THE GENUS *CARPINUS* IN EUROPE IN THE PALEOBOTANICAL LITERATURE

Rodzaj Carpinus w europejskiej literaturze paleobotanicznej

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CONTENTS

Introduction	3
Fossil remains of the genus <i>Carpinus</i>	4
Survey of the paleobotanical literature	7
<i>Carpinus grandis</i> Ung. as the paleobotanical type	12
Fossil involucre of the genus <i>Carpinus</i>	18
1. Involucre from the Oligocene and Miocene	19
2. Involucre from the Pliocene	37
General remarks	44
Summary	48
Streszczenie	49

INTRODUCTION

The history of the genus *Carpinus* in Europe, based upon the palaeobotanical literature, is part of the author's detailed studies dealing with fossil nutlets of the genus *Carpinus* in Poland. The first part was printed in the publications of the Geological Institute in Warszawa, under the title "Fruits of the Genera *Carpinus* and *Ostrya*. Analysis of characters and keys for the determination of species". (J. Jentys-Szaferowa and M. Białobrzaska 1953). This part contained the results of detailed studies concerning the shape of present-day fruits of a number of species of *Carpinus* and *Ostrya*, conducted by means of the statistical method, and of studies concerning the anatomical structure of their perigone and pericarp. Taken into account in these studies, first of all, were the characters with regard to which it is possible to compare fossil nutlets with present-day ones.

In the second stage of her work the author undertook a detailed analysis of fossil nuts of the hornbeam (*Carpinus*), encountered in large

numbers in various geological deposits in Poland, from the Miocene till the present era. The investigated materials were obtained from numerous localities, and the local samples were composed of several dozen or even hundred nutlets each. Such a material, therefore, studied by means of the statistical, anatomical and epidermal methods, supplied a basis for drawing conclusions concerning the history of the genus *Carpinus* in Poland. However, inasmuch as Poland is but a small part of Europe, it became necessary to connect the investigations concerning fossil hornbeams in Poland with the history of the hornbeam outside of Poland. It is a fact that such historical investigations bring no results if they are restricted to the political boundaries of a single country. The author, therefore, was obliged to connect the results of her observations with the known facts from the history of the genus *Carpinus* throughout Europe and, as far as possible, throughout the area of its occurrence.

The results of the author's investigations concerning the history of the genus *Carpinus* in Europe on the basis of the literature of the subject, were originally to be included in an extensive study on the fossil nutlets of Poland, as its final chapter. In view of the fact, however, that the latter chapter had attained a quite considerable bulk, the author decided to publish it separately, as the second part of her investigations concerning the fruits of the genera *Carpinus* and *Ostrya*.

FOSSIL REMAINS OF THE GENUS *CARPINUS*

In fossil floras the genus *Carpinus* occurs in the form of leaves, involucre and fruits. Of these three kinds of fossil remains, the least certain for diagnosing the genus are the leaves. Palaeobotanical works from the XIX century are full of contradictions and false determinations. Reimann (1920), elaborating the families *Betulaceae* and *Ulmaceae* for Kräusel's paper devoted to the Tertiary plants of Silesia, carried out a detailed study, on the one hand, of the criteria which formed the basis for the authors describing the Tertiary fossil floras, and, on the other hand, of the characters of present-day leaves. He thus arrived at the conclusion that neither in the shape, nor in the structure of the leaf margin, nor in the nervature are there any absolutely certain characteristics that distinguish the leaves of the genera *Alnus*, *Betula* and *Carpinus* (p. 25). Moreover, leaves do occur as to which one cannot be certain if they ought to be included in the genus *Ulmus* or *Carpinus* (pp. 69—76), although the latter two genera belong not only to different families, but even to different orders of the vegetable kingdom. Recently the matter was taken up by Nemejc (1949), who confirms Reimann's above-mentioned observations concerning the leaves of

Betula, *Carpinus* and *Alnus*; neither does he exclude the possibility of mistaking the latter genera for the genus *Ulmus* (pp. 52—53).

Berger, in the introduction to his studies on the taxonomy and history of the genus *Carpinus*, writes (1953. 1, pp. 2—3) that he also endeavoured, by following Reimann's suggestions, to discover criteria for the generic determination of *Carpinus* leaves, and that he also arrived at the conclusion that it is difficult to distinguish between the leaves of some species of *Carpinus*, *Betula* and *Alnus*. To distinguish on the basis of single leaves the genera *Carpinus* and *Ostrya* is, according to Berger, altogether impossible.

In view of the difficulties encountered in the generic determination of *Carpinus* leaves, the determination of their species is still more problematic.

As far as the fruits are concerned, at least in the present-day flora there are no plants with fruits so similar to those of the genera *Carpinus* and *Ostrya* as to make a mistake possible. In fossil materials the only difficulty may consist in distinguishing on the basis of the external appearance whether a given fruit belongs to the genus *Carpinus*, or to the genus *Ostrya*. The author is going to discuss this matter in greater detail in the third part of her study devoted to fossil fruits of the genus *Carpinus* in Poland.

Of the latter two genera, *Carpinus* occurred much more widely in the European Tertiary than the genus *Ostrya*. Consequently, a great majority of the fruits determined by palaeobotanists as belonging to the genus *Carpinus*, is determined correctly. An exception is the microcarpous *Carpinus minima* Szafer, described by W. Szafer from the Lower Pliocene of Krościenko near the Dunajec River (1947) and from the Upper Pliocene at Mizerna near Czorsztyn (1954); its fruits occur in the above-mentioned sediments in great quantities. These fruits, seemingly very similar to those of the genus *Carpinus*, upon being subjected to a detailed morphological and anatomical examination proved to be of a different structure than the fruits of the genus *Carpinus*; this matter will be the subject of a separate paper which is being prepared by the author.

Unger, in "Iconographia Plantarum Fossiliúm" (1852), described and depicted under the name of *Carpinus norica* a large fruit, 18 mm. long, discovered in Tertiary deposits in the vicinity of Obdach in Styria; according to Heer, who saw the original specimen in Vienna, it is a small root-tuber (Wurzelknolle) of *Physogenia parlatori* Heer, and according to Šchenk (1890, Palaeophytologia, p. 493), a fruit of *Lauraceae*. Berger (1953, 1) reports that the original specimen of *Carpinus norica* is now so far damaged that, at least morphologically, it is no longer determinable. Similar is the case of *Carpinus oeningensis*,

described by Unger; it was already Heer who expressed the opinion that the latter is not a hornbeam. The above sporadic findings cannot be taken into account in a description of European hornbeam fruits.

Although a determination of the genus of fossil *Carpinus* fruits does not present great difficulties, one cannot venture to decipher the history of the genus *Carpinus* in Europe by means of the descriptions or illustrations of nutlets in palaeobotanical literature. First of all, the abundant literature of the XIX century deals exclusively with leaf floras, in which fruits occur sporadically. Moreover, the figures depicting such sporadic fruits in the above-mentioned works tell us nothing. Only in the last thirty years have detailed studies of fossil seeds and fruits been undertaken. In spite of this, it is a rare occurrence to encounter in palaeobotanical works a good photograph of the given specimen, together with its exact measurements. Furthermore, the author's detailed studies concerning the fossil fruits of *Carpinus* have demonstrated that a determination of the species on the basis of single fossil fruits is no easy matter. Consequently, the author did not even attempt in her studies, concerning the fossil fruits of *Carpinus* in Poland, to include the sporadic material described by other authors from localities outside of Poland, inasmuch as no results could have been gained.

The least doubts are experienced with regard to fossil involucre of the genus *Carpinus*, even if they have no nutlet at their base. The fact is that in such cases it is out of the question to make a mistake between the genera *Carpinus* and *Ostrya*. *Carpinus* has involucre developed in the shape of characteristically incised wings, often several centimeters long, while the involucre of *Ostrya* are grown together into a kind of follicle or capsule. At first, indeed, the fossil involucre of *Carpinus* were confused with the three- of four-lobed fruits of the tropical genus *Engelhardtia* (family *Juglandaceae*), as described below. Thanks, however, to the excellent characterization of the fruits of *Engelhardtia* by Reimann (1920), here too there is no fear any more of making a mistake. That was probably the reason why Berger based his "Studies on the Taxonomy and History of the Genus *Carpinus*" on the involucre, endeavouring to divide the present-day and fossil hornbeams into taxonomic groups according to the structure of their involucre. That is also the reason why in the present paper too, the author undertakes an attempt to reconstruct the history of the hornbeam in Europe exclusively upon the basis of the involucre described and depicted in various palaeobotanical works, endeavouring to assume a critical attitude towards the data contained in the literature. The author did not take into account such works in which the involucre are not depicted.

