereopoma ITT.) JAEG.	–	–	–	–	–	–	–	–	–	40	40	–	–	–	–	–	–	–	–	–
Bryum argenteum HEDW. var. *lanatum* B. S. G.	–	–	–	–	–	–	–	–	–	60	40	40	–	–	–	–	–	–	–	–
B. barbatum C. M. var. *cubensis* THÉR.	–	–	–	–	40	–	–	–	–	–	–	–	40	40	–	–	–	–	–	40
B. coronatum SCHW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B. cruegeri (HPE.) C. M.	–	–	–	–	–	–	–	–	–	60	–	40	–	–	–	–	–	–	–	30
B. truncorum Brid.	–	–	40	40	–	–	–	–	–	–	–	–	40	40	40	–	–	–	–	–
Calymperes donnellii AUST.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C. nashii WILL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C. richardi C. M.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Calyptrothecium duplicatum (SCHW.) BROTH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Campylopodium pusillum (SCHIMP.) WILL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Campylopus brittonae WILL.	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C. cubensis SULL.	–	–	40	40	–	60	40	40	60	100	40	40	40	80	40	–	–	60	–	30
C. cygneus (HEDW.) BRID.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
C. gracilicaulis MITT.	–	–	–	60	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C. porphyriodietion (C. M.) MITT.	–	–	–	–	–	–	–	–	–	–	–	–	80	40	40	–	–	–	–	–
C. saxatilis WILL.	–	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
Cyclodyction albicaule (SPR.) KUNTZE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40

No. of communities	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Number of relevés:	11	10	5	5	5	10	11	10	10	5	10	10	5	5	10	5	5	5	5	10
Acroporium ancistrostegium (SULL.) Crum. et STEERE	–	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
A. pungens (HEDW.) BROTH.	–	80	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Adelothecium bogotense (HPE) MITT.	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Barbula cruegeri SORID.	–	–	–	–	–	40	–	40	100	40	–	–	–	–	–	–	40	40	–	–
B. subulifolia SULL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Brachythecium stereopoma (MITT.) JAEG.	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bryum argenteum HEDW. var. *lanatum* B. S. G.	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B. barbatum C. M. var. *cubensis* THÉR.	–	40	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B. coronatum SCHW.	–	–	–	–	60	60	40	–	40	–	–	–	–	–	–	–	–	40	–	–
B. cruegeri (HPE.) C. M.	–	–	–	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
B. truncorum BRID.	–	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Calymperes donnellii AUST.	–	–	–	40	–	–	–	40	40	–	–	–	–	–	–	40	40	40	–	–
C. nashii WILL.	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	60	–	–	–	–
C. richardi C. M.	–	–	–	–	–	–	–	60	100	40	–	–	–	–	–	–	–	–	–	–
Calyptrothecium duplicatum (SCHW.) BROTH.	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Campylopodium pusillum (SCHIMP.) WILL.	–	–	–	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Campylopus brittonae WILL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C. cubensis SULL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C. cygneus (HEDW.) BRID.	–	40	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C. gracilicaulis Mitt.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C. porphyriodietion (C. M.) MITT.	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C. saxatilis WILL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Cyclodyction ablicaule (SPR.) KUNTZE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 25 Continued 71

No. of communities	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Number of relevés:	11	10	5	5	5	10	11	10	10	5	10	10	5	5	10	5	5	5	5	10
C. cuspidatum	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60
C. lindiquianum (HPE.) KUNTZE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
Dermatodon garberi LESQ. et JAMES	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D. stomatodontus (CARD.) WILL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Dicranella harrisii (C. M.) BROTH.	–	–	–	–	–	–	–	–	–	–	–	–	40	40	–	–	–	–	–	30
D. herminieri BERCH.	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Fabronia wrightii SULL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
Fissidens asplenioides HEDW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
F. dissitifolius SULL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
F. duryae BIZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
F. garberi LESQ. et JAMES	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
F. polypodioides HEDW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60
F. radicans MONT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
F. similiretis SULL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	40	–	–	–
F. vardei THÉR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
F. weizii Mitt.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	70
Funaria calvescens SCHW.	–	–	–	–	–	–	–	–	–	–	–	80	–	–	–	–	–	–	–	–
Groutalla apiculata (HOOK.) CRUM et STEERE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
G. mucronifolia (HOOK. et GREW.) CRUM et STEERE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
G. wagneriana (C. M.) Crum et Steere	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Haplocladium microphyllum (HEDW.) BROTH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Helicophyllum torquatum (HOOK.) BRID.	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Holomitrium marginatum MITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	60
Hookeria acutifolia HOOK. et GREW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Hookeriopsis falcata (HOOK.) JAEG.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
H. guadelupensis (BRID.) JAEG.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	70
H. incurva (Hornch.) BROTH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30

