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G. ANDREÁNSZKY

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INTRODUCTION

Situated in the southeastern outskirts of the town of Eger, the clay pit of the Wind brickworks is a vast exposure well visible even from a distance of several kilometres. The general dip of its sedimentary series is south-southeasterly; hence, the oldest strata are exposed in the northern corner of the pit and the younger ones towards the south. Many layers contain plant remains which may, particularly in the younger layers, locally attain so great an abundance that the individual fossils cannot even be separated from one another. This circumstance renders their study fairly difficult on occasion.

So far, this site has yielded several thousands of more or less well-preserved plant fossils, not all of which, however, have been thoroughly examined as yet. Even the present study, intended as a first detailed presentation of the material, must be restricted to the analysis of the plant remains of the lower groups of strata; it should be noted, however, that this analysis does not by far cover all the imprints furnished by those two groups. As to the vegetal ensemble of the uppermost group of strata, its study has not yet progressed so far as to justify a monographic treatment.

The relative ages of the individual layers are unequivocally fixed by the circumstance of their continuous and conformable deposition. This not only offers a basis for dating the individual levels but also permits to decipher from the succession of strata a history of the flora and of the climate.

Mention should be made as early as this of the difficulties and uncertainties the author had to face when outlining the evolution of flora and climate. The study of the Wind Brickyard flora strikingly illustrates the basis conflict which underlies the floral history of the entire Hungarian Tertiary: the struggle of the so-called Poltavian flora, of a tropical colour, a remnant from the early Tertiary or before, with the so-called Turgayan flora which, in turn, represented a more temperate climate and was then gradually gaining ground in the area. Of these two, the Poltavian flora still predominated in the period we are concerned with, but had lost its supremacy by the time the uppermost strata came to exist. However, the process of its replacement was far from monotonous: the waves of the Turgayan invasion were interrupted by phases of retreat. Consequently, the abundance ratios of the two elements cannot, except with certain reservations, be regarded as a measure of floral evolution. This is one of the difficulties. Moreover, one and the same association of Turgayan elements may have recurred in several subsequent waves. Plant species appeared and spread, then grew scarce or became extinct, only to reappear and thrive in abundance in some later phase.

This fluctuation of the Poltavian and Turgayan species may have been due to climatic as well as phyto-sociological factors. In consequence, the presence or absence of a species, rather than possessing a stratigraphic value, carries at least an ecologic implication. Hence, in the case of the Wind Brickyard flora, the guideline for establishing trends of floral evolution is the order of succession of the strata; the floral changes, on the other hand, provide a fairly accurate picture of the changes of the environment from one layer to the next.

Another difficulty inherent in the study of the flora under discussion is that it contains many types whose next living relations, if any, now thrive in faraway countries. Moreover, a given leaf form and venation may be characteristic of several different genera not necessarily belonging to the same family. Hence, firstly, the determination of a genus is often uncertain and, secondly, no reliable basis exists for establishing territorial affinities. These problems might be solved by cuticle examination. Unfortunately, the fossils found in the Wind Brickyard pit are almost exclusively imprints lacking any leaf tissue, and the rests of organic material, if any, have lost their structure, owing to an uncommonly thorough carbonization. Pollen analysis is another possible auxiliary technique. As far as the Oligocene and the Lower Miocene are concerned, however, pollen analysis has not yet reached the stage at which it may safely correlate pollen forms with the remains of other plant organs. Hence, most pollen forms exist independently of plant species and genera. Nevertheless, attempts at a correlation are constantly being undertaken, in particular also concerning the Wind Brickyard flora.

At any event, the results presented in this volume are liable to some degree of error in spite of the author's efforts at examining the imprints thoroughly in all possible respects and at comparing them with specimens of living plants in the accessible herbaria.

TERTIARY FLORAS OF THE ENVIRONS OF EGER

Of all the regions of Hungary, the environs of Eger are the richest in Tertiary floras. This circumstance suggests that conditions extremely favourable to fossilization frequently prevailed here. In addition, the region used to be a littoral or coastal strip for protracted periods. River deltas, repeatedly developed in the area, accumulated vast amounts of vegetal matter prone to fossilization.

In the environs of Eger, the oldest Tertiary plant remains are those found in the shale of Kiseged Hill. These strata are considered of Lower Oligocene age. On Kiseged Hill, the Eocene also crops out, but it contains animal fossils only. The "Buda marl" also present, already exhibits some plant fossils. (The term Buda marl represents a facies rather than a stratigraphic unit and is not necessarily Eocene.) As its vegetal fossils do not differ in any way from the plants of the overlying Lower Oligocene shale, the Buda marl is considered Lower Oligocene in this region. It is overlain by shale strata containing the richest and most varied Lower Oligocene flora of Hungary. The embedding rock is fine-grained, indicative of deposition in a sea of some depth. As the leaf fossils of these beds are smooth and undamaged, the fine grain suggests a slow sedimentation rather than a long transport, and a deposition far offshore.

The overlying layers of southeasterly dip constitute a succession conformable with the strata of the Wind Brickyard, which latter lies approximately south of Kiseged Hill. Between the two sites, there are but a few localities with sparse vegetal fossils, such as the clay pit of the brickworks in the Vécsey-Valley near Eger, or, still farther, on the Nagyimány, near Noszvaj. The plants of these occurrences will be discussed later. Locally, the fossils occur in the "Kiscell clay", the colour of which is mostly grey. Strata bearing a noteworthy assemblage of vegetal fossils have been disclosed at the northern corner of the clay pit of the Wind Brickyard. These lower strata of the pit are designated X_2. Proceeding southwards in the clay pit, one soon reaches another group of strata which has also produced plant fossils. This is the middle group of strata designated W_2. The plants embedded in the so-called "stone loaves" are considered to belong equally to the flora of the middle strata. The "stone loaves", hard silicified concretions lying in the barren horizon between the middle and upper strata, are usually exposed by the clay mining operations. Doubtlessly older than the strata which include them, they contain a vegetal material of the same approximate age as the middle fossiliferous strata marked W_2.

Distinct as it is from the flora of the lower strata, the middle flora differs much less from its predecessor than the flora of the upper strata differs from both. This latter, separated from the W_2 group by several barren layers, will be called "upper flora" in the following. The two lower groups of strata contain limited quantities of vegetal fossils; the imprints are generally scattered one by one, with the exception of the "stone loaves" in which they are more abundant. In the upper strata the imprints tend to occur *en masse*.

The layers containing the upper Wind Brickyard flora are indicative of changed conditions of sedimentation. The fossils are mostly embedded in a very fine-grained clay, mostly greyish, but yellow near the surface where its iron content is oxidized. In places the strata are coarser, sandier.

There are also sands turned into sandstones by a siliceous cement. Poorly preserved plant remains embedded in sandstone occur, among other sites, also north of the village Andornaktálya, some kilometres south of Eger, as well as within the bounds of the community Demjén. Unfortunately, the plant fossils tend to be poorly preserved in all these coarse-grained deposits. Moreover, the leaves are stacked up in large numbers, which circumstance renders them fairly difficult to study.

The age of the Wind Brickyard series is a much-discussed problem. The present author does not wish to make any essential contribution to this discussion as long as the full evaluation of the material is still pending. He only wishes to state for the present that he considers the lower and middle floras Oligocene in any case, on account of their obvious connexions with the Lower Oligocene flora of Kiseged Hill. The upper flora may rather arbitrarily be located somewhere around the Oligocene-Miocene limit, that is, in the highest Chattian or lowest Aquitanian. It does not agree with any of the floras regarded as typically Aquitanian (e.g. that of the Zsil Valley) to such an extent as would justify the assumption of their absolute contemporaneity.

In the present study the author does not wish to proceed beyond correctly establishing the age of the Wind Brickyard flora at least in its relation to the other floras of the region of Eger. For this purpose, a sound basis is provided by the succession of the sedimentary layers. Consequently, the results here presented may be considered definitive, all the more so since identical results were obtained along the safe path of floral evolution.

Above the uppermost flora-bearing strata of the Wind Brickyard, the continuity of desposition is broken, and the above-described deposits are unconformably overlain by Helvetian (perhaps Burdigalian) tuffs whose continuation may be traced towards the south to the village of Andornaktálya.

Around Tihamér village these strata locally contain interbeddings of diatomaceous earth. Tuff and diatomaceous earth both include in many places Helvetian plant fossils (e.g. at Eger-Tihamér, in several sites at Andornaktálya). Since however there are no vegetal fossils in the rhyolite tuff directly overlying the Wind Brickyard strata, it is uncertain whether this tuff was due to the same paroxysm of eruption as the tuff containing the vegetal fossils.

Plant remains have been found also in the Helvetian strata at Fertővölgy, situated southwest of Eger (Udvarházy 1938; Andreánszky—Novák 1957). Lately, these strata have not yielded further imprints and can be considered as exhausted.

The relative ages of the Helvetian floras of the Eger region (Eger—Tihamér; Andornaktálya—Rákóczi-Street; Andornaktálya—Pincevölgy; Savósvölgy, Fertővölgy) have not yet been cleared up. The floras from the various sites differ considerably, and it could not be established so far whether this is due to age differences or to the preservation of different plant communities of the same flora in the individual sites.

The Tortonian, which succeeds the Helvetian, is not represented in the environs of Eger by flora-bearing strata; neither is the lowest Sarmatian. From the middle of the lower Sarmatian, onwards, however, sandstones very rich in vegetal fossils are known at some distance from Eger, in a region higher upcountry (Egerszólát, Egerbocs, Mikófalva, Dédestapolcsány, Bánfalva and Sály); silicified wood trunks of this same age are scattered as far down as Eger, the centre of their spread being Mikófalva. Vegetal fossils from the upper part of the lower Sarmatian are only found farther north, especially in the neighbourhood of Bánhorváti. This so-called "Bánhorváti" flora group extends westwards to Uppony and Sajómercse, southwards to Dédestapolcsány and the Harica Valley, eastwards to Diósgyőr and northwards to Sajókaza and Vadna.

An early Upper Sarmatian site extremely rich in fossils is that of Felsőtárkány quite near to Eger, at the foot of the Bükk mountains. The flora-bearing strata of Felsőtárkány extend from there to the north and northwest of Eger, being, however, much poorer in fossils everywhere else.

The site which has yielded the Sarmatian flora richest in species of the entire region is situated at a distance of about 25 kilometres north of Eger in the bound of the village Balaton. The flora, embedded in rhyolite tuff, belongs to the upper part of the Upper Sarmatian. The rhyolite-tuff flora of the Szelecsi Valley is considered as being of the same age.

The rare Pliocene sites of the region are also very poor. Of these that of Kerecsend, southwest of Eger, is worth mentioning.

A SURVEY OF PREVIOUS WORK ON THE UPPER OLIGOCENE FLORAS OF HUNGARY

THE ABUNDANT flora of the strata exposed in the Wind Brickyard has been known to science for more than hundred years. Nevertheless, little attention was paid to the exploitation of this extremely rich material; only accidental collections of minor importance were studied in detail. In older times, any such work was performed almost exclusively by foreign authors.

It was the merit of the late F. Legányi, research fellow of the "Dobó István" Museum of Eger, to have constantly followed for several decades the fates of this site. As the exploitation of the clay progressed, he saved an immense material during this period. In the beginning, he did so entirely on his own, having only later received a commission from the Museum of Eger. So it would be unfit to say that systematic collection has but quite recently been commenced, since Legányi's systematic activity goes back to several decades. Still, a more or less thorough study of the flora did not start until 1948 when the Institute of Taxonomical Botany of Budapest University assumed a kind of custodianship over the site and took the initiative of examining in detail the collected material. The focal point of this latter activity was transferred subsequently to the Botanical Department of the Museum of National History, Budapest. The majority of the collected material is kept at the Institute of Taxonomical Botany of Budapest University, at the Botanical Department of the Museum of Natural History, and at the "Dobó István" Museum of Eger. A fairly important material collected by various persons is preserved at the State Geological Institute.

After a few sporadic early communications the present author published some details about the Wind Brickyard flora (Andreánszky 1949a, 1949b, 1955, 1956 and 1962) limiting himself to the description of certain fossil remains. Pálfalvy (1951) also commented on some stratigraphic and other features of the flora. The above-mentioned papers covered only a small fraction of the flora, mostly dealing with species selected at random, although an attempt was made to treat in detail the *Myrica* species (Andreánszky 1955). To illustrate the enormous growth of the collection since that time, as well as the scantiness of the material then available, let us note that, not later than in 1962, a further *Myrica* species came to be described, and in the present study the author proposes to establish two more, likewise from the Wind Brickyard flora.

Also, the data previously recorded are often in want of a revision. The author wishes to rely also in the present study upon the data which are to be considered trustworthy, but does not intend to carry out a revision of the uncertain data prior to the monographic treatment of the entire collected material.

Until now 2 horsetails, 5 ferns, 4 conifers, 43 dicotyledons and 3 palm species have been published (not counting uncertain species). Ettingshausen's plants (1854) are not included in these figures. First of all, he enumerated genera only and, secondly, available evidence is insufficient to identify those of his fossils which were derived from the clay pit of the Wind Brickyard, as Ettingshausen only stated them to have come from the region of Eger. In Hungary, few floras are considered more or less contemporaneous with the Wind Brickyard flora. The flora of Csörög near Vác (Vitális—Zilahy) might be one of these. However, the flora of Kigyó Hill near Csörög shows so few identical features with the Wind Brickyard flora that it is futile even to attempt a detailed comparison. One of the most frequent remains at Csörög is the samara of *Engelhardtia*, a fossil very rare in the Wind Brickyard flora. It is interesting to note that *Asplenium matrense* Andreánszky has been found both at Csörög and Mátraderecske. The two fossils are presumably of the same age. This fern has not so far turned up at the Wind Brickyard.

The Wind Brickyard strata must be considered positively contemporaneous with the already mentioned sandstone layers of the region of Eger, some of which crop out in the bounds of Andornaktálya on the one hand, and of Demjén on the other. These layers are characterized by the extraordinary abundance of *Cinnamomum* leaves. A beautiful leaf of *Sassafras* (to be discussed later) also cropped up; otherwise the flora is remarkable for the small number of its species.

The relations between the remains known from the Wind Brickyard and from the neighbourhood of Salgótarján are far from clear. Some of the fossils from the environs of Salgótarján and Kisterenye might be Burdigalian, but it is by no means impossible that they are closer in age to the Wind Brickyard flora. From Kisterenye, too, we know *Quercus gigantum* Ett., a species fairly frequent in the lower and middle Wind Brickyard floras; there, too, remains of *Cinnamomum* abound; still, no closer relation to the Wind Brickyard flora could be established as yet.

The flora of Ipolytarnóc, also very rich, presents a somewhat similar situation. I consider it Burdigalian on account of its decidedly younger overall aspect; nevertheless, I wish to reserve judgment until it will become known in detail. However, even in recent literature, one finds but a fairly short description of the Ipolytarnóc flora (Rásky 1959).

NEW CONTRIBUTIONS TO THE KNOWLEDGE OF THE WIND BRICKYARD FLORA

IN THE following, the author proposes, on the one hand, to enumerate the species recently identified and, on the other, to make some comments concerning certain species already known. However, in order to provide a complete image of the flora, the taxonomic enumeration below shall include all the species hitherto known from the Wind Brickyard flora, as well as the data relative to their publication.

PTERIDOPHYTA

EQUISETINAE

Equisetum braunii Ung. ex Heer, Fl. tert. Helv. I. 44, 175, t. XIV. 8, t. CXLV. 28, 29 — Andreánszky 1955, *37*, Pl. I. 1.

Equisetum cf. *maximum* L.—Andreánszky 1955, *37*, Pl. I. 2.

FILICINAE

Hymenophyllaceae

Trichomanes radicans L.—Andreánszky 1949a, 3, Pl. IX. 1.

Osmundaceae

Osmunda lignitum Gieb. — Pálfalvy 1951, 61, Pl. I. 5.

Osmunda parschlugiana (Ung.) Andreánszky—Pálfalvy 1951, 62, Pl. I. 2, sub *Pteris parschlugiana* Ung.

Polypodiaceae

Blechnum braunii Ett. — Andreánszky, 1952, 399. Pl. XXI/6.

Lastraea cf. *oeningensis* (A. Br.) Heer, Fl. tert. Helv. I. 1855, 32, t. VI. 3. = Goniopteris oeningensis A. Br. in Stizenb. Verz. der Bad. Verst. 72. (Fig. 1.)

The fern which I propose to describe here in detail had been mentioned in the literature concerning the Wind Brickyard flora under the name *L. oeningensis* A. Br. (Pálfalvy 1951, 62). Pálfalvy justifies its description under that name [rather than under the name *L. stiriaca* (Ung.) Heer] on the grounds that its pinnae are broader and that there are substantial differences also in venation; namely, according to Heer's drawings, the pinnae of *L. stiriaca* (Ung.) Heer are at most 1·5 cm wide, whereas those of the Wind Brickyard fern vary between 2·5 and 3 cm. On the Wind Brickyard fern, the lowest tertiary veins anastomose at an angle with the ramifications of the neighbouring secondary vein and form a common vein which thence proceeds up to the margin of the pinna; the other tertiary veins anastomose with this common vein. The tertiary veins of *L. stiriaca* (Ung.) Heer curve forward and only converge near the margin of the pinna.

Fig. 1. Lastraea cf. *oeningensis* (A. Br.) Heer, upper strata ME*

With the exceptions of its apical region, however, the pinna of the Wind Brickyard fern differs substantially from that of *L. oeningensis* (A. Br.) Heer. First of all, it is considerably broader than even the latter. Secondly,

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*ME signifies the collection of the "Dobó István" Museum of Eger while NR that of the Institute for Taxonomical Botany, Budapest University, in the captions to the figures throughout the book.

its tertiary veins, like those of *L. stiriaca* (Ung.) Heer, number 7 or 8 on both sides, whereas the pinna of *L. oeningensis* (A. Br.) Heer only bears 3 to 5 on each side. In addition, the secondary vein of the Wind Brickyard fern is relatively strong, whereas on the pinnula of *L. oeningensis* (A. Br.) Heer it is not stronger than the tertiary veins. True, on the Wind Brickyard fern there are fewer veins arising from the secondary veins, in the neighbourhood of the apex, where the pinna tapers, and the secondary veins themselves are also thinner there. In this respect the Wind Brickyard fern corresponds to the description and drawing of *L. oeningensis* (A. Br.) Heer. One might, then, suppose that all the specimens of *L. oeningensis* (A. Br.) Heer which formed the basis of description were consistently tips of pinnae. This is, however, contradicted by the fact that *L. oeningensis* has the same number of tertiary veins along the whole length of the pinna as *Dryopteris vivipara* (Raddi) C. Chr. which, although usually referred to *L. stiriaca* (Ung.) Heer, stands in fact nearest to *L. oeningensis* (A. Br.) Heer. The number of tertiary veins is small all over the pinna. I submit therefore that the Wind Brickyard fern is a species distinct from *L. oeningensis* (A. Br.) Heer.

On account of its remarkable similarity to *Dryopteris vivipara* (Raddi) C. Chr., a tropical fern of Brazil, *L. oeningensis* (A. Br.) Heer is to be assigned to the real genus *Dryopteris*.

The fronds of the Wind Brickyard "*Lastraea*" were presumably quite large; the pinnae attained a length of 20 cm. The way the frond is composed of the pinnae is visible on several specimens; we have thus a fairly good idea of the habit of the plant as a whole. At any event, this is the fern species most abundantly represented in the Wind Brickyard flora. The pinnae are rather varied. Sometimes the margin is nearly intact, sometimes it is lobate to a depth of one fourth of the half blade. The more deeply lobate pinnae are very similar to those of *Osmunda lignitum* Ung. This latter fern also occurs in the Wind Brickyard flora; its pinnae are in most cases even more deeply cleft. The two cannot, however, be confused because the tertiary veins of *Osmunda* are furcate whereas those of *L.* cf. *oeningensis* are consistently simple; furthermore, the veins of *Osmunda* do not anastomose at all. In the Wind Brickyard flora, *O. lignitum* is rare as compared to *Lastraea*.

Asplenium egedense Andreánszky, in *Index Horti Bot. Univ. Budap.* 7. (1949) 106, t. X. 5. (Fig. 2). This is the pinna of a fern, complete with sori, differing only inasmuch from the one described under the same name from the Lower Oligocene of Kiseged Hill as it is somewhat longer in relation to its breadth. It was found in the lowest strata (X_2) of the Wind Brickyard.

Having a length of 9 cm and a breadth of 2·3 cm near its base, it is of a strongly asymmetric linear-lanceolate shape; being, unfortunately, damaged at the base. On the underside of the pinna there are 5 slightly curved, linear sori on both sides. The venation is completely effaced.

Fig. 2. Asplenium egedense Andreánszky, lower strata 3192 ME

The narrowness of the pinna and the smaller number of its sori distinguish to some extent the Wind Brickyard specimen from those of Kiseged Hill. But for this, no specific difference can be observed which would justify the establishing of a taxon distinct from *A. egedense* Andreánszky. Furthermore the fossil was found in the lowest strata, and thus the age difference cannot be important, either. All I propose to do is, then, to report the species from a new site, with the remark that there is a slight difference in the form of the pinna. The fossil is kept in the Museum of Eger, under No. 3197.

GYMNOSPERMAE

CONIFERAE

The genus *Pinus* is represented by needle clusters and pine-cones. From the strata of the Wind Brickyard, only *Pinus taedaeformis* (Ung.) Heer has so far been mentioned in the literature (Pálfalvy 1951, 63).

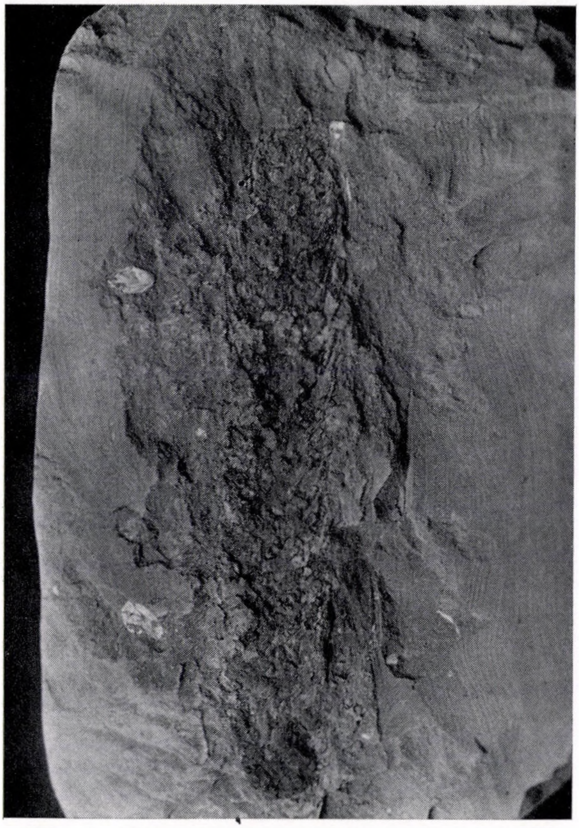

Fig. 3. Pinus sp. cone, middle strata 7290 ME

Pinus taedaeformis (Ung). Heer

Our collection contains four clusters of three needles each from the upper layers and one cluster from the middle layers, all fragments whose original length cannot be established. It is the thinness of the needles which suggests their belonging to the above indicated species. By no means can they represent *P. tuzsoni* Novák, described from Kiseged Hill, as the needles of the latter are thicker.

Pinus palaeostrobus Ett.

We have only a single five-needle cluster from the middle strata. The imprint is that of a small fragment, so that it is impossible to establish the length of the needles. All one can say is that they are very thin and may therefore belong to the form-group of *P. strobus* L.

Fig. 4. Pinus sp. cone, middle strata W 2573 ME

All rather worn, the cones reveal a long transport before deposition. For this same reason, neither the umbo, nor the apophysis can be seen on any of the specimens, so that no taxonomic position can be assigned to them. There are two sharply distinct types. The one is relatively long and thin, cylindrical, having in its present worn state a length of 12 cm and a diameter of 2 cm. It presumably was a dependent cone belonging to the form-group of *P. strobus* L. The scales were apparently thin even at their tip (Fig. 3).

The other type of cone is squatter, conical, about 7 or 8 cm long, with a diameter of 2·5 to 3 cm at the base. The scales are notably thicker than on the other type, but the umbo is not preserved, either, on any of them. (Fig. 4).

The lower and middle strata have been found to yield considerably more cones than the upper strata.

Sequoia langsdorfii (Brgt.) Heer (Fig. 5)

The only specimen furnished so far by the Wind Brickyard strata, the imprint of a shoot, has come from the lower strata. It is registered under No. W 2502 in the Museum of Eger. The needles stand alternately, so that there can be no question of *Metasequoia*. They are linear-lanceolate, fairly large; one is 2·7 cm long and 2·8 mm thick in the middle.

Fig. 5. Sequoia langsdorfii (Brgt.) Heer, lower strataW 2 502 ME

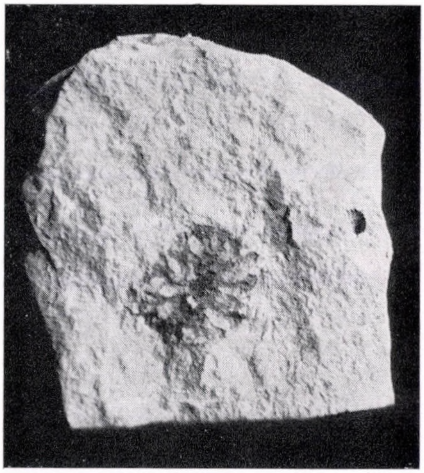

Fig. 6. Sequoia couttsiae Heer, cone, lower strata 12677 NR

Sequoia couttsiae Heer (Fig. 6)

This species was already reported by Pálfalvy from the Wind Brickyard strata (1951, 64) on the basis of cone remains. These cones belong to the most abundant fossils in all three groups of strata. They agree completely with Heer's original description, as well as with the fossils known from the

Lower Oligocene, among others from Kiseged Hill. From this latter site we have imprints of cones attached to the scale-leaved boughs; these boughs also agree with Heer's figures. However, the Wind Brickyard strata have not until now yielded scale-leaved shoots whose leaves would diverge from the shoot at all, to proceed in a needle-like tip, as is the case with *S. couttsiae* Heer. The shoots which are supposed to belong to the cones known by the name *S. couttsiae* Heer are thin, their scales quite short; the tips of the scales hug the shoot, and do not stand out at all. These shoots much resemble those of *Glyptostrobus,* particularly those of *G. ungeri* Heer; for this reason they have been referred to this species (Andreánszky 1959b, 5).

However, since even the most painstaking examination of the Wind Brickyard flora failed to yield a *Glyptostrobus* cone, or a typical shoot of *Sequoia couttsiae* Heer, one is after all obliged to conclude that the cones belong to the scale-leaved boughs. If this is the case, however, the species is not identical with *S. couttsiae* Heer, although the cones of the two cannot be distinguished from each other. This problem will thus have to remain unsolved for the present.

The family *Cupressaceae* is for the time being represented by the sole species *Callitrites brongniarti* Endl. (Andreánszky 1955, 37).

ANGIOSPERMAE

DICOTYLEDONEAE

Magnoliceae

We have so far four leaf types which presumably belong to the genus *Magnolia.* They are all assigned to living species, as it has been impossible to refer them satisfactorily to fossil ones. In view of their poor preservation, it does not seem proper to describe them as new species.

Magnolia cf. *grandiflora* L. Leaf No. W 1311 from the upper strata is assigned to this species. It is the middle part of a fairly large, fragmentary, lanceolate leaf having an entire margin. Its venation is completely identical with that of the living species. Still, neither the base nor the tip of the leaf being available, it is with some reserve that I am referring it to the genus *Magnolia,* and to its above-mentioned living species.

Magnolia cf. *acuminata L.* (Fig. 7). Leaf No. W 2707 from the middle strata. Its belonging to the genus *Magnolia* is virtually certain. It is an ovoid-lanceolate leaf with an entire margin; only its apical part, which probably was of a gradually tapering form, is missing. Its base is rounded and shortly decurrent. The complete blade may have been approximately 15 or 16 cm long and, in the lower two fifths of its length, 7 to 7·5 cm wide. The lateral veins start at a fairly large angle — 60 to 65° — and are camptodrome in a loop. Considering the leaf type of the living plant, the fossil under discussion presumably was a deciduous tree species. This is indicated also by the imprint. *M. acuminata* L. is a denizen of Atlantic North-America. In the Wind Brickyard flora it probably represents a microthermic element.

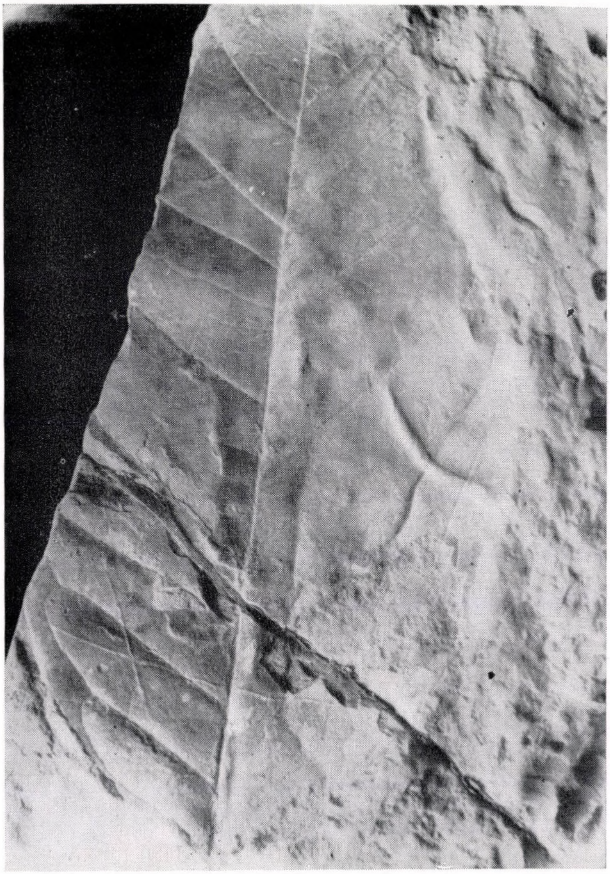

Fig. 7. Magnolia cf. *acuminata* L., middle strata W 2707 ME

Magnolia cf. *dealbata* Zucc. (Fig. 8). This is the fragmentary imprint of a large, presumably elliptical blade. The base is missing, but the fact that the lower primary lateral veins, after arising at an acute angle strongly curve backwards, until becoming perpendicular to the midrib, suggests a cordate base. The rest of the lateral veins also start at fairly acute angles, but, deviating considerably, end up at angles of 75 to 85° to the midrib. The length of the lamina was probably about 20 cm, its breadth 9 to 10 cm. Our specimen undoubtedly deciduous shows the greatest affinity to the Japanese *M. dealbata* Zucc. The imprint came from the middle strata and bears the number W 2661.

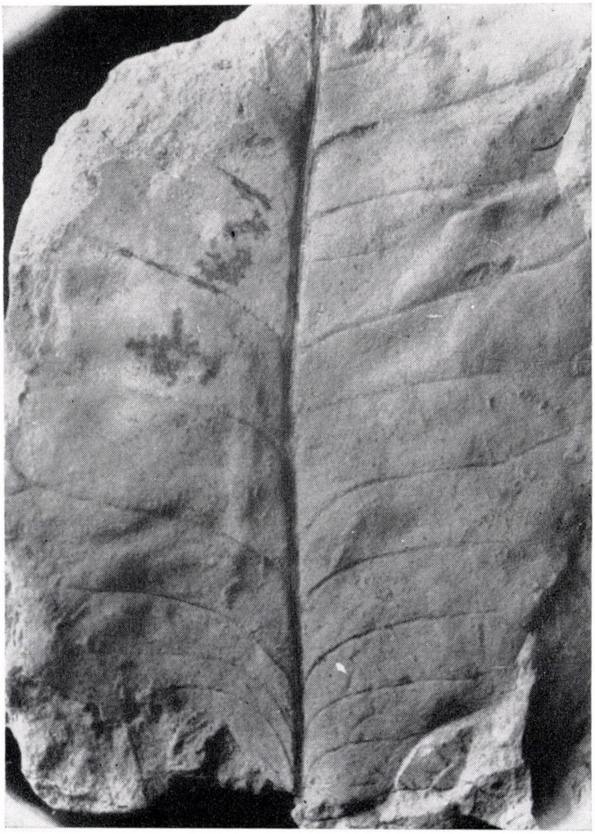

Fig. 8. Magnolia cf. *dealbata* Zucc., middle strata W 2661 ME

Magnolia cf. *punduana* Wall. (Fig. 9)

It is an elliptical leaf of medium size. It is broadly cuneiform at the base, shortly acuminate at the apex, having a length of 14 cm and a breadth of 5·7 cm at the middle. The midrib is very strong; there are about 10 pairs of strong lateral veins, not equidistant; between them, weaker lateral veins at an angle of 60 to 65°. Near the margin of the leaf, the stronger lateral veins are camptodrome in wide loops. The imprint, marked No.

3152, is preserved together with its counter-imprint. It was undoubtedly an evergreen plant, just like *M. punduana* Wall. For purposes of comparison *M. delavayi* Franch. may also enter into consideration, but the apex of the latter is obtuse or rounded and not acuminate. The imprint originates from the lower strata.

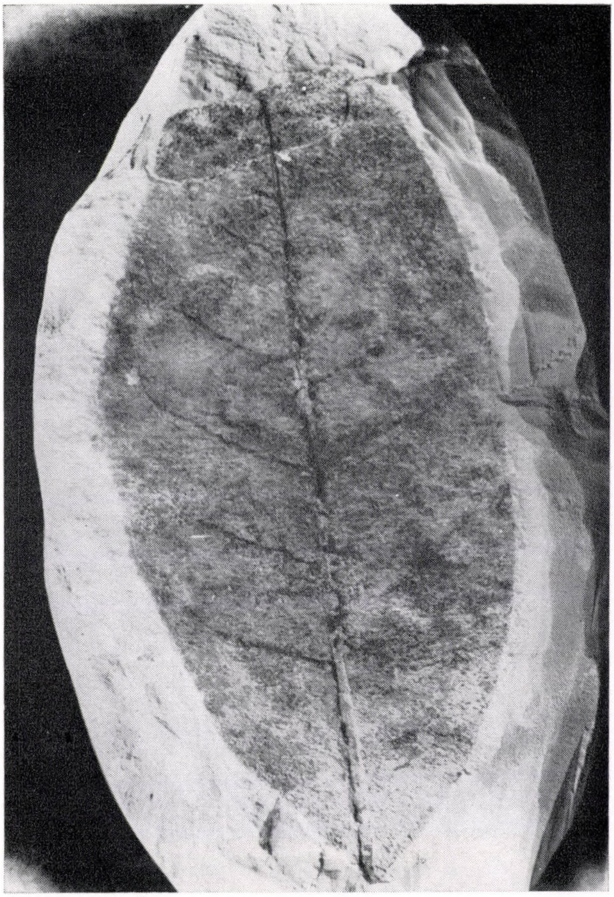

Fig. 9. Magnolia cf. *punduana* Wall., lower strata 3152 ME

Anonaceae

Talauma egerensis Andreánszky, 1955, 38, Taf. L. 5.

Lauraceae

Sassafras lobata Sap. in Annal. Sci. Nat. 5^{e} sér. 7. 1867, 8a pl. VIII. 5—6 sub *Daphnogene (Sassafras?) lobata* (Figs. 10, 11).

Several specimens have been collected; some of them do not belong to the Wind Brickyard flora proper, but to the flora of the sandstone-strata of Kistálya which, I think, are contemporaneous with the upper strata of the Wind Brickyard. The specimens from the Wind Brickyard come partly from the middle, partly from the upper strata.