SURVEY OF THE PALAEOBOTANICAL LITERATURE

Everyone who has had to deal with palaeobotanical literature knows that the latter is a veritable jungle which it is difficult to penetrate. Therefore, to find her way about, the author was obliged to put it into order in a twofold manner. First, the author endeavoured to trace the gradual development of our knowledge of fossil hornbeams; secondly, to associate the data on fossil hornbeams, appearing in various periods of time, with the consecutive geological epochs. Thus it was a chronology of the literature and a chronology of the hornbeam itself during the past geological epochs.

The word *Carpinus* occurs in palaeobotanical literature for the first time in the year 1803, in France, when Faujas de Saint-Fond described under the name of *Carpinus betulus* a fossil leaf discovered in the vicinity of Ardèche. In 1828, also in France, the well-known palaeobotanist Brongniart described some fruit structures, found in the Miocene near Armissan, as involucre of the fossil species *Carpinus macroptera*. In 1845, the Austrian palaeobotanist Unger published the description of a new hornbeam species, *Carpinus grandis* (the detailed history of which is given below), and of the species *Carpinus betuloides*. Since then, new and new fossil species of the genus *Carpinus* make their appearance with extraordinary rapidity. Between the years 1845 and 1850, four new species were described in Europe; between 1850 and 1855, thirteen species; and between 1855 and 1860, six species more. Up to 1890, 46 species of fossil hornbeams were described in all in Europe, without talking into account new varieties or fragments that were designated as *Carpinus* sp. At the above-mentioned date there were 19 authors of the new names, therefore certainly more than there were hornbeam species in the Tertiary of Europe. The principal author of names was Unger who described seven new species of hornbeams; Goepfert described six; Wessel and Weber, five; Saprota, four; remaining authors, from one to three new species each.

In a critically annotated list published in "Fossilium Catalogus", Nagel (1916) describes 56 species of fossil hornbeams apart from forms, such as *Carpinus pyramidalis* Hr. f. *ovalis* Boulay, or seven entries designated as *Carpinus* sp. Since that time the number of such species has grown. New species described since then in Europe are as follows: *Carpinus polonica* Zabł. (1928), *Carpinus minima* Szafer (1947), and, described simultaneously by Szafer, *Carpinus* cf. *Tschonoskii* Maxim and *Carpinus laxiflora* Bl., six new species described by Berger (1953), and apart from the latter a number of new species from eastern Asia, described by Miki, Hu, Husioka, Chang and others.

From among the names listed by Nagel, some twenty concern forms as regards which we now know that they are not hornbeams. Fourteen names concern materials consisting partly or entirely of involucre. A small number are the names of fruits, and the remaining ones concern leaf materials that still await elaboration.

The foregoing brief review of the history of species included in the genus *Carpinus* in palaeobotanical literature, is sufficient to demonstrate that fossil hornbeams are not a material in which it is easy to find one's way about.

Let us now pass on to the history of the genus *Carpinus* itself during the past geological epochs in Europe.

It is difficult to establish the age of the oldest fragments of the genus *Carpinus* in Europe. In the Eocene flora from Sotzka in Styria, Unger (1851) described some structures which he considered to be involucre of the genus *Carpinus* and which he included in two species: *Carpinus macroptera* Brongn. (first described by Brongniart from the

Fig. 1. A₁—A₃ — *Carpinus producta* Ung.; B₁—B₃ — *Carpinus macroptera* Brong. After Unger (1851). — Według Ungera (1851)

Miocene at Armissan near Narbonne) and the new species *Carpinus producta* Unger (Fig. 1).

According to Unger, *Carpinus producta* differs from *Carpinus macroptera* by its central lobe which is narrow and more elongated, and furthermore by possessing at its base a small ribbed nut. Provisionally Unger also included in the same species four leaves (Fig. 2, 7—10) found in the same sediments. Soon afterwards Ettingshausen (1851) disputed the determination of the above-mentioned fragments as *Carpinus*, and suggested that the alleged hornbeam species quoted above, as well as all the other involucres described during the first half of the XIX century as *Carpinus*, belong to the genus *Engelhardtia*; he confirmed this in 1858 by conducting additional studies on the flora from Sotzka, and in 1869 by describing the flora from Bilin. In the third part of „Sylløge Plantarum Fossilium“, published in 1866, Unger admitted that the fossil involucres of *Carpinus macroptera* Brongn. from the Eocene at Sotzka ought to be included in the species *Engelhardtia macroptera* Brongn. As a matter of fact, having carried out a more detailed examination, he discovered that in the lower part of the central lobe two lateral nerves branch off from the main nerve and then run almost parallel to the latter, and are connected with it by means of a regular network of tertiary nerves, this being characteristic of the genus *Engelhardtia*. However, he does not relinquish the Eocene species *Carpinus producta*, described in the flora from Sotzka, and he lists it among the Tertiary fossil hornbeams in his „Geology of European Forest-Trees“ (1869).

Reimann (1920) carried out a more detailed analysis of the fruits of present-day species of the genus *Engelhardtia* than did Ettingshausen, and he drew attention to the fact that apart from the frequent but not always present short fourth lobe on the fruit of *Engelhardtia*, a characteristic feature of this species is a widening of the lobes in their upper part. With regard to the latter feature, the above-described

Fig. 2. 7—10 — *Carpinus producta* Ung.; After Unger (1851), reduced — Według Ungera (1851), zmniejszone.

Carpinus macroptera Brongn. and *Carpinus producta* Unger resemble one another so far (Fig. 1) that without doubt all the above-mentioned fragments of Eocene fruits from Sotzka belong to the same species. The thing that intrigued Unger, i. e. a kind of ribbed nut at the base of the scales, is probably a crushed drupe of *Engelhardtia*, preserved in some specimens.

As regards the leaves in Fig. 2, which have been redrawn from Table XXXII of Unger's "Die fossile Flora von Sotzka" and were designated there by the name *Carpinus producta*, Ettingshausen assumes that the specimen marked No. 7 belongs to the genus *Ternstroemia*, and No. 10, to the species *Elaeodendron degener* v. Ett. He expresses no opinion with regard to leaves Nos. 8 and 9. Therefore, the presence of the genus *Carpinus* in the Eocene of Central Europe is doubtful.

It must be pointed out that in Principi's flora of the Paleogene (1940), the fossil flora from Sotzka, elaborated by Unger, has been placed among the Oligocene floras. If such is indeed the case and the flora from Sotzka is younger than assumed by Unger, then we have up to the present moment no trace of the existence of the genus *Carpinus* in the Eocene of Central Europe.

In the Eocene, according to Principi (1940), the species *Carpinus grandis* Ung. or *Carpinus grandis* Goep. outside of Central Europe have been reported from Russia (province of Kursk), Siberia, Manchuria and Japan, and apart from that in Alaska and the United States of America, in Oregon and Idaho (in the latter countries the genus *Carpinus* only). The author does not know, however, whether the above-mentioned names concern scales, fruits, or leaves.

The findings of Oligocene floras in which the genus *Carpinus* has been reported are numerous in Europe; they are derived, however, almost exclusively from the Upper Oligocene. First of all in Germany the name *Carpinus grandis* Ung. is frequently encountered in the descriptions of Upper Oligocene. The latter name, however, almost exclusively concerns leaves, the generic determination of which, as mentioned above, is uncertain. Oligocene involucres of the genus *Carpinus* have been described, as far as the author knows, only from three fossil floras. One of them, found in Kreuzau near Dürren on the Rhine, was elaborated in 1934 by Weyland and supplemented with hornbeam involucres described in 1953 by Berger. Another, discovered at Berand in northern Bohemia, was described already in 1898 by Engelhardt. The third one is from Lower Lusatia, from laminated clay overlying layers of brown coal, and it was elaborated in 1906 by Menzel (Fig. 8, A, B, R).