No. of communities	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Number of relevés:	11	10	5	5	5	10	11	10	10	5	10	10	5	5	10	5	5	5	5	10
C. cuspidatum	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
C. lindiquianum (HPE.) KUNTZE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Dermatodon garberi LESQ. et JAMES	–	–	–	–	–	–	–	40	100	60	–	–	–	–	–	–	60	40	40	–
D. stomatodontus (CARD.) WILL.	–	–	–	40	–	–	–	40	100	40	–	–	–	–	–	–	100	100	–	–
Dicranella harrisii (C. M.) Broth.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
D. herminieri BERCH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Fabronia wrightii SULL.	–	–	–	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Fissidens asplenioides HEDW.	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
F. dissitifolius SULL.	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
F. duryae BIZ.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–
F. garberi LESQ. et JAMES	–	–	–	60	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–
F. polypodioides HEDW.	–	80	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
F. radicans MONT.	–	–	–	40	–	–	–	40	–	–	–	60	40	–	–	–	40	60	–	–
F. similiretis SULL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
F. vardei THÉR.	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
F. weizii MITT.	–	100	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Funaria calvescens SCHW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Groutalla apiculata (HOOK.) CRUM et STEERE	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
G. mucronifolia (HOOK. et GREW.) CRUM et STEERE	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
G. wagneriana (C. M.) CRUM et STEERE	–	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Haplocladium microphyllum (HEDW.) BROTH.	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–
Helicophyllum torquatum (HOOK.) BRID.	–	–	–	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Holomitrium marginatum MITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Hookeria acutifolia HOOK. et GREW.	–	40	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Hookeriopsis falcata (HOOK.) JAEG.	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
H. guadelupensis (BRID.) JAEG.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
H. incurva (HORNCH.) BROTH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 25 Continued 72

No. of communities	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Number of relevés:	11	10	5	5	5	10	11	10	10	5	10	10	5	5	10	5	5	5	5	10
Hymenostylium recurvirostra (HEDW.) DIX.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Hyophila tortula (SCHW.) HPE.	–	–	–	–	–	40	40	40	60	60	40	60	–	–	–	–	–	–	–	–
H. subcucullata WILL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Hypopterygium tamarisci	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Hypnum polypterum (MITT.) BROTH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	70
Isodrepanium lentulum (WILS.) BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100
Isopterygium tenerum (SW.) MITT.	–	–	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
I. micans (SW.) KUNTH	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	–	–	60	30
I. rufisetulum (C. M.) PAR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Lepidopilium aureofulvum C. M.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
Lepyrodontopsis trichophylla (HEDW.) BROTH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
Leucobryum albicans (SCHW.) KINDB.	–	–	–	–	–	–	–	–	–	–	–	–	60	100	–	–	–	–	40	–
L. albidum (BRID.) KINDB.	–	–	–	–	–	–	–	–	–	–	–	–	80	100	40	60	–	–	–	70
L. crispum C. M.	–	–	–	–	–	–	–	–	–	–	–	–	100	100	40	80	–	–	–	–
L. giganteum C. M.	–	–	–	–	–	–	–	–	–	–	–	–	40	100	40	40	–	–	–	100
L. polakowskyi (C. M.) CARD.	–	–	–	–	–	–	–	–	–	–	–	–	100	100	100	100	–	–	–	100
Leucoloma albidum (SULL.) JAEG.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50
L. schwaneckeanum (HPE.) BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
L. serrulatum BRID.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100
Macromitrium cirrhosum (HEDW.) BRID.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
M. harrisii PAR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
M. jamaicense MITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
M. schwaneckeanum HPE	–	–	–	–	–	–	–	–	–	–	–	–	–	40	80	–	–	–	–	30
Meteoriopsis patula (HEDW.) BROTH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100
Mittenothamnium diminutivum (HPE) BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

No. of communities	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Number of relevés:	11	10	5	5	5	10	11	10	10	5	10	10	5	5	10	5	5	5	5	10
Hymenostylium recurvirostra (HEDW.) DIX.	–	–	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Hyophila tortula (SCHW.) HPE.	–	–	–	60	–	–	–	–	80	40	40	60	–	–	–	–	40	40	40	–
H. subcucullata WILL.	–	–	–	–	–	–	40	–	–	40	–	–	–	–	–	–	–	–	–	–
Hypopterygium tamarisci	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Hypnum polypterum (MITT.) BROTH.	–	100	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Isodrepanium lentulum (WILS.) BRITT.	–	60	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Isopterygium tenerum (SW.) MITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
I. micans (SW.) KUNTH	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
I. rufisetulum (C. M.) PAR.	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Lepidopilium aureofulvum C. M.	–	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Lepyrodontopsis trichophylla (HEDW.) BROTH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Leucobryum albicans (SCHW.) KINDB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
L. albidum (BRID.) KINDB.	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
L. crispum C. M.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
L. giganteum C. M.	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
L. polakowskyi (C. M.) CARD.	–	60	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Leucoloma albidum (SULL.) JAEG.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
L. schwaneckeanum (HPE.) BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
L. serrulatum BRID.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Macromitrium cirrhosum (HEDW.) BRID.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
M. harrisii PAR.	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
M. jamaicense MITT.	–	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
M. schwaneckeanum HPE	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Meteoriopsis patula (HEDW.) BROTH.	–	100	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Mittenothamnium diminutivum (HPE) BRITT.	–	–	–	–	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 25 Continued 73

No. of communities	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Number of relevés:	11	10	5	5	5	10	11	10	10	5	10	10	5	5	10	5	5	5	5	10
M. reptans (HEDW.) CORD.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–	–	–	–	60
Neckeropsis disticha (HEDW.) KINDB.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
N. undulata (HEDW.) REICHARDT	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Octoblepharum albidum HEDW.	–	–	100	100	80	40	40	40	–	–	–	–	–	–	–	–	–	–	–	–
Papilleria imponderosa (TAYL.) BROTH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
P. nigrescens (HEDW.) JAEG.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Philonotis glaucescens	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	30
P. sphaericarpa (HEDW.) BRID.	–	–	–	–	–	–	–	–	–	80	–	–	–	–	–	–	–	–	–	40
Phyllogonium fulgens (HEDW.) BRID.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	–	100
Pilotrichella flexilis (HEDW.) JAEG.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	90
P. hexasticha (SCHW.) JAEG.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Pilotrichum affine (HOOK.) BRID.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
Pilotrichidium brunnescens (SCHIMP.) BERCH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–
Pirella cymbifolia (SULL.) CARD.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P. filicina	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
P. pachyclada R. C.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Pogonatum flexuosum (C. M.) BROTH.	–	–	–	–	–	–	–	–	–	–	–	–	–	40	100	–	–	–	–	–
P. tortile P. DE B.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–	–	–	30
Polytrichum juniperinum HEDW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
Porotrichum insularum MITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Prionodon dentatus (HEDW.) C. M.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Pseudocryphaca flagellifera (BRID.) BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Rhacopilum tomentosum (HEDW.) BRID.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Rhaphidorrhynchium xylophyllum MITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40