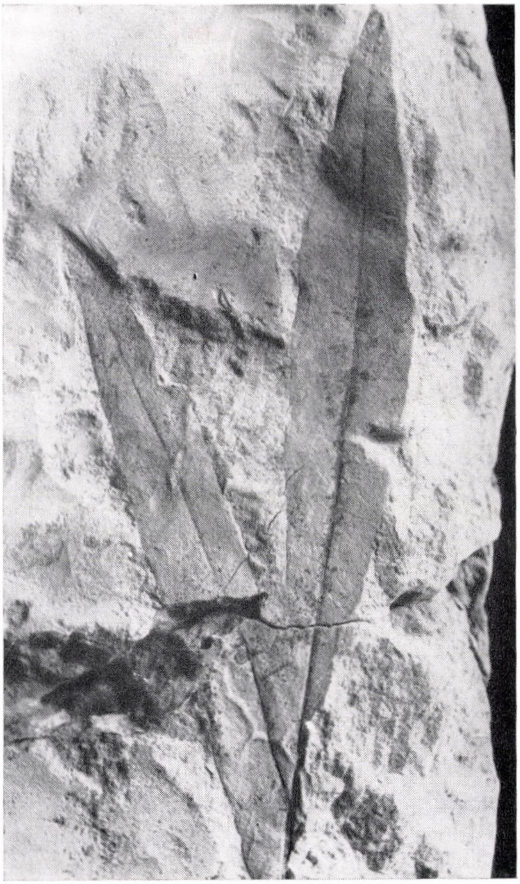

Fig. 10. Sassafras lobata Sap., middle strata 6531 ME

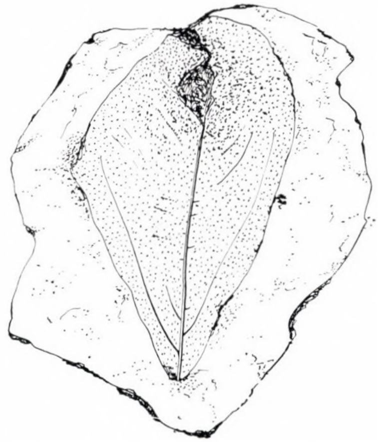

Fig. 11. Sassafras lobata Sap., from Kistálya, 19777 NR

Sample No. 6531 from the middle strata of the Wind Brickyard is the largest *Sassafras* leaf found until now in the Hungarian Tertiary. It has three lobes, only two of which are preserved; one lateral lobe is missing. The strong vein, however, setting out towards the missing lobe is well visible. This proves that the leaf originally had three lobes. This is a fact to be noted, because the leaves are often bilobate. The length of the blade is 15 cm, the lobes are linear-lanceolate, the maximum breadth of the middle lobe does not exceed 1·9 cm. It is in any cases larger and has broader lobes than *S. tenuilobatum* Andreánszky, many specimens of which were collected on Kiseged Hill. A leaf of coriaceous consistency, it agrees most closely with the leaf type described by Saporta under the name *Daphnogene (Sassafras?) lobata;* I shall therefore adhere to this name, with the observation that in my opinion the leaf under consideration is doubtlessly a *Sassafras* leaf.

Leaf No. 19816 from Kistálya is a fragment having only two lobes and asymmetrical in consequence. The main lobe is 2·4 cm wide; the lateral one is very narrow and curved.

Specimen No. 19777, similarly from Kistálya, is an entire, undivided leaf. The upper courses of the two strong lateral veins are curved towards the apex. A small part of the base is missing; the leaf is obovoid-lanceolate; when completed, it is 7·5 cm long. Base acute, apex rounded.

I do not intend to embark here upon a detailed description of the *Cinnamomum* species of the Wind Brickyard; their enumeration is given in Table II., pp 106—111. The number of specimens is uncommonly high, without displaying much variability.

To determine generically the rest of the leaves belonging to the family *Lauraceae* is, in the present state of our knowledge, practically impossible in some cases and highly uncertain in others. It is not less difficult to identify them with the fossil species heretofore described. The generic differences do not show on the leaves; the same characteristic may repeat itself on the leaves of several genera. The fossil species have been variously ascribed to several leaf types; also, the names have sometimes been incorrectly applied. In this situation I thought it best in most cases not to give names to leaf types even if they may readily be distinguished from the others, but to refer them to those living species to which they seem most closely related. This essentially means that I have subdivided our material into form groups. It is to be noted, however, that only the *Lauraceae* of the lower and middle strata will be treated here, and among them only those which can precisely be delimited and related to living species. In this way, many leaves have been left out pending a more accurate determination.

Litsea euryphylla Andreánszky, 1962, 219, Pl. I., Pl. II. 2.

Litsea cf. *terza* (L.) Merr. (Figs 12, 13).

Large, narrowly lanceolate leaves, widest at the middle or somewhat below. The specimen chosen as the type is very well-preserved; although the base is damaged, the venation is quite distinct. It originates from the middle strata. The blade is 18·8 cm long and, in the second fifth from the base 4·6 cm wide. The base is obtuse, the apex, tapering for some length,

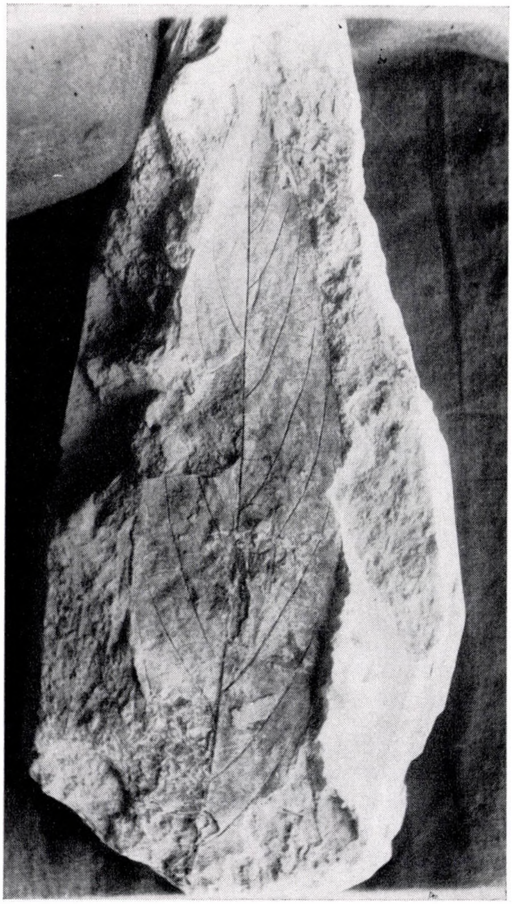

Fig. 12. Litsea cf. *terza* (L.) Merr., middle strata 7394

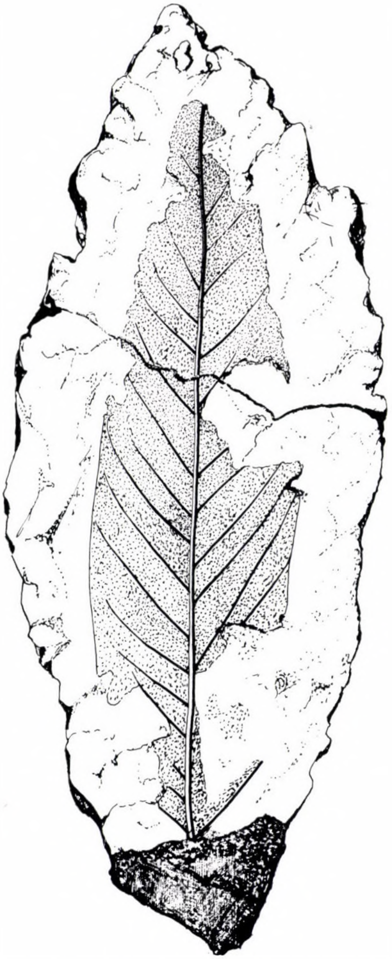

Fig. 13. Litsea cf. *terza* (L.) Merr., lower strata 6658 ME

gently acuminate. Margin entire, petiole missing. Midrib strong, straight; lateral veins (about 12 pairs) alternate, arising at an angle of about 45°. This angle remains the same almost up to the apex of the lamina. It is perhaps slightly less near the apex. Lateral veins slightly curved forward, proceeding for some distance along the margin of the leaf and anastomosing in small loops. Tertiary venation more or less parallel and wide-spaced, approximately perpendicular to the primary lateral veins. Imprint registered under No. 7394. Specimen No. 7206, likewise from the middle strata, is closely related to this type.

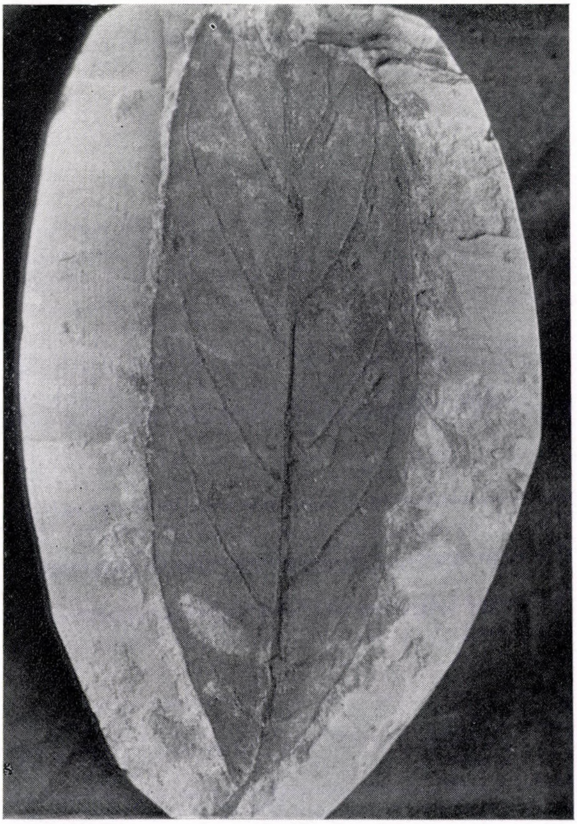

Fig. 14. Litsea cf. *laeta* (Wall.) Benth. et Hook. f., middle strata 7191 ME

Some leaves from the lower strata (6419, 6657, 6730, 6658, 6810) are somewhat smaller, being widest around the middle and tapering thence uniformly towards both ends. The number of the lateral veins is somewhat greater (about 15 pairs); these arise at a slightly greater angle, are more uniform and follow the margin of the leaf for a shorter distance, before anastomosing. Sample No. 6657 is 15·5 cm long and 4 cm wide at the middle. Although the belonging of these leaves to one and the same taxon is uncertain, the differences are too small to warrant a specific distinction.

There are two further leaves that cannot be assigned to this taxon except under reserve (Nos 6357 from the lower and 6732 from the middle strata). They are even smaller; the first one is 13·5 cm long and 2·6 cm wide at the middle. Of the second, only the upper part is left, which is somewhat broader (2·8 cm). Both are shortly acuminate.

Litsea terza (L.) Merr. is indigeneous in the Malay Archipelago. The leaves of a herbarium specimen from the Philippines (collected by Elmer, No. 8147) recall the second type, tallying almost completely with our imprint No. 6658. As regards the rest of the imprints, other *Litsea* species may enter into comparison, such as *L. quercoides* Elm.

Litsea cf. *laeta* (Wall.) Benth. et Hook. f. (Fig. 14)

The leaf is lanceloate with a short petiole (8 to 11 mm), narrowed at the base, or shortly decurrent, 11 to 13 cm long, probably acuminate. The lateral veins, about 7 pairs, issue at a large angle, curving forward and running far up along the margin of the leaf. The upper ones break slightly inwards in the neighbourhood of the margin, and disappear. All these features are found also on the leaf of the living plant. The secondary venation of the leaf shows a marked similarity to the venation of certain *Neolitsea* species (e.g. *N. intermedia* Elm., *N. vidalii* Merr.), but the tertiary venation of the latter is close-spaced, parallel, whereas on our leaves and on those of *Litsea laeta* (Wall.) Benth. et Hook f. the fine venation divides the blade into tiny angular areas. The best preserved specimen is sample No. 7191 from the middle strata. Also Nos 6031 and 6661 found in the lower strata belong to this species. Less typical are two smaller leaves (Nos 7409 and 6272, both from the middle strata), both about 6 cm long and 1·7 cm wide.

Litsea cf. *lancifolia* (Roxb.) Benth. et Hook. f. (Fig. 15)

Rather small, narrow leaves, about 8 cm long and 2—2·1 cm wide, narrowing abruptly at the base which is broadly wedge-shaped or almost rounded. The leaf, gradually tapering at the apex, has a constant breadth in the middle; that is, it is of a linear-lanceolate shape. The relatively short lateral veins, numbering about 10 pairs, arise at a large angle, the upper ones almost at right angles; they curve forwards farther off the midrib. The finer venation divides the intervals between the veins into tiny rectangular areas. The previously described type [*Litsea* cf. *laeta* (Wall.) Benth et Hook. f.] differs from this one mainly in that the latter has a larger number of veins which are shorter and do not follow the margin of the leaf for so long. I count here the specimens Nos. 7266 and W 2540 which come both from the lower strata.

Neolitsea cf. *intermedia* Merr. (Fig. 16)

Medium-sized, narrow, oblanceolate leaves from the lower strata (3064, 6869, 6922, 6723). Petiole about 1·5 cm long, medium thick; lamina 10—12 cm long, 1·6—2·5 cm wide, base acute, apex missing. Moderately close-spaced, the lower lateral veins arise at a very sharp angle (25 to 30°), the upper ones at a somewhat greater one (35 to 45°).

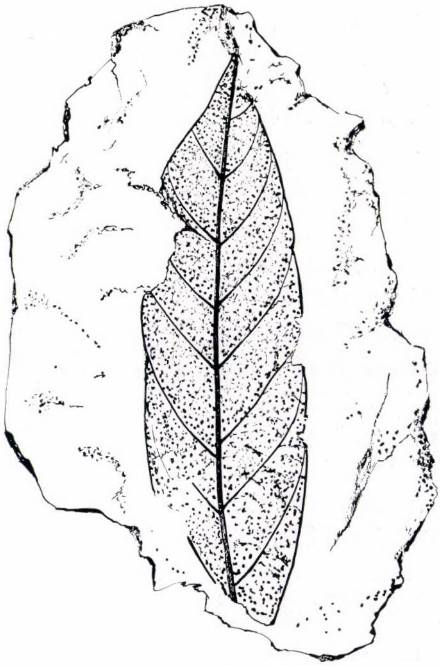

Fig. 15. Litsea cf. *lancifolia* (Roxb.) Benth. et Hook. f., middle strata 7266 ME

Fig. 16. Neolitsea cf. *intermedia* Merr., lower strata 6723, ME

Laurus primigenia Ung. Foss. Fl. v. Sotzka, in Denkschr. Akad. Wiss. Wien, math.-naturw. Kl. 2. 1850, 168, Taf. XL. 2—4. (Figs 17, 18).

Small, lanceolate leaves. Petiole about 1·5 cm long, medium strong, base narrowly acute, apex tapering and acuminate; lamina 9 to 10 cm long, 1·4 to 1·5 cm wide below the middle. Venation unequal; the lower veins are strong and arise at an angle of about 45—50°; the upper ones are shorter and thinner and their angle to the midrib is somewhat greater. The leaves agree completely with Unger's original description, succinct as it is, and with his figures. Since Unger's description, other types of leaves have also been described under this name, but the leaves presented here fit the original description and figure. Specimen No. 6426 from the middle strata is preserved complete with petiole, only its apex is missing; specimen No. 7349, similarly from the middle strata, is very long; specimens Nos 6741 and 6885 are somewhat narrower and less well preserved.

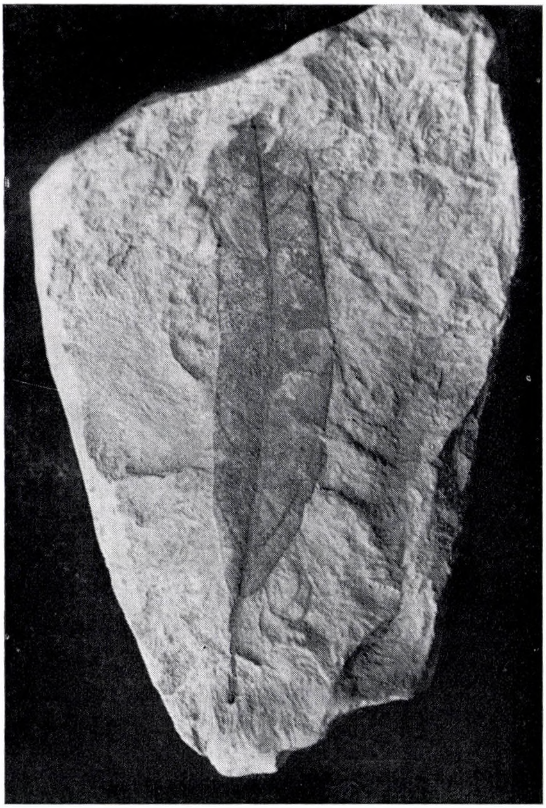

Fig. 17. Laurus primigenia Ung., middle strata 6420 ME

Persea cf. *indica* (L.) Spreng. (Fig. 19)

Somewhat smaller, lanceolate leaves with dense venation. The petiole of imprint No. 6579 from the middle strata is thin, 0·8—1 mm in diameter; its lamina is 8 cm long (the length of other specimens attains 9 to 9·5 cm) and 2·4 cm wide in the middle. Base acute, apex slightly acuminate, acute or obtuse. Midrib medium-strong; there are 12 to 14 pairs of fine lateral veins diverging at angles of 50 to 55°; on certain specimens the angle of the lowest pair of lateral veins is more acute. This latter is not a significant feature, because on the living species the same branch may carry a variety of leaves exhibiting this kind of venation as well as others. The lateral veins have a slightly zigzag course; they are camptodrome, curving forward, tapering off and to some extent ramifying near the margin of the leaf. *P. indica* (L.) Spreng. lives on the Macaronesian Islands.

Fig. 18. Laurus primigenia Ung., middle strata ME

Fig. 19. Persea cf. *indica* (L.) Spreng., middle strata 6579 ME

The following specimens are assigned to this species: Nos 6579, 6655, W 2532 from the middle and 3154, 6915 from the lower strata.

Oreodaphne cf. *foetens* (Ait.) Nees. (Fig. 20)

The most complete specimen is No. 3164, found in the lower strata. Only the apical part is missing. The petiole is thick, with a diameter of 1·2 mm; it is preserved in a length of 5 mm. The lamina has an acute base; the margin is entire; its shape is elliptic and, completed, 9·5 cm long, 3·8 cm in the middle. On other specimens the apex is also preserved: it is acuminate and pointed. Specimen No. 7401 is 10·5 cm long and 4 cm wide; No. 6686 is 4·5 cm wide. The midrib is very thick, strongly protruding on the underside; the lateral veins also protrude. There are 7 to 8 pairs of these latter; the lowest pair which diverges a few mm above the base is nearly opposite; it starts at a relatively small angle (45—50°) running higher than one third of the leaf. Between the thicker lateral veins there are thinner ones which soon branch out into tertiary veins. The other lateral veins diverge at an angle of 60—65° and bifurcate in the neighbourhood of the margin. The specimen taken as an example is largely conformable in size, form and venation to the leaves of the living species. There is a great similarity also to *Oreodaphne heeri* Gaud., but it is uncertain

Fig. 20. Oreodaphne cf. *foetens* (Ait.) Nees, lower strata 3164 ME

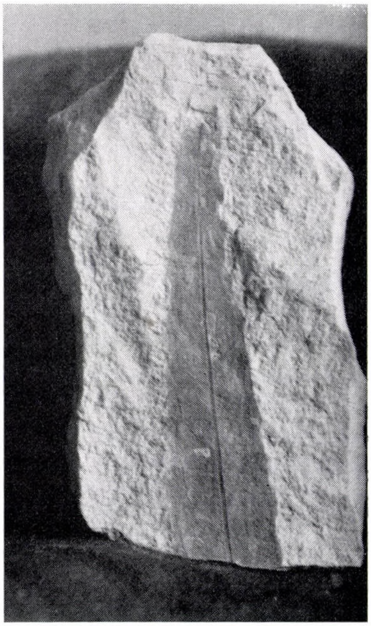

Fig. 21. Lomatites aquensis Sap., upper strata 2604/a NR

whether this similarity amounts to an identity; for this reason, I am relating our specimen to the species living to-day.

*

The *Lauraceae* of the Wind Brickyard are mostly related to South-Asiatic species. *Sassafras*, a genus living also in North-America to-day and the Macaronesian species *Persea* cf. *indica* (L.) Spreng. and *Oreodaphne* cf. *foetens* (Ait.) Nees are the exceptions. In the original description, *Laurus primigenia* Ung. is not referred to any living species. This species can by no means belong to the genus Laurus. If we connected it with *Ocotea wrightii* (Meisse) Mez, to which it seems most similar, that would suggest a Central American affinity.

Proteaceae

Lomatites aquensis Sap. in Annal. Sci. Nat. $4^{\text{ème}}$ sér. *17*, 253, pl. VII. 10. (Fig. 21)

Two imprints were found in the upper strata (2604a and 12355), both being, unfortunately, fragments. Margin and venation of the leaf, both highly typical, are, however, readily visible. In this respect, as well as in form and size, our specimens agree completely with those known from the Sarmatian of Hungary, as well as with Saporta's description and drawings. They also match the leaves of living *Lomatia longifolia* R. Br.

Lomatites aquensis Sap. — if it is the same species throughout — was very long-lived indeed. It was described by Saporta from the lower Oligocene at Aix. We have it among the Upper Oligocene plant fossils of the Wind Brickyard, and, as mentioned, it was also found in two Sarmatian sites of Hungary, Erdőbénye and Bánhorváti (Andreánszky 1959a, 68, 228). Data published in Hungary mention but very few specimens. This southern plant-type could not possibly have been abundant in this country; nevertheless, it is probable that these southern types, even if sporadic, were fairly wide-spread for protracted periods in the northern hemisphere. Evidence thus tends to refute the opinion which denies the presence of the family *Proteaceae* in the northern hemisphere during the Tertiary. Mrs. L. Nagy has found *Proteacea*-pollen in the clay worked in the brickyards of Eger (verbal communication).

Betulaceae

Alnus oligocaenica Andreánszky, in *Acta Bot. Acad. Hung. 8*, 1962, 220 Fig. 1.

Alnus cf. *nepalensis* Don (Figs 22—24)

This is a species of alder represented by a large number of fossils, of which more than 20 are the imprints of leaves. These resemble each other so much that, they doubtlessly belong to the same species and permit an accurate determination of all the features of the leaf. At the same time one may derive a fairly good idea of the variability of the species. The width of the leaf is more variable than its length. Apex, base, margin and venation of the leaves are uniform. The leaf imprints have been collected at different dates, so that their common origin (from the same individual or from trees of the same population) is highly unlikely. Their majority has come from the upper strata, with one specimen only furnished by the middle strata.

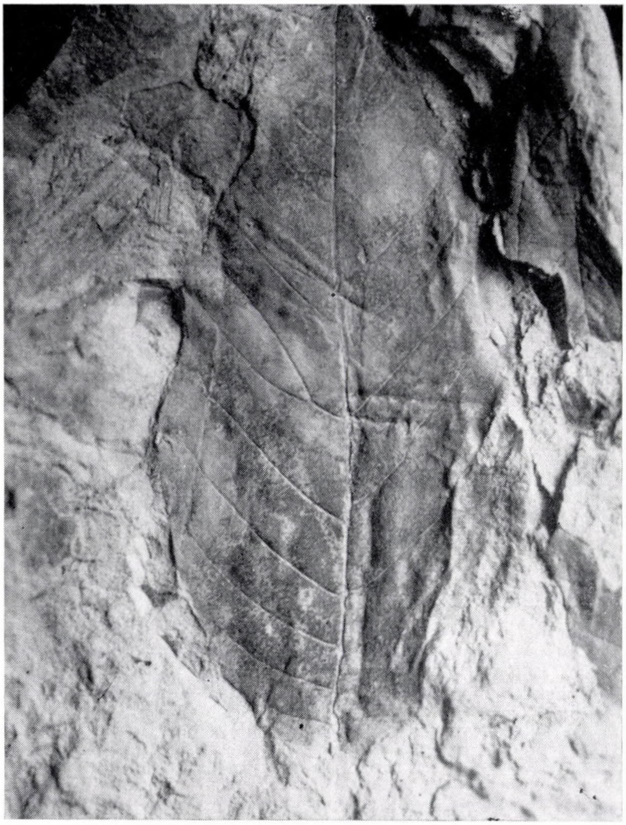

Fig. 22. Alnus cf. *nepalensis* Don, upper strata 2421 ME

The leaf is almost exactly elliptic, being neither ovoid nor obovoid. The base in narrowly rounded here, a certain asymmetry is observed in some cases, the apex is shortly acuminate and obtuse. The petiole was at least 2 cm long and rather thin. The length of the blade varies between 8 and 10 cm; its breadth shows a greater variability, from 3·5 to 5·5 cm. The margin of the leaf is unevenly and finely serrate; the small teeth, hardly half a mm high, are spaced at intervals of 2 to 5 mm. On some leaves the margin is serrate nearly as far down as the base. The lateral veins, numbering 10 to 12 pairs, issue at a constant angle and run parallel to each other. The average of the angles is 50°, somewhat less on narrow leaves and slightly more on broader ones. The veins are gently curved; some of them bifurcate near the margin of the leaf, rarely also between the midrib and the middle of the half-lamina. The veins generally enter the tiny teeth, although their course is somewhat uncertain near the edge of the blade where they tend to get indistinct. The lowest ones usually taper off before reaching the margin of the leaf, but in certain cases they are camptodrome in a curve.

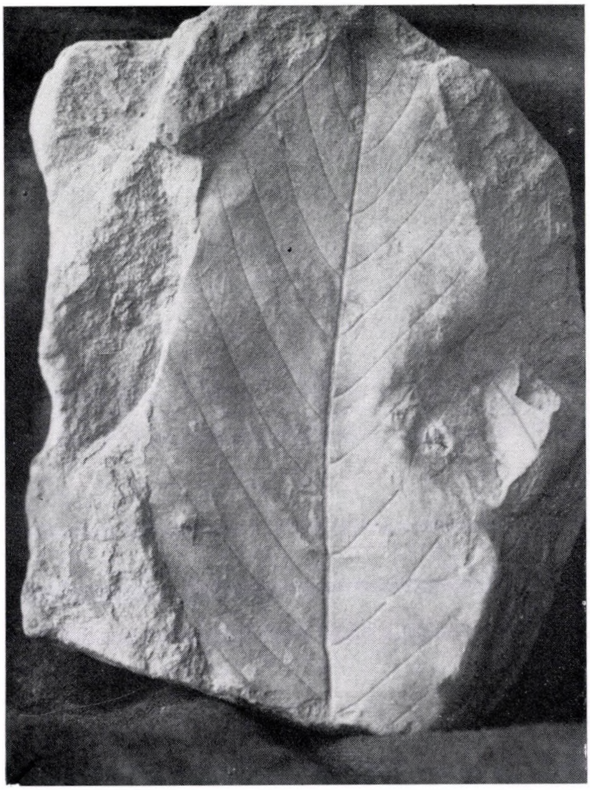

Fig. 23. Alnus cf. *nepalensis* Don, upper strata 2444 ME

Of the fossil species *A. kefersteinii* Ung., mentioned also from the Oligocene, cannot be related to our leaves, because it is obovoid and in most cases biserrate, even almost lobate; also, the number of its lateral veins is smaller. *A. sporadum* Ung. is obtuse at the apex and not acuminate, and the number of its lateral veins which arise at a greater angle, is 7 pairs. The lateral veins of *A. sporadum* Ung. var. *phocaeensis* Sap. equal in number the lateral veins of our leaves, but the former diverge at a greater angle and trace a pronounced forward curve. *A. feroniae* (Ung.) Czeczott *(Fagus feroniae Ung.)* is ovoid, its lateral veins are fewer (8 to 10 pairs), not camptodrome at all, and tend to end in the larger teeth. *A. nostratum* Ung. is also ovoid. *A. antiquorum* Sap., described from Aix, and related by its author similarly to *A. nepalensis* Don, does not match the leaves from the Wind Brickyard, either, because its venation is completely camptodrome.

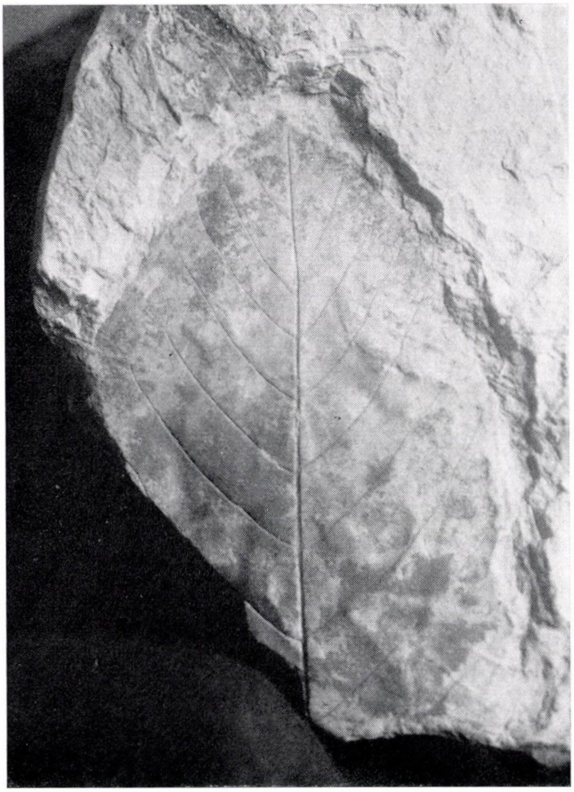

Fig. 24. Alnus cf. *nepalensis* Don, upper strata 6262 ME

The leaves we are concerned with here most resemble those described and illustrated from the Sarmatian under the name *A*. cf. *nepalensis* Don (Andreánszky 1959a 84, Abb. 55, Taf. XIX. 1). Form and margin of the leaf, number and trace of the lateral veins agree completely.

It is very probable that the leaf form discussed here was determined also under some of the above-mentioned names, from sources other than the Sarmatian of Hungary. In this case the determination, as we have seen it, is incorrect; our leaf cannot be identical with any of the named species. Notwithstanding the perfect congruity between the Sarmatian and Wind Brickyard leaves, I do not share the opinion that we have to do necessarily with the same taxon; but, then, this is not excluded either. In any case the age difference between the Wind Brickyard leaf and the living plant is very great. In this situation I do not intend, of course, to attribute to our species the ecology of the plant living in our days.

The leaves of *A. nepalensis* Don show a greater variability than the fossil remains. They correspond rather to our larger leaves. The venation of some of the leaves is practically completely camptodrome (as is the case with *A. antiquorum* Sap.), whereas in some others the lateral veins consequentially end in the tiny teeth. There are leaves whose margin is entire; the leaf form is sometimes obovoid and not perfectly elliptic, some leaves have an acute base, a rounded base is rare.

From the European Tertiary, species of *Alnus* have been described all the way since the Eocene. As regards Hungary, the oldest fossils known so far are the cones and leaves found on Kiseged Hill. The leaves from Kiseged Hill do not agree with those of the Wind Brickyard, and their taxonomic position has not yet been decided. The Wind Brickyard leaves belong to the section *Clethropsis* Spach. Besides these, one single leaf is known from Szarvaskő, from the Lower or Middle Miocene; it corresponds in a general way to *A*. cf. *nepalensis* Don, in spite of its acute base. In the Central-European Lower and Middle Miocene the alder species do not show either a wide spread or a considerable variability; according to Heer (Fl. tert. Helv. II. 38) they do not even occur in the upper Miocene flora of Oeningen. On the other hand, the late Sarmatian flora of Hungary is invaded by a number of *Alnus* species, although the abundance of the individuals rarely places them among the leading floral elements.

Alnus cf. *sporadum* Ung. var. *phocaeensis* Sap. in Annal. Sci. Nat. 5$^{\text{ème}}$ sér. *9*, 21, pl. II. 1–5. (Fig. 25)

I assign to this type a leaf which had unfortunately been considerably damaged during fossilization; I do not, however, identify it with Saporta's variety. The leaf is medium-sized, about 7 cm long, broadly elliptical, with

12 pairs of lateral veins. Apex rounded, base and petiole missing. The margin of the leaf is hardly dentate; in this respect it agrees quite well with Saporta's description. The specimen was found in the middle strata and bears the number 6762.

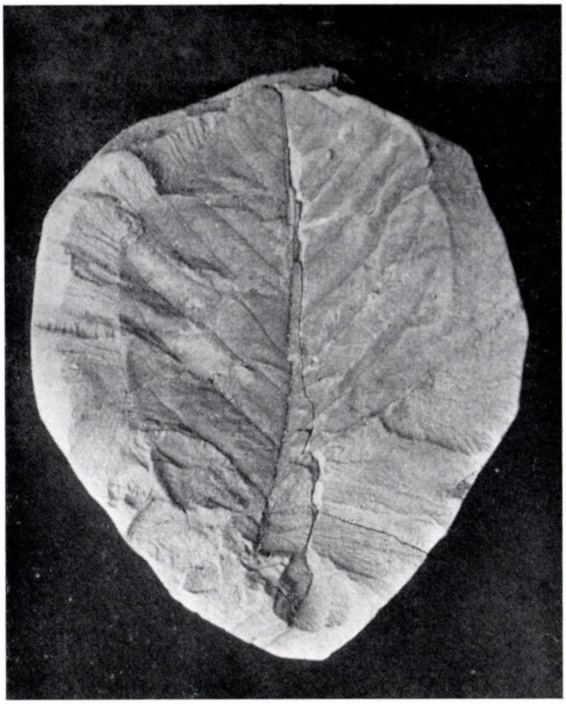

Fig. 25. Alnus cf. *sporadum* Ung. var. *phocaeensis* Sap., middle strata 6762 ME

Alnus sp. (Fig. 26)

Of a further alder leaf, only the lower part is preserved (W 1543/a). The leaf is relatively small, its petiole 1 cm long, lamina 24 mm wide about the middle, oblong, cut off at the base and densely, minutely dentate, but not serrate. Venation slightly asymmetric. The angle of the lateral veins is about 60°, the veins then curve forward and proceed along the margin of the leaf for some distance, resembling in this respect the leaves of the willow. Unfortunately, it cannot be observed whether they anastomose or not. This could, namely, suggest the genus *Rhamnus*. On the preserved fragment 5 lateral veins appear on the one side and 6 on the other; on the entire leaf there were presumably twice as many. As long as no more fully preserved specimen will turn up, I shall assign the one in point to the genus *Alnus*.

Alder cones (Fig. 27)

The strata of the Wind Brickyard have so far yielded the imprints of two kinds of alder cones, one specimen of each. Imprint No. 11484 found in the upper strata, is very small, only 11 mm long, with a diameter of 6 mm. The delicate woody bracts are fairly close-packed. The cones of *Alnus nepalensis* Don are likewise very small, 12 to 15 mm long, with a diameter of 8 mm, and also possess many bracts. Leaf imprints of *A.* cf. *nepalensis* Don being abundantly represented in the Wind Brickyard flora, it seems justified to conclude that the cones also belong to this species, but there is no direct proof for this assumption.

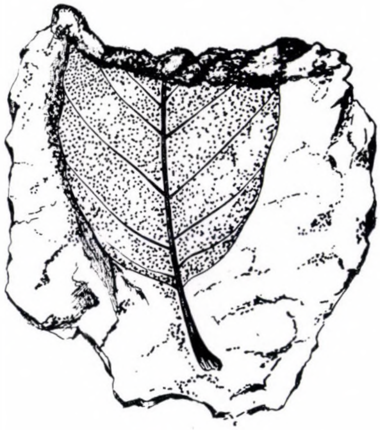

Fig. 26. Alnus sp., upper strata
W 1543/a ME

Fig. 27. Alnus sp. cone, upper strata
11484 NR

The other cone is somewhat larger; unlike the first one, it is roundish rather than cylindrical, 15 to 16 mm long and 13 mm wide. Also, it has fewer bracts. The difference consists, then, not only in size but also in the form and in the number of bracts, proving that this cone belongs to a different species of alder.

Carpinus grandis Ung. Syn. plant. foss. (1845) 220; Iconogr. plant. foss. (1852) 39, t. XX. 2—5. (Figs 28—30)

Hornbeam leaves abound in the middle strata; in the upper strata, a few isolated ones occur here and there. The 60-odd leaves found so far exhibit a considerable variability, but as they form a series of uninterrupted transitions, it is unjustified to delimit distinct species. This is true also of the living species; one may establish statistical differences between their leaves, but in most cases one can tell apart the species only in possession of their cupulae, because certain leaf forms may belong to several species.

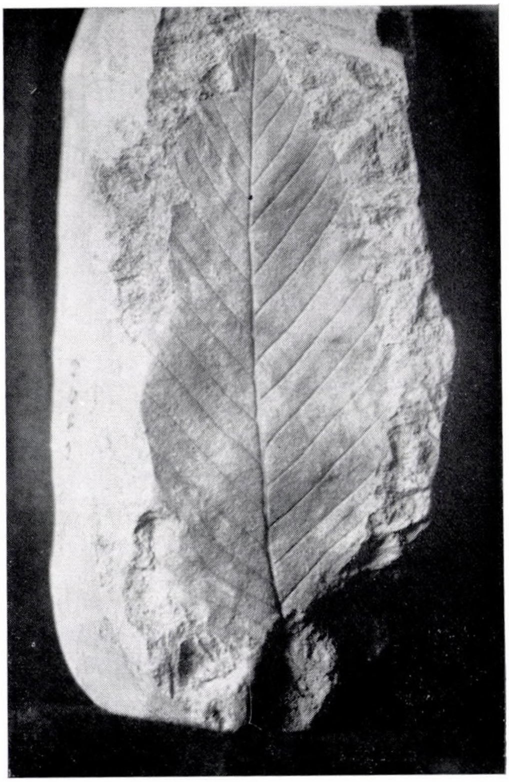

Fig. 28. Carpinus grandis Ung., middle strata 6580 ME

On the Wind Brickyard leaves, the number of lateral veins does not show such a wide variation as could not occur within one and the same species. Cupulae, providing a much sounder basis for distinguishing species, are not known for the time being among the Wind Brickyard fossils. Accordingly, I intend to unite all hornbeam leaves under the name *Carpinus grandis* Ung., although the narrow forms agree better with the drawings of *C. pyramidalis*

Goepp.; still, the scrutiny of a large number of specimens convinced me that even the very narrow forms are not distinct from the others. Moreover, it is doubtful whether the leaves known under the name *C. pyramidalis* Goepp. can be distinguished at all from *C. grandis* Ung. This means that, in the conception of palaeobotany, the *Carpinus* leaves are grouped in artificial species which do not correspond to any natural unit. Natural species cannot be established except on the basis of cupulae. I have tried to classify the leaves on the basis of the differences observed in the finer venation; namely on some fossil leaves all the veins in a field between two primary lateral veins are uniformly fine, whereas on others, parallel tertiary veins connecting the primary lateral veins are apparent; these tertiary veins are connected by very fine and uniform veinules which divide the fields between the veins into tiny

Fig. 29. Carpinus grandis Ung., middle strata 6592 ME

areas. It was, however, estabished that both types of venation may occur in the same living species, so that this criterion fails as a specific difference.