The age of the above-mentioned floras is not altogether certain; some palaeobotanists designate them as belonging to the Lower Miocene. As a matter of fact, there is no distinct geological boundary-line between the Oligocene and the Miocene. In view of the existing difference in determining the age of the above-mentioned floras, we shall be keeping nearest to the truth if we accept that the oldest fossil fragments belonging undoubtedly to the genus *Carpinus* are to be found in Central Europe on the boundary-line between the Oligocene and Miocene, i. e. on the boundary between the Paleogene and Neogene.

Apart from Central Europe, Principi (1940) reports, after Saporta, the discovery in 1868 of two leaves and two involucre of *Carpinus cuspidata* Sap. (Fig. 8, P) in the Lower Oligocene in central and southern France. The age of this flora is also controversial, because some authors include it in the Miocene (Berger 1953, 1). The involucre resemble those of *Carpinus orientalis*; the matter is discussed below. The genus *Carpinus* or the species *Carpinus grandis* Unger has been also reported (Principi) from the Oligocene of Italy, Switzerland, Bulgaria, European Russia, Asiatic Russia (Vladivostok) and Sakhalin.*

In many Miocene fossil floras the genus *Carpinus* occurs often, described under various specific names. The most frequently encountered name is *Carpinus grandis* Unger. Nagel lists more than a hundred palaeobotanical works concerning the Tertiary, in which the above-mentioned species has been described; mostly, however, on the basis of leaves. The name has almost become a synonym for the hornbeam characteristic of the Miocene forest of Europe. In descriptions of Pliocene floras one encounters already a tendency to confer on fossil hornbeams the names of corresponding present-day species.

In view of the fact that the specific name "*Carpinus grandis* Unger" has gained such an appreciation in the European Miocene, the author thinks it proper to devote some words to the history of this name and to describe the type on the basis of which Unger distinguished the species. The following passage is going to be slightly chaotic, being a mixture of the history of palaeobotanical names and of the history of the tree itself. It will, however, give a good illustration of what a botanist experiences when he begins to study the palaeobotanical literature and a palaeobotanical "type" which in spite of its vagueness has become the main basis for the determination of numerous fossil materials.

* My present paper was already in print when there appeared M. E. J. Chandler's account of the Middle Oligocene Flora of the Bovey Tracey Lake Basin, Devonshire (1957). The author gives drawings of some fruits, very variable in shape and size, which she determines as *Carpinus boveyensis* Heer. Some of them are — as the author writes — attributable beyond doubt to *Carpinus*.

CARPINUS GRANDIS UNG. AS A PALAEOBOTANICAL TYPE

Unger used the name *Carpinus grandis* to designate the involucre and leaves discovered in Miocene strata at Radoboj in Croatia. The oldest mention of the name is to be encountered on p. 220 of Unger's "*Synopsis Plantarum Fossilium*", printed in 1845. It runs verbatim as follows:

2. *Carpinus grandis* Ung. *Chlor. protog. inedit.*

In schisto calcareo margaceo ad Radoboium Croatiae.

Exactly the same is reprinted in his work "*Chloris Protogaea*", published in the years 1841—1847.

In 1850 Unger published descriptions of fossil plants under the title. "*Genera et Species Plantarum Fossilium*". In the latter work, not

Fig. 3. *Carpinus grandis* Ung.. A₁—A₂ — involucre; B₁—B₂ — leaves. After Unger (1852)

A₁—A₂ — okrywy owocowe; B₁—B₂ — liście. Według Ungera (1852)

illustrated, is to be found the first short diagnosis of *Carpinus grandis*. It was repeated in 1852 in "*Iconographia Plantarum Fossilium*", together with commentaries and drawings. The exact text of the diagnosis is quoted below, and the pertinent illustration is shown in Fig. 3.

Carpinus grandis Ung.

C. grandis, involucre fructifero trifido, laciniis linearibus obtusis nervosis, lacinia intermedia productiore, nervis in qualibet lacinia tribus subparallellis subaequalibus, rete venoso inter se conjunctis; foliis

petiolatis (?) *subcordatis ovatooblongis acuminatis duplicato-serratis penninervis, nervis simplicibus rectis paralellis.*

Unger. *Gen. et spec. plant. foss.* p. 408.

In schisto calcareo-margaceo ad Radoboium Croatiae ad Trofeiaeh Stiriae.

In his commentaries printed in "*Iconographia*", Unger writes that the lobes of the involucre which he designated by the specific name *Carpinus grandis* have three distinct nerves: the central one and two lateral nerves, running almost parallel, in each lobe. He was struck, however, by the fact that one of the involucre had something resembling a short, roundish fourth lobe, while the other involucre had nothing of the kind. The presence of the above-mentioned fourth lobe, however, did not prevent Unger from including the discovered remains in the genus *Carpinus*; he did, nevertheless, consider the possibility that it could be a different genus, perhaps related to the genus *Carpinus*. As regards the generic determination of the leaves, the author expresses no doubts.

Unger does not state what induced him to confer the specific name *Carpinus grandis* upon the discovered fragments; however, judging by the drawing (Fig. 3), the reason were the dimensions of the involucre, relatively large for the genus *Carpinus*. As a matter of fact, the leaves included by Unger in the same species are small in relation to present-day leaves of the genus *Carpinus*.

It was already in 1851, prior to the publishing of "*Iconographia Plantarum Fossilium*", that Ettingshausen questioned the generic determination of the fruit structures described as *Carpinus macroptera* Brongn. and *Carpinus producta* Unger, as well as of others, described up to that time as involucre of the genus *Carpinus* (see above on p. 9). According to Ettingshausen, all the above-mentioned structures belong to the genus *Engelhardtia*; this was fully confirmed by later investigators.

Unger must have been acquainted with Ettingshausen's opinion, inasmuch as the paper of both these scientists were published in Vienna. However, publishing in 1852 the illustration of his *Carpinus grandis*, Unger disregarded altogether Ettingshausen's critical remarks expressed in 1851. Evidently he considered that, in spite of all, he did have a sufficient basis for regarding the fragments discovered at Radoboj as belonging to the genus *Carpinus*.

Three years after the appearance of Unger's "*Iconographia Plantarum Fossilium*", a fact occurred that was significant for the studies concerning the history of the hornbeam in Europe. In 1855 there appeared the work of H. R. Goepfert: "*Die tertiäre Flora von Schosnitz in Schlesien*", in which the latter proves for the first time the existence of

the fossil genus *Carpinus*, giving a drawing and description of three of its involucre (Fig. 4). Goeppert must have been familiar with Unger's palaeobotanical work from 1852; however, describing his own hornbeams, not by a single word does Goeppert mention *Carpinus grandis* Unger. Evidently he could perceive no resemblance between his own material and the one described by Unger. To the leaves discovered at Sośnica (Schossnitz) he gives three new specific names (*Carpinus ostryoides* G., *C. adscendens* G. and *C. alnifolia* G.), and he describes the

Fig. 4. *Alae fruct. Carp.* Goepp. After Goeppert (1855). Według Goepperta (1855)

involucre as *Alae fruct. Carp.*, stressing their resemblance to present-day involucre of *Carpinus betulus* L. and *Carpinus americana* Mx.

In the following year there was published in Zürich the second volume of O. Heer's "Die tertiäre Flora von Schweiz" (1855—1859), in which the latter already took into account the results of Goeppert's studies. Heer writes in his above-mentioned work that Goeppert was the first to give definite proof of the existence of the genus *Carpinus* in the Tertiary, by finding its involucre at Sośnica.