No. of communities	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Number of relevés:	11	10	5	5	5	10	11	10	10	5	10	10	5	5	10	5	5	5	5	10
M. reptans (HEDW.) CORD.	–	100	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Neckeropsis disticha (HEDW.) KINDB.	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
N. undulata (HEDW.) REICHARDT	–	–	–	60	100	100	100	–	–	–	–	40	–	–	–	–	–	–	–	–
Octoblepharum albidum HEDW.	–	–	–	–	60	100	80	100	100	60	40	40	–	–	–	–	40	40	–	–
Papilleria imponderosa (TAYL.) BROTH.	–	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P. nigrescens (HEDW.) JAEG.	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Philonotis glaucescens	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P. sphaericarpa (HEDW.) BRID.	–	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Phyllogonium fulgens (HEDW.) BRID.	–	100	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Pilotrichella flexilis (HEDW.) JAEG.	100	80	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P. hexasticha (Schw.) Jaeg.	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Pilotrichum affine (HOOK.) BRID.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Pilotrichidium brunnescens (SCHIMP.) BERCH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Pirella cymbifolia (SULL.) CARD.	–	–	–	–	–	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–
P. filicina	–	–	–	–	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–
P. pachyclada R. C.	–	–	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Pogonatum flexuosum (C. M.) BROTH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
P. tortile P. DE B.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Polytrichum juniperinum HEDW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Porotrichum insularum MITT.	–	–	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Prionodon dentatus (HEDW.) C. M.	–	100	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Pseudocryphaca flagellifera (BRID.) BRITT.	–	–	–	40	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–
Rhacopilum tomentosum (HEDW.) BRID.	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Rhaphidorrhynchium xylophyllum MITT.	–	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 25 Continued 74

No. of communities	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Number of relevés:	11	10	5	5	5	10	11	10	10	5	10	10	5	5	10	5	5	5	5	10
Rhizogonium spiniforme (HEDW.) BUCH	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	70
Rhynchosteropsis flexuosa (SULL.) C. M.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
Rhynchostegium serrulatum	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
Schlotheimia torquata (HEDW.) BRID.	–	–	–	40	–	–	–	–	–	–	–	–	100	100	60	100	–	–	–	40
Sematophyllum caspitosum (HEDW.) MITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50
S. galipense (C. M.) MITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50
S. lamprophyllum MITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	90
Sematophyllum sericifolium MITT.	–	–	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
Squamidium leucotrichum (TAYL.) BROTH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
S. nigricans (HOOK.) BROTH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
Stenodictyon pallidum BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
Stereophyllum cultelliforme	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
S. leucostegium (BRID.) MITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
S. radiculosum (HOOK.) MITT.	–	–	60	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Syrrhopodon flavescens C. M.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	50
S. floridanum SULL.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
S. gaŭdichaŭdi MONT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
S. hiorami BIZ. et THÉR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
S. hobsoni H. et G.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
S. lycopodioides (BRID.) C. M.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
S. prolifer SCHW. JR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40
S. tenuifolius (SULL.) MITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–	–	40	–
Taxithelium planum (BRID.) MITT.	–	–	40	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	40	–
Thuidium acuminatum MITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	60	40	–	–	–	80	100
T. involvens (HEDW.) MITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tortella caspitosa-humilis (HEDW.) JENM.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Lf	Ge	No. of communities			21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
		Number of relevés:			11	10	5	5	5	10	11	10	10	5	10	10	5	5	10	5	5	5	5	10
Rhizogonium spiniforme (HEDW.) BUCH	–	100	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Rhynchostepropsis flexuosa (SULL.) C. M.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Rhynokastegium serrulatum	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Schlotheimia torquata (HEDW.) BRID.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Sematophyllum caspitosum (HEDW.) MITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
S. galipense (C. M.) MITT.	–	–	–	–	40	40	–	–	–	80	–	–	–	–	–	–	–	–	–	40	–	–	–	–
S. lamprophyllum MITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Sematophyllum sericifolium MITT.	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Squamidium leucotrichum (TAYL.) BROTH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
S. nigricans (HOOK.) BROTH.	–	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Stenodictyon pallidum BRITT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Stereophyllum cultelliforme	–	–	–	100	40	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
S. leucostegium (BRID.) MITT.	–	–	–	100	40	–	60	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–
S. radiculosum (HOOK.) MITT.	–	–	–	100	80	40	40	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Syrrhopodon flavescens C. M.	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
S. floridanum SULL.	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
S. gaŭdichaŭdi MONT.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
S. hiorami BIZ. et THÉR.	–	–	–	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
S. hobsoni H. et G.	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
S. lycopodioides (BRID.) C. M.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
S. prolifer SCHW. JR.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
S. tenuifolius (SULL.) MITT.	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Taxithelium planum (BRID.) MITT.	–	–	–	100	–	–	–	60	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Thuidium acuminatum MITT.	80	60	60	40	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
T. involvens (HEDW.) MITT.	–	–	–	60	40	80	40	80	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Tortella caspitosa-humilis (HEDW.) JENM.	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Table 25 Continued 75