The hornbeam leaves of the Wind Brickyard are mostly large and narrow, their length attaining as much as 12 cm. Their serration is rarely deep and by far not so sharp as that of the living species. Among our leaves, the specimen with the smallest relative breadth is 9·5 cm long and 2·8 cm wide; the one having the greatest relative breadth, 6·2 cm long and 3 cm wide. Another leaf is 10 cm long and 4·2 cm wide. The petiole is usually 1·5 cm long. The base is rarely acute, more frequently rounded, sometimes slightly asymmetrical. Apex in most cases shortly acuminate. Leaves with an apex tapering as gently as those of *C. pyramidalis* Goepp. on Heer's drawings have not been encountered. The lateral veins number 15—18—21 pairs,

Fig. 30. Carpinus grandis Ung., middle strata ME

their angle varies between 35 and 50°. Furcate veins are very rare. Form of the blade, narrow ovoid or, very seldom, narrow obovoid, elliptic, or oblanceolate.

Authors sometimes connect *C. grandis* Ung. with *C. betulus* L. The large number of veins rather suggests, in my opinion, *C. japonica* Bl. which has more than 20 pairs of veins.

The genus *Carpinus* includes deciduous trees of the temperate zone, which in Central America spread also south of the tropic (*C. caroliniana* Willd. var.). Although it would be far-fetched to relate our species of the Wind Brickyard flora to this latter rather than to an East Asiatic species, its heat requirements may have been greater than those of the majority of living *Carpinus* species. Nevertheless, it is to be considered microthermic as compared to the plant assemblage of that period.

Although in Hungary it is here that hornbeam leaves first crop up in a greater number, several leaf imprints provide evidence that the genus lived here as early as the Lower Oligocene, perhaps even the Eocene. In France, *Carpinus* species are reported from Tertiary deposits considerably older than the Wind Brickyard strata. Still, even in younger ages, *Carpinus* leaves are rarely encountered in abundance. In our experience, *Ostrya* leaves tend to be more frequent and *Carpinus* leaves more sporadic in the younger Miocene. It seems, then, that there never existed a deciduous forest in which the hornbeam would have been the dominant species. The wave which strewed the middle strata of the Wind Brickyard with hornbeam leaves might well have been the most important event in the history of the genus in the Hungarian Tertiary.

The leaves of *Carpinus* being highly uniform, it is impossible to distinguish between old and younger species; consequently, one has no conclusive evidence as to the origin of the living ones, either. I think that the reason for the hornbeam being apparently always represented by the same species in floras of different climates (which, after all, is rather improbable) is that the individual species of the genus were fairly modest in their requirements even in those times and often took the place of other species of trees in deteriorating associations. In other words, they played the same role in the vegetal cover of those periods as does the hornbeam in our forests of to-day.

THE FORM GROUP OF THE OAK

In collaboration with Mrs. É. Kovács

In the description of the oak species of the Wind Brickyard flora we have adopted the system of A. Camus (1936—1954) and adhere to the sequence followed in that system. In addition to the genus *Quercus* we could establish the remains of the genera *Castanopsis* and *Lithocarpus*, moreover, if *Cyclobalanopsis*, which figures in Camus's system as a sub-genus of *Quercus*, is regarded as an independent genus, as it is by several authors, then we have it for a fourth genus.

The genus *Castanopsis*

Castanopsis callicomaefolia Andreánszky, in *Acta Bot. Acad. Scient. Hung.* **8**, 1962, 221, pl. II. 2—4, pl. III. 1.

A species of highly variable leaves, it essentially differs from *C. furcinervis* (Rossm.) Kr. et Wld., so frequent in the Lower Oligocene, in that its primary lateral veins do not bifurcate before reaching the tooth, and in that its leaves are consistently smaller. Of all the species belonging to the form group of the oak, the remains of this species are most abundant in the Wind Brickyard series (particularly in the lower strata, and much less so in the middle strata). In the upper strata this species could not be demonstrated as yet.

? Castanopsis furcinervis (Rossm.) Kr. et Wld.

Indicated by a fragment with bifurcating lateral veins, the conservation of which is, however, not so good as to prove conclusively the presence of the species in the Wind Brickyard flora. From a deposit considerably younger than the Wind Brickyard strata, i.e. from the Helvetian of Andornaktálya, we possess an imprint identical beyond doubt with *C. furcinervis* (Rossm.) Kr. et Wld. This proves that, in Hungary, this species survived the Oligocene. The Wind Brickyard fragment came from the lower strata. It presumably was broadly lanceolate. The lateral veins arise at an angle of about 45°. The width of the lamina is 2·6 cm.

Castanopsis sp. I. (Fig. 31)

The conservation of the leaf is too poor to permit a new species to be established. So much is certain, however, that it differs from the rest of the *Castanopsis* fossils. Some features, as e.g. the ramification of the lateral veins before reaching the lobes, relate it to *C. furcinervis* (Rossm.) Kr. et Wld., but the lateral venation is considerably denser. In this respect it recalls *C. callicomaefolia* Andreánszky, but the latter has simple lateral veins and the leaf forms do not agree either. The apex of the imprint is damaged. The length of the leaf probably was 15 cm. Only a very small part of the petiole is extant. The lamina is linear-lanceolate having a breadth of 3·2 cm at the middle. The midrib is strong, straight, but the petiole seems to be relatively thin. The margin of the leaf is uniformly serrate. The lateral veins, almost completely straight, number 21 to 22 pairs, and arise at an angle of 50 to 55°. In the number of lateral veins the leaf corresponds to an imprint from the Lower Oligocene of Csillaghegy near Budapest, which, although fairly different from the others, in my opinion does belong to *C. callicomaefolia* Andreánszky. The Csillaghegy specimen is, however, linear rather than lanceolate. The Wind Brickyard imprint was found in the upper strata and bears No. 56.1342 in the Museum of Eger.

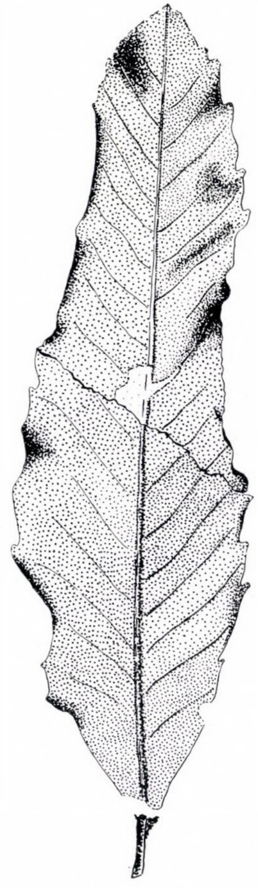

Fig. 31. Castanopsis sp. I, upper strata 56.1342, ME

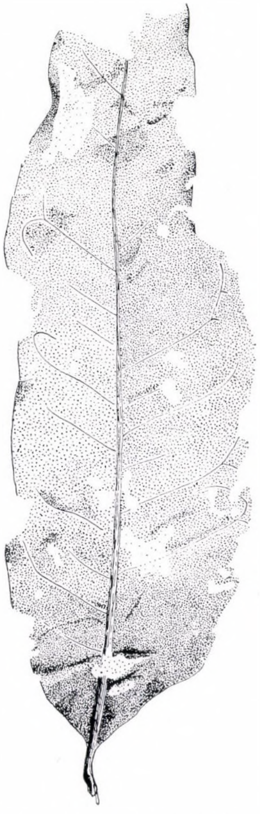

Fig. 32. Lithocarpus debilinervis Andr. et Kov., middle strata 6525 ME, holotype

The genus *Lithocarpus*

Both the sub-genera *Cyclobalanus* and *Pasania* are represented.
Subgen. *Cyclobalanus?*
Lithocarpus debilinervis Andr. et Kov. n. sp. (Fig. 32)

Several fossils from the middle strata (6525, 7342, 3230) and one from the lower strata (3072) are grouped here. All these specimens belong to the collection of the Museum of Eger.

Folium petiolatum, petiolo tenui et brevi (8 mm). Lamina lineari-lanceolata, in ambis extremitatibus plus minusve aequaliter angustata, basi cuneata vel parum in petiolum angustata, 11·5 cm longa, in medio 3·5 cm lata, integerrima. Nervus principalis validus, nervi secundarii debillimi, in angulo ca. 70° orti, fere recti, sed irregulares. Nervi secundarii ca. 15 pares, inter eos nervi debiliores et breviores. Nervi secundarii longiores jam ante marginem laminae arcum formantes et anastomosantes.

Holoptypus in collectione Musei Agriensis de Stephano Dobó nominati sub. No. 6225. In stratis mediis fabricae laterarum Wind dictae, olig. super.

This venation differs from that of most living species of the genus *Lithocarpus*, the venation of which is strong and regular. Nevertheless, some species of the genus have thin primary lateral veins just as irregular as those of our species. An example in point is *L. spicata* (Sm.) R. et W. var. *yunnanensis* Schky. That species has, however, a broad lanceolate leaf with lateral veins running far forward rather than anastomosing in regular semicircular arches, as in the case with our specimens. As regards the shape of our leaves, they rather resemble *L. colchica* Kolak., to be mentioned below under the subgenus *Pasania*, but they are smaller and their primary lateral veins are by far not so regular, nor so strong.

The remains in our possession represent in our opinion a coriaceous-leaved evergreen species undoubtedly belonging to the genus *Lithocarpus*; however, they do not conform with any of the living species to such an extent as would suggest a direct relationship. It is a question as yet unsolved whether they belong to the subgenus *Cyclobalanus* or *Pasania*.

Lithocarpus sp. I. cf. *L. leiostachya* A. Camus (Fig. 33)

This type is represented by a single specimen which, although fragmentary, is well enough preserved; the lateral veins are readily seen. It bears the number 3222 in the Museum of Eger. The fossil came from the middle strata; it occurs on a hand specimen of rock which also bears an imprint of *Carpinus grandis* Ung.

It is the basal part of the leaf which is preserved, complete with a petiole 8 mm long. The lamina is ovate-lanceolate, base slightly decurrent, acute; the margin seems to be entire, although it might have been dentate in its apical region. Completed, the leaf is 8 cm long and 3·8 cm wide at the middle or slightly above it. The midrib is pronounced, the lateral veins are also fairly well developed, nearly opposite; their number may have been 8 or 10 pairs. Straight in their lower course, they diverge at a large angle (about 70°), then curve strongly forward and anastomose only quite far up. The finer venation is network-like. The leaf resembles *L.* (subgen. *Cyclobalanus) leiostachya* A. Camus; furthermore, it vaguely recalls one herbarium specimen of the already mentioned *L. spicata* (Sm.) R. et W. var. *yunnanensis* Schky. *L. leiostachya* A. Camus lives in Annam, at an altitude of about 800 m above sea-level. The other species lives in China (Yunnan).

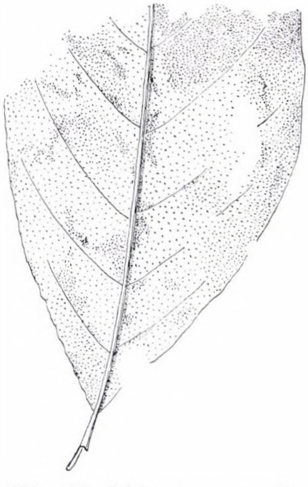

Fig. 33. Lithocarpus sp. I, lower strata 3222 ME

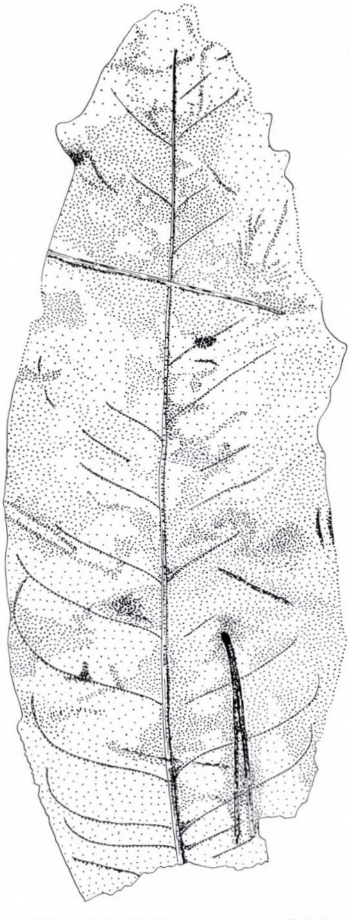

Fig. 34. Lithocarpus colchica Kolak., middle strata 7292 ME

Subgen. *Pasania*

Lithocarpus colchica Kolak. in Trud. Suchumsk. Bot. Sad, *12* (1959) 232 tab. VIII. 3—4. (Fig. 34)

Imprint No. 7297 (Museum of Eger) is a very large leaf of markedly camptodrome lateral venation. The diverging angle of the veins is large, and uniform. The apex is shortly acuminate. The imprint agrees very well with Kolakowsky's drawing which only shows the upper part of the leaf, the lower part being a reconstruction. Our leaf is more complete, only its base is damaged; completed, it is 17 cm long, being somewhat shorter and at the same time narrower (5·2 cm) than the type; the apex is slightly less acuminate. Issuing almost at right angles in the basal part of the leaf, and at an angle of about 70° higher up, the veins anastomose in highly regular arches.

Another specimen (6515), similarly from the middle strata, may have been slightly smaller, 15 to 16 cm long and 3·5 cm wide; it was more elongately acuminate and, in this respect, conform to type.

According to Kolakowsky, the species is related among the living ones to *L. (Pasania) pseudo-molucca* Rehd.

Lithocarpus sp. II. cf. *L. falconeri* (Kurz) Rehd. (Fig. 35)

We refer to this unit specimen No. 2394 from the upper strata. It is a fairly large leaf, with the apical part missing and the base slightly damaged. The relatively thick petiole, preserved in a length of about 8 mm, was certainly longer originally. Lamina probably oblanceolate, base acute, apex unknown. Lateral venation regular and parallel, except for some veins which arise at angles different from the others. The aberrant lateral veins probably result from some irregularity of development. The lamina may have been 15 to 16 cm long, and 4·6 cm wide above the middle. Margin entire, although it might have been dentate in the apical region.

As regards the living species, it closely resembles *L. falconeri* (Kurz) Rehd. and *L. fordiana* Chun, although the latter is somewhat broader with a slightly closer-spaced venation and serrate in its upper third. *L. falconeri* (Kurz) Rehd. lives on the Malay Peninsula, in Burma and in Siam.

The taxonomic position of the fossil species here described is not yet fully established, as in the subgenus *Cyclobalanopsis* of *Quercus* there occur fairly similar leaf forms such as the leaf of *Q. semiserrata* Roxb. Still, the lateral venation of the latter is wider-spaced.

Q. tenuipetiolata Andreánszky — to be enumerated among the species of the genus *Quercus* — might conceivably also belong to the subgenus *Pasania* of *Lithocarpus*. As a conformable living species, *L. echinocarpa* A. Camus, from Annam, and *L. buddii* A. Camus, from the Philippines, may be mentioned.

The genus *Quercus*

Two subgenera of the genus *Quercus* are represented in the Wind Brickyard flora, namely subgen. *Cyclobalanopsis* and subgen. *Euquercus*.

Subgenus *Cyclobalanopsis*

Quercus tenuipetiolata Andreánszky, in Acta Bot. Acad. Scient. Hung. **8**, 1962, 222, Fig. 2.

The species is represented by a single pair of imprint and counterimprint. It is a small leaf with very regular, semi-camptodrome venation. As already mentioned, its belonging to the genus *Quercus* is open to some doubt.

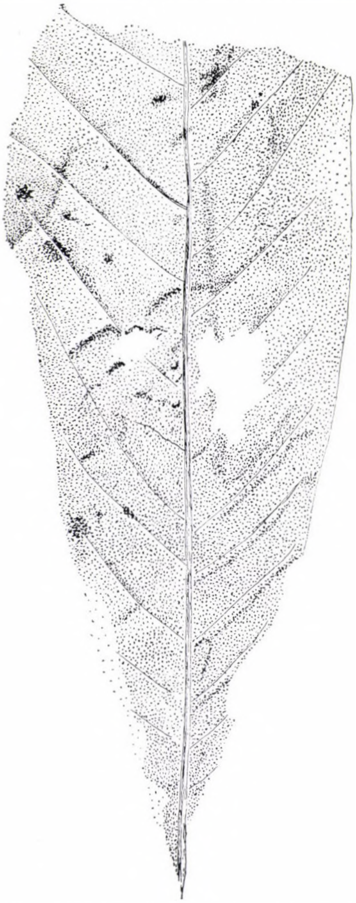

Fig. 35. Lithocarpus sp. II, upper strata 2394 NR

Fig. 36. Quercus legányii Andr. et Kov., middle strata 6717 ME, syntype

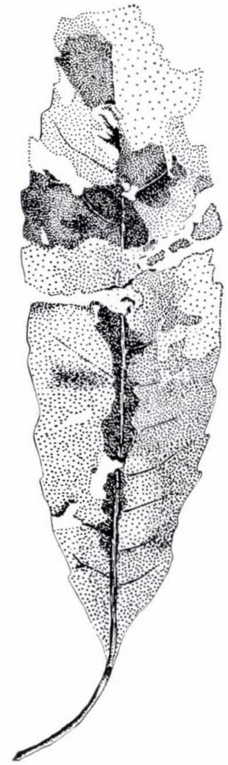

Fig. 37. Quercus legányii Andr. et Kov., middle strata 6830 ME, syntype

Quercus legányii Andr. et Kov. n. sp. (Figs 36 and 37).

For the moment we possess two leaves which certainly belong here and one for which this is probable; all three have been found in the middle strata.

Folium oblanceolatum, petiolus mediocre validus, 1·5 mm diam. 1·5 cm longus vel longior. Lamina longe in petiolum angustata, apice ignoto, margine sat crebre minute denticulata, dentibus in numero nervos laterales aequantibus, usque ad 1·5 mm altis parum prorsum arcuatis. Lamina tota ca. 5·5 cm longa, in parte 1/3 superiore 2·1 cm lata. Characteres enumerati speciminis 6717. Specimen alterum, 6830, longius, in parte 2/5 superiore 2·7 cm latum. Nervi laterales in speciminibus ambis 18 pares, parum asymmetrici, in angulo aperto (60—80°) orti et valde prorsum arcuati, in dentibus terminantes. Nervatio in ambis speciminibus identica. Petiolus speciminis 6830 parum longior et tenuior. Speciminis 7352 solum pars media conservata, nervatio inconspicua, dentes minusculi. Pars conservata 5 cm longa et 2·1 cm lata.

In stratis mediis fabricae laterarum Wind dictae olig. super. Syntypi in collectione Musei Agriensis de Stephano Dobó nominati sub Nris 6717 et 6830.

The leaf, evergreen, differs significantly from the *Cyclobalanopsis* species hitherto known; moreover, it does not seem related to any of them. It stands probably nearest to *Q. lobbii* Ettingh. The latter has an oval or oboval, sometimes oval-lanceolate leaf, its base is slightly obtuse or acute; length 5 to 10 cm, width 3 to 3·5 cm; its 13 or 14 lateral veins, parallel to each other branch off at equal distances, but their starting angle is much sharper, about 40°. It is especially this latter feature which distinguishes *Q. lobbii* from our fossil leaves.

Quercus agriensis Andreánszky, in Acta Bot. Acad. Scient. Hung. 8. 1962, 224, pl. III. 2.

Recently a further fragmentary specimen has been added to our collection. This species thus appears more abundant than originally believed. It differs considerably from our other leaves classified under the subgenus *Cyclobalanopsis*; nevertheless, its belonging to that unit is not open to doubt.

A species already known from the Hungarian Tertiary, *Cyclobalanopsis palaeoacuta* Kolak. (Andreánszky, in Acta Bot. Acad. Scient. Hung. **5.** pl. I. Fig. 2) several specimens of which have been found in the Lower Oligocene shale of Kiseged Hill, also differs in many respects from all the other *Cyclobalanopsis* species here enumerated. It is thus necessary to emphasize that the four species hitherto known from the Hungarian Tertiary [*Q. (Cyclobalanopsis) tenuipetiolata* Andreánszky, *Q. legányii* Andr. et Kov., *Q. agriensis* Andreánszky and *C. palaeoacuta* Kolak.] all substantially differ from each other and require to be assigned to different groups of species. It is to be hoped, however, that further imprints of each one of these types will turn up; it will then be easier to fit them into the system of the living species. As already mentioned, it is not impossible that the species reported under the name *Lithocarpus* sp. II. also belongs to this subgenus. If this rather improbable case were to prove true, that species would have to be referred to a separate fifth group of species.

The species of the subgenus *Cyclobalanopsis* just as those of the genera *Lithocarpus* and *Castanopsis*, live — except for one species each which are typical denizens of Pacific North America, — in Southeast Asia, and their ecology is fairly uniform. At most, *Q. legányii* Andr. et Kov. differs in that it is somewhat more drought-resistant. This being the case, their territorial affinities and climatic implications can be established even in lack of an accurate and definitive taxonomic determination.

Subgenus Euquercus

Quercus tenerrima Web. in Paläontogr. *2.* 1852, 172, t. XVIII. 15, 4. 132, t. XXI. 6—7. (Figs 38 and 39).

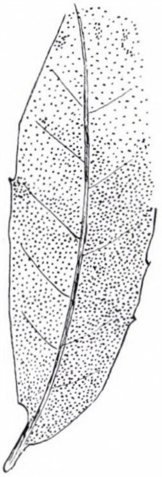

Fig. 38. Quercus tenerrima Web., middle strata 3250 ME

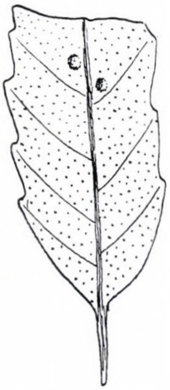

Fig. 39. Quercus tenerrima Web., from Eger-Tihamér, 7411 ME

A small leaf from the middle strata, bearing No. 3250 in the collection of the Museum of Eger. Petiole 3·5 mm long, medium strong, lamina asymmetric, curved, linear-elliptic, base acute; one of the half-laminae reaches deeper down on the petiole than the other; apex missing; the margin bears tiny, sharp, forward-leaning teeth spaced at intervals of about 5 mm. The complete lamina may have been 4·2 to 4·5 cm long, 1·1 cm wide at the middle. Venation asymmetric, primary lateral veins very fine, hardly perceptible, arising at a relatively large angle (55 to 60°) and reaching the teeth in an arch. There were probably 8 or 9 pairs of primary lateral veins. The morphological features of the leaf indicate a very hard consistency. This fact is highly suggestive of the ecologic conditions then prevailing at the Wind Brickyard site.

Collecting activity lately produced from the Helvetian diatomaceous earth of Eger-Tihamér a fossil leaf (7411) which can also be assigned to this species. This leaf is likewise small, slightly broader than the above one; its venation is better visible because the embedding rock is finer-grained. The petiole is somewhat longer.

Both leaves agree with *Q. tenerrima* Web. described from and frequent in the Upper Oligocene of Rott; a slight difference consists in that the lateral veins of the latter are better visible, at least on the photograph. *Q. tenerrima* Web. is usually compared with the Mexican *Q. lancifolia* Schlecht. et Cham. and with *Q. xalapensis* Humb., respectively. In our opinion, this fossil is closely related to the species of the section Protobalanus, particularly to *Q. chrysolepis* Liebm. According to A. Camus, the species of this section, shrubs or moderately tall trees in the southern part of Pacific North America and in Central America, have hard leaves of the *Ilex* type; their margin is entire, or serrate with thick, spiny teeth. Their wood is hard. The *Protobalanus* section is connected with the section *Lepidobalanus* through the subsection *Virentes*, and with the section *Erythrobalanus* through the subsections *Agrifoliae* and *Durifoliae*. The leaves of *Q. chrysolepis* Liebm., that persist on the tree for 3 to 4 years are oval, oval-elliptic, or lanceolate, 2·5 to 5 cm long and 1 to 4 cm wide; margin entire, rarely serrate or sinuate-dentate, with 4 to 10 short, spiny teeth on both sides. Midrib thin, there are 6 to 10 pairs of lateral veins, the middle ones diverging at an angle of 45 to 50°; sometimes they bifurcate before reaching the margin; the finer veins, rarely visible, form an irregular network. Petiole thin, 2 to 5 mm long. The species lives together with the trees *Quercus californica, Q. agrifolia, Pseudotsuga macrocarpa, Pinus ponderosa, Libocedrus decurrens*, at altitudes ranging from 450 to 2700 metres above sea level, in the southwestern part of the Sierra Nevada and over most of the Coast Range; it constitutes a chaparral with the trees *Q. wislizeni* and *Q. kelloggii*, whereas *Q. breweri* tends to form impenetrable thickets. In the United States it extends from South California as far up as southern Oregon, and the state of Washington.

Sect. *Erythrobalanus*

Subsect. *Mexicanae*

Quercus palaeofournieri Andr. et Kov. n. sp. cf. *Q. fournieri* Trel. vel *Q. copeyensis* Müller (sect. *Macrobalanus)*; (Figs 40, 41)

There are in our possession three leaves from the lower and middle strata, respectively, which seem to belong to one and the same species and stand near to the above-mentioned two living species, notwithstanding the fact that the latter belong to two different sections. *Q. fournieri* Trel. lives in Mexico, on the eastern side of the Sierra Madre; evergreen *Q. copeyensis* Müller lives under a cool climate in Costarica and Panama.

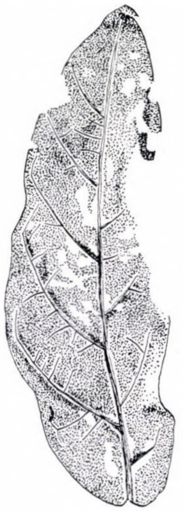

Fig. 40. Quercus palaeofournieri Andr. et Kov., lower strata 3126 ME, holotype

Fig. 41. Quercus palaeofournieri Andr. et Kov., middle strata 7376 ME

The description refers to specimen No. 3126 from the lower strata.

Lamina oblongo-lanceolata, apice breviter triangularis, basi rotundata et parum emarginata, 7 cm longa, 2·2 cm lata, integra sed parum undulata. Nervus principalis validus, parum arcuatus. Nervi laterales in uno latere in numero 7, in altero in numero 8 adsunt, in angulo ca. 50° orti, mox valde arcuati et in vicinitate marginis in arco lato anastomosantes, camptodromi. Inter nervos laterales primi ordinis nervi debiliores et breviores in angulo fere recto orti. Area inter nervos secundarios a nervillis in areolas polygonas laxas irregulares divisa.

In stratis inferioribus fabricae Wind nominatae, olig. super. Holotypus in collectione Musei Agriensis de Stephano Dobó nominati sub No. 3126.

The midrib was probably straight originally; its curvature may be due to fossilization.

Specimen No. 7376 from the middle strata is somewhat smaller; its apex and base are missing; completed, it may have been 6·5 cm long and 1·9 cm wide; venation hardly distinguishable, but the lateral veins, likewise camptodrome, seem to emerge at a somewhat larger angle. Specimen No. 3081 from the lower strata is even smaller and more fragmentary.

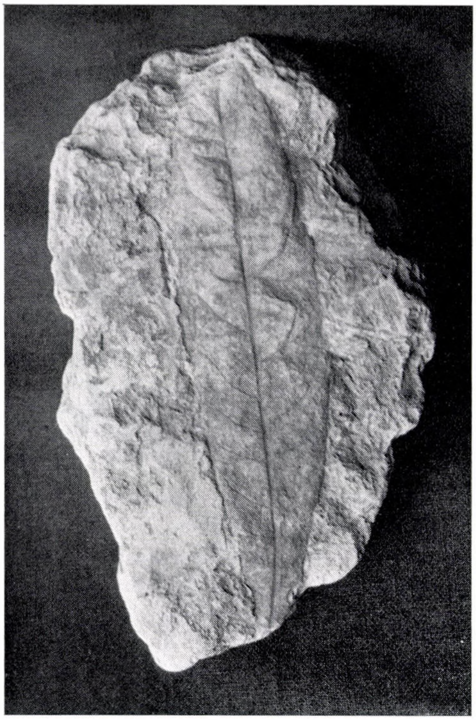

Fig. 42. Quercus salicina Sap., upper strata 4496 NR

On the basis of the greatest probability, we classify our leaves under the section *Erythrobalanus*. This section comprises many hard-leaved *Quercus* species of the New World; this implies that our species had been hard-leaved, too.

Quercus salicina Sap. Ex. anal. p. 29 et in Annal. Sci. Nat. 4ème sér. *17*, 1862, 237, pl. VI. 6. (Figs 42—44).

Besides *Quercus* cf. *bourgaei* Oerst. this is the only oak species represented in the upper strata. Oak leaves of a similar general form and venation were described under several names by Saporta. Of these, the description and drawing of *Q. salicina* Sap. agree best with our leaves.

Apex and petiole of leaf No. 4496 are missing and the base is damaged, otherwise it is fairly well preserved. Lamina narrow oblanceolate, tapering more gently towards the base than towards the apex. In a completed state it is 9 cm long and, slightly above the middle, 2 cm wide; margin entire, base decurrent for some length, apex probably obtuse. Midrib slightly curved, strong. Lateral veins, about 16 pairs thin but well visible; emerging at large but not quite equal angles, they are non-parallel and slightly asymmetric on the two sides of the leaf. The lower ones arise almost at right angles on both sides, the upper ones nearly so on one side, at about 60 to 70° on the other side. Farther off the midrib the veins curve forward and ramify, being camptodrome in large loops. Leaf No. 4535 is shorter, about 7·8 cm long, but comparatively broader, as it has the same breadth (2 cm) as the above specimen; there are 14 pairs of lateral veins, likewise asymmetric, although somewhat more regular and parallel than on the previous leaf.

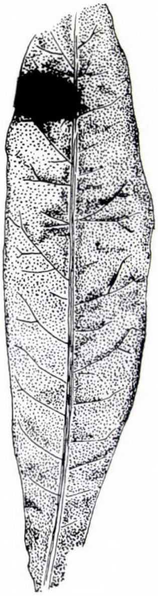

Fig. 43. Quercus salicina Sap., upper strata 4496 NR

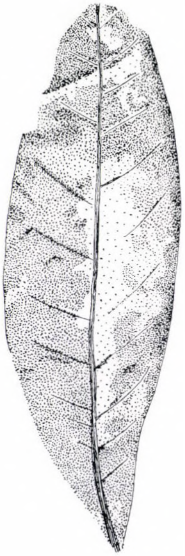

Fig. 44. Quercus salicina Sap., upper strata 4535 NR

A third leaf is more fragmentary and the number of its lateral veins seems to be smaller.

The leaves undoubtedly belong to one and the same species. Their classification in the subsection *Mexicanae* is uncertain, because the two species to which they may be related belong to two different subsections. One is *Q. mexicana* Hunb. et Bonpl. (sect. *Erythrobalanus* subsect. *Mexicanae)* from Mexico; this is, however, a deciduous tree, although its leaves are rather coriaceous. It grows, planted, in Berlin. The other species, *Q. salicina* Née (sect. *Erythrobalanus* subsect. *Salicifoliae)* very similar and likewise deciduous, also lives in Mexico. Accordingly, our species probably was also deciduous and comparatively microthermic.

Subsect. *Lanceolatae*

Quercus cf. *bourgaei* Oerst. (Fig. 45)

A narrow lanceolate leaf, tapering just a little more gently towards the base than towards the apex. Although a very small part of the base is missing, it must obviously have been acute. The apex, missing, probably was also acute. Margin entire. Midrib marked, curved, perharps as a result of fossilization. Length of the completed lamina is 7 cm, its breadth 2 cm. Primary lateral veins particularly thin, hardly perceptible, course uncertain; there are about 9 pairs. The veins form an asymmetric pattern: on the one side they arise at nearly right angles, except for the upper ones which do so at a sharper angle; on the other side even the lower ones arise at an angle of 60 to 70°. The veins then arch forward considerably, anastomosing with the others and forming a somewhat zigzag marginal vein. This latter runs at a distance of 2 to 3 mm from the margin of the leaf and is just as strong as are the lateral primary veins themselves. The enclosed space and also the border outside the marginal vein are divided by finer veins into minuscule areas which, although irregular, are more or less rectangular in shape. Between two primary lateral veins a thinner vein usually arises from the midrib and joins the border vein without change of direction.

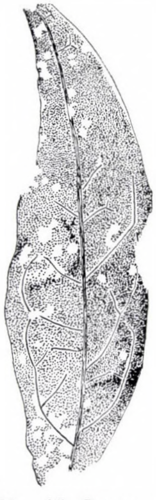

Fig. 45. Quercus cf. *bourgaei* Oerst., upper strata 11524 NR

The leaf may be related to the deciduous *Q. bourgaei* Oerst. of Mexico, although our leaf rather seems to be evergreen. The living species thrives at altitudes from 2400 to 3000 m. Our leaf coming from the upper strata bears No. 11524 in the collection.

Subsect. *Pagodaefoliae*

Quercus gigantum Ett. Foss. Fl. v. Tokay (1953) t. III. 4. (Figs 46—49) In the middle, and particularly in the lower strata of the Wind Brickyard a large number of relatively large, deeply lobed oak leaves have been found. Unfortunately none of the larger leaves is fully preserved, but, taken together, the leaves provide a fairly good basis for the reconstruction of the leaf form. In addition, we have some very well-preserved and complete small leaves. The leaves agree perfectly with the fragment shown on the original drawing of *Q. gigantum* Ett. Thus, notwithstanding the age difference (Upper Oligocene—Lower Sarmatian) it would be unwarranted to separate the Wind Brickyard leaves from this species. Moreover, Pálfalvy already

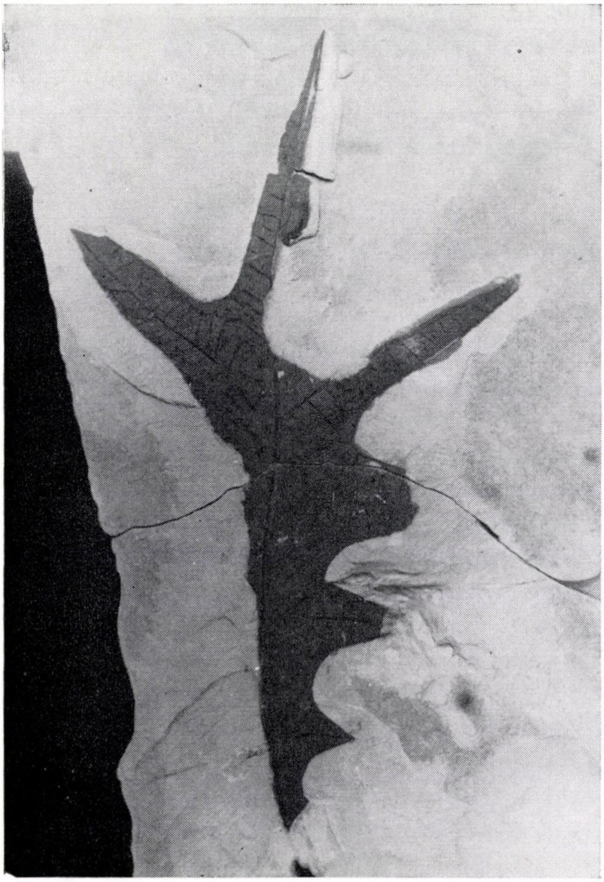

Fig. 46. Quercus gigantum Ett. lower strata 3280 ME

published this species from the Wind Brickyard (1951, 17, t. II. 2.). An imprint yielded by the Lower Miocene deposits of Kisterenye (Czár—Józsa, ex Andreánszky—Kovács, 1955, 14) proves that this species had a tendency to disappear and turn up again repeatedly during its long life-time.