In Switzerland, no involucre of *Carpinus* were discovered in Tertiary materials, only leaves similar to those of present-day hornbeams; 25 such specimens are depicted by Heer in Tables LXXII and LXXIII (Table I). The smaller ones, in Heer's opinion, were similar to the leaves drawn in 1852 by Unger in his "Iconographia", and consequently Heer retained for his own fossil material the name *Carpinus grandis* Ung., and he says: "Die kleineren Formen stimmen mit den Blättern überein, welche Unger mit grossflügligen Früchten zusammengestellt und *Carpinus grandis* genannt hat. Ich belasse ihnen diesen Namen obwohl er sich eigentlich zunächst auf die Früchte bezieht, welche wohl nicht zu *Carpinus*, sondern zu der Gattung *Engelhardtia* gehören".

Thanks to Heer, the very uncertain species *Carpinus grandis* Ung.

obtained a solid foundation of new material. In consequence, some later palaeobotanists regarded Heer as the real author of the species *Carpinus grandis* and began to parenthesize Unger's name. Ettingshausen went still further and proposed in 1867, in the flora from Bilin, to confer

Fig. 5. *Carpinus grandis* Ung. After Unger (1866). Wedhug Ungera (1866)

the name *Carpinus Heerii* upon the fragments of fossil hornbeams described by Heer; he based his proposition on the fact that the name *grandis* applied to the involucre and not to the leaves. The newly proposed name, however, did not take root in palaeobotanical literature.

In the third part of his "*Sylloge Plantarum Fossilium*", published in 1866, Unger admitted at last that the involucre described and depicted in "*Iconographia Plantarum Fossilium*" belong to the genus *Engelhardtia*, and he conferred on them the specific name *Engelhardtia grandis* Unger, quoting the name *Carpinus grandis* Ung. as its synonym. He retained, however, the name *Carpinus grandis* for two insignificant and indistinctive leaves shown in Table XLIII of "*Iconographia Plantarum Fossilium*" and redrawn in Fig. 3. He also presents in Table XXI (Fig. 5) under the name of *Carpinus grandis* a considerable number of other leaves: from Liesch near Prevela in Carinthia (4—9), from Bilin (10) and from Gossendorf near Gleichenberg in Styria (11 and 12); discovered at the latter locality was also the fragment of an involucre (13) which, according to Unger, resembles more closely the involucre of the present-day *Carpinus americana* Willd. than that of the European *Carpinus betulus*. The above-mentioned table, redrawn in Fig. 5, is rather indistinct, inasmuch as No. 12 and No. 13 each occur twice; nevertheless, for later authors this table became the basis for the determination of *Carpinus grandis* Ung. It is, however, difficult to understand how Unger, who was a good botanist, could maintain that the involucre in Fig. 5 is similar to that of *Carpinus americana* (= *caroliniana* Walt.), since it can be rather associated with the species *Carpinus betulus*. At any rate, comparing Fig. 3 and Fig. 5 (which in relation to the original is reduced 0,7 times), one perceives that many morphological forms can be classed as *Carpinus grandis*.

In his "Geologie der Europäischen Waldbäume", published in 1869, Unger gives a synthesis of his studies on fossil hornbeams. Stubbornly he retains there the names *Carpinus producta* Unger and *Carpinus oblonga* Unger. He is even unwilling to forsake definitely the name *Carpinus macroptera* Brongn. for the involucre which were proven incontestably by Ettingshausen to belong to the genus *Engelhardtia* and to be identical, within the limits of variability, with the structures depicted by Unger in 1852 as *Carpinus grandis* Unger. As regards the latter, i. e. *Carpinus grandis* Ung., Unger maintains that typical of it are the leaves depicted in Fig. 5, states that it occurs "häufig in den Blättern und nur in einem verstümmelten Involucrum erhalten" at Bilin, Wetterau, Prevala, Gossendorf, etc., and he considers it to be a species characteristic of all the strata of the Miocene. In the latter species he also includes the involucre discovered at Swoszowice (1849)

(Fig. 6) which he had, as he writes, incorrectly included in the species *Carpinus macroptera* Brongn.

In the outcome, the type *Carpinus grandis* consists in Unger's works of the following:

1. Two leaves discovered at Radoboj in Croatia, depicted by Unger in his "*Iconographia Plantarum Fossilium*" (Fig. 3).

2. Eleven leaves of various shapes, discovered in Miocene floras in Croatia, Bohemia and Styria, and a strongly damaged involucre of the type *Carpinus betulus* (Fig. 5).

3. An involucre and a small leaf depicted in the flora from Swoszowice (1849) as *Carpinus macroptera* Brongn., and regarded by Unger in his "*Geologie der Europäischen Waldbäume*" (1869) as belonging to the species *Carpinus grandis*, the latter being considered simultaneously as the parent form for the present-day *Carpinus americana* (Fig. 6).

4. Two involucres depicted by Unger in Table 1 of his above-mentioned work, as Nos. 11 and 12 (Fig. 7), the origin of which is not stated. Upon close observation it is perceivable that involucre No. 11 is undoubtedly copied from Goepfert's work on the flora from Sośnica (Fig. 4 A), it being difficult to assume that two identical involucres could have been discovered in various fossil materials. No. 12 seems to be the involucre from Swoszowice, with the missing lobe supplemented (cf. Fig. 6).

It is thus evident that the species *Carpinus grandis* Unger has no classical locality of occurrence, and the specimens that ought to be considered as classical come from various localities, and in some cases are even of unknown origin.

It must be added that both the above-described involucres and the leaves stated by Unger to be typical of the species *Carpinus grandis* Unger are not especially large, and there is nothing to justify the retaining for them of the name *grandis*.

Fig. 6. *Carpinus grandis* Ung. (*Carpinus macroptera* Brong.). From Unger (1849). Według Ungera (1849)

Fig. 7. *Carpinus grandis* Ung. After Unger (1869). Według Ungera (1869)

It is interesting indeed that later palaeobotanists have quoted as typical of *Carpinus grandis* Unger the materials from Sośnica, hitherto the richest find of fossil hornbeams, described by Goeppert as: *Carpinus ostryoidea*, *Carpinus alnifolia*, *Carpinites macrophyllus*, *Betula carpinoides* and *Alae fruct. Carp.*, although Goeppert rightly perceived no resemblance between his own material and the type described and depicted in 1852 by Unger. Furthermore, the involucres and leaves of the genus *Carpinus* from Sośnica are generally regarded as the prototype of *Carpinus betulus*, while Unger considers his *Carpinus grandis* to be the prototype of *Carpinus americana* (= *caroliniana*).

All the foregoing data have been quoted for the purpose of proving that a palaeobotanical type itself is frequently a difficult problem to solve.

FOSSIL INVOLUCRES OF THE GENUS *CARPINUS*

An analysis of the palaeobotanical literature, a small part of which has been discussed above, inclines one to assume a sceptical attitude towards the results of studies concerning the fossil fragments of hornbeams, and, on such a background, the possibility of deciphering the history of hornbeams in Europe appears to be quite hopeless. The outlook, however, is not altogether bad. Such a conclusion was arrived at by Berger in his paper on the taxonomy and history of the genus *Carpinus* (1953, 1), in which he undertook an attempt to eliminate uncertain materials and to base the investigations on the involucres. He did not manage, however, to keep strictly to the line laid down by himself, inasmuch as he attached too much importance to some of the specific palaeobotanical names, and he included in his considerations some data based not upon involucres but on fossil fruits, to which it is not possible to apply the same criteria. In order to avoid this, the author decided to break away completely from the specific palaeobotanical names, and to take into consideration only such works in which the description is supplemented by a figure, i. e. an accurate drawing or photograph, of the given invulcre. The author did not take into account at all any work in which the description was not supplemented by a drawing or photograph.

Berger arranged his material taxonomically, dividing both present-day and fossil involucres according to their morphology. The present author has arranged her material geographically. All the drawings of fossil involucres included in the present paper have been copied from the original sources with the exception of the involucres from Mont-Dore (Fig. 17, A) and the ones from eastern Asia (Fig. 21),

which have been taken from Berger (1953, 1). In American literature the author has found only short mentions as to the occurrence of the genus *Carpinus* or the species *Carpinus grandis* in fossil floras, but nowhere could she find an illustration of an involucre. The material collected together in Figs. 8, 15 and 17 is perhaps incomplete and the author may have omitted some position from literature, nevertheless the picture thus obtained is characteristic and permits one to draw certain conclusions.