No. of communities	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Number of relevés:	11	10	5	5	5	10	11	10	10	5	10	10	5	5	10	5	5	5	5	10
Tortella mollissima BROTH.	–	–	–	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–
Tortula agraria SW.	–	–	40	40	40	40	40	40	40	60	40	80	–	–	–	–	–	–	–	–
Trichostomium involutum SULL.	–	–	40	100	100	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Vesicularia crassicaulis (MITT.) BROTH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	60	–
V. vericularis (SCHW.) BROTH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	30
Weisia controversa HEDW.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Lf	Ge	No. of communities	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
		Number of relevés:	11	10	5	5	5	10	11	10	10	5	10	10	5	5	10	5	5	5	5	10
		Tortella mollissima BROTH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
		Tortula agraria SW.	40	40	80	60	40	100	60	–	–	–	–	–	–	–	–	80	40	40	–	–
		Trichostomium involutum SULL.	40	–	–	–	80	40	40	100	100	40	40	–	–	40	60	80	–			
		Vesicularia crassicaulis (MITT.) BROTH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
		V. vesicularis (SCHW.) BROTH.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
		Weisia controversa HEDW.	–	–	–	–	–	–	40	–	–	–	–	–	–	–	–	–	–	–	40	–

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MAGYAR TUDOMÁNYOS AKADÉMIA KÖNYVTÁRA



MAGYAR
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Strangler fig and epiphytic bromeliads *(Ficus crassinervis* and *Hohenbergia penduliflora)* on a giant *Bombacopsis cubensis* tree in a coastal semi-deciduous forest in the "El Veral" Nature Conservation Area, Guanahacabibes Peninsula (Photo: A. Borhidi)



Secondary savanna with groups of the endemic *Gastrococos crispa* palm, on serpentine in Villa Clara Province (Photo: A. Borhidi)



Dry evergreen littoral thicket on the dog-tooth limestone area of Maisi, with *Melocactus acunae* and emergent *Pilosocereus brooksianus* cacti. (Photo: A. Borhidi)



Dry evergreen littoral forest with *Thrinax radiata* and *Coccoloba uvifera* on the Guanahacabibes Peninsula (Photo: A. Borhidi)



Laplacea angustifolia, a dominant tree of the montane rainforests of the Sierra Maëstra (Photo: A. Borhidi)



Elfin thicket on the northern ridge of the Turquino Peak at about 1800 m above sea level
(Photo: T. Pócs)



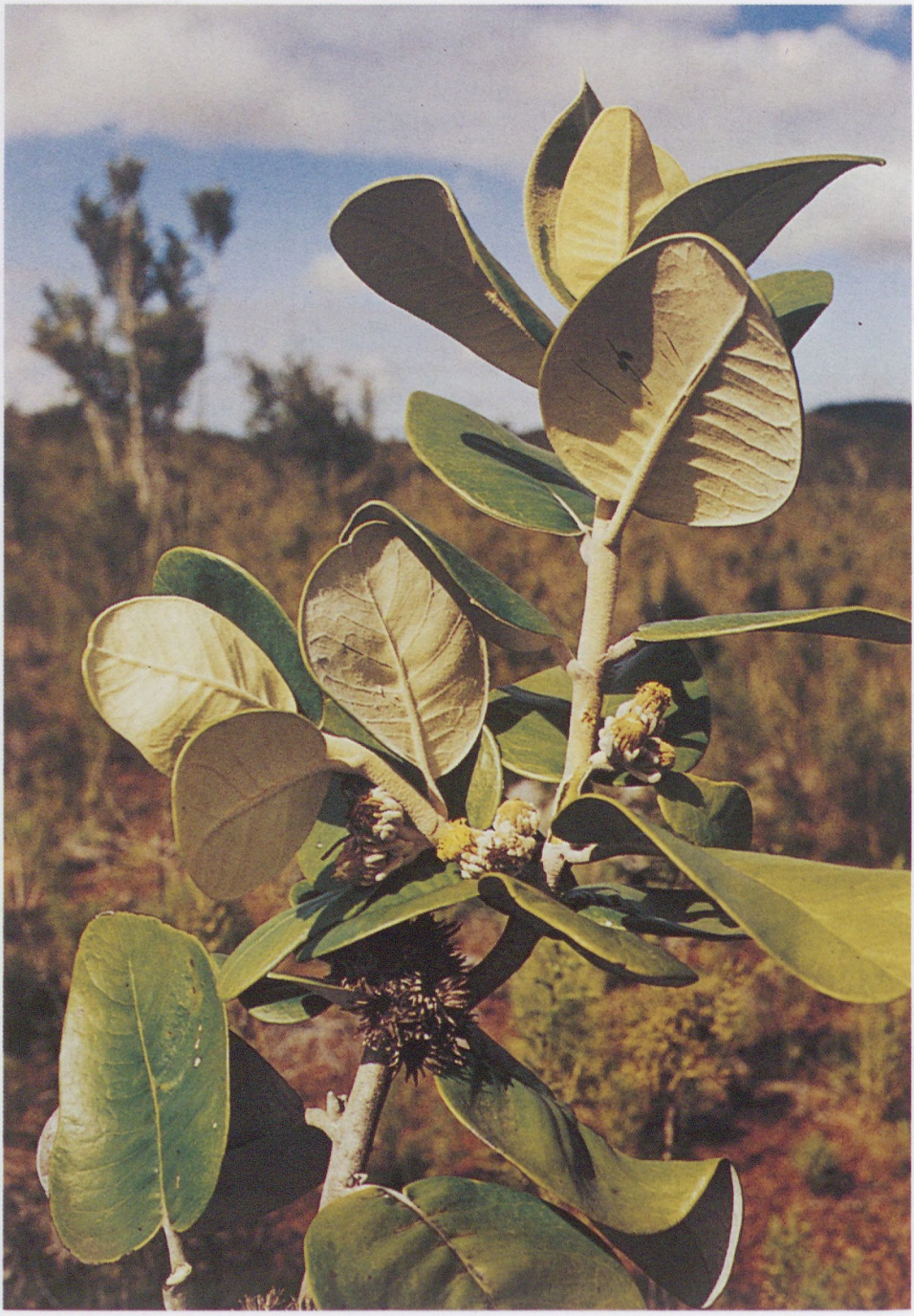
Pine forest of *Pinus caribaea* on the serpentine ferritic soils of Mt. Cajalbana, West Cuba
(Photo: A. Borhidi)