Fig. 47. Quercus gigantum Ett., lower strata 6410 ME

It is the most complete of the large leaves from the Wind Brickyard which we are going to describe here. The petiole is short, 1·3 cm, and fairly strong. The lamina, decurrent and superficially lobed in its lower part, is deeply cleft higher up, forming altogether 5 pairs of lobes. On other leaves there are only 4 pairs of lobes, even fewer on the small leaves. The lowest lobes have the shape of short, squat triangles, the upper ones have about the same width (1·5 cm) at their base, but their greater length makes them appear linear-lanceolate. The lower lobes arise at right angles, whereas the upper ones form an angle of about 70° with the midrib. The lobes taper into a bristle at the tip, which, missing from most of the fossils, is 2 mm long where it exists. The lobe is neither rounded nor truncated where the bristle emerges: this fact distinguishes these leaves from those of many living North American oak species. The leaf is 16 cm long and 10 cm wide between the tips of the two upper lobes. On the upper part it is cleft to three fourths of the lamina; between two lobes of 5 cm length each the uncleft part is only 3 cm wide.

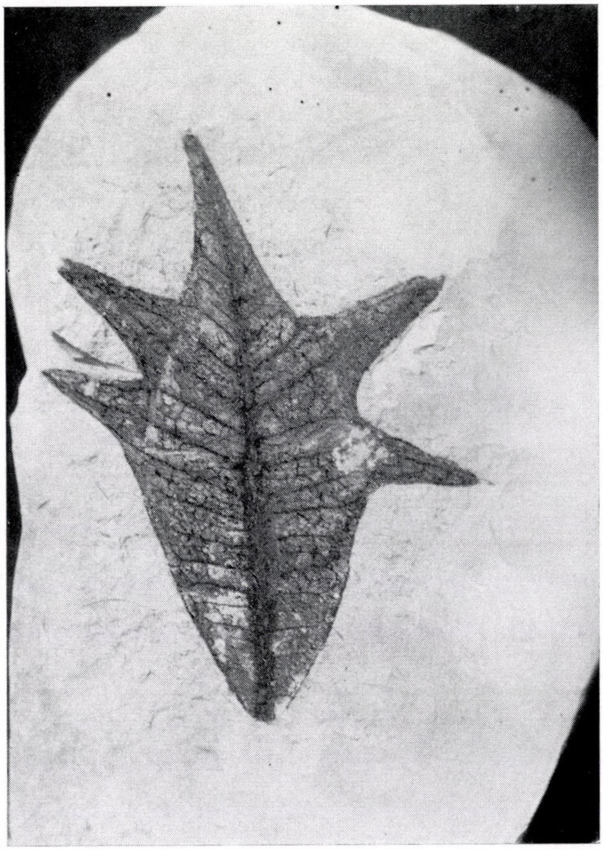
Fig. 48. Quercus gigantum Ett., lower strata ME

The midrib and the lateral veins running into the lobes are very strong. The latter continue into the bristle, whereas those lateral veins which do not enter the lobes are camptodrome and, anastomosing with the ramifications of the lateral veins of the lobes, constitute a marginal vein along the sides and up to the tips of the lobes.

Among the oaks living to-day, similar leaf forms are exclusively found in Atlantic North America. However, most of them differ from the Wind Brickyard species in that on their leaves the lobes are truncated under the bristle. In addition, the lobes of most show a secondary lobation and the marginal vein is absent. It is the leaf of *O. pagodaefolia* (Ashe) Elliott which most resembles ours, although even the lobes of this species show some contraction before reaching the bristle. On the living species, the bristle is nothing but a primary lateral vein prolonged beyond the tip of a rounded or truncated lobe or tooth. From the point of view of affinity, only *O. pagodaefolia* (Ashe) Elliott can come into question, and from the point of view of environment, warmer Atlantic North America. In the Wind Brickyard flora this species was a microthermic element. As the oak leaves in question are of a fairly peculiar shape, it is most probable that the various fossils of different ages belong to the same species. This species must, then, have been very long-lived. The leaves do not show any considerable vari-

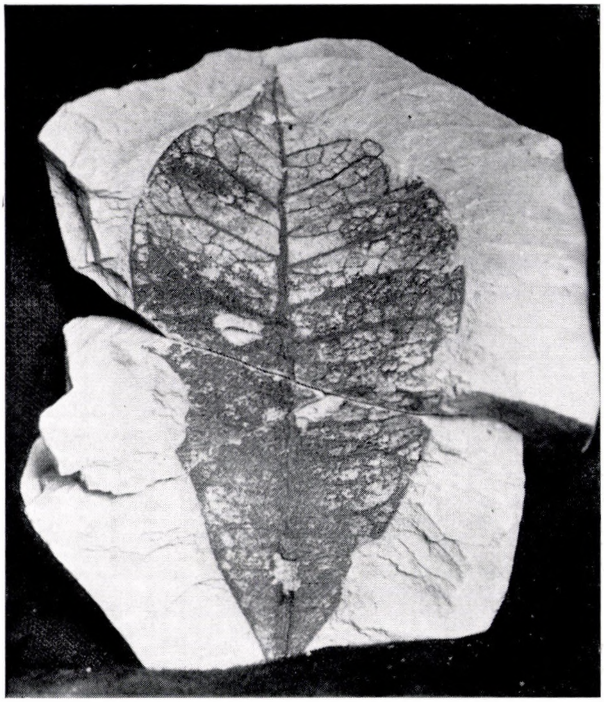

Fig. 49. Quercus gigantum Ett., lower strata 3112 ME

ability, except that the primordial leaves are smaller and less deeply divided, sometimes even entire, while the leaves developing on the upper part of the shoot are large, deeply divided and well-developed. The leaves in our possession constitute a full range of forms from the entire leaf to the largest, deeply divided type, but their venation and other characteristics are fully identical.

The Wind Brickyard species is suggested by its living relationship to have been deciduous. This is the only oak species in the Wind Brickyard flora which might conceivably have been a Turgayan element.

In the Hungarian Tertiary this is the only oak species with deeply cleft leaves whose lobes end in a bristle. It is an ancient type of oak which did not split up into several species, except in Atlantic North America. *Q. alexejevii* Pojark. was until now assigned to this form group, but it does not really belong there, as has been explained elsewhere (Andreánszky 1959a, 116).

Incertae sedis

Quercus crassipetiolata Andr. et Kov. n. sp. (Figs 50—53)

Folium petiolatum, petiolus 3 cm longus, pervalidus, 1·8 mm crassus, rectus; lamina oblongo-linearis, basi rotundato-cuneata, apice ignoto, verisimiliter ca. 7 cm longa (pars conservata typi 4·7 cm longa) et 2 cm lata, margine undulato-dentata, dentibus in numero utrinque 7, parum prominulis, dorso rotundatis, solum in parte superiore minute acuminatis. Nervus principalis validus, rectus, nervatio secundaria parum asymmetrica, nervi laterales in uno laterale in angulo 50—55°, in altero angulo 40—45° in spatiis inaequalibus exeuntes, verisimiliter 7 vel 8 pares (5 pares adsunt), leviter arcuati, craspedodromi, in proximitate marginis infracti et bifurcati. Nervatio tertiaria ad nervos secundarios perpendicularis, subparallela, sinuosa. Nervi subtiles conspicui, laminam in areolas minutas irregulares dividentes.

In stratis mediis fabricae Wind nominatae ad oppidum Eger, Hung. sept. Holotypus in collectione Musei Agriensis de Stephano Dobó nominati sub No. 6875. Specimina altera 6835, 6835/a, 7269, 7304 (specimina duo ultima in stratis inferioribus collecta).

Although none of the leaves is complete, and the upper part of each one is missing, the form, venation and serration of the leaf are excellently visible and are sufficiently typical to serve as specific features. We consider the leaf to belong to a species of oak, without being able for the moment to establish its taxonomic position. It somewhat resembles certain *Myrica* species, but the primary lateral veins, some of which end in the teeth, indicate the genus *Quercus*. One branch of each lateral vein runs directly into the teeth, while the other proceeds forward, parallel with the margin of the leaf and then disappears. In this respect our leaves agree with *Castanopsis furcinervis* (Rossm.) Kr. et Wld. However there is another oak species which exhibits a similar lateral venation *(Q. pseudofurcinervis* É. Kovács and Pálfalvy in Kovács, É., 1962, 293, Abb. 5); apart from this, the thick petiole distinguishes our species sharply from *Castanopsis*.

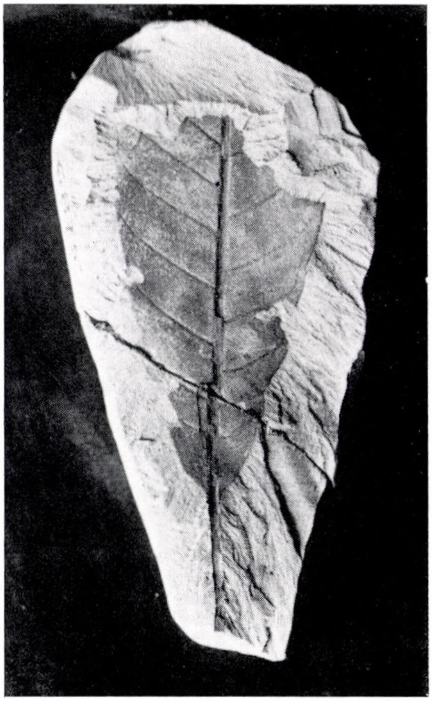

Fig. 50. Quercus crassipetiolata Andr. et Kov., middle strata 6875 ME

Fig. 51. Quercus crassipetiolata Andr. et Kov., middle strata 6875 ME, holotype

Initially, *Q. pseudofurcinervis* É. Kovács and Pálfalvy figured under the name of *Q.* cf. *muehlenbergii* Engelm. (Andreánszky 1959a, 115, Taf. XXX. 4, 5). The species known from the Sarmatian seemed to be most closely related to this living species. Lately, É. Kovács (l. c.) thoroughly revised the taxonomy of this oak leaf and came to the conclusion that although it stands indeed nearest to the above-mentioned species, a closer affinity is improbable.

It is unfortunate that the imprints from Balaton-Déllő, considered to be specimens of *Q. pseudofurcinervis* É. Kovács and Pálfalvy, are leaf fragments that show neither base nor petiole. These features can, however, be observed on an imprint from Füzérradvány, which, according to É. Kovács, belongs to the same species. That leaf, however, has a thin petiole. It is consequently highly improbable that the Wind Brickyard leaves should belong to *Q. pseudofurcinervis* although, in leaf form and dentation as well as venation, their similarity to some samples from Balaton-Déllő is quite obvious. They may, however, belong to the same form-group and a definite relationship may exist between them. Still, as the taxonomic position of *Q. pseudofurcinervis* É. Kovács and Pálfalvy is not known either, this assumed relationship fails to bring us any nearer to establishing the position of our species. It seems to us that we are confronted with a new group of species, presumably extinct, including for the moment two species, *Q. pseudofurcinervis* É. Kovács et Pálfalvy and *Q. crassipetiolata* Andr. et Kov.

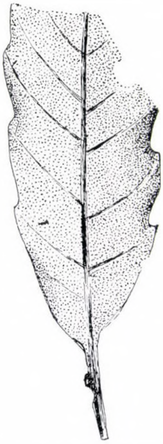

Fig. 52. Quercus crassipetiolata Andr. et Kov., middle strata 6835 ME

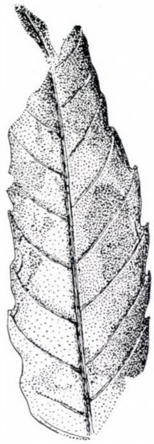

Fig. 53. Quercus crassipetiolata Andr. et Kov., middle strata 6845 ME

We do not know whether our species was evergreen or deciduous. Since most of the imprints derive from the middle strata, the flora of which comprises a fair percentage of deciduous species indicative of a temperate climate *(Carpinus grandis* Ung., *Quercus gigantum* Ett. etc.), it may be supposed that our species was also deciduous and had, furthermore, rather modest heat requirements.

We intend to facilitate insight into the taxonomic relationships, regional affinities and foliage types of the enumerated species by presenting them in tabulated form (Table I).

The distribution of the species over the stratigraphic succession is as follows. Of the *Castanopsis* species, *C. callicomaefolia* Andreánszky and *C. furcinervis* (Rossm.) Kr. et Wld. are most abundant in the lower, less so in the middle strata; from the upper group of strata, only *Castanopsis* sp. I. is known. Of the species belonging to the genus *Lithocarpus* only *Lithocarpus* sp. II. came from the upper strata. Most of the specimens have been yielded by the middle, and to a smaller extent by the lower strata. So far, subgenus *Cyclobalanopsis* of the genus *Quercus* and section *Protobalanus* of the subgenus *Euquercus* has mostly been encountered in the middle and to a smaller extent in the lower strata. From the upper strata we have no fossils belonging to these taxonomic units. From among the species of the section *Erythrobalanus*, *Q. palaeofournieri* Andr. et Kov. and *Q. gigantum* Ett. have occurred in both the lower and middle strata, *Q. salicina* Sap. and *Q.* cf. *bourgaei* Oerst. in the upper strata only. The majority of the remains of *Q. crassipetiolata* Andr. et Kov. — of unknown taxonomic place — was found in the middle strata, and the rest in the lower strata.

It follows from the aforesaid that, in the Wind Brickyard strata, the *Quercus* group first shows an increase in the number of species, with the greatest number encountered in the middle strata; this number suddenly decreases afterwards, and from the rich upper strata only 4 of the enumerated 16 species are known. On the other hand, in the middle strata, very poor even if all plant species are considered, the *Quercus* group is represented by 10 species. As regards the number of individual specimens, the lower strata are the most favoured because most of the remains of *Castanopsis callicomaefolia* Andreánszky — most abundant of all species — have been found in the lower strata. The species from the upper strata are, on the contrary, very scarce also as regards the number of individual fossils.

From the point of view of territorial affinities, the genera *Castanopsis* and *Lithocarpus* and the subgenus *Cyclobalanopsis* of *Quercus* are represented by species related without exception to Southeast Asiatic forms, whereas the species of the subgenus *Euquercus* nearly always reveal New-World affinities. Western Eurasian as well as Mediterranean affinities are completely absent. The latter are seen to evolve rapidly in the late Tertiary. Also, any relationship with Eastern Asiatic *Euquercus* species is lacking. As to the species having New-World affinities, the counterparts of some live in Atlantic, but most of them in Pacific North America.

From the point of view of foliage, the distribution is as follows. The genera *Castanopsis* and *Lithocarpus*, as well as the subgenus *Cyclobalanopsis* of the genus *Quercus*, as we have seen, show a consequential Southeast Asiatic affinity, and are consequentially evergreen, possessing a laurel-type foliage,

TABLE I. *Taxonomy, regional affinity and foliage type of the form group*

Species	Subgenus	Sectio
Castanopsis callicomaefolia Andreánszky		
Castanopsis ? furcinervis (Rossm.) Kr. et Wld.		
Castanopsis sp. I.		
Lithocarpus debilinervis Andr. et. Kov.	*Cyclobalanus*	
Lithocarpus sp. I.	*Cyclobalanus*	
Lithocarpus colchica Kolak.	*Pasania*	
Lithocarpus sp. II.	*Pasania*	
Quercus tenuipetiolata Andreánszky	*Cyclobalanopsis*	
Quercus legányii Andr. et Kov.	*Cyclobalanopsis*	
Quercus agriensis Andreánszky	*Cyclobalanopsis*	
Quercus tenerrima Web.	*Euquercus*	*Protobalanus*
Quercus palaeofournieri Andr. et Kov.	*Euquercus*	*Erythrobalanus*
Quercus salicina Sap.	*Euquercus*	*Erythrobalanus*
Quercus cf. *bourgaei* Oerst.	*Euquercus*	*Erythrobalanus*
Quercus gigantum Ett.	*Euquercus*	*Erythrobalanus*
Quercus crassipetiolata Andr. et Kov.	incertae sedis	

although *Q. tenuipetiolata* Andreánszky and *Q. agriensis* Andreánszky show certain xerophilous features which bring them closer to the hard-leaved trees. The *Euquercus* species are divided between the hard-leaved and the deciduous trees. *Q. tenerrima* Web. belongs undoubtedly, *Q. palaeofournieri* Andr. et Kov. probably, to the former. *Q. gigantum* Ett. were certainly, *Q. salicina* Sap., *Q. crassipetiolata* Andr. et Kov. probably, *Q.* cf. *bourgaei* Oerst. possibly deciduous.

In the vegetation represented by the Wind Brickyard flora, only *Castanopsis callicomaefolia* Andreánszky played an important role, as only this species is really abundant in the strata. Of all the other we have but a few specimens; consequently, those could only have been accessory elements in the ancient forest. This is all the more remarkable since *Q. tenerrima* Web. is very frequent in the Rott flora.

The middle strata of the Wind Brickyard are the youngest in Hungary to bear the remains of a *Castanopsis* species in an important quantity. This suggest a forest whose ecology agreed with that of the *Castanopsis* species. *Castanopsis callicomaefolia* Andreánszky already existed in the Lower Oligocene, too, but at that time it was considerably scarcer than *C. furcinervis* (Rossm.) Kr. et Wld. which played a leading role at that time. The genus itself persisted in Hungary, as we have seen it, until the Helvetian at least, *of the oak in the Upper Oligocene flora of the Wind Brickyard*

Subsectio	Regional affinity	Foliage type
	Southeast Asia	laurineous evergreen
	Southeast Asia	laurineous evergreen
	Southeast Asia	laurineous evergreen
	Southeast Asia	laurineous evergreen
	Southeast Asia	laurineous evergreen
	Southeast Asia	laurineous evergreen
	Southeast Asia	laurineous evergreen
	Southeast Asia	hard-leaved or laurineous evergreen
	Southeast Asia	laurineous evergreen
	Southeast Asia	laurineous evergreen
	Pacific North America	hard-leaved evergreen
Mexicanae	Mexico	hard-leaved evergreen
?Mexicanae	Southern North America	deciduous
Lanceolatae	Mexico	?deciduous
Pagodaefoliae	Warmer Atlantic North America	deciduous
	?Atlantic North America	deciduous

but did not attain much importance after the period of the Wind Brickyard flora.

According to our present knowledge, it is here that the genus *Lithocarpus* appears in Hungary for the last time, but this may be due to insufficient research and, in our opinion, the genus is likely to crop up from our Lower and Middle Miocene, too. Furthermore, the subgenus *Cyclobalanopsis* of the genus *Quercus* presumably persisted even longer; we hope that this assumption will also prove true in the light of further investigations.

The complete absence of oaks of Mediterranean hard-leaved type from the Wind Brickyard, as well as from other Hungarian floras of the same age, is remarkable, if we take into account that *Q. mediterranea* Ung. was encountered in Western Europe also in much older strata. Consequently, we should not consider their absence from the Hungarian floras as definitively established.

Juglandaceae

Engelhardtia brongniarti Sap.

Only one fruit imprint is known from the upper strata. This is rather unexpected inasmuch as this fruit is one of the most abundant fossils in the Upper Oligocene flora of Csörög, which is much poorer otherwise, and fairly frequent also in other Oligocene sites. Besides the fruit we possess from the upper Wind Brickyard flora the imprint of a leaflet which probably belongs to this genus, but its poor preservation precludes a definite determination.

Pterocarya denticulata (O. Web.) Heer

Several leaflets are in very good agreement with the named species. The venation is very dense in general. Nevertheless, as such Pterocarya leaves are known not only from many Tertiary sites, but also among the living species, this cannot be taken as a distinctive feature. Of course, one cannot determine the *Pterocarya* species on the basis of leaflet imprints alone: it would be necessary to possess the samara, too. For the moment, however, no such fossil is known from the Wind Brickyard flora.

Juglans cf. *regia* L.

From each group of strata we possess several imprints of leaflets which agree with living *J. regia* L. Pálfalvy reported *J. ungeri* Heer from the Wind Brickyard strata (1951, 65, Tab. I. 6.). It is doubtful whether our leaflets really belong to this species, as the agreement with the original drawing seems to be somewhat vague.

Juglans cf. *cinerea L.* (Fig. 54)

This is a smallish, markedly asymmetric lanceolate, leaflet, base asymmetrically rounded, apex missing. Margin minutely serrate. Lateral venation medium-dense, locally bifurcating and camptodrome. The leaflet agrees well with those of *J. cinerea* L. The imprint, preserved together with the counter-imprint, comes from the middle strata and bears No. 7366.

Carya falcata Andreánszky, 1956, 221, Taf. II. 3, 4.

Myricaceae

Myrica (Comptonia) *acutiloba* Brgt. — Andreánszky, 1955, 41.
Myrica onocleaefolia Andreánszky, 1955, 49, Taf. II. 7.
Myrica cf. *aethiopica* L. — Andreánszky, 1955, 41.
Myrica lignitum (Ung.) Sap. — Andreánszky, 1955, 40, Taf. II. 6.
Myrica vindobonensis (Ett.) Heer — Andreánszky, 1955, 41.
Myrica cf. *longifolia* Teysm. et Binn. (non Ung.); (Fig. 55)

We possess several fragments to be classed here. However, as the base and apex are not preserved on any of the specimens, it seems hardly justifiable to establish a new species. Our leaves differ from all the described fossil species, but agree with the above-mentioned living species so much that a close relationship between the two is highly probable.

It can be established that the leaves were large, lanceolate. Our most complete fragment is 10 cm long but originally it may have had a length of 15 to 16 cm. Its width is about 3 cm where it is broadest. Its margin is almost entire, with a few sharp teeth visible here and there. It is to be noted though, that on some specimens the teeth stand fairly close-spaced. We shall discuss this point later on. The midrib is very strong. Spaced very irregularly, the primary lateral veins arise at unequal but generally fairly large angles, curving forward before reaching the margin of the leaf and bifurcating at the same time; the branches anastomose after having for some small distance run parallel with the margin for the leaf. On one of the leaves (No. 12030 in the collection of the Institute of Taxonomical Botany) the lateral veins display a pronounced asymmetry. The finer venation is also very

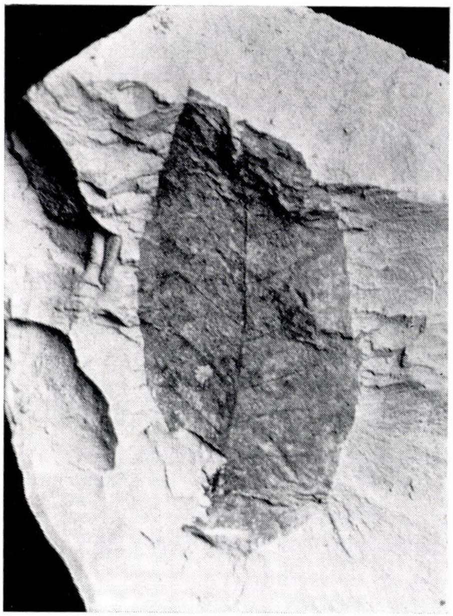

Fig. 54. Juglans cf. *cinerea* L., middle strata 7366 ME

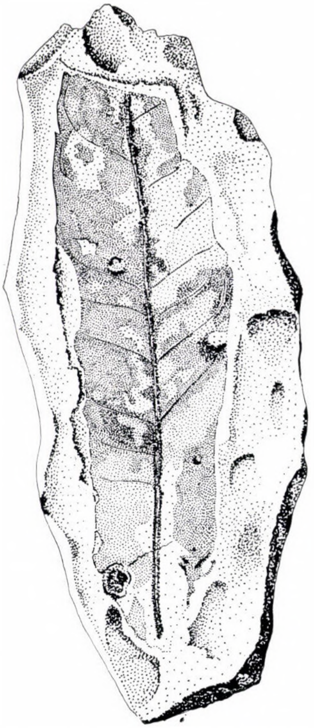

Fig. 55. Myrica cf. *longifolia* Teysm. et Binn., upper strata 12030 NR

irregular. This species of ours shows a certain similarity to *M. salicina* Ung., but the leaf of the latter is never longer than 10 cm; its shape is rather obovoid, and its margin entire.

The fossils referred to this group are kept under Nos 2399, 12030 and 12110 in the collection of the Institute of Taxonomical Botany, and under Nos. 6301 and W 2128 in the collection of the Museum of Eger, respectively.

A further *Myrica* leaf, similar to some extent to the above-mentioned ones and kept at the Museum of Eger under No. 9908, differs — as already mentioned — from the former ones in that its margin is more regularly and densely serrate and the course of its lateral veins more regular. In the case of this specimen the form group of *M. lignitum* (Ung.) Sap. may also enter into consideration. *M. lignitum* (Ung.) Sap. is, however, considerably smaller and narrower, as the largest of our leaves approximates a length of 20 cm and exceeds a breadth of 3 cm.

Myrica angustissima Wat. — Andreánszky 1955, 40, Taf. II. 9.
Myrica macrodonta Andreánszky 1962, 225, Fig. 3.
Myrica cf. *javanica* Bl. — Andreánszky 1955, 41. Abb. 2.
Myrica matheronii Sap. in *Annal. Sci. Nat.* 5$^{\text{ème}}$ sér. *18*, 1873, 30, pl. VI. 3, 4, 6. (Fig. 56)

A relatively broad Myrica leaf, pronouncedly and sharply serrate. From the Wind Brickyard, one fragment only is available from the upper strata (No. 3135 in the collection of the Museum of Eger). It is the upper part of a leaf, whose apex, however, is missing. The leaf was broadly lanceolate, about 9 to 10 cm long, and had a breadth of 3 cm or slightly more. The tip probably was acuminate. (Since the apex is missing on all the drawings of Saporta, too, it is impossible to make a comparison in this respect.) The venation is poorly visible on the imprint, it was probably very fine, because the contours of the leaf are well-defined. Some primary veins run into the teeth, some into the bays between the teeth; the latter ramify before reaching the margin. Our imprint best agrees in breadth with Saporta's broadest specimen, of which, however, only the basal part is extant. On Saporta's drawings, the teeth are somewhat wider-spaced than on our imprint; otherwise the agreement is excellent in all respects.

M. zachariensis Sap. var. *crassifolia* Sap. (in *Annal. Sci. Nat.* 4$^{\text{ème}}$ sér. *19*, 17, pl. V. 1A) is also very broad-leaved, but its lateral veins anastomose in beautiful loops which cannot be observed on our specimens.

M. matheronii Sap. should not be confused with *M. (Comptonia) matheroniana* Sap. (in *Annal. Sci Nat.* 5$^{\text{ème}}$ sér. *4.* 93, pl. V. 7) also described by Saporta, which belongs to the subgenus *Comptonia*.

Myrica hakeaefolia (Ung.) Sap. — Andreánszky 1955, 41, Taf. II. 10.

The genus *Myrica* as represented in the Wind Brickyard flora will require further detailed work although on a previous occasion I already tried to sort out the forms (Andreánszky 1955, 39—42) and succeeded in demonstrating many *Myrica* species. Those considerations still hold good, except that *M. (Comptonia) grandifolia* Andreánszky cannot be retained as a valid denomination, because the name *Comptonia grandifolia* Ung. has already been attributed to a different species (Unger: Fossile Flora von Sotzka, 1850, *Denkschr. Akad. Wien,* Math. Naturw. Kl. *2,* 161, Pl. XXIX. 1.). Accordingly, a new name had to be given: it is *M. (Comptonia) grandis* Andreánszky, nomen novum. Since then, a great deal of recently collected material added several new species to the old ones. In this situation I intend to elucidate in the near future the role of this genus in the Wind Brickyard flora by a new monograph.

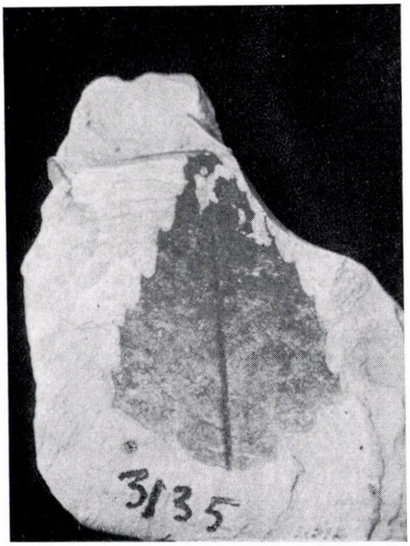

Fig. 56. Myrica matheronii Sap., upper strata 3133 ME

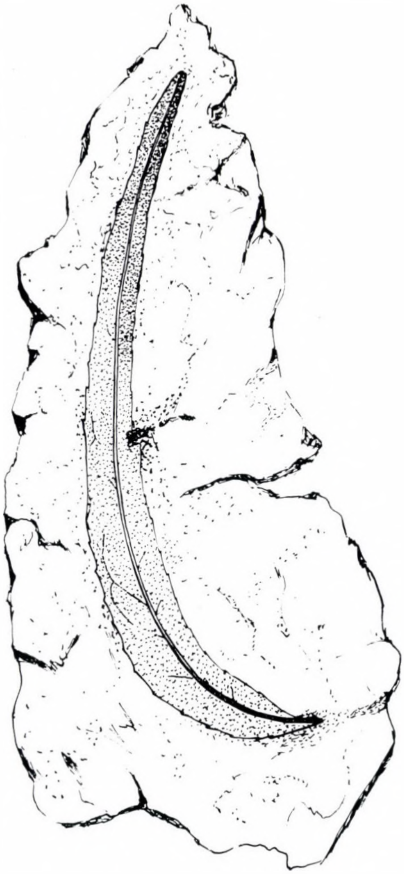

Fig. 57. Salix lavateri Heer, lower strata 6585 ME

Salix lavateri Heer, Fl. tert. Helv. II. 1856, 28, T. LXVI. 1—12. (Fig. 57)

The lower and middle strata have so far yielded three distinct types of willow leaf, each of them serrate. One of these types (Nos 3139, 6585 and W 2501 from the lower and 6550 from the middle strata) differs from the others by its narrow outline. This agrees with the description and drawings of *S. lavateri* Heer. According to Heer, the breadth of the leaf is 1/9 of its length. Although this criterion cannot be admitted as a specific difference,

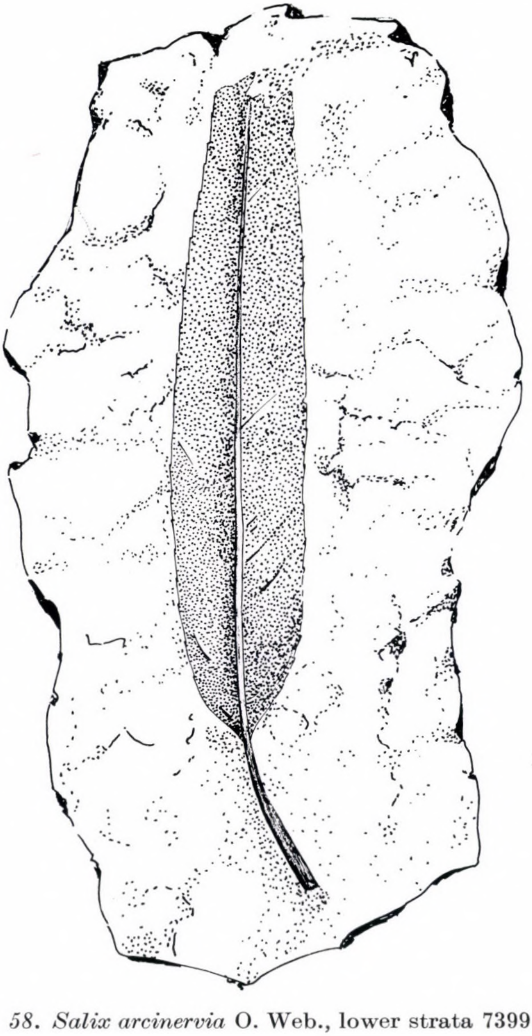

Fig. 58. Salix arcinervia O. Web., lower strata 7399 ME

the above-mentioned leaves are substantially different from the others in their narrowness; it seems therefore, justified to refer them to a separate species.

Salix arcinervia O. Web. in *Paläontogr. 2.* 1852, 177, Taf. XIX. 96. (Fig. 58)

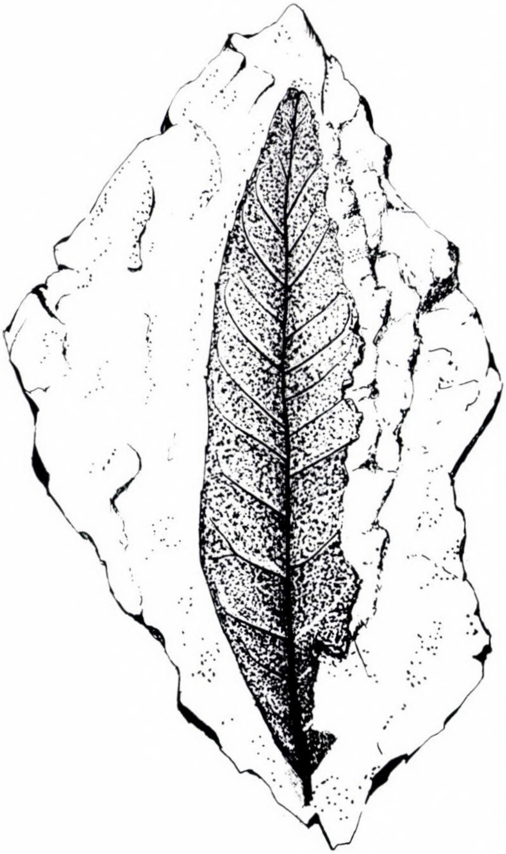

Fig. 59. Salix varians Goepp., lower strata
3169 ME

Fig. 60. Ulmus, type I., upper strata
W 1513 ME

This is the most frequent willow-leaf form in the lower and middle strata of the Wind Brickyard. It is typically broadest in its lower part; base broadly acute; the lateral veins, arising generally at a large angle, are short and do not run high. The petiole is strong. On one of the specimens it is preserved in its entirety: it is 2·4 cm long and 2 mm thick. Imprints Nos 7399, 7400, etc. from the lower, and Nos 6758, etc. from the middle strata belong to this species.

Salix varians Goepp. Foss. Fl. v. Schossnitz, 26, T. XX. 1, 2. (Fig. 59)

This is a narrowly lanceolate but not linear leaf (No. 3169 from the lower strata); broadest in its lower two fifths; very finely serrate; the lateral veins, arising at a sharper angle than on the previously described species, run farther up along the margin. It agrees well with one of Heer's figures (Fl. tert. Helv. II. Pl. LXV. 14), although it is somewhat smaller.

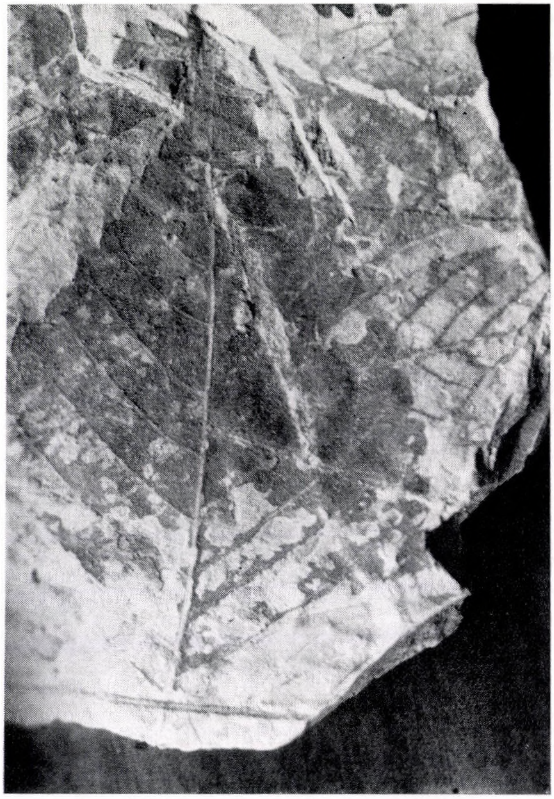

Fig. 61. Ulmus, type I., upper strata W 1725 ME

Fig. 62. Ulmus, type II., upper strata W 1366 ME

Ulmaceae

The genus *Ulmus*

The monographic treatment of the Tertiary *Ulmus* species of Hungary is being carried out by G. Sz. Cziffery. For the moment, the Wind Brickyard species are classified according to types presumably representing independent taxons whose precise taxonomic determination and distinction will, however, require further careful studies.

Type No. I. (Figs 60, 61). Markedly asymmetric, large ovoid leaves, with serrate or biserrate margin. Length of the leaf 10 to 14 cm, width 4 to 6½ cm. The lateral veins, numbering 12 to 16 pairs, strongly curve forward. *U. drepanodonta* Grub. of the fossil species and *U. americana* of the living stand nearest to this form.