1. Involucres from the Oligocene and Miocene

The author shall first discuss the involucres shown in Fig. 8. The materials collected there are so arranged that in the upper and middle part of the figure we have drawings of involucres which are similar to the present-day species *Carpinus betulus* or resemble it morphologically. At the bottom of the figure we have involucres which decidedly belong to other species.

In the first row of Fig. 8 there are six involucres that have been described from the Upper Oligocene and they are, therefore, the oldest hornbeam involucres discovered hitherto in Europe. In a similar manner, i. e. chronologically, the author wished to arrange the whole material. It proved, however, to be impossible on account of the differences in opinion as to the age of some fossil floras, and the author did not feel herself competent to decide the matter. Consequently, the author laid stress mainly on a different arrangement, one in which materials obtained from the same localities were put side by side and designated with the same letters. For instance, the first three involucres in Fig. 8 belong to two different morphological types, separated from one another by means of a vertical line. They were obtained, however, from the same fossil flora from Kreuzau on the Rhine, and for this reason all three of them are designated with the letter A. It is the same with the involucres from Sośnica in Silesia, designated with the letter E, the ones from Kokoszyce in Silesia, marked with the letter L. etc.

By means of the same letters used for designating the involucres in Fig. 8, are marked in Fig. 20 the localities from which the given involucres were obtained. This makes orientation easier and links up Fig. 8 with the map in Fig. 20.

Below the author gives a list of the publications from which the drawings of the above-mentioned involucres were taken, and also the names under which they have been described; the latter are also designated with the same letters. In such a manner Fig. 8, the map in Fig. 20, and the list of names supplement each other:

All the involucres in Fig. 8 have been copied from the original

Fig. 8. Involucres of *Carpinus* from the Oligocene and Miocene in Europe, Details on page 21.

Okrywy owocowe rodzaju *Carpinus* z europejskiego oligocenu i miocenu. Szczegóły na str. 21.

works. Some of them have been redrawn from photographs, sometimes not altogether distinct and difficult to copy, as for instance involucre L_1 . In order, therefore, to supplement them, the author gives in Table II the reproductions of the pertinent photographs (A, B, C, D, G) and of photographs of some more involucres from the Oligocene and Pliocene (E, F, H, I).

Involucres from Oligocene and from Miocene in Europe (Fig. 8)

- $A_1 - A_2$ *Carpinus huziokai* Berger. Kreuzau near Düren, Berger W. "Eine neue *Carpinus*-Art aus dem Oberoligozän des Rheinlandes". Botan. Notis. H. 3. Lund 1953, 343, f. 1 AB.
- A_3 *Carpinus* cf. *betulus* Berger, ibidem f. 1 C.
- $B_1 - B_2$ *Carpinus grandis* Unger. Zschipkau. Menzel P. "Über die Flora der Senftenberger Braunkohlen-Ablagerungen". König. Preuss. Geol. Landesanst. N. F. 46, Berlin 1906. T. I. f. 13 b, T. VIII, f. 10.
- C *Carpinus grandis* Unger. Rauno near Senftenberg. Kirchheimer F. "Grundzüge einer Pflanzenkunde der deutschen Braunkohlen". Halle a. d. S. 1937, 53, f. 50 b.
- D *Carpinus macroptera* Brongniart. Swoszowice Unger F. "Blätterabdrücke aus dem Schwefelflötze von Swoszowice in Galizien. Heidingers Naturw. Abhandl. Bd. 3, Abt. 1. Wien 1849. T. XIII, f. 8.
- $E_1 - E_3$ *Alae fruct. Carp.* Goeppert. Sośnica. Goeppert. H. R.: „Die Tertiäre Flora von Schossnitz in Schlesien“, Görlitz 1855. T. V. f. 4—6.
Carpinus grandis Unger. Gleichenberg. Unger F. "Sylloge Plantarum Fossilium" *Pugillus tertius*. Denkschr. Mat.-Naturw. Cl. Kaiser. Akad. Wiss. Bd. XXV. Wien 1866, T. XXI. f. 13.
- G *Carpinus grandis* Unger. Himmelsberg near Fulda. Engelhardt H. "Über Tertiärpflanzen vom Himmelsberg bei Fulda" Abh. d. Senckenb. Naturf. Gesell. B. 20, H. 3. Frankfurt a M. 1902. T. II. f. 37.
- H *Carpinus Heerii*. Ettingsh. Moskenberg. Ettingshausen C. "Die fossile Flora von Leoben in Steiermark". Denkschr. Kaiser. Akad. d. Wissensch. Mat.-Natur. Cl. Bd. 54. Wien 1888. T. III. f. 9.
- I *Carpinus pyramidalis* Gaud. Montaione. Gaudin C.T. & Strozzi C. "Memoires sur quelques gisements de feuilles fossiles de la Toscane". Denkschr. allg. Schweiz. Ges. f. ges. Naturw. Zürich, 1858. T. V. f. 5.
- $J_1 - J_2$ *Carpinus pyramidalis* Gaud. Gabbro. Livorno. Berger W. "Eine neue *Carpinus*-Art. aus dem Oberoligozän des Rheinlandes". Bot. Notis. H. 3. Lund 1953. fig. 1. D, E.
- K *Carpinus vera* Andrae Thalheim. Andrae K. J. "Fossile Flora Siebenbürgens und des Banates. I. Tertiär-Flora von Szakadat und Thalheim in Siebenbürgen". Abhandl. d. Geolog. Reichsanst. B. 2. Wien 1855. T. I. f. 7.
- L_1 *Carpinus* sp. *Carpinus Neilreichii* Kovats. Kokoszyce near Rybnik Steger V. "Die schwefelführenden Schichten von Kokoschütz" Ratibor 1883. p. 15, Reimann H. in Kräusels "Pflanzen des schlesischen Tertiärs". Jahrb. K. Preuss. Geol. Landesanst. Bd. XXXVIII. Berlin 1920. T. 3. f. 3.

- L₂ *Carpinus* sp. (*Carpinus grandis* Ung.) Kokoszyce near Rybnik Steger V Ibidem p. 14, Reimann H. ibidem T. 9, f. 2.
- M₁ — M₂ *Carpinus* aff. *betulus* L. Zalesce/ Wiśniowiec. Czeczottowa H. "The Middle-miocene flora of Zalesce near Wiśniowiec (Volhynia)". Acta Geol. Polon. Warszawa 1951. T. III. f. 13 a b.
- N₁ *Carpinus grandis* Ung. Kövágó-oldal (Erdöbénye) Cziffery-Szilágyi G. in Andreánszky G. & Kovács-Sonkodi E. "Gliederung und Ökologie der jüngeren Tertiärfloren Ungarns". Ann. Inst. Geol. Publ. Hung. XLIV, F. 1. Budapest 1955. T. VII. 24.
- N₂ *Carpinus producta* Unger. Erdöbénye. Kovats J. "Fossile Flora von Erdöbénye". Arb. Geol. Ges. Ungarn. B. I. Budapest 1856. T. IV. f. 5.
- N₃ — N₅ *Carpinus Neilreichii* Kovats. ibidem T. IV. f. 1—3.
- O *Carpinus Unger* (Ettinghausen) Saporta. Manosque ibidem f. 78, 4.
- P₁ — P₂ *Carpinus cuspidata* Saporta. St. Zacharie. Saporta G. "Die Pflanzenwelt vor dem Erscheinen des Menschen". Übersetzt v. C. Vogt. Braunschweig 1881. f. 66, 4—5.
- R *Carpinus Neilreichii* Kovats. Berand. Engelhardt H. "Die Tertiärfloren von Berand im Böhmischem Mittelgebirge". Abh. nat.-medic. Verein. "Lotos" B. I. Prag 1898. T. IX, f. 13.

The hornbeam involucre shown in Fig. 8 can be divided into four morphological types:

1. Type *Carpinus betulus*. Included here are 17 involucre shown in the middle and upper right part of Fig. 8. All of them, with the exception of involucre G, have a relatively narrow and long central lobe, slightly widened at its base, and considerably shorter lateral lobes which are of unequal width. Involucre G is strongly damaged, and the author included it in type *Carpinus betulus* chiefly on account of the relatively large dimensions of the nut. In involucre F, L₂ and M₁ — M₂, the narrowness alone of the central lobe is sufficiently conclusive to include them in type *Carpinus betulus*.