Submontane rainforest in the Yara Valley of the Sierra Maëstra near to Bayamo (Photo: T. Pócs)



Jacaranda cowellii, a leptophyllous dwarf shrub of the serpentine thickets in the surroundings of Holguin (Photo: A. Borhidi)



Shafera platyphylla, a monotypic endemic genus of Asteraceae characteristic element of the montane serpentine pine forests of the Moa-Toa range in East Cuba (Photo: A. Borhidi)



Erythrina standleyana, a beautiful shrub of the littoral thickets of the Guanahacabibes Peninsula (Photo: A. Borhidi)



Dichrostachys cinerea an invading African savanna shrub forming secondary thickets on overgrazed pastures (Photo: A. Borhidi)



Montane rainforest on the Real Peak of the Turquino group at 1900 m above sea level with a second canopy formed by tree ferns. (Photo: A. Borhidi)



Isolated "haystack hill" in the conic karst mountain of Sierra de los Organos, near Viñales
(Photo: A. Borhidi)



Mangrove of *Rhizophora mangle* in a lagoon at the southern foot of the Sierra Maestra near Uvero
(Photo: A. Borhidi)



Serpentine thicket (with reddish-brown colour) with *Coccothrinax roseocarpa* and semi-deciduous limestone forest (green, in the background) in Matanzas Province. (Photo: A. Borhidi)