Fig. 63. Ulmus type II. upper strata W 1659 ME

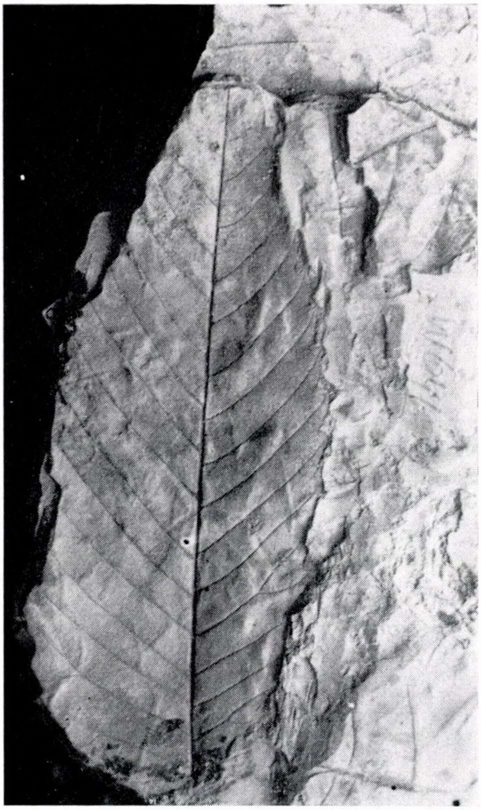

Fig. 64. Ulmus, type III., upper strata W 641 ME

Type No. II. (Figs 62, 63). Long, narrow leaves, most of them simply, coarsely serrate; base but slightly asymmetric. Length of the leaf 8 to 12 cm, width 1·5 to 4 cm; 12 to 20 pairs of veins. They do not agree with *U. longifolia* Ung. inasmuch as they are larger, narrowly lanceolate and not oblong-lanceolate. The type does not seem related to any living species.

Type No. III. (Figs 64, 65). Long, medium-wide and likewise rather large leaves. Margin in most cases simply serrate; lamina markedly asymmetric, 8 to 11 cm long and 4 to 5 cm wide. It bears some resemblance to *U. bronni* Ung., but it has a smaller breadth, or, in other words, a greater relative length.

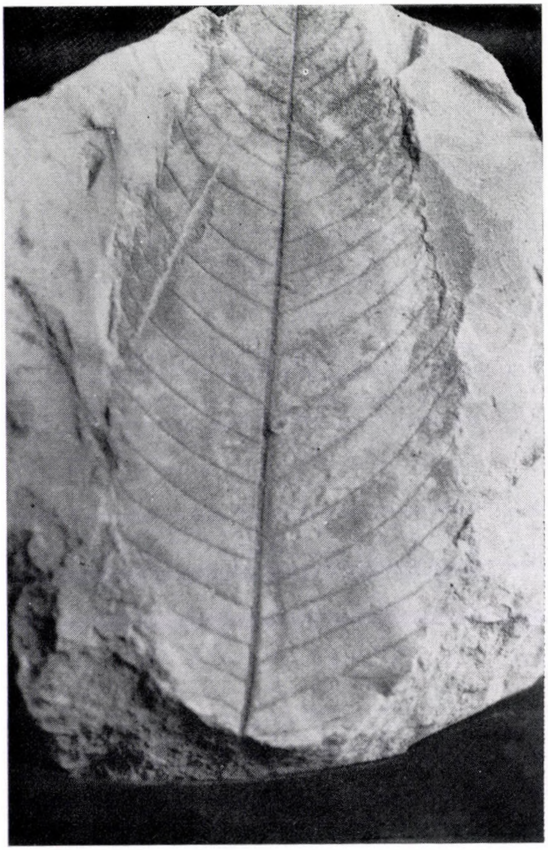

Fig. 65. Ulmus type III., upper strata W 1723 ME

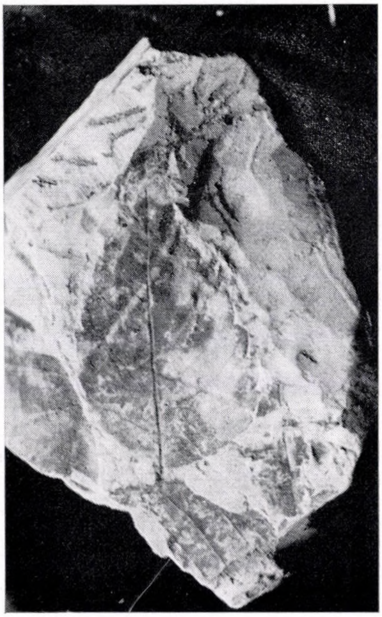

Fig. 66. Ulmus, type IV., upper strata W 1650 ME

Type No. IV. (Figs 66, 67). Small leaves, broad especially at the base; simply, coarsely serrate; in all these respects they stand near to *Zelkova*, from which, however, they differ in their asymmetry. Lamina 3·5 to 5 cm long and 1·8 to 2·5 cm wide. There are 10 to 12 pairs of lateral veins, 6 to 7 pairs on smaller specimens. It is especially these latter which resemble *Zelkova*. A detailed scrutiny has, however, convinced me that the leaves in hand do not belong to any *Zelkova* species and that, in consequence, the genus *Zelkova* is not represented in the ensemble of macrofossils, although, according to an oral communication by Mrs. L. Nagy, pollen analysis has succeeded in demonstrating the genus *Zelkova*.

Type No. V. (Figs 68, 69). These medium-sized and fairly broad *Ulmus* leaves stand nearest to living *U. levis* Pall. Margin biserrate, lateral veins dense, straight, moderately curved. The leaves found in the middle strata all belong to this type. The rest are known from the upper flora only.

Fig. 67. Ulmus, type IV., upper strata 56.1250 ME

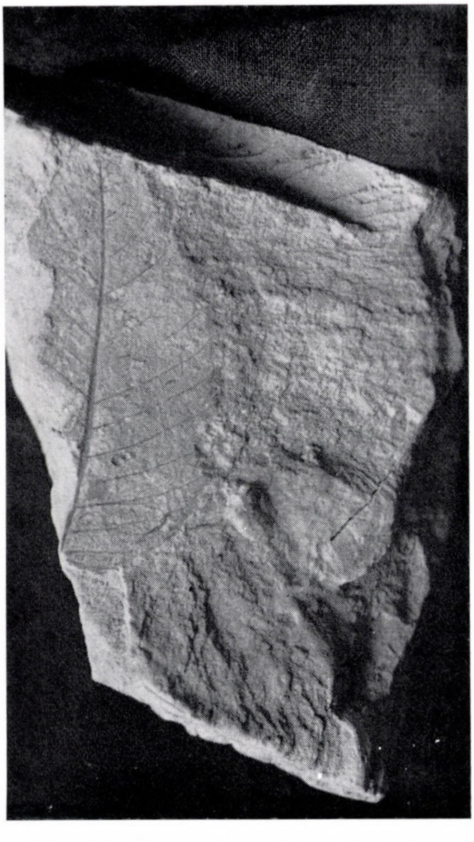

Fig. 68. Ulmus, type V., middle strata 6689 ME

Moraceae

Ficus latsonoides n. sp. (Figs. 70—72)

Folium in magnitude valde variabile, ovato-rotundatum, vel rotundato-reniforme, maximum inter specimina verisimiliter 13 cm longum et 16 cm latum, minora 12 cm longa et 10 cm lata, minima 6 cm longa et 5·8 cm lata, apice rotundata, basi recte abscissa vel leviter emarginata, omnia longe (5 cm vel ultra) petiolata, petiolo ca. 3 mm crasso, margine undulato-integerrima. Nervatio palmata, nervi basales (3) 5. Medius validus, rectus usque ad apicem folii conspicuus in parte inferiore simplex, a medio vel in speciminibus alteris solum supra medium ramosus, ramis suboppositis vel alternis, in angulo ca. 50° ortis, parum arcuatis, ad marginem laminae arcos latos formantibus, camptodromis. Nervi basales laterales cum medio angulum 50—60° formantes, solum extus ramosi. Nervi basales infimi brevissimi, simplices, marginem inferiorem laminae sequentes. Nervatio tertiaria indistincta.

Fig. 69. Ulmus, type V., upper strata 56.1099 ME

Fig. 70. Ficus latsonoides Andreánszky, middle strata 6350 ME

In stratis inferioribus et mediis fabricae laterarum Wind nominatae ad oppidum Eger. Syntypi in collectione Musei Agriensis de Stephano Dobó nominati sub Nris 6350, 3204 et 3607.

From the point of view of placing this fossil in the system, several genera can enter into consideration, such as *Grewia*, *Buettneria*, *Dombeya* and *Cercis*. A comparison with some living species of these genera led me to the conclusion that our leaves most resemble those of the genus *Ficus*, and, more particularly the leaves of *F. latsoni* Elm. living in the Philippines. But the Wind Brickyard leaves also differ from the latter in that they are broader and less markedly cordate than even the broadest leaves of *F. latsoni* Elm.

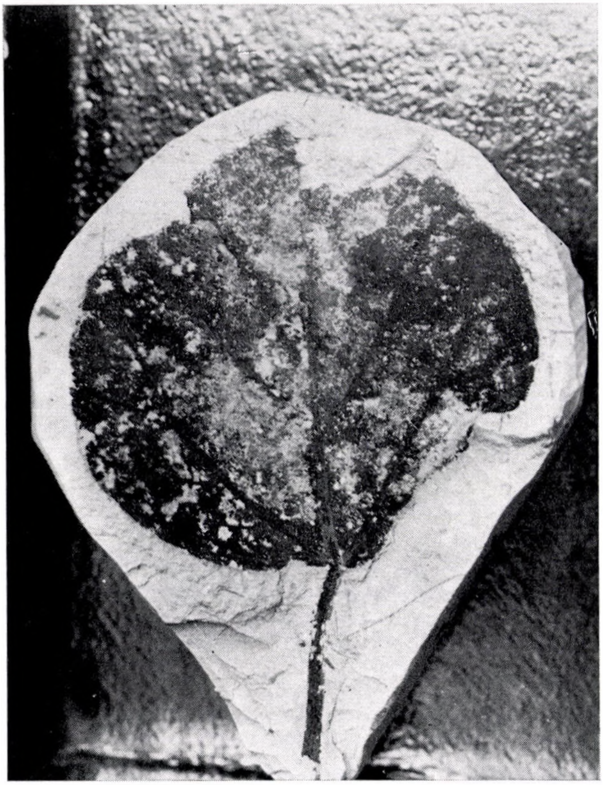

Fig. 71. Ficus latsonoides Andreánszky, lower strata 3204 ME

Many circular, broad leaves of fossil *Ficus* have been described, but our leaves do not agree sufficiently with any of them; of all, *F. grandifolia*

Fig. 72. Ficus latsonoides Andreánszky, lower strata 3074 ME

Ung. seems to stand nearest. It differs from the Wind Brickyard specimens in that the lower principal veins of the latter do not run as far up towards the apex. There is also a substantial age difference, as this species was first described by Unger from the Sarmatian. I am presenting this new species with a certain reserve because, owing to the great variability of *Ficus* leaves it may easily have passed unnoticed under some other name. This species has not been found yet in the upper strata.

Ficus adhatodaeformis Andr. et Nov. in *Annal. Hist. Nat. Mus. Nat. Hung.* n. ser. *8*, 1957, 45, t. II. 2. (Fig. 73)

This species, described from the Lower Oligocene flora of Kiseged Hill and hitherto known exclusively from that site, has cropped up also in the lower and middle strata of the Wind Brickyard, in about a dozen specimens, which shows that it could hardly have been rare. An excellent specimen is No. 3220 in the Museum of Eger. The fossil is almost complete, only the apex is missing. These leaves, together with those of Kiseged Hill, clearly exhibit the distinctive features and to a certain extent also the variability of the type. The petiole is preserved on one sample only, in a length of 3 mm. It need not have been longer than that. Base acute, margin straight. Con-

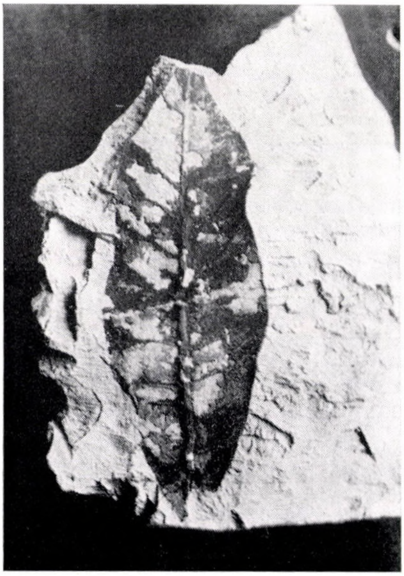

Fig. 73. Ficus adhatodaeformis Andr. et Nov., lower strata 6228 ME

Fig. 74. Diospyros brachysepala A. Br., upper strata 3205 ME

frontation with the original description shows that the species may be related to several species living in the tropics. In any case it shows palaeo-tropical affinities.

Ficus agriensis Andreánszky 1962, 226, Fig. 4.

As against the relatively numerous *Ficus* species from Kiseged Hill, the upper strata of the Wind Brickyard, richest in fossils otherwise, hardly contain any specimens of *Ficus*. In contrast, the lower and middle strata still show signs of its abundance in the previous floras. This fact also shows the close relationship between the floras of the Wind Brickyard and of Kiseged Hill. Otherwise, the course of floral evolution in the Oligocene was characterized by a decreasing abundance of *Ficus* species. It is interesting to note that from the Upper Oligocene flora of Rott no *Ficus* species is mentioned at all.

Ebenaceae

Diospyros brachysepala A. Br. in Bronn, Jahrb. Miner. 1845, 170; Heer, Fl. ter. Helv. III. 1859, Taf. CII. 1—14. (Fig. 74).

One fruit imprint from the upper strata and several leaf imprints from all three groups belong to this species. The fruit imprint includes the fruit, of a diameter of 9 mm, and part of the calyx. It agrees well with Heer's Fig. No. 13 as well as with the fruits of *D. lotus* L.

The leaf imprints also agree with those of *D. lotus* L.

Diospyros cf. *atra* Merr. (Fig. 75)

Large leaves, one of which (No. 6408 from the lower strata) is fairly well preserved; the petiole, 3 mm thick, is extant in a length of 1·3 cm; it was probably hardly longer than that. Lamina elliptic, base obtuse; the apical part is missing. Completed, the leaf may have been 13 to 14 cm long and 6·5 cm wide; its margin is entire. Lamina quite shortly decurrent. Midrib very strong; there may have been 10 to 11 pairs of primary lateral veins; 8 pairs are visible, with some shorter veins between them. The veins arise at angles of 75 to 80°, the angles being somewhat smaller on a smaller specimen (No. 6760). The lateral veins anastomose in a wide loop at a distance of about 5 mm from the margin. Tha marked likeness of our leaves to those of *D. atra* Merr. (Borneo) suggests a close affinity with the latter. The finer venation is only visible here and there, owing to a not too good preservation, but it agrees, where visible, with the finer venation of the living species.

Two further specimens, fragments of very large leaves, are to be referred here. Both their bases and apices are missing; they were perhaps 18 to 20 cm long and 8 to 9 cm wide. This is more or less the size of the leaves of the living species. (Imprints No. 3100 from the lower and No. 6340 from the middle strata.)

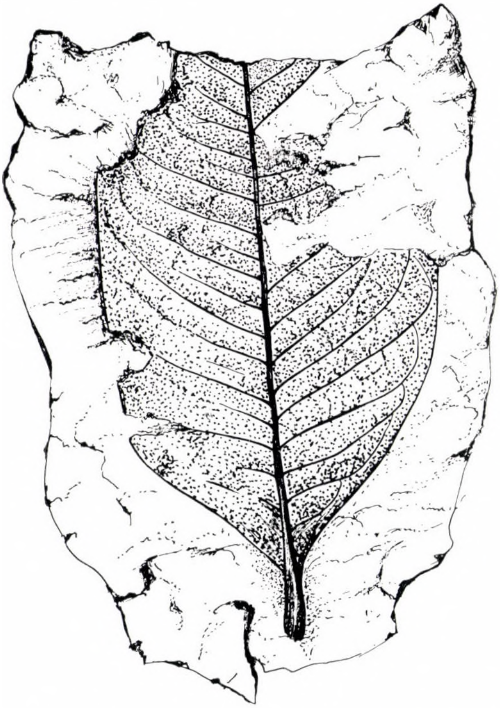

Fig. 75. Diospyros cf. *atra* Merr., lower strata 6408 ME

Fig. 76. Styrax cf. *japonica* Sieb. et Zucc., upper strata W/a ME

Styracaceae

Styrax cf. *japonica* Sieb. et Zucc. (Fig. 76)

A smaller, slightly oblanceolate leaf from the upper strata. Petiole short, 3 mm; after correction for a very small missing part of the apex, the lamina is 6 cm long and 2 cm wide in the upper two fifths; base acute; the apex may have been shortly acuminate. On the margin of the leaf, spaced at intervals of about 2 to 4 mm, there are very fine, sharp, protruding teeth. Midrib strong, 7 lateral veins on the one side, 8 on the other. The lower ones arise at angles of about 45 to 50° and, curving forward, run far up along the margin. The upper ones emerge at a larger angle, and curve forward farther from the midrib. Each vein anastomoses with a branch of the lateral vein above. The fine venation is very well preserved on the imprint and divides the blade into tiny irregular quadrangular spaces. Our specimen fully agrees with *S. japonica* Sieb. et Zucc. as regards its venation and the fine dentation of its margin. On the other hand, the leaves of the living species are broader at the middle and taper more gradually at both ends, although there exist also leaves exactly like those from the Wind Brickyard. *S. hookeri* Clarke is a further possibility, but its leaves are larger and its venation is also different. There is a fair similarity also to New-World *S. camporum* Pohl. The leaf must have belonged to a deciduous tree. In the collection it bears the mark W/a.

Cunoniaceae

Cunonia oligocaenica Andr. et Nov. In *Annal. Hist. Nat. Mus. Hung.* n. ser. *8*, 1957, 47, t. II. 5. (Fig. 77)

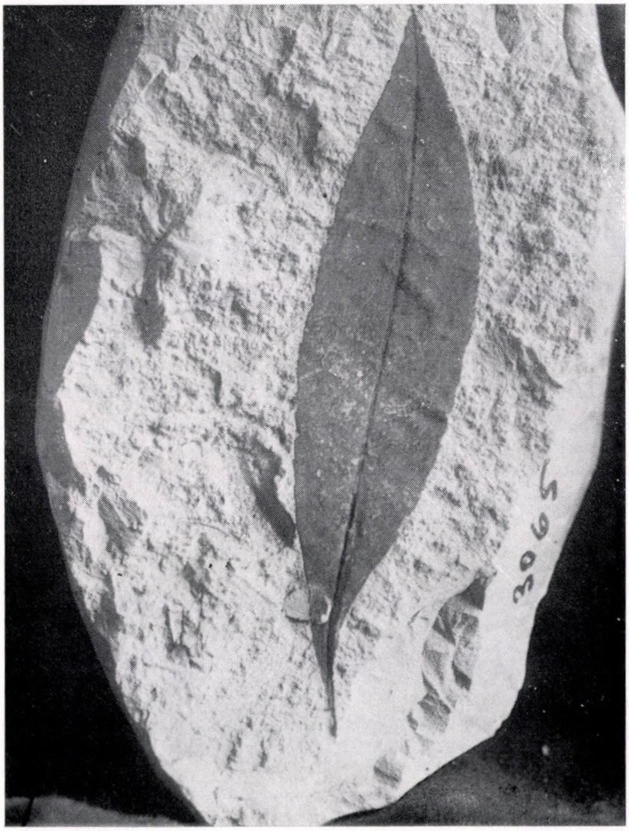

Fig. 77. Cunonia oligocaenica Andr. et Nov., lower strata 3065 ME

The leaves of this species have been encountered in fairly large numbers in the lower strata and sporadically even in the middle strata of the Wind Brickyard. For the time being, these fossils seem to be the youngest representatives of this species in the Tertiary flora of Hungary. The leaves agree quite well with those from Kiseged Hill, but the former are larger on the average. One leaflet is 13 cm long and 4 cm wide. The asymmetry of the venation, so typical of the leaflets from Kiseged Hill, is clearly visible.

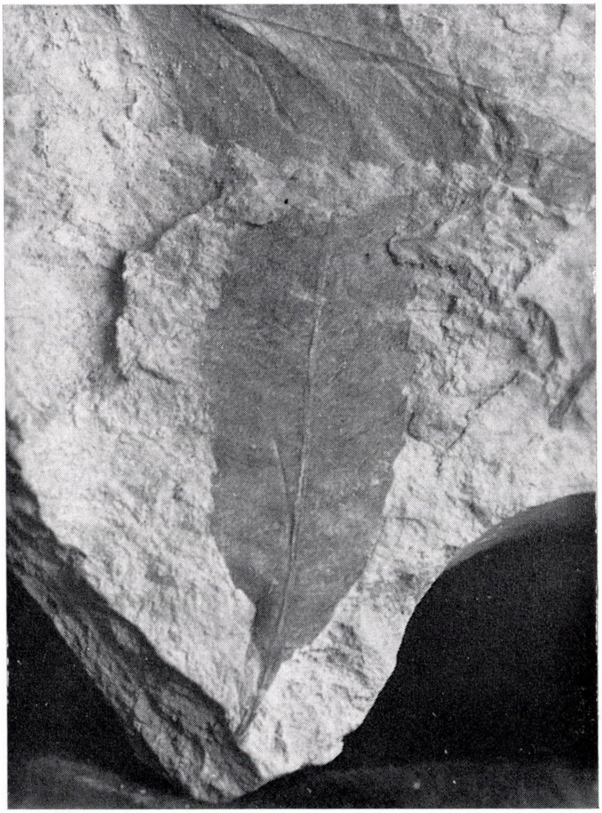

Fig. 78. Callicoma sp., middle strata W 2675 ME

Since even the most painstaking search failed to unearth this type of leaf from the upper strata, one may attach some stratigraphic importance to this species, besides its implications as to ecology and floral evolution.

Callicoma sp. *(C. egedensis* Andr. et Nov. in *Annal. Hist. Nat. Mus. Nat. Hung.* n. ser. *8.*, 1957, 46, t. II. 3. (Fig. 78)

From the lower and middle strata of the Wind Brickyard we possess a few rather fragmentary imprints, most of which belong to the genus *Callicoma* and agree with the species described under the name *C. egedensis* Andr. et Nov. Very careful further examinations proved the name to be invalid, as it covers two distinct leaf types. One of them is in fact a *Callicoma*, with a thick petiole, dentate rather than serrate; the other type is identical with *Castanopsis callicomaefolia* Andreánszky, a species described since just from the lower strata of the Wind Brickyard. It is regrettable that the specimen figuring as the holotype of *C. egedensis*, the petiole of which is missing, gives the impression of being a *Castanopsis* rather than a *Callicoma*. As long as this question is not settled with regard to the flora of Kiseged Hill, I propose to group the fossils belonging here under the name *Callicoma* sp. without any attempt at a specific determination. One of the most complete specimens (W 2675 from the middle strata), the apical part of which is missing, has a petiole extant in a length of 1·1 cm, thickish, of a diameter of 1·5 mm. The leaf is linear-lanceolate; it may have been 10 cm long originally; it is 2·5 cm wide about the middle; it had perhaps 18 or 20 pairs of lateral veins; on the extant part, 14 pairs are visible. Margin coarsely serrate, with triangular teeth standing out.

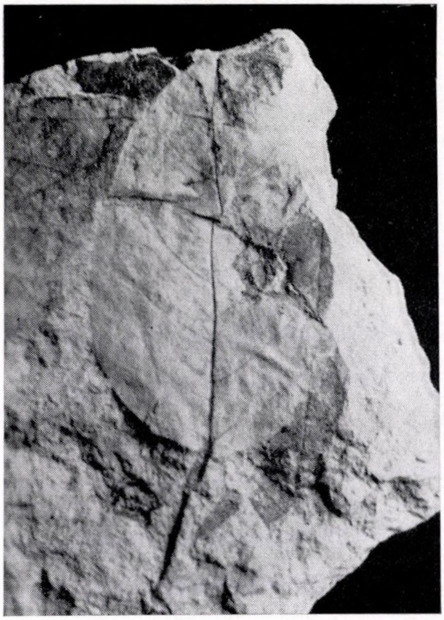

Fig. 79. Pirus sp., middle strata 6680 ME

A close relationship may be supposed to exist between this species and *C. serratifolia* Andrz., living in Australia today.

Rosaceae

Pirus sp. (Fig. 79)

Leaf ovoid-oblong, 5·2 cm long and 3 cm wide below the middle; petiole thin, but a short fraction only is extant; its thinness suggests that it was fairly long originally. Midrib thin, well marked; primary lateral veins very thin, 6 on the one side and 7 on the other; they emerge at an angle of about 60° and then curve forward; the upper ones run for some length parallel to the margin of the leaf before anastomosing. The margin is apparently entire but, considering the coarseness of the embedding rock, it may just as well have been finely serrate. The specimen bears the number 6680 and comes from the middle strata. It is preserved together with the imprint of a *Symplocos* leaf on a hand specimen of rock.

Leguminosae

The Wind Brickyard flora has yielded so far 5 types of pods of *Leguminosae* mentioned in the literature under the collective name *Leguminocarpon* (Pálfalvy 1951, Andreánszky 1962). Of these, only two are referred to a real genus. Considering that even these connections are very loose and give no reliable indication either concerning the regional affinities or the ecology of the respective species, I have not entered the latter in Table II.

Combretaceae

The genus *Terminalia*

Of the three imprints grouped here, one, No. 6436, originates from the lower, the second (No. 7229) from the middle and the third (No. 2519) from the upper strata.

Type I. (Fig. 80). Leaf No. 6436 is very narrow; at the base, it seems to taper very gradually into the petiole, but the base of the leaf is unfortunately missing; it is broadest near the apex, but even there it does not exceed 2·4 cm, whereas its complement length is 8 cm. The apex is apiculate and culminates in a short, narrow dripping point. Midrib strong; 6 pairs of lateral veins emerge at angles of about 70 to 80°, then curve forward and run up along the margin. The rather sparse lateral venation, the narrow shape and the drip tip remind of *T. calamansanay* Rolfe, but our leaf is even narrower than that.

Type II. (Fig. 81). Imprint No. 7229 is complete, narrow obovoid, apex apiculate; the base tapers very gradually into the petiole; lamina 7·5 cm long, 2·7 cm wide at the upper part. This type also reminds of *T. calamansanay* Rolfe, except for the absence of the dripping point. It seems, then, to be related rather to *T. nitens* Presl, from which it differs in its slightly denser venation and in the fact that its base tapers even more gradually into the petiole. *T. nitens* Presl is a species of the Malay Archipelago.

Type III. (Fig. 82). On leaf No. 2519, small parts of both the apex and the base are missing. Lamina obovoid-lanceolate; originally it was perhaps 10 cm long and 4·3 cm wide; it gradually tapers into the petiole. Venation considerably denser than on the previous leaves; there are 14 pairs of veins which follow, however, the pattern usual on *Terminalia* leaves. A comparison with the fossil species shows that the leaves just described do not agree with *T. radobojensis* Ung., because they are smaller and narrower and their venation is denser. The lateral veins of *T. elegans* Heer are short, camptodrome in an arch, and do not run up along the margin of the leaf. The description does not mention the venation of *T. fenzliana* Ung., nor is it shown in the figure; we cannot, consequently, collate it with the above type. The venation of the living species is wider-spaced in general.

Fig. 80. Terminalia, type I., lower strata 6436 ME

Fig. 81. Terminalia, type II., middle strata 7229 ME

Myrtaceae

Callistemon cf. *lanceolatus* Sweet (Fig. 83)

A narrow-lanceolate, relatively short leaf (No. 6667) from the middle strata, of very hard consistency and entire margin, agrees well with the characteristics of this species. The lateral veins are indistinctly visible, owing to the hardness of the leaf; they emerge at sharp angles and their course is uncertain. The blade is 4·6 cm long and 1·3 cm wide at the middle.

Another very similar leaf (No. 6754. Fig. 84) from the middle strata is longer and relatively narrower, being 10 cm long and 1·4 cm wide. The lamina would agree with the above-named species, but it has a petiole extant in a length of 6 mm. Now, the leaves of the living species are decurrent but sessile. So our fossils either belong to a different species of *Callistemon* or to a different genus of the family *Myrtaceae*. There are numerous fossil *Callistemon* species, but they have been described on the basis of a very few characteristics, so it is fairly difficult to distinguish them by relying on the descriptions or figures. On these hard leaves, the lateral veins offer no point of support, either; the form of the lamina is uniform; consequently, the determination as to species is highly uncertain.

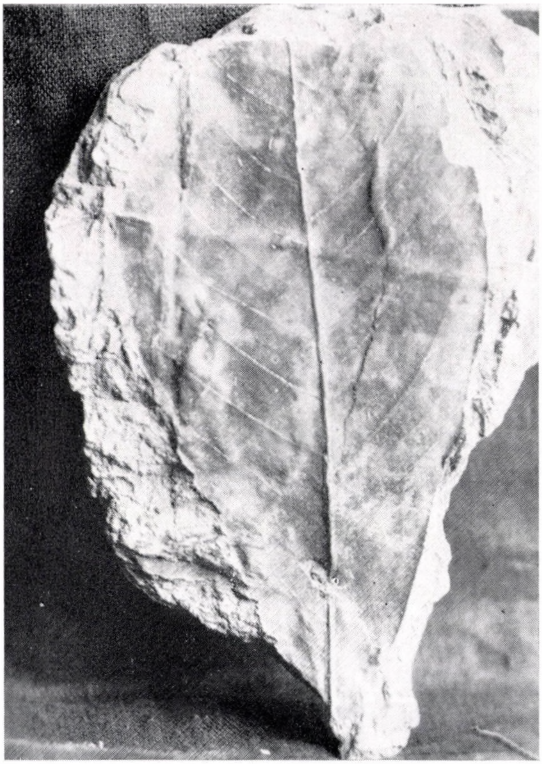

Fig. 82. Terminalia, type III., upper strata 2512 ME

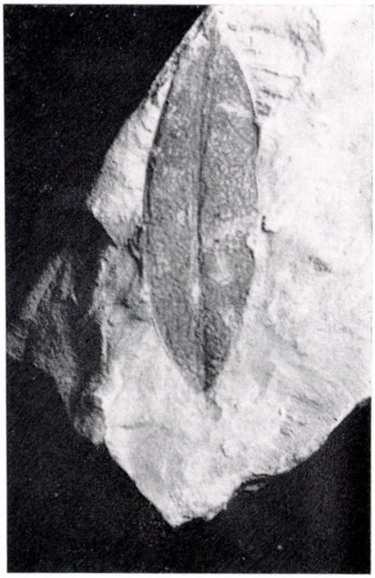

Fig. 83. Callistemon cf. *lanceolatus* Sweet, middle strata 6667 ME

Malpighiaceae

Banisteriaecarpum papilio Andreánszky 1955, 43, Abb. 4.

Anacardiaceae

Rhus succedanoides Andreánszky, 1962, 229, Fig. 6.
Ryus cf. *glabra* L. (Fig. 85)

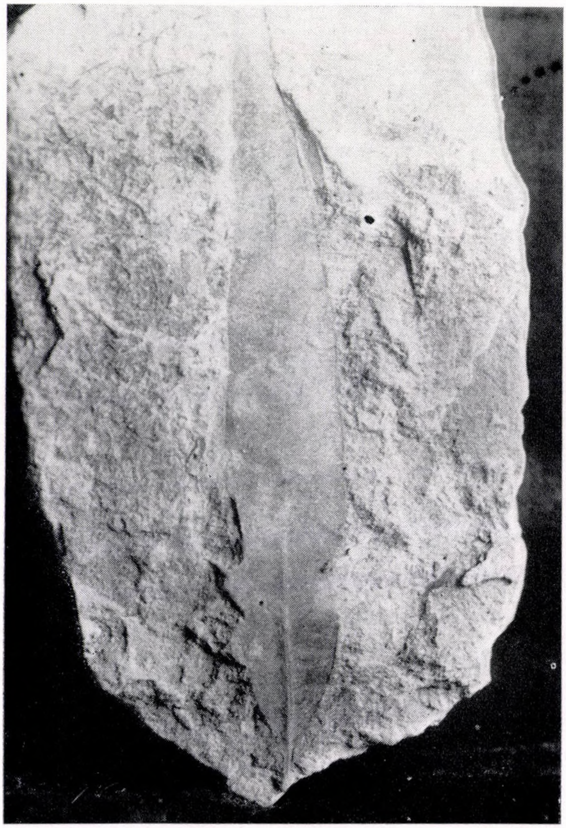

Fig. 84. Callistemon sp., middle strata 6754 ME

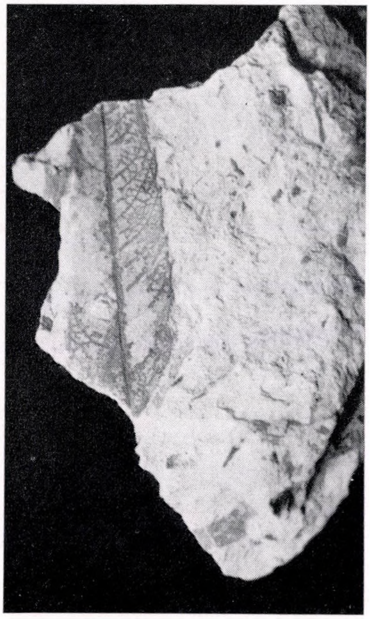

Fig. 85. Rhus cf. *glabra* L., upper strata 6444 NR

Two fragments agree so much with the leaflets of *R. glabra* L. that a close relationship seems certain. One of the leaflets is preserved in its greater part; the missing fractions are a very small part of the base and the apical quarter of the leaflet (No. 6444). The base is asymmetric and this proves that we really have a leaflet here. The margin is serrate; from this point of view, too, our specimens completely agree with the leaflet of *R. glabra* L.

The venation shows the typical *Rhus* pattern, with the lateral veins bifurcating close to their end points and the branches anastomosing with the branches of the neighbouring veins. The venation is clearly visible on the fossil. The leaflet may have been 6 cm long and, near its base, 1·4 cm wide. The other leaflet (No. 6445) is smaller and its preservation is less good.

In view of the incompleteness of the above-described specimens, I do not intend to attach a name to this fossil species. Under the name *Rhus* cf. *glabra* L., a leaf type has already been described from the Sarmatian of Hungary (Andreánszky 1959, 152); it does not, however, agree with the Wind Brickyard leaflet because its lateral veins, although ramifying, mostly reach the margin without anastomosing. On the living species, however, anastomosis is the rule rather than the exception. As we have only a single fragmentary leaflet from the Sarmatian, it is for the time being impossible to decide the point.

Meliaceae

Cedrela macrophylla Andreánszky, 1955, 44, Abb. 5.

Sapindaceae

Dodonaea salicoides Andreánszky in *Acta Bot. Acad. Sci. Hung.* 5, 1959, 13, Fig. 6, pl. II. 8. (Fig. 86)

The occurrence of this species in the Wind Brickyard flora is a further connecting link towards the flora of Kiseged Hill. From the lower and middle strata we have 4 imprints in all. Of these, sample No. W 2724 from the middle strata is well-developed, 12 cm long, 2·5 cm wide, with 15 pairs of lateral veins. It agrees in every respect with the description, as well as with the features, of the living species to which it is referred (*D. viscosa* L. of Central America and *D. salicifolia* DC. of New Guinea).

In the Wind Brickyard flora, and more particularly in all its groups of strata, the family *Sapindaceae* plays an important role, although none of the leaf types belonging to it is exceedingly abundant. The monographic treatment of the family is under way, but has not yet progressed to a stage which would justify a detailed discussion here.

Aceraceae

Acer hungaricum Andreánszky, in *Annal. Inst. Geol. Publ. Hung. 44*, 1. 1955, 81, 200, tab. XXII. 1, 2.

Acer trilobatum (Strnb). A. Br. — Pálfalvy, 1951, 71, tab. II, 1, 5/b

Acer agriense Andreánszky, 1961, 230, Fig. 7, pl. III. 3.

Elaeocarpus palaeolanceolatus Kolak. in Trud. Suchumsk. Bot. Sad, *10*, 1957, 257, tab. XXII. 2. (Fig. 87)

The presence of this species is proved by a well-preserved imprint from the middle strata (No. 6692). As to form, margin and venation, the leaf agrees completely both with the figure given by Kolakovsky and with living *E. lanceolatus* Bl. This increases by one the number of species which thrived in the Oligocene in Hungary and persisted up to the Pliocene south of the Caucasus.

Fig. 86. Dodonaea salicoides Andreánszky, middle strata 62.667 ME

Fig. 87. Elaeocarpus palaeolanceolatus Kolak. upper strata 11431 NR

Elaeocarpus europaeus Ett. Foss. Fl. v. Bilin, III. 17, tab. XLIII, Fig. 6—10. (Fig. 88)

The leaf, complete with counter-imprint, is fairly well preserved. It comes from the lower strata. Blade elliptic, tapering equally at both ends, base acute, apex obtuse, margin crenate. Petiole missing, blade 7·3 cm long and 3·7 cm wide at the middle; the lower primary lateral veins arise at sharp angles (45 to 50°), the upper ones at more obtuse angles. There are 7 primary lateral veins on each side, some of them shorter and thinner than the rest. The leaf agrees with that of the living species *E. cumingii* Turcz., to which it is usual to relate the fossil species. Other *Elaeocarpus* species, however, may also enter into consideration, e.g. *E. lanceaefolius* Roxb. A palaeotropical affinity is in any case doubtless.