Highly characteristic is what the authors themselves write on the subject of the involucre shown in Fig. 8. In connection therewith, several quotations are given below.

Goepfert, the discoverer of the involucre of fossil hornbeams, in his description of the Tertiary Flora from Sośnica, writes as follows on the subject of *Alae fruct. Carp.* which were found there (1855 p. 19): "Sehr häufig sind die Fruchthüllen von *Carpinus*-Arten, die vielleicht drei verschiedenen Arten, gewiss wenigstens zweien angehören. Die einen Art, Tab. V, Fig. 4 u. 6 (see Figs. 4, A, B and 8, E₂ — E₃, sind 3 teilig, der mittlere Lappen vorgezogen, noch einmal, ja wohl anderthalbmal so lang als die seitlichen, an der Basis in etwas spitzem Winkel abstehenden Lappen, alle mit einem Mittelnerven versehen, von welchem rechtwinklig seitliche, bald ein Nervenetz bildende Nerven abgehen. Zuweilen sind alle fast ganzrandig, Fig 6 (Fig. 4, B), und nur

hie und da finden wir an dem mittleren Lappen einen Zahn, worauf aber keine Artverschiedenheit gegründet werden kann, da auch die Hülle des jetztweltlichen, unser fossilen sehr ähnlichen *Carpinus*, sich ganz gleich verhält, d. h. der mittlere Lappen bald zahnlos, bald gezähnt erscheint. Fig. 4 (Fig. 4, A) ist eine mehrgezähnte Form. Verschieden ist jedoch eine zweite, viel seltenere Fig. 5 (Figs. 4, C and 8 E₁), ähnlich der Cupula von *Carpinus americana* Mx., deren mittlerer Lappen an der Basis mit 2 seitlichen Lappen versehen ist, die an Grösse fast den oberen erreichen“.

It is very characteristic that Goepfert, who described the leaves found at Sośnica as those of three different species of hornbeam, conferring upon them new names (see p. 14) and perceiving in them only a similarity to present-day species, does not attempt to give any „fossil name“ to the above-mentioned involucre, but identifies them directly with present-day species. He only bestows the name *Carpinus involvens* on an alleged third species which, as ascertained later, has nothing in common with the hornbeam (Kräusel 1921, p. 395).

Karl Andrae (1855), describing a hornbeam involucre discovered in the Upper Miocene of southern Transylvania (Fig. 8 K), gives it the name *Carpinus vera* and writes that it is completely similar not so much to *Carpinus betulus* as to *Carpinus intermedia* Wierzb., which grows

at present in Banat and Transylvania, and which, as the latter author points out, is perhaps only a form of *Carpinus betulus*. In Table I he gives a drawing of the involucre of *Carpinus vera* and, side by side, an involucre of the above-mentioned *Carpinus intermedia* Wierzb.; the character of both is indeed completely similar (Fig. 9). Andrae conferred the name *Carpinus vera* on the Transylvanian involucre on account of the fact that in his opinion it is certainly not an *Engelhardtia*, but a “true” *Carpinus*. It must be added that Winkler in his monograph (1904) recognized *Carpinus intermedia* Wierzb. neither as a separate species, nor even as a form, and he quotes the latter name as a synonym of *Carpinus betulus*.

Fig. 9. A — *Carpinus vera* Andrae; B — Present-day involucre of *Carpinus intermedia* Wierzb. After Andrae (1855)

A — *Carpinus vera* Andrae; B — Współczesna okrywa owocowa *Carpinus intermedia* Wierzb. Według Andrae'ego (1855)

Andrae's work on the Miocene flora in the vicinity of Thalheim in Transylvania appeared in the same year as Goeppert's work on the flora from Sośnica; Andrae, therefore, beside Goeppert, is the second discoverer of indisputable fossil fragments of the genus *Carpinus* in Europe.

H. Czechottowa, elaborating the Middle-Miocene flora from Zalesce near Wiśniowiec (1951), gave the name *Carpinus aff. betulus* L. to the fruits and fragments of an involucre found at that locality (Fig. 8, M₁ — M₂), thus stressing their unquestionable relationship to the present-day species *Carpinus betulus*. Equally rational was the procedure adopted by W. Berger (1953, 3), who gave the name *Carpinus cf. betulus* to an Upper-Oligocene involucre that he had found in the Geological Institute of the Köln University, in materials collected at Kreuzau on the Rhine, although he considered it not altogether typical, manifesting as it does in its shape a certain tendency towards *Carpinus caroliniana* (Fig. 8, A₃).

The foregoing data have been selected from literature as a proof that palaeobotanists, who seldom identify fossil leaves of the genus *Carpinus* with present-day species, have no doubt as to the similarity between fossil involucre and present-day ones.

From among the Upper-Oligocene and Miocene involucre shown in Fig 8, the greatest doubts are evoked by involucre N₂ from the flora from Erdöbénye in Hungary, described in 1856 by Kováts under the name of *Carpinus producta* Unger (cf. Fig. 1). Ettingshausen, in 1851, brought into question the determination as *Carpinus* of all the trilobate fruit structures described thus up to that time by Unger and other authors, and he argues that they belong to the genus *Engelhardtia*. Kováts seems to have been familiar with Ettingshausen's foregoing opinion, inasmuch as he writes: „Die hier abgebildete Frucht, die einzige, die ich bisher in Erdöbénye fand, ziehe ich ohne Bedenken zur obengenannten Species Ungers, und halte sie, nachdem ich selbe mit Früchten der Gattung *Engelhardtia* sorgfältig verglichen habe, für eine echte *Carpinus*-Art“. The trilobate structure found by Kováts does indeed manifest some similarity to Unger's *Carpinus producta* (compare Fig. 1) on account of its narrow and strongly elongated lobes; however, its lobes do not widen in their upper part, as is characteristic of *Engelhardtia* (Reimann drew attention to the latter feature in 1920). Furthermore, its nervature bears a much stronger resemblance to *Carpinus betulus* than it does to the genus *Engelhardtia*. For these reasons the author has placed it among the Miocene involucre of the genus *Carpinus*. Berger was evidently of the same opinion, including as he did the above-mentioned fragment in the fossil species *Carpinus pyramidalis*

which, according to him, belongs to the group of fossil forms of *Carpinus betulus*.

It must be added that G. Cziffery-Szilágyi elaborated a new find of Sarmatian flora at Erdőbénye, one and a half kilometres from the classical locality of Kováts (Andreánszky 1955, p. 161), and she

Fig. 10. Involucres of present-day *Carpinus betulus*. After Berger (1953, 1)
Okrywy owocowe współczesnego *Carpinus betulus*. Według Bergera (1953, 1)

found there numerous tripartite involucre bracts which she described under the name of *Carpinus grandis* Ung. and gave a photograph of one of them (Fig. 8, N₁; Table II). She did not, however, find any fragments of the genus *Engelhardtia*.

As regards the scale of variability of the involucre bracts of the type

Carpinus betulus shown in Fig. 8, it is relatively small if we consider the fact that these involucre come from 12 localities and from a long period of time, and that they are also deformed both by fossilization and as the result of not being always drawn altogether true to nature. As

Fig. 11. Involucre from one tree of *Carpinus betulus*. (Original)
Okrywy owocowe *Carpinus betulus* z jednego drzewa. (Oryginalne)

proof thereof is Fig. 10, copied from Berger (1953, 1). This figure does not illustrate the whole scale of variability of the present-day species *Carpinus betulus*, nor does it give an idea of the frequency of occurrence of forms deviating from the type; it rather gives a general conception only. However, it does inform us sufficiently that the variability of

involucres of the present-day *Carpinus betulus* is by no means smaller than the variability of its prototype of millions of years ago.