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679798

MAGYAR TUDOMÁNYOS AKADÉMIA KÖNYVTÁRA

CUBA

Map of the natural potential vegetation

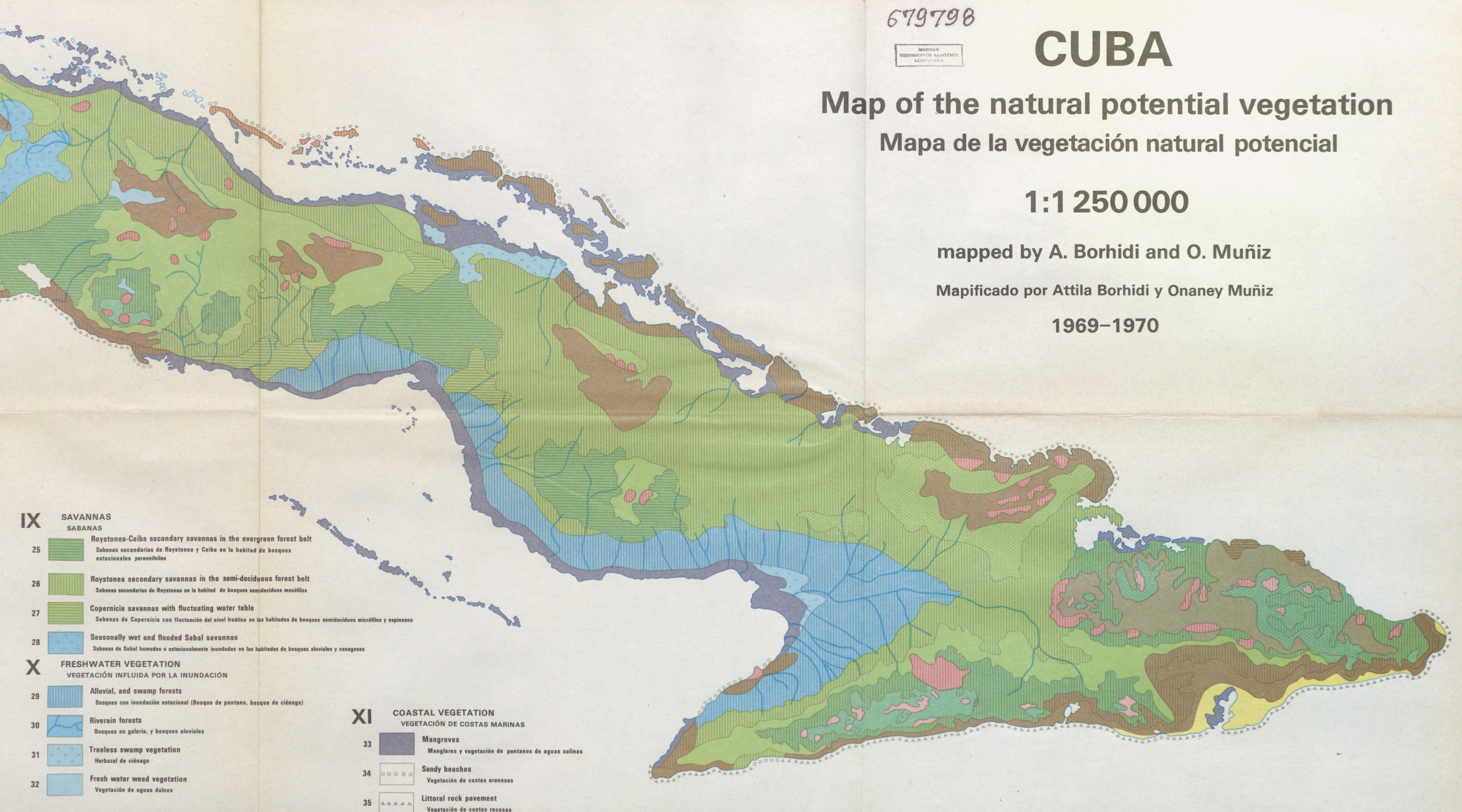
Mapa de la vegetación natural potencial

1:1 250 000

mapped by A. Borhidi and O. Muñiz

Mapificado por Attila Borhidi y Onaney Muñiz

1969–1970



IX SAVANNAS
SABANAS

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Sabanas secundarias de Roystonea y Ceiba en la habitad de bosques estacionales perennifolios

26 Roystonea secondary savannas in the semi-deciduous forest belt
Sabanas secundarias de Roystonea en la habitad de bosques semideciduos mesófilos

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Sabanas de Sabal humedas o estacionalmente inundadas en las habitades de bosques aluviales y cenagosas

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Herbazal de ciénaga

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VEGETACIÓN DE COSTAS MARINAS

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35 Littoral rock pavement
Vegetación de costas rocosas

KV. Bp. 638436



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Pluvisilvas submontanas

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Pinares de zonas pizarras y areniscas con Pinus tropicalis y Pinus caribaea

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23 Pinus cubensis forest on serpentine
Pinares de zonas serpentinosas con Pinus cubensis

24 Montane tree fern-pine forest
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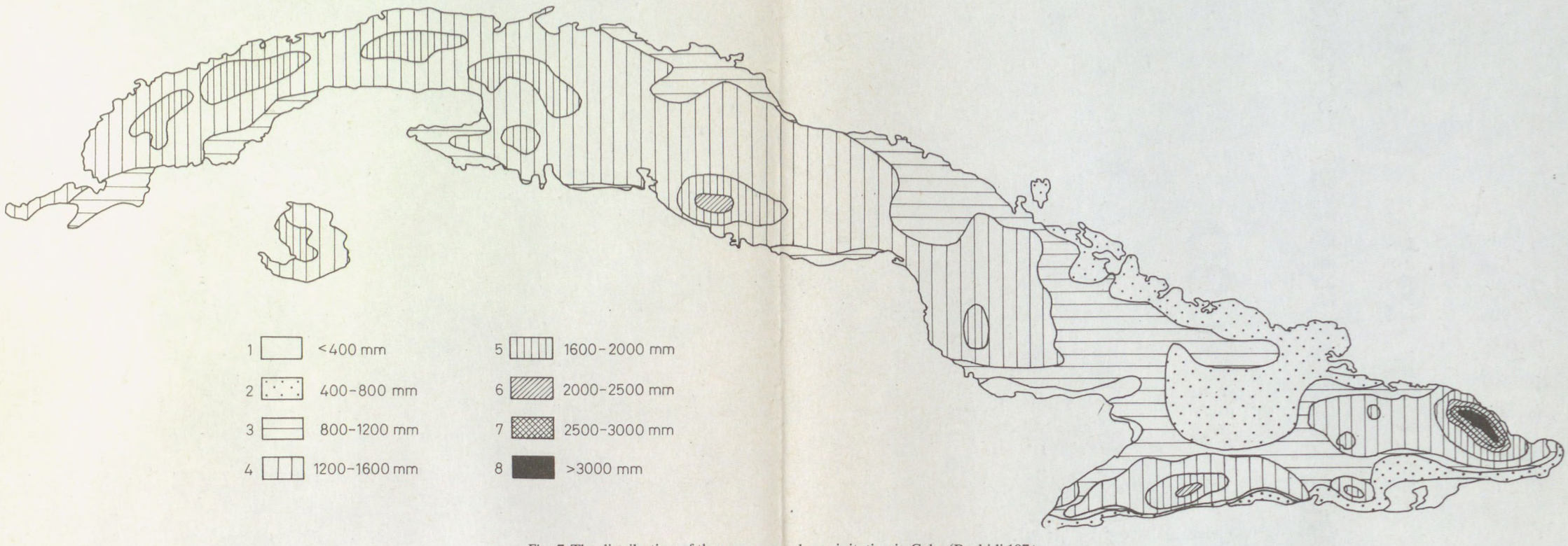