Fig. 88. Elaeocarpus europaeus Ett., lower strata 6914 ME

Fig. 89. Rhamnus cf. *purshiana* DC., upper strata W 1150 ME

Rhamnaceae

In the following I shall endeavour to give a concise report on all leaf types of the genus *Rhamnus*, encountered so far in the Wind Brickyard strata.

Rhamnus cf. *purshiana* DC. (Fig. 89)

Length of the leaf 7·8 cm, breadth 4·3 cm; elliptic, base rounded, very slightly cordate; petiole probably short, apex shortly acuminate. Leaf complete and well preserved, fine venation clearly visible. Margin almost entire, with some very tiny teeth here and there. The numerous subparallel primary lateral veins (13 pairs) are gently curved, mostly simple; more seldom, they send off a short lateral vein right below their end point. Arching backwards, they anastomose quite close to the margin of the leaf; near the base they arise practically at right angles, but towards the apex the angles are gradually diminishing. The tertiary veins are parallel and dense.

Many living *Rhamnus* species have similar leaves, e.g. *R. fallax, R. latifolia* etc., but a comparison with herbarium samples revealed our leaves to be most closely related to those of *R. purshiana* DC, a tree or tall shrub living in Pacific North America, mostly in the shrub level of coniferous forests. The shrub level in question is extremely rich in species, some of them evergreen.

The sample described here is preserved in the collection of the Museum of Eger under No. W 1150.

As the shrub in question is not a tropical, but at most a subtropical type, our fossil species could not have been macrothermic, either. It is remarkable that although microthermic species generally tend to abound in the Wind Brickyard flora, there is only one leaf which belongs beyond doubt to this species; this is the case also with the similarly microthermic *Cornus büchii* Heer.

The specimen comes from the upper flora.

Rhamnus deletus Heer, Fl. tert. Helv. III. 1859, t. CXXIII. 19—23. (Fig. 90)

Two leaves from the upper strata of the Wind Brickyard agree precisely with Heer's description and with his Figures 20 and 21. The rest of his figures, matching neither the features of our leaves nor the above-mentioned two figures of his, do not represent the same species. Our leaves are 4 cm long, 2·2 cm wide, slightly cordate, margin entire in the lower part, serrate with a few small obtuse teeth in the upper part. There are 8 or 9 pairs of lateral veins, markedly curved, some of them dividing near the margin of the leaf. The tertiary veins cross the primary lateral veins, as was already noted by Heer, who related his species to *R. confluens* Boiss. from Kurdistan. One of our leaves is registered at the Institute of Taxonomical Botany (No. 4154) and the other at the Museum of Eger (No. 6293).

Rhamnus cf. *deletus* Heer (Fig. 91)

Small, elliptic-ovoid leaf (No. W 1715 in the Museum of Eger) the base of which is obtuse and gently emarginate. The apex, missing, was probably acute. Margin of the leaf finely incised, with obtuse teeth. There are 8 pairs of lateral veins, the lower ones arising at an angle of 60°, the upper ones at angles of 45 to 50°; they are not quite parallel and not quite regular inasmuch as on both sides there is a short lateral vein not reaching the margin between each pair of longer veins (the short veins are included in the 8 pairs). The lower veins are markedly curved, the upper ones approximately straight, bending abruptly forward before reaching the margin of the leaf and anastomosing. This is fairly unusual, because the lateral veins of the *Rhamnus* species generally tend to form round loops rather than abrupt angles near the margin. It is in this point that our leaf differs from *R. deletus* Heer which is otherwise highly similar in general outline, size and form of the base; a further difference consists in that on Heer's species the lateral veins arise at a sharper angle and are less curved. Insufficiency of the material in hand forbids, however, to establish a species distinct from *R. deletus* Heer.

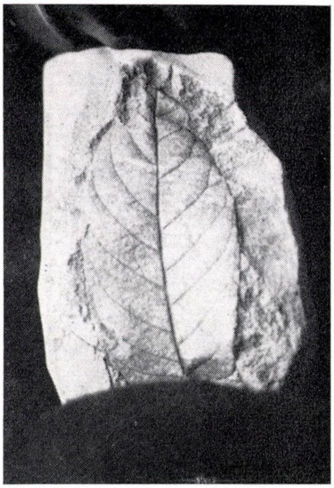

Fig. 90. Rhamnus deletus Heer,
upper strata 4514 NR

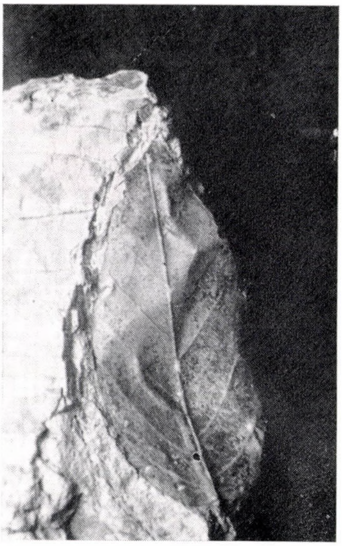

Fig. 91. Rhamnus cf. *deletus* Heer,
upper strata W 1715/a ME

Rhamnus warthae Heer, in *Földt. Int. Évk. 2.* 1872, 33, t. V. 2—3, t. VI. 3—5.

This species has already been reported from the Wind Brickyard material (Pálfalvy 1951, 74, t. II. 6). The fossils from Eger agree with both Heer's and Staub's description and figures. Notwithstanding, the question whether this fossil species can be distinguished from *R. gaudini* Heer is still open.

Rhamnus angustifrons Andreánszky, 1962, 233, Fig. 9.

Rhamnus sp. I. (Fig. 92)

This well-preserved fragment of a leaf shows the *Berchemia*-type venation typical of many *Rhamnus* species, although the fine veins are somewhat wider-spaced. The fossil originating from the upper group of strata bears the number W 178. Its incomplete preservation does not justify its description as a new species; on the other hand, it does not resemble any of the species already established so much as to warrant an identification. As regards living species, it agrees with *R. prinoides* L'Hérit. in the spiny, serrate margin of the leaf, but differs from it considerably in its finer venation. The leaf is 2·5 cm wide and 5 or 6 cm long, elliptical; base and apex are missing. The reconstruction of the apex is not possible, but the base was presumably acute as in *R. prinoides* L'Hérit. The strongly marked margin suggests it to have been an evergreen plant. There are 7 or 8 pairs of primary lateral veins, arising at a relatively large angle (about 70° for the lower veins, 60° for the upper ones). The veins bend forward in a rather sharp curve, running along the margin for some distance and issuing short branches into the teeth, and finally tapering off. The fine venation is perpendicular to the midrib in the middle of the blade; farther out, near the margin of the leaf, it curves downward. It connects the lateral veins in a somewhat undulating pattern of sub-parallel trajectories.

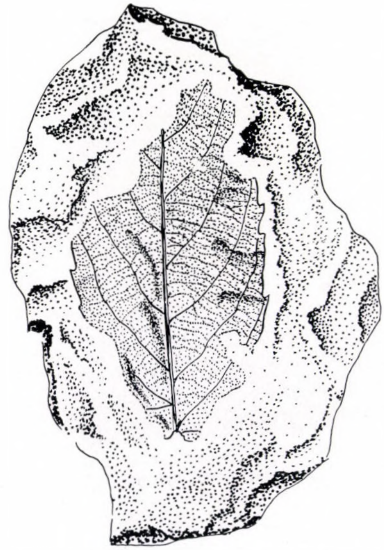

Fig. 92. Rhamnus sp. I, upper strata W 178 ME

Berchemia cuneata Andreánszky, 1962, 232, Fig. 8.

Zizyphus zizyphoides (Ung.) Wld.

The upper strata of the Wind Brickyard have yielded three imprints which agree quite well with the specimens known from the Lower Oligocene of Hungary (Region of Buda, Kiseged Hill). On sample No. 12502 the thin petiole, 13 mm long, is also extant.

From the lower and middle strata we possess in all 5 imprints of *Zizyphus* leaves which agree quite well among each other but differ slightly from the remains found in the upper strata, as well as from the other known leaves of *Z. zizyphoides* (Ung.) Wld. The leaves are larger and, in particular, wider. On specimen No. 3096, from the lower strata, the petiole is missing, the base damaged, but the apex complete. Blade slightly asymmetrical, rhomboido-elliptic, tapering towards both ends at a nearly equal rate, apex running into a short dripping point; length 9·2 cm, greatest breadth 4 cm; margin rather regularly but superficially serrate. It shows a marked similarity to the leaves of *Z. paradisiacus* (Ung.), but is larger than those and more regularly serrate.

Size and shape of the leaves seem to indicate a mesophytic tree or shrub; they do not reveal the same degree of drought-resistance as the leaves found in the Lower Oligocene of Kiseged Hill. The other four leaves are even broader than the one just described.

On account of the overall similarity of the *Zizyphus* leaves, coupled with a substantial variability of the leaf form within one and the same species, it is impossible to separate our leaves from *Z. zizyphoides* (Ung.) Wld. Still, the fact that the leaves coming from the lower and middle strata agree among each other but differ from those yielded by the upper strata suggests an independent taxon which I propose to name for the time being *Z.* cf. *zizyphoides* (Ung.) Wld. (Fig. 93).

Vitaceae

Tetrastigmophyllum hungaricum Andreánszky, 1955, 47, Taf. III. 14. Abb. 6

Apocynaceae

Apocynophyllum sp. I. cf. *Alstonia macrophylla* Wall.

We possess the imprint and counterimprint (Nos. 6485, 6488) of a leaf fragment from the middle strata with the middle and upper parts extant and the apex missing. The length cannot be established; the maximum breadth is 5·2 cm. The leaf was broadly oblanceolate, its margin entire. The primary lateral veins are spaced at intervals of 1 cm, but between them there are shorter veins which do not reach the margin of the leaf. The venation fully agrees with that observed on herbarium samples of the species.

Apocynophyllum sp. II. (Fig. 94)

A very large leaf, length 29 cm, breadth slightly above the middle 6·4 cm, oblanceolate, sclerophyllous. It is decurrent for a considerable length, tapering more abruptly at the apex, which is acute with the point rounded off. Midrib very strong; lateral veins, thinner than those of the aforementioned species, arise at a more acute angle (60 to 70°, rather than almost 90°, as on the other species); closer-spaced, the veins first run straight, then, curving forward, turn camptodrome. While the type of *Apocynophyllum* I agrees well with *Alstonia macrophylla* Wall., this one differs from it in the features enumerated.

Symplocaceae

The genus *Symplocos*

In the lower strata no *Symplocos* fossil has been found until now. This does not, of course, mean that this genus did not yet live in Hungary at

Fig. 93. Zizyphus cf. *zizyphoides* (Ung.) Wld., lower strata 3096 ME

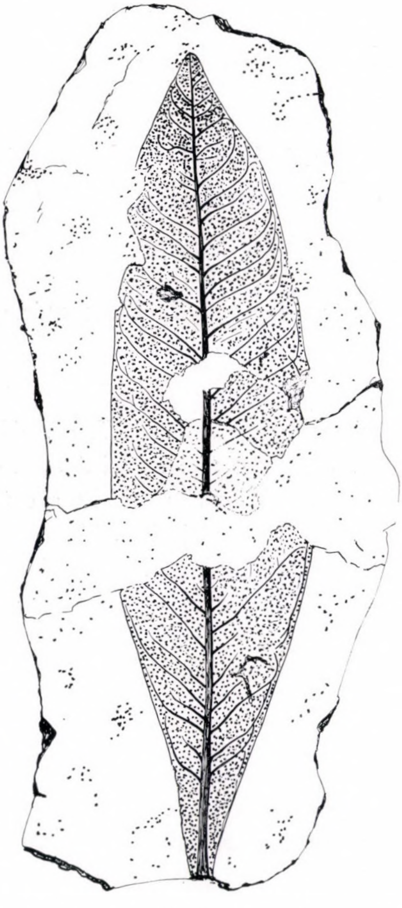

Fig. 94. Apocynophyllum sp. II, upper strata 1560/a NR

that time, because even the Lower Oligocene flora of Kiseged Hill has yielded some sporadic leaves of *Symplocos*. From the middle strata we have some specimens which may be divided into two types, to be described in the following. Both types are known to occur in the upper strata, too, together with several other species, some of which were enormously abundant. These species have not, however, been systematically treated so far.

Fig. 95. Symplocos cf. *phanerophlebia* Merr, upper strata 2297 NR

Symplocos cf. *phanerophlebia* Merr. (Fig. 95)

Oblong-lanceolate leaves, with sparse primary lateral veins which — after emerging at a rather large angle — curve forward and run up at a certain distance from the margin of the leaf, anastomosing with the vein above. Margin finely serrate or practically entire.

Symplocos cf. *rubiginosa* Wall. (Fig. 96)

Broader, elliptical leaves of acute apex; margin entire, with a denser venation running up to the margin of the leaf and curving forward there, then, after a short distance anastomosing in small arches with the vein above. The finer venation is parallel and practically perpendicular to the midrib. Blade 11 to 12 cm long and 5 cm wide; petiole 12 mm long.

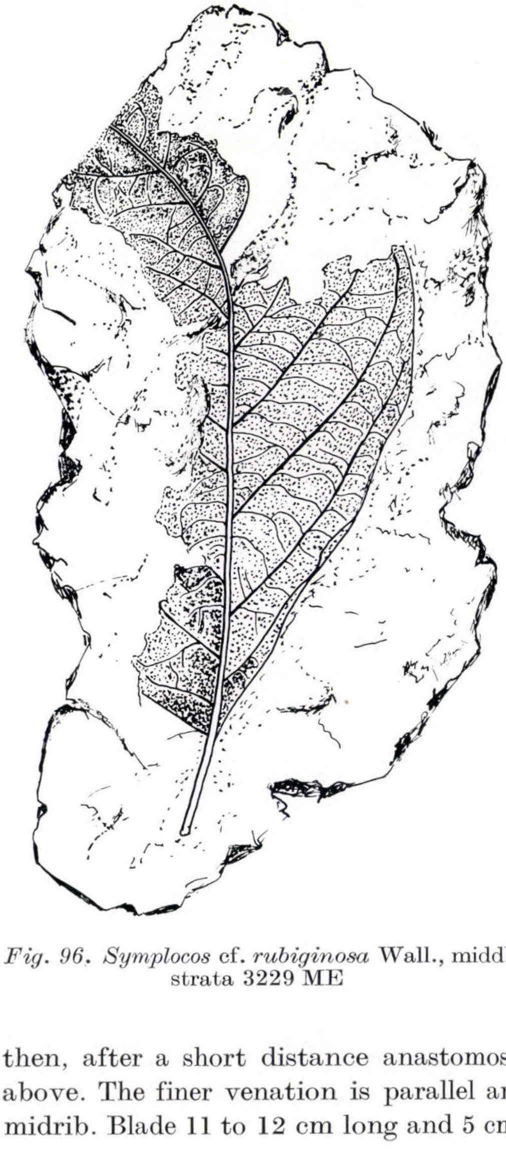

Fig. 96. Symplocos cf. *rubiginosa* Wall., middle strata 3229 ME

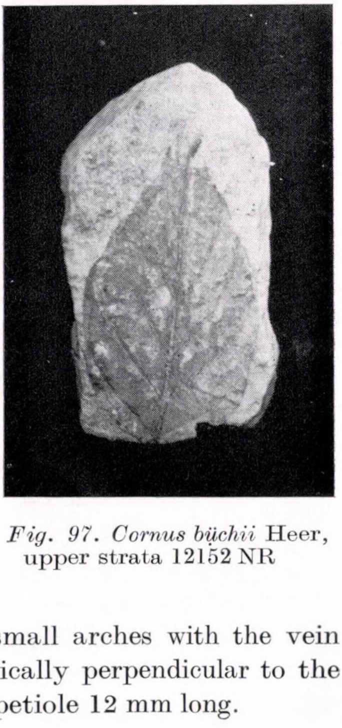

Fig. 97. Cornus bųchii Heer, upper strata 12152 NR

Symplocicarpum sp.

We possess a single fossil fruit belonging to this genus; the peduncle is extant in a length of 4 mm. The fruit itself is roundish-oval, 7 mm long and 6 mm wide, pointed at the apex. It was found in the upper strata and is registered under No. 2563.

Cornaceae

Cornus büchii Heer, Fl. tert. Helv. III. 1859, 26, t. CV. 6—9. (Fig. 97)

This is a small leaf, almost complete; length 4·5 cm, breadth 2·3 cm; elliptic-lanceolate, base rounded, apex gradually tapering, acute. Margin repand; on the one side there are 6, on the other, 7 pairs of lateral veins arising at angles markedly decreasing towards the apex; this is highly characteristic of the *Cornus* species. Tertiary venation dense and parallel. The description given by Heer is most laconic, the published drawings do not show the finer venation at all. Heer reported the species from Oeningen, that is, from considerably younger strata. Since then it was reported from faraway sites of much older age (e.g. the Eocene flora of Alaska and quite recently the similarly Eocene Mormon Creek flora from the State of Montana [(H. Becker 1960, 118, pl. 25., Figs 2—5, pl. 34, Figs 8—11]). The figures agree fairly well with our leaf. On the drawing given by Becker the tertiary venation is also shown; it also resembles that of our specimen. The difference consists at most in that, on all these drawings, the number of lateral veins is somewhat smaller, but this cannot be precisely established owing to the incompleteness of the leaves. The floras of Alaska and Montana presumably thrived under a relatively cool climate; the majority of the species shows an ecology corresponding to that of our Turgayan element, comparable with that of the flora of Oeningen, but not with that of the Wind Brickyard flora. (We have seen it already in several cases that our flora is rich in elements of moderate heat requirements.) Our leaf comes from the upper strata and is registered under No. 12152 in the collection of the Institute of Taxonomical Botany.

Ericaceae

Arbutus praeunedo Andreánszky, 1962, 235, fig. 10.

Clethraceae

Clethra cf. *barbinervis* Sieb. et Zucc. (Fig. 98)

Lanceolate leaf, gradually tapering at the apex; acuminate; base unknown, it may have been 10 to 12 cm long and 3·6 cm wide; margin serrate with pointed teeth. Originally there were probably 13 or 14 pairs of lateral veins. On the one side, 10 veins are visible, arising at an angle of 45°, gently arched and ramifying near the margin of the leaf. The thin veins formed in this way are seen to anastomose. In this respect our leaf differs markedly from C. *helvetica* Heer (Fl. tert. Helv. III. 1859, 9, t. CIf. 36), the primary lateral veins of which anastomose in wide loops before reaching the margin of the leaf. On the other hand, it agrees well with the leaves of living *C. barbinervis* Sieb. et Zucc., although it is somewhat narrower than the unique specimen

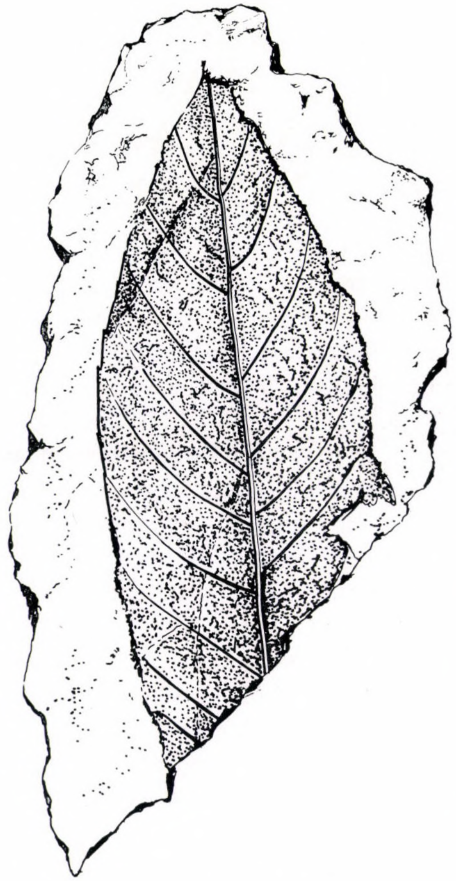

Fig. 98. Clethra cf. *barbinervis* Sieb. et Zucc., middle strata 2230 NR

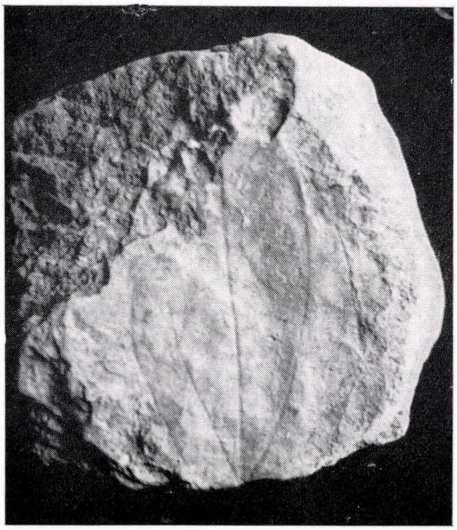

Fig. 99. Smilax cf. *china* L., upper strata 12485 NR

kept in the Herbarium of the Hungarian National Museum. Besides, on the fossil leaf, the serration is less regular and the teeth are less acute. The species is deciduous.

MANOCOTYLEDONEAE

Palmae

Tuzsonia hungarica Andreánszky, 1949b, 31, Figs 1—3, Taf. I—III.
Phoenicites legányii Andreánszky, 1955, 48, Taf. III. 15.
Phoenicites sp. — Andreánszky, 1955, 49, Taf. III. 16, 17.

Smilacaceae

Smilax grandifolia (Ung.) Heer

Very rare in the Wind Brickyard flora.

Smilax cf. *china* L. (Fig. 99)

There is a single imprint of a three-veined leaf, oval, rounded at the base; in addition to the three principal veins, a thin marginal vein is constituted by the lateral branches of each of the two outside veins, these marginal veins running up as far as 2/3 of the length of the leaf. Blade 5·5 cm long and, at the middle, 3·4 cm wide; margin entire. It resembles *S. hyperborea* Ung., but the age difference is considerable.

*

The annexed Table shows the species reported until now with their nearest relations and foliage types, indicating the associations in which they thrived. The numerous gaps illustrate the difficulties we are confronted with.

TABLE II. *List of the species hitherto*

Group of strata	Species	Living equivalent
U	*Equisetum braunii* Ung.	*Equisetum* sp.
U	*Equisetum* cf. *maximum* L.	*E. maximum* L.
U	*Trichomanes radicans* L.	*T. radicans* L.
U	*Osmunda lignitum* Gieb.	*O. japonica*
U	*Osmunda parschlugiana* (Ung.) Andreánszky	*O. regalis* L.
U	*Blechnum braunii* Ett.	*B. brasiliense* Desv.
L	*Asplenium egedense* Andreánszky	?
U	*Lastraea* cf. *oeningensis* (A. Br.) Heer	*Dryopteris vivipara* (Raddi) C. Chr.
U	*Pinus taedaeformis* (Ung.) Heer	*P. taeda L.*
MU	*Pinus palaeostrobus* Ett.	*P. strobus* L.
L	*Sequoia langsdorfii* (Brgt.) Heer	*S. sempervirens* (Lamb.) Endl.
LMU	*Sequoia couttsiae* Heer	?
U	*Callitrites brongniarti* Endl.	*Tetraclinis articulata* Mast.
U	*Magnolia* cf. *grandiflora* L.	*M. grandiflora* L.
M	*Magnolia* cf. *acuminata* L.	*M. acuminata* L.
M	*Magnolia* cf. *dealbata* Sieb. et Zucc.	*M. dealbata* Sieb. et Zucc.
L	*Magnolia* cf. *punduana* Wall.	*M. punduana* Wall.
U	*Talauma egerensis* Andreánszky	*T. pubescens* Merr.
MU	*Sassafras lobata* Sap.	*S. albida* (Nutt.) Nees
U	*Litsea euryphylla* Andreánszky	*L. latifolia* Bl.
LM	*Litsea* cf. *terza* (L.) Merr.	*L. terza* Merr.
LM	*Litsea* cf. *laeta* (Wall.) Benth. et Hook. f.	*L. laeta* (Wall.) Benth. et Hook f.
L	*Litsea* cf. *lancifolia* (Roxb.) Benth. et Hook. f.	*L. lancifolia* (Roxb.) Benth. et Hook. f.
L	*Neolitsea* cf. *intermedia* Merr.	*N. intermedia* Merr.
M	*Laurus primigenia* Ung.	*Ocotea wrightii* (Meissn.) Mez
LM	*Persea* cf. *indica* (L.) Spreng.	*P. indica* (L.) Spreng.
LM	*Oreodaphne* cf. *foetens* (Ait.) Nees	*O. foetens* (Ait.) Nees
LMU	*Cinnamomum lanceolatum* (Ung.) Heer	*C. pedunculatum* Nees
LMU	*Cinnamomum scheuchzeri* Heer	*C. pedunculatum* Nees
U	*Lomatites aquensis Sap.*	*Lomatia longifolia* R. Br.
U	*Alnus oligocaenica* Andreánszky	?
MU	*Alnus* cf. *nepalensis* Don	*A. nepalensis* Don
M	*Alnus* cf. *sporadum* Ung. var. *phocaeensis* Sap.	*A. subcordata* C. A. Mey.
U	*Alnus* sp.	?
MU	*Carpinus grandis* Ung.	*C. japonica* Bl.
LM	*Castanopsis callicomaefolia* Andreánszky	*Castanopsis indica* L.
L	*Castanopsis furcinervis* (Rossm.) Kr. et Wld.	*Castanopsis* sp.
U	*Castanopsis* sp. I.	*Castanopsis* sp.
LM	*Lithocarpus debilinervis* Andr. et Kov.	*Lithocarpus sp.*
M	*Lithocarpus* sp. I.	*L. leiostachya* A. Camus

known from the Wind Brickyard flora

Distribution of the living equivalent	Life form	Vegetation type
cosmopolitan	rhizome helophyte	Vegetation Type river-bank
northern circumpolar	rhizome helophyte	temperate riparian forest
wide-spread under oceanic climate	saxicolous fern	temperate riparian forest laurineous forest
Pacific Asia	terricolous fern	Cedrela-Symplocos forest
cosmopolitan	cryptogamous helophyte	Myrica swamp
?tropical South America	terricolous fern	Cedrela-Symplocos forest
?tropics	saxicolous fern	Castanopsis-Lauraceae forest
?tropical South America	terricolous fern	Cedrela-Symplocos forest
subtropical Atlantic North America	needle-leaved tall Conifer	laurineous forest
temperate North America	needle-leaved tall Conifer	laurineous forest
California	needle-leaved giant Conifer	Castanopsis-Lauraceae forest
?	scale-leaved giant Conifer	in various associations
south-western Mediterr.	scale-leaved tall shrub	palm savannah
subtropical Atlantic North America	laurineous evergreen	laurineous forest
Atlantic North America	deciduous tree	laurineous forest
Japan	deciduous tree	laurineous forest
tropical Asia	tropical evergreen tree	Castanopsis-Lauraceae forest
tropical Asia	tall tropical evergreen	Cedrela-Symplocos forest
Atlantic North America	tall deciduous tree	laurineous forest
China		
tropical Asia	laurineous tall shrub	laurineous forest
Malaysia	laurineous tree	laurineous forest
tropical Asia	laurineous tree	Castanopsis-Lauraceae forest
tropical Asia	laurineous tree	Castanopsis-Lauraceae forest
Malaysia	laurineous tree	Castanopsis-Lauraceae forest
Central America	laurineous tree	Castanopsis-Lauraceae forest
Macaronesia	laurineous tree	Castanopsis-Lauraceae forest
Macaronesia	laurineous tree	Castanopsis-Lauraceae forest
Southern Japan	laurineous tree	laurineous forest
Southern Japan	laurineous tree	laurineous forest
Australia	southern type hard-leaved shrub	palm savannah
?	deciduous shrub	temperate riparian forest
Himalaya	deciduous tall shrub	stream-bank grove forest
?Eastern Mediterranean	deciduous small tree	stream-bank grove forest
?	?deciduous tree	stream-bank grove forest
Japan	deciduous tree	Castanopsis-Lauraceae forest
Southeastern Asia	laurineous tree	Castanopsis-Lauraceae forest
Southeastern Asia	laurineous tree	Castanopsis-Lauraceae forest
Southeastern Asia	laurineous tree	laurel forest
Southeastern Asia	laurineous tree	Castanopsis-Lauraceae forest
Southeastern Asia	laurineous tree	Castanopsis-Lauraceae forest

TABLE II.

Group of strata	Species	Living equivalent
LM	*Lithocarpus colchica* Kolak.	*L. pseudomolucca* Rehd.
U	*Lithocarpus* sp. II.	*L. falconeri* (Kurz) Rehd.
M	*Quercus tenuipetiolata* Andreánszky	*Q. augustini* Skan
LM	*Quercus legányii* Andr. et Kov.	?
L	*Quercus agriensis* Andreánszky	*Q. crassilamellata* A. Camus
M	*Quercus tenerrima* Web.	*Q. chrysolepis* Liebm.
LM	*Quercus palaeofournieri* Andr. et Kov.	*Q. fournieri* Trel.
U	*Quercus salicina* Sap.	*Q. mexicana* Humb. et Bonpl.
U	*Quercus* cf. *bourgaei* Oerst.	*Q. bourgaei* Oerst.
LM	*Quercus gigantum* Ett.	*Q. pagodaefolia* (Ashe) Elliott
LM	*Quercus crassipetiolata* Andr. et Kov.	?
U	*Engelhardtia brongniarti* Sap.	*Engelhardtia* sp.
LMU	*Pterocarya denticulata* (O. Web.) Heer	*P. fraxinifolia* (Lam.) Spach
LMU	*Juglans* cf. *regia* L.	*J. regia* L.
M	*Juglans* cf. *cinerea* L.	*J. cinerea* L.
U	*Carya falcata* Andreánszky	*C. olivaeformis* Nutt.
U	*Myrica (Comptonia) acutiloba* Brgt.	*Comptonia asplenifolia* (L.) Spreng.
U	*Myrica (Comptonia) grandis* Andreánszky	?
U	*Myrica onocleaefolia* Andreánszky	?
LMU	*Myrica longifolia* Ung.	?
U	*Myrica* cf. *aethiopica* L.	*M. aethiopica* L.
MU	*Myrica lignitum* (Ung.) Sap.	?
U	*Myrica vindobonensis* (Ett.) Heer	?
U	*Myrica* cf. *longifolia* Teysm. et Binn.	*M. longifolia* Teysm. et Binn.
MU	*Myrica angustissima* Wat.	?
U	*Myrica macrodonta* Andreánszky	?
U	*Myrica* cf. *javanica* Bl.	*M. javanica* Bl.
U	*Myrica matheronii* Sap.	?
U	*Myrica hakeaefolia* (Ung.) Sap.	?
LM	*Salix lavateri* Heer	*S. russeliana* Sm.
LM	*Salix arcinervia* O. Web.	*Salix* sp.
LM	*Salix varians* Goepp.	*S. fragilis* L.
U	*Ulmus* sp. Type I.	*U. americana* L.
U	*Ulmus* sp. Type II.	?
U	*Ulmus* sp. type III.	?
U	*Ulmus* sp. Type IV.	?
MU	*Ulmus* sp. Type V.	*U. levis* Pall.
LM	*Ficus latsonoides* Andreánszky	*F. latsoni* Elm.
LM	*Ficus adhatodaeformis* Andr. et Nov.	*F. adhatodaefolia* Schott
L	*Ficus agriensis* Andreánszky	?
U	*Diospyros brachysepala* A. Br.	*D. lotus* L.
LM	*Diospyros* cf. *atra* Merr.	*D. atra* Merr.
U	*Styrax* cf. *japonica* Sieb. et Zucc.	*S. japonica* Sieb. et Zucc.

(continued)

Distribution of the living equivalent	Life form	Vegetation type
Southeastern Asia	laurineous tree	Castanopsis-Lauraceae forest
Southeastern Asia	laurineous tree	laurineous forest
Southeastern Asia	laurineous or hard-leaved tree	dry scrub forest
?	laurineous tree or shrub	Castanopsis-Lauraceae forest
Southeastern Asia	laurineous or hard-leaved tree	dry scrub forest
Pacific North America	hard-leaved shrub	dry scrub forest
Mexico	hard-leaved tree	dry scrub forest
Southern North America	deciduous tree	Cedrela-Symplocos forest
Mexico	deciduous tree or shrub	Cedrela-Symplocos forest
warmer Atlantic North America	tall deciduous tree	Castanopsis-Lauraceae forest
?	deciduous tree	Castanopsis-Lauraceae forest
subtropical South Asia	deciduous tree of tropical mountains	temperate riparian forest
Near East	deciduous tree	temperate riparian forest
S. Europe, Near East	deciduous tree	temperate riparian forest
Atlantic North America	deciduous tree	Castanopsis-Lauraceae forest
temperate and subtropical North America	deciduous giant tree	temperate riparian forest
Atlantic North America	deciduous shrub	palm savannah
?	?	?
?	?	?
?	?	?
tropical Africa	hard-leaved shrub	palm savannah
?	hard-leaved shrub	Myrica swamp
?	shrub	?
East Indonesian Archipelago	laurineous tall shrub	laurineous forest
?	?	?
?	?	?
East Indonesian Archipelago	laurineous tall shrub	laurineous forest
?	?	?
?	?	?
Europe	deciduous tree or shrub	temperate riparian forest
?	deciduous tree or shrub	temperate riparian forest
Europe	deciduous tree or shrub	temperate riparian forest
Atlantic North America	deciduous giant tree	Cedrela-Symplocos forest
?	deciduous tree	Cedrela-Symplocos forest
?	deciduous tree	Cedrela-Symplocos forest
?	deciduous tree	Cedrela-Symplocos forest
Eurasia	deciduous tree	Cedrela-Symplocos forest
Malaysia	tropical evergreen tree	gallery forest
tropical Asia	tropical evergreen liana	gallery forest
?	tropical evergreen	gallery forest
S. Europe, Asia	deciduous tree	Cedrela-Symplocos forest
Malaysia	tropical evergreen	gallery forest
Japan	deciduous tree or shrub	Cedrela-Symplocos forest

TABLE II

Group of strata	Species	Living equivalent
LM	*Cunonia oligocaenica* Andr. et Nov.	*C. capensis* L.
LM	*Callicoma* sp.	*C. serratifolia* Andrz.
M	*Pirus* sp.	*Pirus* sp.
L	*Terminalia* sp. Type I.	*T. calamansanay* Bl.
M	*Terminalia* sp. Type II.	*T. nitens* Presl
U	*Terminalia* sp. Type III.	?
M	*Callistemon* cf. *lanceolatus* Sweet	*C. lanceolatus* Sweet
U	*Banisteriaecarpum papilio* Andreánszky	*Malpighiaceae* sp.
U	*Rhus succedanoides* Andreánszky	*R. succedanea* Sieb. et Zucc.
U	*Rhus* cf. *glabra* L.	*R. glabra* L.
U	*Cedrela macrophylla* Andreánszky	?*Cedrela saxatilis* Roxb.
LM	*Dodonaea salicoides* Andreánszky	*D. viscosa* L. *D. salicifolia* *DC.*
U	*Acer hungaricum* Andreánszky	*A. pennsylvanicum* L.
U	*Acer trilobatum* (Strnbg.) A. Br.	*A. rubrum* L.
U	*Acer agriense* Andreánszky	?
MU	*Elaeocarpus palaeolanceolatus* Kolak.	*E. lanceolatus* Bl.
L	*Elaeocarpus europaeus* Ett.	*E. cumingii* Turcz.
U	*Rhamnus* cf. *purshiana* DC.	*R. purshiana* DC.
U	*Rhamnus deletus* Heer	*R. confluens* Boiss.
U	*Rhamnus* cf. *deletus* Heer	?
U	*Rhamnus warthae* Heer	*R. grandifolia* Fisch. et Mey.
U	*Rhamnus angustifrons* Andreánszky	*R. prinoides* L'Hérit.
U	*Rhamnus* sp. I.	?
L	*Berchemia cuneata* Andreánszky	*B. volubilis* DC.
U	*Zizyphus zizyphoides* (Ung.) Wld.	*Zizyphus* spp.
LM	*Zizyphus* cf. *zizyphoides* (Ung.) Wld.	*Zizyphus* spp.
U	*Tetrastigmophyllum hungaricum* Andreánszky	*Tetrastigma papillosum* (Bl.) Planch.
M	*Apocynophyllum* sp. I.	*Alstonia macrophylla* Wall.
U	*Apocynophyllum* sp. II.	*Alstonia* sp.
MU	*Symplocos* cf. *phanerophlebia* Merr.	*S. phanerophlebia* Merr.
MU	*Symplocos* cf. *rubiginosa* Wall.	*S. rubiginosa* Wall.
U	*Symplocicarpum* sp.	*Symplocos* sp.
U	*Cornus büchii* Heer	*Cornus paniculata* L'Hérit.
M	*Arbutus praeunedo* Andreánszky	*A. unedo* L.
U	*Clethra* cf. *barbinervis* Sieb. et Zucc.	*C. barbinervis* Sieb. et Zucc.
U	*Tuzsonia hungarica* Andreánszky	?
U	*Phoenicites legányii* Andreánszky	?
MU	*Phoenicites* sp.	?
U	*Smilax grandifolia* (Ung.) Heer	*S. aspera* L.
U	*Smilax* cf. *china* L.	*S. china* L.