Fig. 10 is supplemented by Fig. 11 in which are also shown 12 involucres of *Carpinus betulus*, but in the latter case all are from the same tree. This gives us, in contrast with Fig. 10, a picture of the variability of a single individual. Neither does Fig. 11 show the whole scale of variability in the involucres of a given individual; the involucres

Fig. 12. Involucres from one tree of *Carpinus betulus* (Original)
Okrywy owocowe pochodzące z jednego okazu *Carpinus betulus* (Oryginalne)

are the first twelve taken from a large sample, they were desiccated and twisted, and their real shape was revealed only after they had been soaked and then straightened out between sheets of blotting-paper. In spite of the completely haphazard sampling and the small number of specimens, we perceive large morphological differences between the respective variants. They exist in the degree of elongation of the central lobe, in its shape, ending and curvature, in the nervature, in the disposition of the lateral lobes, in their length, etc. If the sample were composed of more specimens, it would surely contain still more extreme variants.

There is still one difference more between Fig. 10 and Fig. 11. Most of the involucres in Fig. 10 have lobes with dentate margins, while all of

the involucre in Fig. 11 have entire margins. The author draws attention to this fact because Berger states in his "Taxonomy and History of the Genus *Carpinus*" (1953, 1) that involucre of *Carpinus betulus* with entire margins are rare in the present-day flora. As a matter of fact, in Poland one does encounter involucre with entire margins just as frequently as ones with dentate margins. The dentate margin in involucre is a character that undergoes changes even within a single individual (Figs. 12 and 22). The author shall return to this matter in the „General remarks" (page 44).

On the basis of Figs. 10, 11, and 12 the variability of fossil involucre of the type *Carpinus betulus* in Fig. 8 seems to be small. All these

Fig. 13. A₁—A₅ — *Carpinus caroliniana* Walt. from five localities (z 5 miejscowości); B — *Carpinus tropicalis* D. (Sm) Lund.; C₁—C₃ — *Carpinus laxiflora* S & Z. Bl.; D — *Carpinus macrostachya* (Oliv.) Koidz.; E₁—E₂ — *Carpinus viminea* Walt.; F — *Carpinus kweichowensis* Hu. After Berger (1953 a). Według Bergera (1953a)

involucre, if they were found nowadays alive, would be considered without any hesitation as belonging to the species *Carpinus betulus*.

2. In the upper left-hand part of Fig. 8 there are four involucre which, according to Berger's taxonomic classification, should be included in the group *Carpinus caroliniana* (*C. americana*). The first two (A₁—A₂) were found by Berger in the above-mentioned materials from Kreuzau on the Rhine. In his second paper published in 1953 and devoted to the subject of hornbeams, he writes with regard to the above-mentioned involucre: "Rezente Vergleichsart: *Carpinus caroliniana* (völlige Übereinstimmung)". Evidently he did not find in them any

resemblance to the involucre of certain Oriental species which he also includes in the group *Carpinus caroliniana* (see Fig. 13, B—F). However, it is indeed unfortunate that Berger gave to the two above-mentioned involucre the name *Carpinus husiokii*, instead of calling them simply *Carpinus* cf. *caroliniana* or *C. caroliniana* aff., analogically to the simultaneously discovered *Carpinus* cf. *betulus*. The name *Carpinus husiokii*, regardless of the reader's wish, directs his mind to the Far East, and thus does not facilitate his groping in the maze of palaeobotanical names.

Below involucre A_1 and A_2 the author placed involucre D, found by Unger at Swoszowice and involucre E_1 , discovered by Goepfert at Sośnica (see p. 16 and Figs. 6 and 4C). Both of the above-mentioned authors considered that the discovered fragments belong to the protoplasts of *Carpinus americana* (= *caroliniana*).

Involucre of the type *Carpinus caroliniana* shown in Fig. 8 do not form such an uniform morphological group as do the involucre of *Carpinus betulus*. Involucre D, found by Unger at Swoszowice, is striking on account of the absence of sharp dentation and that is the reason why Berger included it conditionally in the fossil species *Carpinus pyramidalis* (see p. 44). Not having seen Unger's original specimen, the author is unable to say whether the entire margins can be caused here by inaccuracy of the drawing or by damaging of the specimen. Involucre E_1 was provisionally included by Berger in the type *Carpinus macrocarpa*. Berger writes on page 20 (1953, 1): „Mit den hierher gezogenen Formen hat ein von Goepfert abgebildeter, offenbar unvollständig erhaltener Fruchtbecher eine gewisse Ähnlichkeit. Es kann sich dabei allerdings ebensogut auch um ein Fragment eines abnorm geformten Fruchtbeckers aus der Formengruppe der *Carpinus betulus* handeln". On the other hand, even in such a scanty comparative material of *C. caroliniana* as that shown in Fig. 13 and of *C. betulus* shown in Fig. 14 it is possible to detect analogical forms, such as involucre A_2 and E_1 . The position and role of the type *Carpinus caroliniana* in the European Oligocene and Miocene remain therefore highly doubtful. This subject shall be resumed towards the end of the present chapter.

Below the involucre described above, we have in Fig. 8, H an involucre found by Ettingshausen at Leoben in Styria. Ettingshausen described it under the name of *Carpinus Heerii* Ettingsh., considering the latter name to be more appropriate for materials described hitherto as *Carpinus grandis* Ung. (cf. p. 16). Of this involucre Ettingshausen writes: "Die Fruchthülle Fig. 8 und die Frucht Fig. 7 passen gut zu den aus anderen Lagerstätten der Tertiärformation vorliegenden Fruchtresten dieser Art". As regards the above-mentioned involucre, the

author is impressed by the relatively great width of the lower part of the central lobe and by its acute termination; this suggests that the latter involucre, if it were not damaged, would perhaps be similar to the type shown above it. For this reason it has been placed in a separate field, the author not being able to decide whether it ought to be included in the group *Carpinus betulus*, or in the group *Carpinus caroliniana*.

3. In the lower part of Fig. 8 are shown seven involucre of another morphological type (N_3 —R). According to various authors, these

Fig. 14. Seven involucre of *Carpinus betulus* found among 252 involucre collected from 84 trees in one forest (see page 45 and Figs. 22 and 23). Original
Siedem okryw owocowych *Carpinus betulus* znalezionych między 252 okrywami zebranymi z 84 drzew w jednym lesie (patrz str. 45 oraz ryc. 22 i 23). Oryginalne

involucre are altogether similar to the present-day species *Carpinus orientalis*, which now grows in South-Eastern Europe and in Asia Minor.

Kováts, elaborating in 1856 the Miocene flora from Erdöbénye in Hungary, found there, apart from *Carpinus producta* Unger (discussed above), three involucre which he named *Carpinus Neilreichii* Kov. (Fig. 8, N_3 — N_5). Of the latter he writes on page 24: "Diese ausgezeichnete Frucht ist wohl ohne allem Zweifel eine echte *Carpinus*, und mit der im südlichen Europa, auch Ungarn, Krain, Istrien u. s. w. wachsenden *Carpinus duinensis* Scop. (*C. orientalis* Lam.) sehr nahe verwandt, wie aus der beigegebenen Zeichnung Taf. IV Fig. a deutlich zu ersehen ist". In the above-mentioned table Kováts shows, as Fig. a, an involucre of

the present-day *Carpinus orientalis*, indeed deceptively similar to those mentioned above.

To an Oligocene involucre discovered at Berand in Czechoslovakia. Engelhardt (1898) also gave the name *Carpinus Neilreichii* (Fig. 8, R) thus noting its identity with those described above.

Saporta described some involucre, found in the Miocene of southern France, under the name of *Carpinus cuspidata* (Fig. 8, P₁ — P₂). Later authors have identified this species with *Carpinus orientalis* (Nagel, 1916). To a small involucre, also from the Miocene of southern France, Saporta gave the separate specific name of *Carpinus Ungerii*. Schenk, however, in „Palaeophytologia“, identified it with *Carpinus duinensis* Scop., and Berger also included it in the group *Carpinus orientalis* (Fig. 8, O).

All the above-mentioned authors are of one accord in recognizing the latter seven involucre as belonging to protoplasts of the present-day *Carpinus orientalis* Lam.