Fig. 7 The distribution of the mean annual precipitation in Cuba (Borhidi 1974,

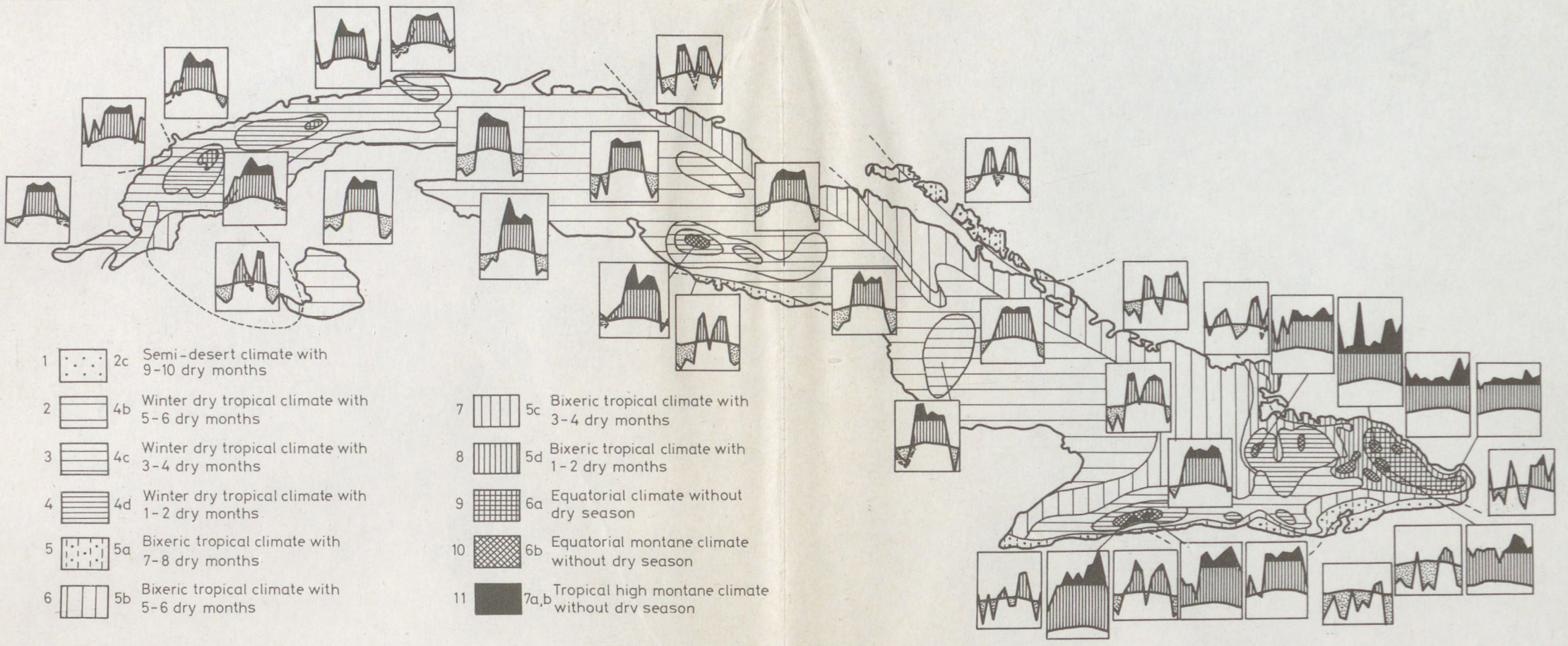

Fig. 23 The bioclimatic map of Cuba, (Borhidi 1974)

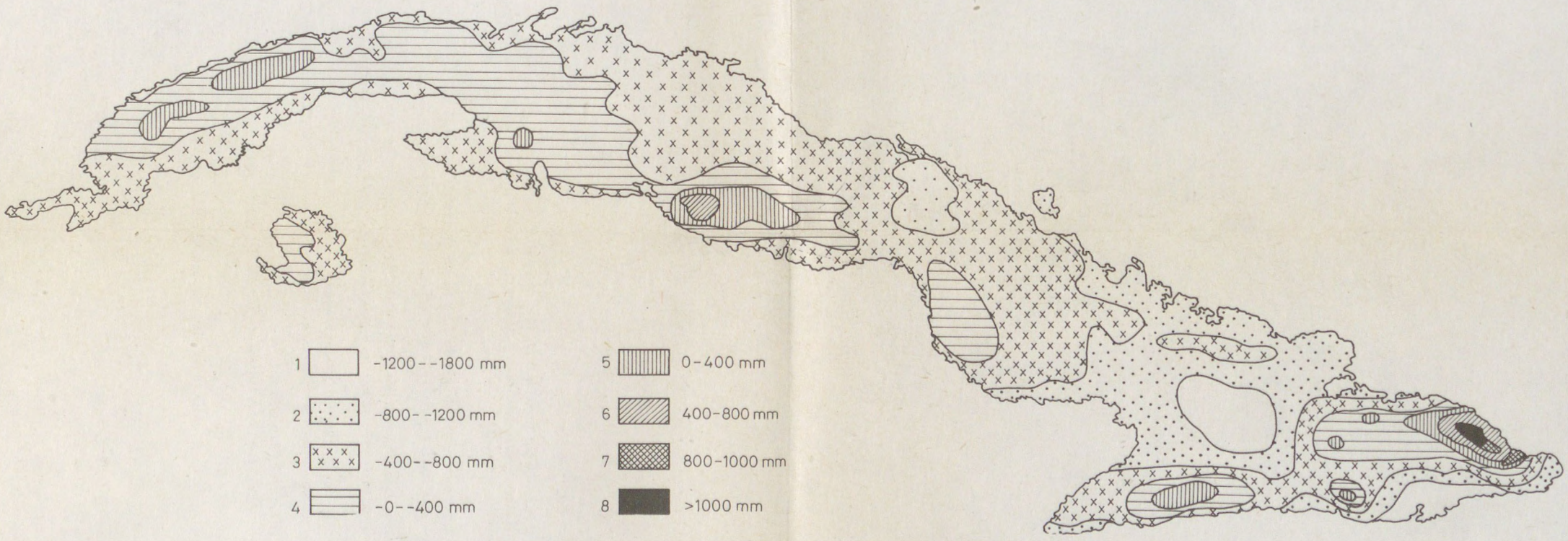

Fig. 49 The climatic water-balance (precipitation — evaporation) in Cuba (Borhidi 1970)