L = lower, M = middle, U = upper group of strata

(continued)

Distribution of the living equivalent	Life form	Vegetation type
Cape colony	hard-leaved small tree	dry scrub forest
Australia	hard-leaved tall shrub	dry scrub forest
northern extratropical region	deciduous tree	?
tropical Asia	tropical evergreen (?monsoon tree)	gallery forest
Malaysia	tropical evergreen (monsoon tree)	gallery forest
?	tropical evergreen (monsoon tree)	Cedrela-Symplocos forest
Australia	hard-leaved shrub	dry scrub forest
?	?	?
Japan	deciduous tall shrub	Cedrela-Symplocos forest
Atlantic North America	deciduous tall shrub	palm savannah
tropical Asia	tropical evergreen giant tree	Cedrela-Symplocos forest
Neotropics	hard-leaved tall shrub	dry scrub forest
New Guinea		
Atlantic North America	deciduous small tree	Cedrela-Symplocos forest
Atlantic North America	deciduous giant tree	temperate riparian forest
?	deciduous tree	?
tropical Asia	tropical evergreen shrub	Cedrela-Symplocos forest
tropical Asia	tropical evergreen shrub	Castanopsis-Lauraceae forest
Pacific North America	deciduous tall shrub	Cedrela-Symplocos forest
Kurdistan	deciduous shrub	palm savannah
?	?	palm savannah
Caucasus	deciduous tall shrub	Cedrela-Symplocos forest
Cape Colony	hard-leaved shrub	palm savannah
?	?	?
warmer Atlantic North America	deciduous liana	gallery forest
Southeastern Asia or Cape colony	deciduous tree or shrub	Cedrela-Symplocos forest
Southeastern Asia	deciduous tree or shrub	Castanopsis-Lauraceae forest
tropical Asia	liana	gallery forest
tropical Asia	tropical evergreen tree	Castanopsis-Lauraceae forest
tropical Asia	tropical evergreen tree	Cedrela-Symplocos forest
Malaysia	tropical evergreen tree	Cedrela-Symplocos forest
tropical Asia	tropical evergreen tree	Cedrela-Symplocos forest
tropical Asia	tropical evergreen tree	Cedrela-Symplocos forest
Atlantic North America	deciduous shrub	Cedrela-Symplocos forest
Mediterranean region	laurineous or hard-leaved shrub	dry scrub forest
Japan	deciduous tall tree	laurineous forest
?	tuft tree (“Schopfbaum”)	palm savannah
?	tuft tree (“Schopfbaum”)	palm savannah
?	tuft tree (“Schopfbaum”)	palm savannah
Mediterranean region	evergreen liana	dry forest
China, Japan	liana	dry forest

FLORAL CHANGE

In the brief stratigraphic presentation of the Wind Brickyard site I have stated that the strata containing the plant fossils may be divided into three larger groups, the lower, middle and upper group. I have mentioned further that the floras of the lower and middle groups are fairly closely related, whereas that of the upper group stands rather far apart.

Although in absence of a detailed examination we cannot yet offer an adequate survey of the enormously abundant and highly varied plant fossils of the upper strata, so much is certain that, as far as the distribution of the categories among the groups of strata is concerned, two kinds of behaviour may be distinguished. Certain species, genera, families even, are represented with nearly the same weight throughout the entire series; in other words, these were permanent members of the Wind Brickyard flora, whereas other species tend to occur in greater abundance or exclusively in one group of strata only, completely absent from, or, at best, sporadically represented in, both or at least one of the other two.

Two genera occur in considerable abundance throughout: *Cinnamomum* and *Myrica*, although the latter genus shows a much greater variety in the upper flora than in the middle or lower one. The following are represented in all three groups in about equal abundance, but in less important numbers: *Sequoia couttsiae* Heer, *Lauraceae* (with the exception of the genus *Cinnamomum*), *Juglandaceae*, the genus *Salix*, *Ebenales*, *Myrtaceae*, *Leguminosae* and *Sapindaceae*.

The following occur either largely or exclusively in the lower and middle strata only: the genus *Carpinus* (almost exclusively in the middle strata), and the family *Fagaceae* (of which only the form group of the oak is represented, as the genus *Fagus* seems to be completely absent). The most abundant species, *Castanopsis callicomaefolia* Andreánszky, is a speciality of the lower strata; it is scarcer in the middle strata, and absent from the upper strata. The *Ficus* species and the genera *Cupania* and *Dodonaea* of the *Sapindaceae* family, have turned up in the lower and partly also in the middle strata. Further specialities of the lower strata are *Asplenium ege-*

dense Andreánszky and *Berchemia cuneata* Andreánszky while *Arbutus praeunedo* Andreánszky is peculiar to the middle strata.

It is obvious from the above that species and genera typical of the lower and middle strata but absent from or scarce in the upper strata are few and far between. The lower and middle strata differ above all in the absence of many elements present in the upper strata.

Species and genera typical of and abundant in the upper strata are: *Osmunda lignitum* Gieb., *Lastraea* cf. *oeningensis* (A. Br.) Heer, *Blechnum braunii* Ett., the genera *Alnus* and *Ulmus, Cedrela macrophylla* Andreánszky, the genus *Acer* and the family *Symplocaceae*, probably represented by the single genus *Symplocos*. It will be recalled that the *Myrica* species attain the greatest number in the upper strata (about 10 species as against the 4 species in the lower and middle strata). Similarly, many other genera, e.g. *Rhamnus* and *Cornus*, appear either exclusively in the upper strata, or at least in a greater abundance than in the lower and middle strata.

The distribution of the conifers is as follows. In the material from the lower strata, *Sequoia langsdorfii* (Brngt.) Heer figures for the moment with one imprint only. *Callitrites brogniarti* Endl. only occurs in the upper strata in any abundance, although even there it is comparatively scarce. Fossil pines tend to be rare in general. Nevertheless, many *Pinus* cones have lately been found in the lower, and particularly in the middle strata. Unfortunately these do not lend themselves to a more precise determination. Analytical data of pollens also indicate the middle strata to have been richest in pines.

The above-named types, transient elements in the Wind Brickyard flora, provide in themselves a fair basis for the systematic subdivision of the flora. In addition, these distinctive types represent at the same time different ecologies and different territorial affinities. The definitely tropical types tend to occur in the upper strata; now the tropical ferns also abound in the upper strata only. The few pronouncedly tropical types to be found in the lower and middle strata, particularly the *Ficus* species and some others, probably lived in tropical riparian forests. The tropical species of the upper strata, above all the *Symplocos* species, *Talauma egerensis* Andreánszky and *Cedrela macrophylla* Andreánszky, imply a mesophytic forest. Others, such as the palms and the xerophytic *Myricaceae* most of all, suggest a dry forest, some kind of monsoon forest or savannah. The mesophytic forest included some temperate deciduous species throughout, but different ones in each group of strata: *Quercus gigantum* Ett. in the lower, *Carpinus* and species of *Magnolia* in the middle, species of *Alnus, Ulmus* and *Acer* in the upper strata. The mesophytic forest as a whole probably was less changeful, as shown by the almost invariable abundance of *Cinnamomum* and *Lauraceae*. However, the dry forest underwent a marked change, as in the lower and middle strata it consisted of subtropical rather than tropical elements (considerable numbers of *Cunoniaceae, Arbutus*, species of *Quercus)*, whereas in the upper strata, included, as already mentioned, pronouncedly tropical elements (palms, etc.). In the mesophytic forest the most remarkable change apparently was that of the laurineous types, *Castanopsis* and *Lithocarpus* turned up in the lower and to a certain extent also in the middle strata. In the upper strata their place is taken by tropical evergreens.

The great difference between the floras of the lower, middle and upper strata is also manifest in leaf form. The majority of the leaf imprints embedded in the two lower groups of strata are narrow, largely lanceolate (mainly *Lauraceae, Quercus* species, *Castanopsis* etc.), and in most cases entire. The forms of the leaves lying in the upper strata are much more varied.

The greatest difference is apparent in the riparian associations. The riparian association of the lower and to some extent of the middle strata, a gallery forest with tropical evergreens, had disappeared without traces by the time the upper strata came to exist, to be replaced by a streambank forest of temperate affinities. On the other hand, the hygrophilous shrub may have remained the same and was probably populated above all by *Myrica* species.

As regards territorial affinities, the greatest difference is that the dry forest of the lower strata consisted of extratropical species of the southern hemisphere *(Cunonia, Callistemon)*, whereas that of the upper strata included tropical (presumably largely palaeotropical) elements.

It may be inferred from all that has been said above that the subdivision into three phases is justified not only on the basis of floristics, but on ecologic and phytosociologic grounds as well, and always leads to unequivocal results.

The changes which separate the phases were brought by two kinds of factors: climatic changes and floral evolution; the latter essentially brought about the withdrawal of the southern elements and the invasion of new species from the north. Rather than to discuss in detail these questions here I intend to take up the point more fully in the following chapters.

The study of the floras situated nearest to the Wind Brickyard and considered of the same age (Andornaktálya, Demjén etc.) led to the conclusion that these floras are related to and contemporaneous with the upper Wind Brickyard flora.

Table III. presented here is given in order to correlate the facts that have served as a basis for the proposed subdivision.

TABLE III. *Chronological subdivision of the*

Group of strata	Characteristic families, genera, species	Regional affinity
Upper	*Lastraea* cf. *oeningensis* *Blechnum braunii* *Talauma egerensis* a great variety of *Myrica* species genus *Ulmus* *Cedrela macrophylla* genus *Acer* prevalence of the genus *Symplocos* palms	ferns of neotropical affinity Dicotyledons of palaeotropical affinity genus *Ulmus:* northern extratropical affinity *Acer* species of North American affinity Southern affinity insignificant
Middle	no ferns *Carpinus grandis* greatest variety in the form group of *Quercus* regression of *Castanopsis* and *Ficus* species one or two species of *Ulmus* and *Alnus, Acer* absent *Arbutus praeunedo* moderate role of the genus *Symplocos*	Old and New World affinity in the *Fagaceae* family mainly Old World *Lauraceae* riparian forest of palaeotropical species affinity to the southern hemisphere decreasing *Carpinus* of East Asiatic affinity
Lower	*Asplenium egedense* *Castanopsis callicomaefolia* *Quercus* and *Lithocarpus* species many *Lauraceae* *Acer, Ulmus* and *Alnus* absent *Cunonia oligocaenica* deciduous *Magnoliae* genus *Symplocos* absent	Old World *Lauraceae* and *Fagaceae* *Quercus gigantum* with New World temperate-zone affinity riparian forest of Old World tropical affinity affinity to the southern hemisphere significant *(Cunoniaceae)*

A more detailed subdivision of these three floral phases encounters, however, great difficulties. Part of the fossils from the lower and middle strata were collected by the workers in the clay pit; thus the original locality of these fossils within the stratigraphic succession is not precisely known; all we know is whether they have been picked from the lower or middle strata. In any case, the material of the lower strata is uniform inasmuch as one cannot distinguish several floras within this group. As regards the middle strata, there already is a difference between the strata themselves, and the "stone loaves". Between these two floras, a more detailed examination may be expected to establish certain differences. Unfortunately, the "stone loaves" are not fine-grained enough to yield imprints as well-preserved as those found in the strata proper. There are, consequently, few imprints which could be precisely determined, whereas the rest requires a detailed examination which has not been carried out until now.

Characteristic associations	Climate
Cedrela-Symplocos forest of tropical colouration and of many levels, many deciduous and laurineous trees grass level constituted mainly by ferns palm savannah riparian forest of temperate colouration, composed exclusively of deciduous trees tropical riparian forest not developed	warm subtropical climate at the border of the tropical zone; the abundance of precipitations changes several times during the deposition of this group of strata in dry periods, the climate becomes rather extreme but without frequent frost: decrease of temperature at the end of the period
laurineous forest: mostly *Lauraceae*, mingled with *Carpinus* last traces of the dry Knysna-type Cape forest tropical riparian forest hardly developed	uniformly warm subtropical climate, somewhat cooler than in the lower or upper strata (with the exception of the last phase of the upper strata), climate moderately humid, distribution of precipitation uniform
Castanopsis-Lauraceae forest with few deciduous trees dry Knysna-type Cape scrub-forest riparian forest composed of evergreen tropical species no trace of mangrove	climate uniform; more humid than Kiseged Hill but only slightly warmer; distribution of precipitation uniform subtropical temperature

In the upper strata, a further subdivision is feasible and also essential both from the point of view of floristics and ecology. Indeed, it is the ecology of the flora that creates the possibility of further subdivision: a vegetation indicative of a more humid climate was replaced by one implying an arid climate. This type of change was repeated several times. The differences shall be treated in more detail in the following chapters. It is, however, impossible to piece together a coherent stratigraphic picture, because the strata containing the individual, separate floras have a tendency to wedge out and disappear, only to show up again farther away. In the meantime the shoreline of the sea had also shifted, and coarse-grained sediments bearing ill-preserved fossils which are hard to identify came to be deposited between the finer-grained beds. Pollen analysis, extending over all the strata, may eventually allow a clearer insight into the changes involved.

ANALYSIS OF THE FLORA

In the Wind Brickyard flora, ferns are represented by a smaller number of species than in the Lower Oligocene of both Kiseged Hill and the environs of Buda. This may indicate that topography and vegetation were less varied here and, that from among the ferns of varied ecologic requirements, fewer species were able to find their peculiar living conditions; even of these, not all have been preserved as fossils. In contrast, there are two species whose imprints occur in an abundance unparalleled in the Lower Oligocene floras. These are *Lastraea* cf. *oeningensis* (A. Br.) and *Blechnum braunii* Ett. Especially the former played a prominent part in the grass level of the ancient forest; indeed, it was supreme among all the herbs. None of these species can be related to any living ones.Those with which they are sometimes compared, *Dryopteris vivipara* (Raddi), C. Chr. and *Blechnum brasiliense* Desv., respectively, are neotropical ferns.

The conifers play a rather subordinate role as regards the number of both species and individuals. Only the cones corresponding to *Sequoia couttsiae* Heer are encountered in large numbers, but their taxonomic position, as already mentioned in the pertinent chapter, is not quite definitively established as yet. The conifers are represented in the Wind Brickyard flora by three families. *Pinaceae*, by some needle-clusters and numerous cones of *Pinus*, *Taxodiaceae*, by two *Sequoia* species, *Cupressaceae*, by the sole *Callitrites brongniarti* Endl., which last-mentioned one has yielded both cones and some segments of boughs.

Ferns and conifers do not divide into Poltavian and Turgayan elements as is the case with the dicotyledons; their history, completely different, justifies a separate analysis. Of the ferns, the two above-named species would appear neotropical in view of the spread of the living species they are compared with. Still, the connexion between the fossil and living species does not by far seem close enough to prove their neotropical affinities. The rest of the ferns like *Osmunda lignitum* Gieb, and *Trichomanes* cf. *radicans* L. are climatic indicators rather than plants specific of any particular phytogeographic region. *T.* cf. *radicans* L. is closely related to, and perhaps even identical with, a species which occurs in Europe, too. The circle of relations of *Asplenium egedense* Andreánszky is completely unknown.

In the Wind Brickyard flora, fern fossils almost exclusively occur in the upper strata. Only *Asplenium egedense* Andreánszky was encountered in the lower strata. The reasons for this may consist in differences in the forest associations.

Throughout the Tertiary of Hungary, the history of the conifers differs from that of the angiosperms mainly in that, among the conifers, the forms of the northern extratropical regions *(Pinaceae* and *Taxodiaceae,* to a lesser extent *Cupressaceae* and *Taxaceae)* were dominant from the beginning. *Podocarpaceae,* although severally reported, were very much in the background, even if not entirely absent; no *Araucariaceae* have been encountered so far. Hence, conifers of the tropics and of the southern hemisphere played no role in our flora. True, one of the Wind Brickyard conifers *(Callitrites brongniarti* Endl.) belongs to an Australian relationship, but, it can almost specifically be identified with the only northern species of that group. It is, consequently, a Mediterranean element.

The affinities of the *Pinus* species represented by needle-clusters and cones are unknown, and so are, in consequence, their implications concerning the flora as a whole. It is even uncertain whether they are related to species of the Old or the New World. The species corresponding to *Sequoia langsdorfii* (Brngt.) Heer, *S. sempervirens* (Lamb.) Endl. is a conifer of Pacific North America, *S. couttsiae* Heer is an extinct species whose territorial affinities cannot be established. The presence of *Glyptostrobus* in the Wind Brickyard, probable though unproved, would mean an East Asiatic subtropical affinity. As regards foliage type, only *Sequoia langsdorfii* (Lamb.) Endl. and *Callitrites brongniarti* Endl. are fully known. The former belongs to the laurineous trees, the latter to the sclerophyllous ones. *Sequoia couttsiae* Heer and the *Pinus* species are probably also divided between those types.

The Wind Brickyard fossil ensemble is largely composed of leaves of dicotyledonous trees, shrubs and lianas; the number of monocotyledonous elements, which can be determined at least generically, such as palms and *Smilax* species, is very small. Except for the *Lauraceae, Betulaceae, Fagaceae, Myricaceae, Moraceae, Ulmaceae, Ebenaceae, Leguminosae, Meliaceae, Sapindaceae, Aceraceae, Rhamnaceae* and *Symplocaceae,* no dicotyledonous family is represented by appreciable numbers of fossils. Among the monocotyledons the palms play the most important role as far as the number of individuals is concerned.

As already mentioned in the introductory part, we may distinguish in our Tertiary floras two groups of elements. The Poltavian flora mostly consists of tropical-subtropical evergreens. These, or their ancestors, already lived in Western Eurasia in the early Tertiary. The species of the Turgayan flora, mostly deciduous and of lower heat requirements, gradually invaded our flora in the course of the Tertiary, supplanting the Poltavian species. To these two groups a third one, called Xero-Atlantic, came to be added (Andreánszky, Vegetatio *9.* 1936, 110); the elements of this group split off from the Poltavian and later also from the Turgayan flora, and took form in the subtropical semi-arid zone of the Western Eurasian littoral, in a center of evolution, which was active there for some time. Unfortunately, an analysis of the entire Wind Brickyard flora according to the above viewpoints is not feasible at present, because the upper flora is insufficiently examined, and the flora of the lower strata is not fully known, either. In this situation I only whish to attempt a rather general analysis without putting forward numerical data and without establishing a spectrum.

The Wind Brickyard flora doubtlessly contains more than 50% of Poltavian elements, such as the species of tropical affinity, the *Anonaceae, Lauraceae* (perhaps with the exception of *Sassafras)*, most if not all *Fagaceae* (perhaps with the exception of *Quercus gigantum* Ett.); the *Myricaceae, Moraceae, Sapotaceae, Myrtaceae, Leguminosae, Meliaceae, Sapindaceae,* the genus *Elaeocarpus*, the *Oleaceae, Symplocaceae* and the palms. The Turgayan element comprises the *Betulaceae*, part of the *Juglan daceae*, and the *Comptonia* species among the *Myricaceae;* the *Salicaceae, Ulmaceae;* the genus *Acer;* some *Rhamnaceae* and the genus *Cornus*. To the Xero-Atlantic element, I refer the following: among the conifers, at least *Callitrites*, although this is, as already mentioned, a case apart, some *Myrica* species (e.g. *M.* cf. *aethiopica* L.); *Lomatites aquensis* Sap., the *Cunoniaceae*, the group of *Callistemon; Dodonaea salicoides* Andreánszky; at least part of the *Notelaea* species and *Arbutus praeunedo* Andreánszky.

The ratio of the Poltavian to the Turgayan elements shifts to a certain extent in favour of the Turgayan element, if the number of individuals is considered. Some genera and species, respectively, of the Turgayan element, such as *Ulmus* and *Acer*, played a fairly important role in the vegetation of the Wind Brickyard. In the material collected so far, the number of imprints of the genus *Acer* exceeds 200. If we estimate the whole collection at between 5000 and 6000 specimens, then this single genus makes up about 5% of the flora, which is a far from negligible proportion. From the Poltavian element only the genera *Cinnamomum, Symplocos* and certain *Myrica* species, as well as *Lastraea* cf. *oeningensis* (A. Br.) Heer, can compete with *Acer* in abundance. Except for *Cinnamomum*, high percentages of Poltavian species or genera tend to be restricted to the upper strata. The Xero-Atlantic element plays a subordinate role as regards the number of both species and individuals.

Just as one cannot for the moment offer numerical data concerning the respective abundances of the Poltavian and Turgayan elements, one cannot establish a spectrum of their territorial affinities, either. The great majority of the Poltavian element exhibits a southeastern Asiatic affinity. This holds good for most of the *Lauraceae*, above all the *Cinnamomum* species, the *Anonaceae*, the majority of the *Ebenales* and *Sapindaceae*, *Cedrela* and the palms, although the affinities of the latter are not sufficiently known as yet. In addition to the ferns, one or two species among the *Lauraceae* and *Sapindaceae* may also be regarded as having neotropical affinities. Of the Turgayan element, *Carpinus grandis* Ung., *Alnus* cf. *nepalensis* Don, probably one *Ulmus* species or another, *Pterocarya*, *Rhus* and possibly some of the *Rhamnus* species may be considered Old-World elements. On the other hand, *Sassafras*, *Quercus gigantum* Ett., probably one or two *Ulmus* species, *Acer hungaricum* Andreánszky, *A. trilobatum* (Strnbg.) A. Br. and some *Rhamnus* species point towards the New World. As against the Poltavian element, plants of New World affinities are dominant in this group. As regards the stratigraphic sequence, Old-World affinities tend to be prominent in the Turgayan element of the lower and middle strata, whereas that of the upper strata exhibits a marked New-World influence.

Most of the species of the Xero-Atlantic element show some affinity with the southern hemisphere. Among them one may cite the *Cunoniaceae*, species of the *Myrtaceae* family, one or two *Myrica* species, *Rhamnus angustifrons* Andreánszky, species of *Notelaea* and perhaps some types which have not been precisely determined so far. The Mediterranean affinity is represented by *Arbutus praeunedo* Andreánszky and *Callitrites brongniarti* Endl. On the other hand, the relations of hard-leaved oaks now live in semi-arid Pacific North America. As regards the oaks, however, a separate analysis of their affinities has been given in the Taxonomic Part.

With the living relations of many established species unknown and the taxonomic determination of many leaf forms still a task of the future, the enumeration presented here cannot pretend to be complete and final.

Since the great majority of our species are trees or shrubs, we have to classify them also according to foliage type. Among these, let us cite the needle- and scale-leaved conifer types, the tropical evergreens, laurineous and hard-leaved leaf forms, the green-in-the-summer deciduous types and tufty ("Schopfbaum") foliages (palms). There is no conclusive evidence as to the presence of the deciduous-in-the-summer, so-called monsoon type.

In my opinion, this type is certainly represented among the *Leguminosae*. Most abundant among the foliages is the laurineous type, followed by the tropical evergreens and by the almost as frequent green-in-the-summer deciduous plants. In the lower and middle strata the laurineous type is, as it were, paramount, whereas in the upper strata the dominance is more equally divided between the three above-mentioned types. Remarkably enough, it is just in the era in which the green-in-the-summer deciduous types already play a fairly important role that the palms occur in greatest numbers. The hard-leaved type, still fairly abundant in the lower and middle strata, is substantially reduced in the upper strata.

It is not my intention to analyse here the Wind Brickyard flora with regard to the distribution of the species among the plant associations of that time. I propose to attack in a separate chapter this problem which, in the present state of our knowledge, is in any case difficult enough to treat. The pertinent data are listed in Table III. Another difficult question is the classification of life forms according to their occurrence in the different levels of the forest. Although it can be decided for most of the species whether they were tall trees, shrubs or lianas, there are many species about which this is not known with certainty. The sclerophylls generally were small trees or shrubs. Some of the laurineous trees certainly thrived in the lower levels of the forest. Most if not all *Myrica, Rhamnus* etc. species were presumably shrubs. There was at least one species of tall palm, as proved by an imprint of a rather large trunk surface. All these points will be treated in the chapter on the aspect of the plant cover.

ECOLOGY OF THE FLORA

In a Hungarian relation, the Wind Brickyard flora is the richest one of all the Upper Oligocene floras; the fossil material yielded by that site most fully represents the flora of that period in Hungary; furthermore, being composed of the best preserved and therefore most accurately determinable imprints, it has been the object of the thoroughest and most detailed research. The other contemporaneous sites [Csörög, Salgótarján, Nógrádverőce (?)] furnished a relatively poor material as compared with the abundance of the Wind Brickyard fossils. This is why the environmental conditions of the period in point have to be established on the basis of the Wind Brickyard ensemble alone.

As regards the climate of the Wind Brickyard flora, only some very general statements and estimates have been made so far. The value given in some earlier papers (Pálfalvy 1951, Andreánszky 1954, Andreánszky and Kovács 1955), based almost entirely on estimation, are the following (Andreánszky and Kovács 1955, Table I): yearly mean temperature 20 to 22 degrees centigrade; average of the coldest month 12 °C; at least 6 months had a mean temperature above 20 °C; average yearly precipitation about 1500 mm, subject, however, to marked fluctuation throughout the deposition of the Wind Brickyard sediments; the distribution of the precipitations was of the one-maximum type, with the maximum occurring after the summer solstice.

In possession of a more thorough knowledge of the Wind Brickyard flora, I now propose to assess the environmental conditions on a broader basis. Of course, we are able to outline today the climatic conditions only, and even those approximately, whereas inferences as to soil conditions are for the time being both neglected and uncertain.

The climate of the Upper Oligocene cannot be computed with such methods as are applied to the various stages of the late Tertiary. First of all, close relations of descendency, often existing between plants of the more recent periods and those living to-day, are seldom encountered between the species of the Upper Oligocene and the living plants. Secondly, the Upper Oligocene species are in most cases related to species of faraway, often tropical regions whose ecological implications and precise climatic requirements are little known. Also the principle of actualism has to be applied with reserve, because even though the species may have changed little or not at all morphologically in the past 25 to 30 million years, their ecological requirements must have undergone certain modifications.

A further method, the gist of which is to transpose the conditions prevailing today in a region whose flora more or less agrees with our fossil one, does not produce acceptable results either, as the Wind Brickyard flora is related with species living in widely different regions; hence, there is today nowhere on Earth a flora which would even remotely resemble ours.

It seems to answer our purpose best to consider the distribution of the foliage types, as well as the climatic requirements, of the more abundantly represented species and genera. Furthermore, one must take into account the scarce elements of the flora, since there are many species of particular climatic requirements among them. A sound climatic reconstruction must envisage, for all the species constituting the flora, not only the bare minimum needed to keep alive but also a surplus that permitted them to assert themselves in the struggle for life. Of course, the abundant species (e.g. large-leaved *Lauraceae* like *Litsea euryphylla* Andreánszky) are attributed greater weights in the process of reconstruction. For such species, it is the climatic conditions prevailing in the centre of gravity of their present spread rather than in the marginal regions of the same that have to be taken into account.

The strata of the Wind Brickyard were not deposited at the same time, and the climate changed in the course of deposition. First of all, I am going to try to reconstruct the climate contemporaneous with the upper flora, and then, by extrapolation, to extend the reconstruction to the climates of the middle and lower floras.

Among the decidedly tropical elements of the upper strata, *Symplocos* species have furnished the largest number of individuals. Today the genus is mainly tropical, but some of its species transgress both the northern and southern 31st parallel. In South Virginia, in the subtropical zone of North America, they reach as far up as 37° N. lat., in Australia as far down as 35° S. lat. At the mentioned latitudes, however, the genus is represented by a single species only. It is, consequently, not the climatic parameters of those marginal regions which will obtain in our case, because the Wind Brickyard flora includes several *Symplocos* species, some of them in remarkable abundance. The genus is definitely dominant in the upper flora; consequently, conditions were close to its climatic optimum. Within the tropics, the *Symlpocos* species do not live in the hot valleys and lowlands, but in the cooler mountainous regions, at altitudes between 2000 and 4000 metres above M. S. L. The Wind Brickyard strata being marine deposits, the *Symplocos* species could not have lived so high above the sea in that neighbourhood. This would suggest, notwithstanding the above considerations, the marginal regions of the tropical zone: the *Symplocos* species could have descended lower there. In such areas of Southeast Asia and of the Malay Archipelago, the mean annual temperature is 20 to 21 °C and the annual fluctuation does not usually exceed 10 °C.

Of the elements with higher heat requirements, let us further examine the behaviour of the palms. In our days the palms, too, reach far beyond the tropics, towards the poles, but just like in the previously mentioned case, only one or two species are living at those extremes. Furthermore, the forms which extend up to the polar limit are invariably dwarf palms. In the Wind Brickyard flora, the fossils of at least three species (one fan palm and two feather palms) have been encountered. Also, beyond doubt, one at least of these species had a tall trunk. Consequently, here too we must reckon with the climate of the central region of the palm belt rather than with the climatic parameters prevailing at or near the cold limit of palms. One cannot establish differences between the heat requirements of fan and feather palms. So much is certain, however, that the youngest (Lower Sarmatian) palm of Hungary was a feather palm. In contrast, the only living European palm is a fan-palm. It so seems that the palms represent climatic conditions similar to those implied by *Symplocos*, at least as far as the temperature is concerned.

Several different lines of thought lead up to the conclusion that in the Tertiary, the continents already occupied the same positions as to-day, and the Wind Brickyard site was situated then as now at a relatively high latitude (47° 54′ N. lat.). Even if, at that latitude, a temperature considerably higher than to-day is not contradictory to the principle of actualism, the exceedingly small yearly fluctuation that suggests itself would appear plausible only if the flora lived either on the shores or in the midst of large bodies of water. This, however, is improbable. Our territory lay in the coastal region of a smaller water surface; the large waters began far to the west. Thus, although certain species, especially *Trichomanes radicans* L., can only subsist in an even climate, we have to reckon with a more pronounced yearly fluctuation. This is indicated also by the far from negligible number of deciduous trees.

A highly uniform climate is much more favourable to the evergreen plants, particularly to the laurineous ones, than to the green-in-the-summer deciduous species; in fact, under such a climate, the former tend to outweigh the latter to a considerable degree. Consequently, abundant deciduous species imply a fairly great yearly temperature fluctuation, especially if the mean temperature is high, nearly tropical.

Since leaves of *Acer* and *Ulmus* have been found together with *Symplocos*, *Cedrela* and other tropical species on the same hand specimen of rock and in the same state of preservation, the notion that they lived at different altitudes above sea level has little merit. The assumption that the deciduous species had been introduced into the preceding evergreen flora by a sudden deterioration of the climate is similarly excluded because the deposit in which these elements coexist is fairly thick. Another explanation could be that the deciduous trees were consistently riparian species which, in their humid sites, did not enter into competition with the tropical elements that had an absolute supremacy otherwise. The *Alnus* species might have been riparian (but this is far from being a proved fact), as well as some, but certainly not all, of the *Ulmus* species. *Acer trilobatum* (Strnbg.) A. Br. and the majority of the *Juglandaceae* were undoubtedly riparian. By no means could, however, all the deciduous species be riparian; for one, *Acer hungaricum* Andreánszky most certainly was not. The solution must be looked for in the accidented topography of the region where each one of the different mesoclimates tended to enhance species of different heat requirements. The yearly fluctuations of the mesoclimate were bound to be considerably higher.

The upper flora of the Wind Brickyard includes several floral phases, widely different from the point of view of precipitation. Warm and dry periods with a flora composed of species with tiny and narrow leaves and of palms, were succeeded by wetter periods with an abundance of large-leaved tropical trees (*Cedrela, Talauma, Litsea euryphylla* Andreánszky), and with masses of *Symplocos*. It was during these latter periods that the deciduous elm and maple multipled. The temperature decrease was, however, offset by richer precipitations, so much so that the proportion of tropical elements hardly diminished. The eclipses of the large-leaved species were due to spells of aridity rather than to temperature drops. In those phases, the climate was perhaps more extreme, but in any case so arid that the deciduous trees fell victim to heat and drought; the number of their fossils in the strata of the dry phases is, in consequence, rather small.

Unfortunately we have no flora, directly subsequent to the Wind Brickyard ensemble, which would provide more ample information as to the gradual cooling reflected by the final phase of our flora. The flora of Ipolytarnóc, with its abundant palms, must already have lived after the end of this cool spell.

It may consequently be stated that the climate implied by the Wind Brickyard flora presumably corresponded to the conditions now prevailing at the borders of the tropical climate zone, but that the varied topography permitted trees of different heat requirements to thrive fairly close to each other. In a very general way, an annual mean temperature of 20 to 21 °C may be assumed, with a yearly fluctuation exceeding 10 °C, and in more extreme periods even 15 °C. It was about once in ten years that the temperature dropped to 0 °C, and still more seldom to 1 or 2 degrees below zero. It is probable that the increasing winter cold attracted hosts of deciduous trees to the more elevated places nearby; from those higher levels they then descended fairly soon down the northern slopes to the littoral.

The flora ensemble indicates—even in the wetter periods — a semi-humid climate with much less rain than is usual in the tropical rain forests. Precipitation may hardly have exceeded 1500 mm. On the other hand, in the dry periods, precipitation must have diminished considerably below 1500 mm. It was in these spells that palms became preponderant. The abundance of *Tuzsonia hungarica* Andreánszky proves the palms to have played an important role in the vegetation. At such times the climate was, as regards the distribution of both humidity and precipitations, near to the monsoon climate. In the dry season the moisture content of the air was far from saturation. The large-leaved tropical evergreens, the laurineous trees and the likewise fairly large-leaved *Ulmus* species, were repressed by the lack of moisture in the dry season.

The distribution of precipitation in the more humid periods was either fairly even, or there was a summer maximum of rains; a longer dry season did not, however, develop. The above-mentioned large-leaved species could not have withstood it.

In assessing the climate of Hungary in the early Tertiary one has to keep in mind that the region in point was situated just like at present, at a fairly high latitude and therefore conditions exactly like those of today's tropical zone could not possibly develop, although the temperature was probably higher than it is now anywhere at the same latitude. The sun never reached the zenith and the difference in insolation between the slopes of northern and southern exposure was considerable.

As compared to the upper strata, the climate of the middle and lower strata was somewhat cooler and decidedly drier than in the humid phases of the upper flora; nevertheless, drought never was as severe as in the dry phases of the upper strata. A lower temperature is indicated by the absence of *Cedrela, Talauma,* of the other large-leaved tropical species, of neotropical ferns, and, on the other hand, by the greater abundance of the genus

Carpinus, the presence of *Quercus gigantum* Ett., as well as of deciduous *Magnolias.* The sclerophyllous species indicate temperatures not warmer than subtropical and less precipitation. On the other hand, the predominance of laurineous trees implies a relatively even temperature distribution and a climate without a dry season. The large-leaved tropical trees occurring in the lower and middle strata, above all *Ficus latsonoides* Andreánszky, lived in gallery forests where the deficiency in precipitations was compensated by the permanent humidity of the soil. The fact that among the microthermic fossils the leaves of the *Ulmus* species are few and far between and that the genus *Acer* has not so far been encountered at all in these two groups of strata is not due to climatic reasons but to floral evolution and to migration, respectively. It was only at a later phase that these elements invaded our region in force.

At the time the two genera *Acer* and *Ulmus* had already established themselves in Hungary. The Lower Oligocene of Kiseged Hill has yielded fruits of *Ulmus.* Although *Acer atavissimum* Andreánszky described from that same site, is not quite certainly an *Acer,* still, a fruit which has been found since and which is an *Acer* fruit beyond doubt, proves the presence of this genus in the flora.

Let us revert here once more to the subject of topography which, as stated, must have been fairly varied. The assumption of a flat littoral is contradicted by the almost total absence of reed and sedge associations. Nor is there any trace of a mangrove forest, although the climatic conditions would have permitted the development of this association. In the vicinity of the Wind Brickyard site, a fairly steep littoral may have existed everywhere throughout the period. The sediment embedding the plant fossils is fine clay or more or less coarse sand. Plant fossils occur in every kind of deposit, locally attaining an enormous abundance even in the finer-grained rocks, which could not, consequently, have been deposited at a greater distance offshore.

Fossils of fresh-water plants, of water lilies or pondweeds, have not been found at this site. (Plants of this kind occur in fairly large quantities in the Lower Oligocene shale of Kiseged Hill.) This means that, in the neighbourhood of the steep littoral, there were no fresh-water lakes or sluggish rivers in which such plants could exist.

ASPECT OF THE VEGETAL COVER. PLANT ASSOCIATIONS

THE CONSIDERATIONS hitherto exposed may convince the reader that tree associations corresponding to the Wind Brickyard forest do not actually exist anywhere on Earth. The Wind Brickyard association includes elements originating from the tropical rain forest, riparian forest, monsoon and laurineous forest, from the southern and northern type of hard-leaved forest and scrubs, from the coniferous forest and green-in-the-summer deciduous forest. The elements of the temperate riparian forest belong to this latter assemblage. Our studies into the Tertiary floras have definitely established that the composition of the riparian forests changed and evolved much slower than the forests on dry ground. The riparian associations of the Wind Brickyard are consequently much more closely related to those well known from the later Tertiary than are the mesophilous and xerophilous forests of that time to the younger ones, as proved by the fact that the most frequent riparian tree of the Wind Brickyard flora is that same *Acer trilobatum* (Strnbg.) A. Br. which is so abundant in the Sarmatian of Hungary. Further riparian tree species were — and still are — the alders, species of *Juglandaceae*, some willows, perhaps one or two *Ulmus* species. The *Myrica* species also inhabited the swamps, but the latter were independent of the riparian forests. First of all, in contrast to the riparian forests, usually of considerable height, the *Myrica* populations only constituted shrubby formations. Also, in the Wind Brickyard strata, the fossils of *Myrica* tend to be segregated from the larger leaves of the riparian trees. This results in a fluctuation in their proportions, with now the one, now the other type in the lead. This suggests that in humid sites, the two kinds of population, the riparian forest and the *Myrica* swamp, were fairly sharply separate. This is proved also by pollen analysis (oral communication by Mrs. L. Nagy).

In the plant cover of the dry grounds, it is more difficult to distinguish separate associations, as the different species are much more thoroughly mingled. One cannot name any tree species which would have had an absolute supremacy in the tree level. Furthermore, it does not seem open to doubt that the mixed forest typical of the upper flora, instead of constituting a coherent canopy, rather resembled in this respect the tropical rain forests and was constituted by tree species of different height. Unfortunately, *Sequoia couttsiae* Heer, presumably the tallest tree of all, is extinct and we have no indications as to its height. *S. langsdorfii* (Brgt.) Heer, the ancestor of living *S. sempervirens* (Lamb.) Endl., is known for the moment from the lower flora only, and even from there we have but a single specimen. In contrast, the canopy formed by the trees of the middle and lower floras was more uniform. Even if one or two gigantic trees stood out above the rest, there was a medium-high canopy level in the *Castanopsis-Lauraceae* forest. This fairly coherent canopy presumably consisted of *Castanopsis* (which, though not dominant, left the most abundant fossils except for *Cinnamomum*), further of *Quercus gigantum* Ett. (though this species might have been taller than the average canopy level) and of *Carpinus*, besides the members of the laurel family. This was a laurineous forest interspersed with deciduous trees. At the drier spots it was interrupted by a scrub forest constituted by *Cunonia*, *Arbutus*, one or two *Myrica* species, *Callistemon*, *Berchemia* and some other smaller trees and shrubs. These patches of scrub forest may be considered a descendant of the well-developed Knysna-type dry forest of the Kiseged flora. From the grass level of the closed forest, only *Asplenium egedense* Andreánszky is known so far. There was further a tropical riparian forest of *Ficus* and other tropical species distinct from the mesophytic laurel forest and the dry scrub forest. No well-developed deciduous riparian forest could be proved, however, for the lower and middle strata. Only certain species of *Juglandaceae* and some *Salix* leaves indicate a riparian association of moderate temperature requirements.

In the tropical-type multi-storied mesophytic forest of the upper flora, there were, besides *Sequoia*, several other tall tropical trees having a height of about 60 m standing out above the canopy. Beneath them there was a mixed level, consisting besides the *Lauraceae* mainly of *Symplocos* species of different height. This level was interspersed with a variable proportion of deciduous trees, depending on whether the forest lay on the warmer or on the cooler slope. This is called a *Cedrela—Symplocos* forest. In its grass level, ferns were extremely abundant.

In most young Tertiary floras the laurineous trees generally occur in the lower levels. This phenomenon can be explained in terms of the evolution of associations. In the laurineous forest, the cooling of the climate first results in a replacement of the tree level by deciduous trees while the laurineous population persists in the shrub level. In the Wind Brickyard flora it was, as stated above, not so much the cooling which caused the deciduous trees to multiply; even before that there were many microthermic elements such as deciduous shrubs. The population of the lower levels is almost as mingled as that of the tree level. Tropical shrubs (above all, *Symplocos* species), laurineous elements (mainly *Cinnamomum)*, and deciduous ones (species of *Alnus*, *Rhus*, *Rhamnus* and *Cornus)* render this higher or lower shrub level more varied. Lianas were also present *(Tetrastigmophyllum Smilax)*, but no *Ficus* species have been found so far.

The genus *Castanopsis* does not persist any further, nor do the hard leaved and laurineous oaks and the *Lithocarpus* species. Only *Quercus salicina* Sap. appears, whose height, however, cannot be established.

Light was sufficient even at the lower levels, as proved by the huge-leaves of *Litsea euryphylla* Andreánszky. The *Lauraceae* species, being, as is well known, no shadow plants, leaves of this size, were obviously contingent upon favourable light conditions.

Instead of a transition towards a riparian forest of tropical colouration the *Cedrela-Symplocos* forest locally grades into the already mentioned temperate deciduous stream-bank forest, as well as into a dry tall scrub dominated by certain *Myrica* species (e.g. *Myrica* cf. *aethiopica* L.), *Rhamnus angustifrons* Andreánszky, *Lomatites aquensis* Sap. and *Callitrites brongniarti* Endl. This in turn shows a transition towards a savannah-like association with dominant palms which is in consequence called a palm savannah. This stood apart from the mesophytic forest in time rather than is space, being restricted to the arid phases of the climate. As soon as the precipitations grew more abundant, the *Cedrela-Symplocos* forest returned.

The two typical elements of the *Cedrela-Symplocos* forest have not been encountered in such abundance anywhere else in Hungary. *Cedrela macrophylla* Andreánszky is only known for the moment from the upper strata of the Wind Brickyard; species of *Symplocos* already appear in the Lower Oligocene flora of Kiseged Hill, and further in the middle strata of the Wind Brickyard, but do not attain dominance before the times of the upper strata. This forest is, then, quite distinct from all the other Tertiary forests of Hungary. Unfortunately, research in the tropical regions, hampered by considerable difficulties, did not as yet establish the phytosociological role of the *Symplocos* species in the tropical forests of to-day. It is, consequently, impossible to confront the Wind Brickyard flora with the actual situation. From Germany, fruit remains of *Symplocos* have been reported in large numbers from some Oligo-Miocene sites. There is only one fossil fruit in the Wind Brickyard material, the rest being the imprints of leaves. Our flora thus does not lend itself to any detailed comparison with the German floras of fruit remains; nor can the respective abundances of the species be confronted.

Reviewing the subject of the aspect and the subdivision into levels and phytosociological communities of theflora, let us enumerate the associations which can be reconstructed from the fossils found in the lower and middle strata of the Wind Brickyard. There was a mesophile *Castanopsis-Lauraceae* forest with a fairly homogenous canopy level (20 to 25 m high), in which the laurineous evergreens were interspersed with green-in-the-summer deciduous species *(Carpinus* and tall *Quercus gigantum* Ett., which latter tended to jut out above the canopy). There were further patches of a dry scrub forest which conserved some features of the much better developed South African Knysna forest of Kiseged Hill; finally, there was a riparian forest of tropical colouration. A temperate riparian forest is implied at most by some fossils of *Salix* and *Juglandaceae*. There certainly was also a *Myrica* swamp, but of no great extent.

In the upper flora the swampy shrubs attained a greater extent and were more varied. Along the waters, groves suggestive of a temperate climate grew, with *Acer trilobatum* (Strnbg.) A. Br. as the dominant tree species. The greatest part of the territory was covered in the humid phases by a *Cedrela-Symplocos* forest. This consisted of trees and shrubs of different height which defined several stories and were underlain by a rich grass level consisting of ferns; it had no coherent canopy. This forest was sprinkled with many deciduous elements, especially species of *Acer* and *Ulmus*. In periods of aridity the large-leaved tropical and deciduous trees disappeared and the whole mesophytic forest was replaced by a palm savannah. This was a scrub forest in which the principal tropical element, the palms, were accompanied by many other small xerophilous trees and shrubs, some of which preferred a temperate climate *(Myrica* species, *Rhamnus angustifrons* Andreánszky, *Lomatites aquensis* Sap.).

In favourable periods, the mesophytic forest tended to change towards the tropical rain forests, as implied by tree species having very large leaves and tropical affinities *(Talauma egerensis* Andreánszky), and by laurels with giant leaves *(Litsea euryphylla* Andreánszky). In the upper strata there is no trace of a mangrove forest. Nor is there any indication in any of the three groups of strata of fresh-water plants, pond-weeds or water-lilies.

IMPLICATIONS FOR FLORAL EVOLUTION AND CLIMATIC HISTORY

From the standpoint of floral evolution, the Wind Brickyard floras exhibit two contradictory tendencies. The tropical and temperate features are enhanced simultaneously, both to the detriment of the hitherto dominant subtropical features. If this phenomenon is examined in the context of the preceding and subsequent floras, the following process emerges. It is a well-known fact that the moderately warm climate of the lowest Eocene was followed by a warming up and it was presumably sometime in the Eocene that Central Europe attained the highest temperature in the course of the Tertiary. In the early Oligocene a marked cooling took place which did not, however, swamp Hungary with Turgayan elements, but resulted largely in the multiplication of subtropical elements bearing affinities to the southern hemisphere, and to East Asia, respectively, this to the detriment of the tropical elements. Palms grew scarce while conifers thrived. The cooler temperature of the Lower Oligocene persisted throughout the Middle Oligocene, although we know of no flora which might properly be called "Middle Oligocene" as distinct from the Lower Oligocene flora. Temperature did not increase in the early Upper Oligocene, either, all change being restricted to the precipitation. In the lower part of the Upper Oligocene which corresponds to the lower and middle floras of the Wind Brickyard, floral evolution asserts itself in that the elements with southern affinities are replaced by those with East Asiatic affinities, quadripartite calices *(Abelia, Hydrangea)* become rarer (even totally absent, as far as the Wind Brickyard flora is concerned), while certain Turgayan species tend to grow increasingly abundant. In the upper part of the Upper Oligocene, or perhaps in the lowest Aquitanian, represented by the upper strata of the Wind Brickyard, the temperature began to mount, entailing a multiplication of tropical elements. In certain warmer phases the amount of precipitation also increased and this gave prominence to large-leaved tropical elements and to ferns. At the same time quite a series of Turgayan elements invaded the region. This was made possible by a highly accidented topography. The invasions in question were spasmodic and, apparently, the Turgayan elements did not stay for long. This statement should, however, be taken with some reserve, because — as already mentioned — we have no flora examined in detail from the period immediately following the deposition of the Wind Brickyard strata. So much is certain that the hornbeam wave, known from the flora of the middle strata, did not become permanent, as hardly any hornbeam leaves have been found in the upper strata which, in turn, was invaded by a fresh wave of maple and elm. Nor have these genera been reported in greater quantities from the Lower Miocene. Furthermore, they are just as scarce in the Helvetian floras of both the Mecsek Mountains and the region of Eger. This implies that their invasion into a flora of tropical colouration is unlikely to be due to a marked and permanent cooling. Apart from this, the upper Wind Brickyard flora is considerably richer in palms than the Lower Oligocene floras, or the lower two floras of the Wind Brickyard. I am therefore inclined to see the causes of this invasion of temperate species in conditions favourable to migration and settling.

In order to get a plausible picture of floral evolution, one must by all means start from the immensely rich and varied flora of Kiseged Hill. It has been established (Andreánszky 1959b) that the warm-subtropical population of this flora consisted of elements of the southern hemisphere, and particularly of species having Southeast Asiatic affinities. The number of pronouncedly tropical elements is inferior to that of the subtropical ones and tends to comprise the species of the gallery forests. The dry-ground forest is, by and large, devoid of tropical features. From the point of view of humidity the forest was situated between two extremes; the one was the mesophytic *Castanopsis* forest of Southeast Asiatic affinity, the other a dry scrub forest which included many southern elements and which resembled in many respects the Knysna forest of the Cape of today. The mangrove still flourished, and the tropical riparian forest was rich in species.

Next in the succession is the flora of the uppermost strata of Kiseged Hill, in which there already occurs the imprint of an *Acer* leaf (*Acer atavissimum* Andreánszky). This flora unfortunately includes so few determinable imprints that this transition cannot be reconstructed.

From the period delimited by the strata of Kiseged Hill on the one side, and of the Wind Brickyard on the other, and represented by the conformable series of strata in between, we possess fossils from the clay-pit of the brickyard in the Vécsey Valley (in the immediate vicinity of Eger) and from the sites Nagyimány and Hercegoldal, near Noszvaj, farther away. However, owing to their insignificant number and relatively poor preservation, the fossils in question do not provide a satisfactory basis for the reconstruction of a whole flora. Nevertheless, the intermediate place of these floras between those of Kiseged Hill and the Wind Brickyard is illustrated by the following list of the species hitherto determined.

Middle Oligocene strata of the brickyard in the Vécsey Valley:

Lauraceae sp. cf. *Litsea laeta* (Wall.) Benth. et Hook. f.
Lauraceae sp. cf. *Neolitsea intermedia* Elm.
Dryophyllum sp., very narrow form
Castanopsis furcinervis (Rossm.) Kr. et Wld.
Castanopsis sp. indet.
Carya sp. fructus
Myrica longifolia Ung.
Cunonia oligocaenica Andr. et Nov.
? Dodonaea salicoides Andreánszky
Zizyphus zizyphoides (Ung.) Wld.
Quadripartite calix (not *Abelia quadrialata* Reid and Chandler)

Middle Oligocene strata, Noszvaj, Hercegoldal:

Pinus sp. aciculis binis, very thin needles
Pinus sp., end of a needle-leaved bough, needles thicker, their number undeterminable
Sequoia couttsiae Heer, bough with needles
Sequoia langsdorfii (Brngt.) Heer, boughs with leaves
Cinnamomum scheuchzeri Heer
Cinnamomum lanceolatum (Ung.) Heer
Castanopsis furcinervis (Rossm.) Kr. et Wld.
Engelhardtia brongniarti Sap.
Carya sp. fructus
Zizyphus zizyphoides (Ung.)Wld.

Middle Oligocene strata, Noszvaj-Nagyimány:

Sassafras lobata Sap. sub *Daphnogene (? Sassafras) lobata* Sap.
Castanopsis furcinervis (Rossm.) Kr. et Wld.
Castanopsis fruit imprint

In Hungary it is in the Middle Oligocene that we find the last narrow *Fagaceae* leaves, so markedly typical of the Lower Oligocene, which could not hitherto be assigned to living genera and are, consequently, comprised in the collective genus *Dryophyllum.* The narrow leaf-form from the Vécsey Valley is most characteristic also of the Lower Oligocene strata of Kiseged

Hill and of the region of Buda. It is similarly here that we find the last quadripartite calices in the Middle Oligocene, part of which has not yet been appropriately placed in the system. This flora is thus closely connected with the Lower Oligocene.

The fossils in question have not been encountered in the lowest strata of the Wind Brickyard, at least not until now. This implies that they could not have abounded in the Upper Oligocene flora of that time. On the other hand, the lower strata still bear the genus *Castanopsis*, although not *C. furcinervis* (Rossm.) Kr. et Wld., but *C. callicomaefolia* Andreánszky, which already turned up in the floras of Kiseged Hill and of the Buda region, and the traces of a gallery forest with *Ficus* species and other tropical elements. A *Ficus* species common with Kiseged Hill and not encountered as yet in other floras is *F. adhatodaeformis* Andr. et Nov. The dry forest of southern type became very poor in forms, but *Callicoma, Cunonia oligocaenica* Andr. et Nov. and *Dodonaea* still exist. Among the rare species, *Asplenium egedense* Andreánszky, *Quercus agriensis* Andreánszky and many others are common. On the contrary, *Eucalyptus, Schinus oligocaenicum* Andr. et Nov. etc., had completely disappeared. In the *Castanopsis* forest, the laurels, above all the *Cinnamomum* species, gained prominence, and tended to repress even *Castanopsis callicomaefolia* Andreánszky. Conifers grew considerably scarcer, as regards both species and individuals. *Sequoia sternbergii* (Goepp.) Heer is absent and a single specimen only of *S. langsdorfii* (Brngt.) Heer was found. The situation is unaltered in respect of *S. couttsiae* Heer whose cones persist up to the uppermost strata of the Wind Brickyard where they are still frequent, although apparently for the last time in Hungary. The role of the genus *Pinus* does not change either; although needle clusters are very rare in the Wind Brickyard flora, cone remains are more frequent than on Kiseged Hill.

While the modest ensemble of fossils, encountered in the strata comprised between those of Kiseged Hill and of the Wind Brickyard, and briefly dealt with here, cannot by far be considered representative of the flora of that time, the remains hitherto known from the lower and middle strata of the Wind Brickyard are likely to offer a sound basis for comparing our flora with other floras as to the number of constituent species. Let us state that, as compared to the flora of Kiseged Hill, it was poor in species and much less varied. This implies that the whole vegetation became more uniform, especially at the canopy level, and that the shrub level grew poor especially in shrubs requiring much sunshine, probably owing to the unfavourable light conditions in the interior of the forest. The flora of Kiseged Hill owed its richness in the first place to the great variety of the shrub level.

The upper flora was more colourful again. This, in my opinion, was due to the fact that two contradictory features, the tropical and the temperate, were gaining strength and, in the process, enriched the flora with many new elements. This, however, increased not only the number of species, but also the number of levels in the forest. A great change took place in the evolution of the dry forest. In the flora of Kiseged Hill the dry forest owed its full development and richness to the fact that it still included numerous subtropical arid and semi-arid Australian, Cape and East Asiatic elements. In the upper strata of the Wind Brickyard the dry forest rather consisted of tropical savannah elements, with a very few subtropical species. On the other hand, the change in the riparian forest consisted in that the tropical riparian assemblage of Kiseged Hill was replaced by a stream-bank forest including deciduous elements of temperate climate.

As was stated above, the riparian associations changed in the course of the Tertiary much less and much slower than the dry-ground associations. This change, which took place during the deposition of the Wind Brickyard strata, was perhaps the most important event in the history of riparian vegetal associations during the Tertiary.

Planetrees and poplars were absent from the riparian forest of the Wind Brickyard.

We are unfortunately in no position to trace the evolution of the Wind Brickyard flora in subsequent times. A study published on the subject of the Burdigalian flora of Ipolytarnóc (Rásky 1959) does not enter into these problems and thus provides no information as to floral evolution in the time span between that flora and the Wind Brickyard assemblage.

In this respect the Helvetian floras, including those of the Mecsek mountains, and the floras of several sites around Eger—Tihamér and Andornaktálya, are much better known. In these, the tropical traits are considerably attenuated. The so-called hemitropical flora of the Wind Brickyard, in which tropical elements mingled about half-and-half with subtropical—temperate elements, is replaced by the first subtropical flora (Andreánszky et Kovács 1955, Table I), characterized by laurineous subtropical trees. The extraordinary abundance of *Myrica* in the Wind Brickyard flora finds its continuation here, although in a much smaller number of species. In a Hungarian relation, the period of the Wind Brickyard flora was the golden age of the genus *Myrica*; at that time, many of its species were drought-resistant. In the swamps they retained their role throughout the Burdigalian up to the Helvetian stage. It seems that the xerophilous species were the first to disappear. In rapid retreat from the North Hungarian flora after the Helvetian, the genus *Myrica* almost totally disappeared later on.

It would lead us very far afield if we wished to extend these considerations to the floras of more recent times. Instead, I shall endeavour to give here an outline history of climatic evolution.

The opinion that temperatures decreased gradually and permanently from the Eocene onwards does not fit the facts except as a very rough approximation. In between, namely, some greater fluctuations took place. It was not the oldest Eocene (Palaeocene) which was hottest: in the course of the Eocene, a fairly important warming up occurred. Again, the Lower Oligocene was considerably cooler; the palms and many tropical elements were forced into retreat. The climate deteriorated to warm-subtropical, but retained certain features of the tropical climate, favourable to a mangrove forest. A climate which would have permitted a tropical rain forest to develop, cannot be proved in respect of either temperature or humidity. The climate was decidedly dry. The elements of the tropical rain forest retreated to the riparian forests. However, a prolonged, periodic lack of rains, that is, a well-defined dry season, is not implied: hence, there could be no typical monsoon climate, either. The abundant fern species and many other plants suggest that, although our region was situated on the same latitude then as it is now, there was no sharply distinct hot summer, nor a winter period of complete dormancy. The precipitations probably were not subject to greater annual fluctuations, either. Still, the fairly large proportion of sclerophyllous plants in certain periods indicates some extent of drought in the summer.

On the basis of the flora we cannot separate a Middle Oligocene, and this implies that the climate underwent no important change, either, although the precipitations increased somewhat. The fossil ensemble of the Clay of Kiscell in the Buda region already contains larger and broader leaves than the flora of the Kiseged Hill; similarly, the Upper Oligocene flora of the lower strata at the Wind Brickyard indicates a slightly greater abundance of precipitation. In the middle strata, the multiplication of hornbeams implies also some decrease of temperature. The comparatively large leaves of *Quercus gigantum* Ett. and of the hornbeam are a sign of richer precipitations. Still, even in the cool phase of the middle strata, temperature did not diminish so much as to bring the average of the coldest months near the freezing point; the latter was but rarely reached as an absolute minimum. It is nevertheless probable that, throughout the Hungarian Oligocene, the lowest temperature prevailed at the time of deposition of the middle strata. Pollen analytical research in northern Germany has shown that the Oligocene as a whole was cooler than either the Eocene or the Lower Miocene. Turgayan elements were abundant in the North German Oligocene.

The temperature drop can also be proved for this country, but it appears that greater quantities of Turgayan elements reached the southerly regions of Central Europe by the end of the Oligocene only.

The upper flora points to a further increase of precipitation and, at the same time, of temperature. Precipitation began to fluctuate without, however, influencing the temperature, at least not in the yearly average. Still, the increasing aridity may have been accompanied by greater yearly fluctuations of temperature. The arid phases were at least as dry — if not drier, considering the higher temperature — as the climate of the Kiseged flora. This was presumably the warmest climate in the course of the entire Oligocene; or, if we assign this period to the Lowest Miocene, we may state that the Miocene brought a warming up in comparison with the Oligocene.

A warmer climate stayed on, after the Aquitanian, also in the early Burdigalian; it was only later in the Burdigalian that a further cooling down set in. Precipitation was again scantier in the Lower Miocene than in the wettest period of the Wind Brickyard series; for some time, palms were more abundant than even in the Wind Brickyard flora, but the very large leaves typical of the wettest phases of the Wind Brickyard did not turn up any more.

RELATIONS TO OTHER FLORAS CONSIDERED OF THE SAME AGE

IN THE earlier phase of tertiary floral research an exaggerated importance was attributed to the comparison of the floral list of diverse sites, largely because a percentual comparison with certain floras, having a well-established age and considered, as it were, as standards, was thought to be an infallible method for determining the relative age of the flora.

This would perhaps be a correct principle if the floras selected for this purpose belonged to the same floral region or at least to the same zone of vegetation. For instance, today the whole lowland of Central Europe shows a great uniformity, especially if we consider the arborescent plants, which, in fossil floras, tend to be the only ones preserved. Oak forests are prevalent and the accessory trees are also more or less the same; there are only one or two tree or shrub species which are absent in the West but present in the East, or vice versa. As regards the past, however, floral limits are still very imperfectly known; moreover, small ecological differences may have caused considerable differences in the composition of the flora. Stockholm and Zagreb both fall within the zone of deciduous oak forests; nevertheless, at a much smaller distance south of Zagreb, the composition of the forests turns out to be substantially different. As regards the past, differences in space are complicated by differences in age. This being the case, it is often very difficult to establish whether similar floral lists signify contemporaneity or only similar ecological conditions. In the same way, differences in composition do not necessarily imply differences in age. Furthermore, the fossil material of certain sites includes the plants of one or a few associations only, rather than the whole flora; this holds especially for the younger Tertiary floras. Comparison of such incomplete floras is even more liable to lead to erroneous deductions.

Some comparisons among contemporaneous floras in Hungary have already been effected. Let us add that the differences between them may be due to the existence of floral boundaries between the sites. In contrast to the abundance of Engelhardtia fruits at Csörög, hardly any such fossils have been found so far in the Wind Brickyard ensemble. In any case, one finds much greater differences if one compares with the Wind Brickyard flora the Upper Oligocene or Lower Miocene floras of sites lying farther away. In general, only the species spread over a large area and persistent throughout a long span of time tend to be common among several fossil floras. To this category belong *Engelhardtia brongniarti* Sap. (frequent not so much at the Wind Brickyard flora as at Csörög), *Myrica lignitum* (Ung.) Sap., *Comptonia acutiloba* Brngt., the *Cinnamomum* species, *Embothrites borealis* Ung. (although unknown from the Wind Brickyard, this latter is frequent on Kiseged Hill and at Magyaregregy), *Acer trilobatum* (Strnbg.) A. Br. etc. On the other hand, the species to which the Wind Brickyard flora owes its individuality, such as the numerous *Symplocos* species, *Acer hungaricum* Andreánszky, *Sequoia couttsiae* Heer, are not represented at all (or represented by a single species in the case of *Symplocos*) in the flora of Rott which is also considered Upper Oligocene (Weyland 1937—1941). Nor does the flora of Rott show the rich variety of the *Myrica* species, the large-leaved *Anonaceae*, *Cedrela* etc. Besides the very widespread elements, there are but one or two common species to the two floras: *Sequoia langsdorfii* (Brngt). Heer, *Callitrites brongniarti* Endl., *Carpinus grandis* Ung., one or two *Lauraceae*, *Quercus tenerrima* (very frequent in the flora of Rott, this species is represented by a single leaf in the Wind Brickyard flora), *Zizyphus zizyphoides* (Ung.) Wld. All these common species occur also in several of our younger floras. A comparison would thus suggest that the two floras are markedly different in age, the flora of Rott being considerably younger. For instance, *Ilex rottensis* Wld., described from the flora of Rott, has turned up in our Helvetian floras (Andreánszky 1956, 226, Taf. IV. 13).

The other Central European sites are mostly also situated farther north than the Wind Brickyard site, so that they presumably were more closely related to the Turgayan flora. For this reason they generally show a younger colouration. So, for instance, remains of *Fagus* have been reported from the Lower Oligocene of the Bavarian Alpenvorland whereas this genus is absent from the fossil ensemble of the Wind Brickyard. With the exception of *Cinnamomum scheuchzeri* Heer and of *Myrica lignitum* (Ung.) Sap., none of the characteristic species abundant at the Wind Brickyard is enumerated in E. Knobloch's paper (1961) on the "Upper Oligocene" flora of Pirskenberg, Northern Czechoslovakia. In contrast, among some 60 species enumerated in that paper, there are about 55, the majority of which crop up in our Sarmatian flora, and the rest of which also fit into the same. For the most part these are decidedly microthermic species, such as *Liriodendron procaccinii* Ung. which does not occur in Hungary until the Helvetian and

Cercidiphyllum crenatum (Ung.) Brown which is missing even from our lowest Sarmatian, to become afterwards a typical element of our mesophytic forests.

Although the site of Pirskenberg is situated farther north, this vast difference in age (Upper Oligocene to Upper Miocene) requires careful consideration. This northern Czechoslovak flora may eventually turn out younger than Upper Oligocene.

According to the aforesaid, the comparison of floral lists is unsuited to the determination of relative ages, particularly if no proper attention is paid to the relative abundances of the individual species. This is why I have consistently avoided all attempts at this kind of comparison in the present study.

SUMMARY

The Wind Brickyard flora is considered Upper Oligocene because it shows transitions from the Lower Oligocene flora of the Kiseged Hill and there is a conformable succession of strata between the two sites. The Wind Brickyard flora itself, however, covers an extended span of time, so that the flora of the upper strata presumably attains the Oligocene-Miocene limit established on the basis of palaeozoology. Nevertheless, I feel that the differences between the lower and middle floras of the Wind Brickyard on the one hand and the upper flora on the other, owing to the replacement of some elements of the flora by others, are not significant enough to justify drawing there the Chattian-Aquitanian limit, which is also the Oligocene-Miocene, and, in the end, the Palaeogene-Neogene limit. I have repeatedly mentioned that the undoubtedly Miocene flora of Ipolytarnóc is not yet sufficiently known. If no significant change in composition will be proved there, either, then it might turn out correct to draw the Chattian-Aquitanian limit between the middle and upper strata at the Wind Brickyard. Since the Wind Brickyard flora has not yet been studied in its entirety, one cannot express in figures the respective abundances of the ancient (tropical—hot subtropical) elements on the one hand and the younger (warm-temperate—temperate) ones on the other. I think, however, that beyond doubt the Turgayan element is still in minority as regards both the quantity of individuals and the number of species.

The Wind Brickyard flora represents on a rough average a climate somewhat warmer and wetter than that of the Kiseged Hill. As a result, the southern sclerophyllous elements almost disappear, *Castanopsis furcinervis* (Rossm.) Kr. et Wld. is hardly represented and *Zizyphus* leaves are also very scarce. Notwithstanding the higher temperature, the traces of the mangrove disappear and the region is swept by two microthermic waves, the *Carpinus* wave in the middle flora and *Ulmus*-and-*Acer* wave in the upper flora. Above the middle strata the flora assumes markedly tropical traits: *Cedrela macrophylla* Andreánszky turns up, the genus *Symplocos* multiplies, three palm species appear and, in the grass level, *Lastraea* cf. *oeningensis* (A. Br.) Heer becomes prevalent.

In the lower and middle floras the forest had a coherent canopy (a subtropical feature); in the upper strata a multi-levelled tropical-type forest was formed. This forest does not present the phenomenon that, proceeding downwards in the succession of leaves, one encounters plants of higher and higher heat requirements. Namely, the replacement of the lower levels is retarded in comparison with the higher ones: the shrub and grass level adapt themselves naturally to the upper levels and transform only after the latter is exchanged, that is, with a certain time lag. Owing to the gradual cooling of the climate, it is usual in the younger Tertiary for the plants of the uppermost level to be first replaced by microthermic elements, whereas, in the shrub level and particularly in the grass level, macrothermic elements may persist. Since, however, temperature was rather low in the times preceding the Wind Brickyard flora, the shrub level consisted of elements having even lower heat requirements than the tree level.

From the point of view of territorial affinity, the Wind Brickyard flora undoubtedly shows the closest bonds with Southeast Asia. Conifers and ferns are exceptions, and so are the intermittent waves of microthermic elements; their connexions must be looked for at higher latitudes. These connexions, however, have more or less been obliterated since.

REFERENCES

Andreánszky, G. (1949a) Néhány páfrány a Kárpátmedence harmadkorából. (Some ferns from the Tertiary of the Carpathian Basin), *Index Horti Bot. Univ.* Budapest 102—108 Summary in French

Andreánszky, G. (1949b) Reste einer neuen tertiären Palme aus Ungarn. *Hung. Acta Biol.* **1.** 31—36

Andreánszky, G. (1952) Újabb harmadidőszaki páfrányok. (New Tertiary ferns) *Földt. Közl.* **82.** 397—402 Summary in French

Andreánszky, G. (1954) Ősnövénytan. (Palaeobotany), Budapest

Andreánszky, G. (1955) Neue und interessante tertiäre Pflanzenarten aus Ungarn. *Annal. Hist. Nat. Mus. Nat. Hung. n. ser.* **6.** 37—50

Andreánszky, G. (1956) Neue und interessante tertiäre Pflanzenarten aus Ungarn. *Annal. Hist. Nat. Mus. Nat. Hung. n. ser.* **7.** 221—229

Andreánszky, G. (1959a) Die Flora der sarmatischen Stufe in Ungarn. Budapest

Andreánszky, G. (1959b) Contributions à la connaissance de la flore de l'oligocène inférieur de la Hongrie et un essai sur la reconstitution de la flore contemporaine. *Acta Bot. Acad. Sci. Hung.* **5.** 1—37

Andreánszky, G. (1962) Contributions à la connaissance de la flore de l'oligocène supérieur de la briqueterie Wind près d'Eger (Hongrie sept.). *Acta Bot. Acad. Sci. Hung.* **8.** 219—239

Andreánszky, G. and Kovács, É. (1955) Gliederung und Ökologie der jüngeren Tertiärfloren Ungarns. *Annal. Inst. Geol. Publ. Hung.* **44.** 1

Andreánszky, G. and Novák, E. (1957) Neue und interessante tertiäre Pflanzenarten aus Ungarn. III. *Annal. Hist. Nat. Mus. Nat. Hung. n. ser.* **8.** 43—53

Becker, H. F. (1960) The Tertiary Mormon Creek Flora from the Upper Ruby River Basin in Southwestern Montana. *Palaeontogr.* **107.** B, 83—126

Bews, J. W. (1925) Plant forms and their evolutions in South Africa. London

Camus, A. (1936—1954) Les Chênes. I—III. Atl. I. 1936—38, II. 1938—39, III. 1952—54

Csepreghy-Meznerics, I. (1956) Stratigraphische Gliederung des ungarischen Miozäns im Lichte der neueren Faunauntersuchungen. *Acta Geol. Acad. Sci. Hung.* **4.** 183—207

Ettingshausen, C. (1954) Fossile Pflanzen nächst Erlau. *Jahrb. Geol. Reichsanst.* **5.** 211

Heer, O. (1855—1859) Flora tertiaria Helvetiae I—III

Heer, O. (1872) Az Erdélyben fekvő barnakőszén virányáról. (The flora of the brown coal in Transylvania), *Földt. Int. Évk.* **2.** 4—29

Hirmer, M. (1942) Die Forschungsergebnisse der Paläobotanik auf dem Gebiet der känophytischen Flora. *Eng. Bot. Jahr.* **72.** 347—563

Jablonszky, J. (1914) A tarnóczi mediterrán korú flóra. (The Middle Miocene flora of Tarnócz), *Földt. Int. Évk.* **22.** 227—273

Knobloch, E. (1961) Die oberoligozäne Flora des Pirskenbergs bei Sluknov in Nord-Böhmen. *Sbornik Ustr. Ust. Geolog.* **26.** 241—315

Kolakovsky, A. A. (1957) The addition to the Pliocene Flora of Kondor (Meore Atara). *Trud. Suchumsk. Bot. Sad.* **10.** 235—318 Russian, summary in English

Kovács, É. (1959) Note sur la flore éocène de Lábatlan (Transdanubie du Nord). *Annal. Univ. Scient. Budap.* **2.** 135—140

Kovács, É. (1961) Középső-eocén flóra Lábatlanról. (Middle Eocene flora from Lábatlan), *M. Áll. Földt. Int. Évi Jelent. 1957—58. évről* Summary in German

Kovács, É. (1962) Untersuchungen an ungarländischen Eichen des Tertiärs. I. Sarmatische Eichen. *Acta Bot. Acad. Sci. Hung.* **8.** 283—302

Nagy, E. and Pálfalvy, I. (1963) Az egri téglagyári szelvény ősnövénytani vizsgálata. (Palaeobotanical examination of the profile of the brickyard at Eger), *Földt. Int. Évi Jelentés 1960-ról,* 223—263 Summary in French

Pálfalvy, I. (1951) Növénymaradványok Eger harmadkorából. (Plant fossils from the Tertiary of Eger), *Földt. Közl.* **81.** 57—80 Summary in French

Pantic, N. (1956) Biostratigraphie des flores tertiaires de la Serbie. *Annal. Géol. Pénins. Balk.* **24.** Beograd. 199—321

Rásky, K. (1943) Die oligozäne Flora des kisceller Tons in der Umgebung von Budapest. *Földt. Közl.* **73.** 503—536

M. Rásky, K. (1959) The fossil flora of Ipolytarnóc. Preliminary Report. *Journ. of Paleont.* Menasha, Wisconsin. **33.** 453—461

M. Rásky, K. (1960) Pflanzenreste aus dem Obereozän Ungarns. Senckenberg. *Lethaea* **41.** 423—442

Saporta, G. (1862—1874) Études sur la végétation du Sud-est de la France à l'époque tertiaire. *Ann. Sci. Nat.* $4^{ème}$ *sér. 16.*—$5^{ème}$ *sér. 18*

Staub, M. (1887) A Zsilvölgy aquitán korú flórája. (The Aquitanian Flora of the Zsil-Valley), *Földt. Int. Évk.* **7.** 287—424

Szőts, E. (1956) La limite entre le paléogène et le néogène et le problème des étages chattien et aquitanien. *Acta Geol. Acad. Sci. Hung.* **4.** 209—219

Udvarházi, J. (1938) Harmadkori növénymaradványok Eger környékéről. (Tertiary fossil plants from the environs of Eger), *Földt. Közl.* **68.** 131—143

Vitális, Gy. and Zilahy, L. (1951) Csörög környéki harmadidőszaki növénymaradványok. (Tertiary fossil plants in the vicinity of Csörög), *Annal. Biol. Univ. Hung. 1951.* 161—170

Weyland, H. (1937—1941) Beiträge zur Kenntnis der Rheinischen Tertiärfloren. Erste, zweite und dritte Ergänzungen und Berichtigungen zur Flora der Blätterkohle und des Polierschiefers von Rott im Siebengebirge, *Paläontogr. (B)* **83** and **86**

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