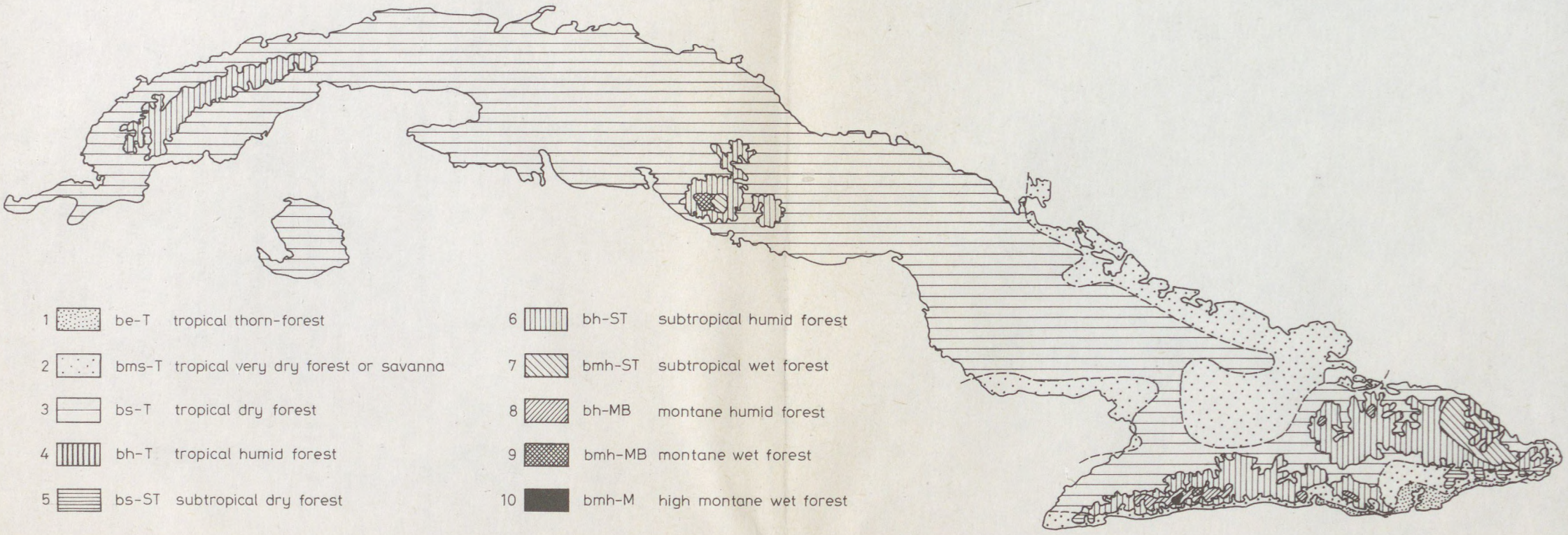

Fig. 50 The ecological map of Cuba according to Holdridge's life-zone system (Borhidi 1970, unpubl.)

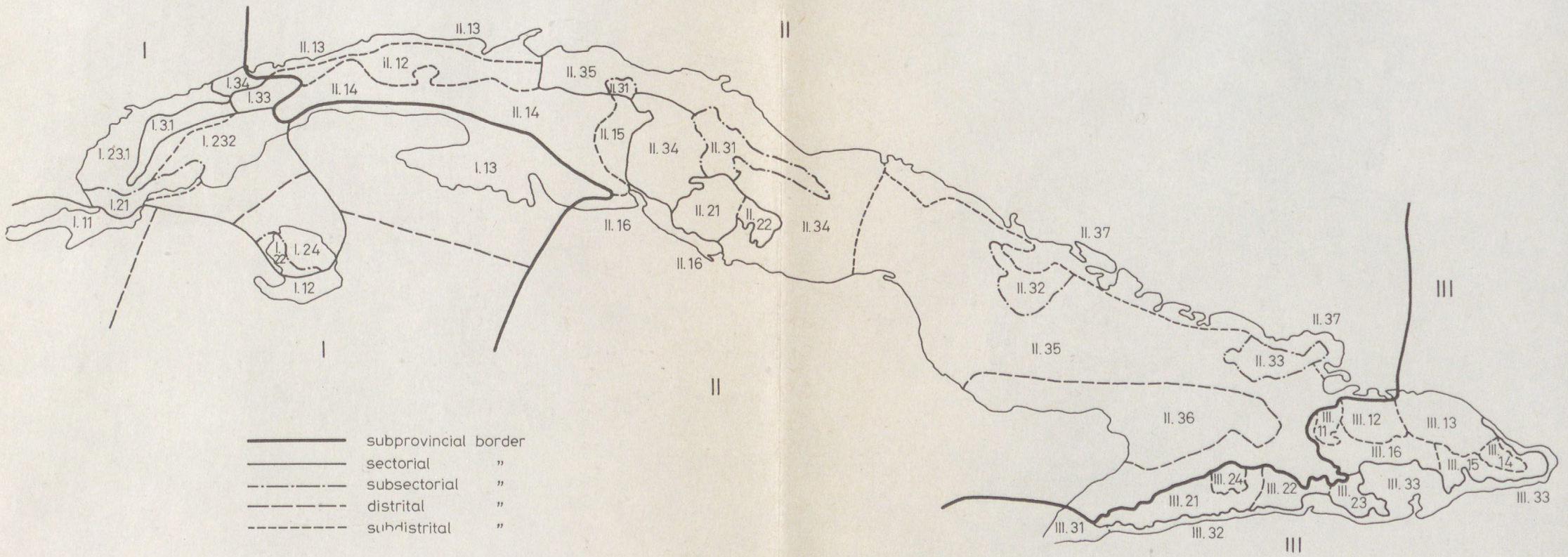

Fig. 140 Phytogeographical regions of Cuba (Borhidi and Muñiz 1970).