4. In Fig. 8 there is one involucre more, which the author could not include in any of the above-mentioned groups. This is involucre L₁, discovered in 1883 in Poland, at Kokoszyce in Silesia. Steger found there, in the Lower Miocene, two involucre which he described under the name of *Carpinus* sp. One of them (L₂) must be included in the group *Carpinus betulus*; the above-mentioned author himself identifies it with the involucre drawn by Goepfert in the flora from Sośnica. As regards the other involucre, Steger writes as follows: „*Carpinus* sp. Fruchthülle. Sie ist nicht, wie gewöhnlich dreiteilig, sondern nur einlappig, oval. Durch diesen einen Lappen geht ein kräftiger und mehrere schwächere Hauptnerven, welche eine grosse Anzahl von sekundären durchgehenden Nerven entsenden. Der rechte Rand ist stumpf gezähnt. Es sind im ganzen drei Zähne vorhanden von denen die zwei unteren Zähne Hauptnerven, der oberste einen Sekundärnerven empfängt”.

Steger gives no picture of the above-mentioned involucre. However, in Reimann's work (1920) there is a photograph of the two involucre found by Steger at Kokoszyce (Table IIG). These photographs, unfortunately, are not sufficiently distinct to be redrawn in all details. Particularly the determination of the left-hand side of involucre L₁, is shown very faintly.

As a matter of fact, Reimann's description does not conform in its details to Steger's description. Steger describes that his involucre from Kokoszyce has obtuse teeth on the right-hand side, while the involucre photographed in Reimann's work appears to be dentated on the left. Reimann describes it as follows: „Die Seitenlappen sind hier

nicht entwickelt, im übrigen ist die Hülle asymmetrisch, die rechte Seite schmal mit ungeteiltem Rande. Ausser dem Hauptnerven gehen von der Basis 4 weitere kräftige Nerven aus, 3 auf linken, 1 auf der rechten Seite. Diese sowie die vom Primärnerv ausgehenden Sekundärnerven verästeln sich, die Äste verbinden sich z. T. untereinander, z. T. laufen sie in die Randzähne aus“.

In spite of the differences in the description, it is difficult to suppose that it is a matter of two different involucres. The fact is that Reimann, giving the photograph of the specimen, writes distinctly that the specimen is Steger's. Moreover, the other involucre, found by Steger and photographed by Reimann, corresponds to the original description (Fig. 8 L₂).

Reimann did not know how to classify the above-mentioned involucre because, in his opinion, there are no present-day horbeams with that kind of involucres. To him it seemed to be most similar to the species *Carpinus orientalis*, although, in comparison to the latter species, its dentation was too shallow, and for this reason he included it in the fossil species *Carpinus Neilreichii*. Such involucres do exist, however, in Asiatic hornbeams included by Berger in the group *Carpinus Tschonoskii* (Fig. 19). The details of this matter are going to be discussed in the description of Pliocene materials.

Summarizing what has been discussed above, it must be stated that among the 30 involucres shown in Fig. 8 there are 17 of the type *Carpinus betulus*, 4 approximate to the type *Carpinus caroliniana*, one involucre of an uncertain character (H) but belonging to one of the two latter groups, 7 involucres of the type *Carpinus orientalis*, and one of the type *Carpinus Tschonoskii*. If we express this in percentages, 57—60% of the involucres belong to the type *Carpinus betulus* (the exact percentage depending on the classification of the involucres H from Leoben), 13—17% belong to the type *Carpinus caroliniana*, 23% to the type *Carpinus orientalis*, and 3 to the type *Carpinus Tschonoskii* *.

Fig. 8 is supplemented by Fig. 15 in which the author has grouped together 27 involucres, more or less damaged, from the Upper Miocene at Sośnica in Silesia, the richest find of involucres of

* My paper was already in print when I received two reprints of P. Grangeons papers on the fossil Floras of the South of France. In the first (1951) the author gives a picture of an involucre of *Carpinus betulus* L. from the Upper Pliocene of Crosas (near the town Le Puy). In the second (1953) the author depicts 3 involucres of *Carpinus orientalis* Lam. (among the six he found) from the Upper Miocene in Gourgouras (Ardèche). Grangeon has no doubt that these involucres belong to the species mentioned above. This does not change the general picture of the occurrence of these species in the past (see Fig. 8), it only raises the percentage of *Carpinus orientalis* found in the Miocene in Europe, which even so is only provisory.

fossil hornbeams in Europe. The first four involucres are copied from Reimann's work (1920, p. 60). The following two represent the classical involucres described in 1855 by Goepfert (see Fig. 4). They are not,

Fig. 15. Involucres of *Carpinus* from Sośnica. The first six are copied from Reimann (1920) the next one from Goepfert (1855), the remaining ones are depicted from of the original specimens from Sośnica

Okrywy owocowe *Carpinus*. Sześć pierwszych odrysowano z pracy Raimanna (1920), następną z rozprawy Goepperta (1855), pozostałe odrysowano z oryginalnych okazów muzealnych z Sośnicy

however, redrawn from Goepfert's paper, but from the photographs of these specimens given by Reimann in Table 3 as Nos. 4 and 18. Copies of these photographs are given in Table II of the present paper. The author has done so on purpose to demonstrate the difference between the original

drawing and a photograph of the given specimens. Numerous details shown by Goeppert cannot be detected in the photograph. This applies particularly to the dentation and the nervature. This does not mean that Goeppert drew more than he saw; it means that either the picture became partly obliterated during photographic reproduction, or else in the course of years the specimens have become damaged. Especially the author did not succeed in detecting the abundant dentation shown by Goeppert in the specimen marked No. 4 in his original Table V (in the present paper it is No. 5 in Fig. 15):

Specimen No. 7 in Fig. 15 is Goeppert's original specimen, marked No. 6 in his Table V. (Fig. 4, B). Specimens Nos. 8—20 are copied from Goeppert's original specimens or from specimens determined by Kräusel, Meyer and Reimann as *Carpinus grandis* Ung.; at present they are in the museum of the Department of Palaeobotany in the University of Wrocław (Breslau). Specimens Nos. 21—27 were found at Sośnica after second World War by Polish palaeobotanists; some of them are preserved in Wrocław, others in Warsaw (Muzeum Ziemi) and Cracow (Institute of Botany of the Polish Academy of Sciences). Goeppert's classical specimens (Fig. 4) could not be found in Wrocław after the war. All the drawings were made with great care, with the assistance of big enlargements, special attention being devoted to the margins of the involucre.

In contrast with Fig. 8, in which are grouped involucre from the greatest possible number of localities and from a long period of time (from the Upper Oligocene up to the end of the Miocene), Fig. 15 shows a collection of involucre from a single locality and from a relatively short period of time, giving thus a picture of local variability in the Upper Miocene. A comparison of Figs. 8 and 15 allows one to draw interesting conclusions.

First, it must be stated that the variability of the involucre in Fig. 15 is by no means smaller than the variability of involucre of an analogical type in Fig. 8; however, of the 27 involucre, only one (No. 6) resembles distinctly the type *Carpinus caroliniana*, while involucre No. 12 has but an approximately similar character. Involucre No. 17 is damaged; its compression was not in one plane and that is the reason why it has a twisted shape in the picture. The percental participation of the type bearing a resemblance to *Carpinus caroliniana* was, therefore, small at Sośnica, amounting to some 4—6%. This agrees with Goeppert's description; he stated that this type is rare.

Secondly, attention is drawn to the fact that Goeppert's classical drawings do indeed show three involucre with strongly dentate margins

and that this suggested that the Miocene hornbeams from Sośnica were characterized by dentate involucres, but an analysis of a more abundant material from Sośnica demonstrates that involucres with dentate margins form there a distinct minority. Most of the involucres had entire margins. This goes to show that a few drawings taken from a few authors are not a sufficient basis for judging the character of plants in a given flora. Among the involucres in Fig. 15 there are great differences both as to shape and as to dimensions, however, with the exception of the two mentioned above, there is not a single one of them that cannot be included in the present-day species *Carpinus betulus*.

In Goeppert's publication from 1855 in the Table V there is one picture more of a compression named "*fructus Carpinii*". It resembles a fructiferous hornbeam-shoot (Fig. 16, A). As the involucres of this

Fig. 16. A — „*Fructus Carpinii*“ — After Goeppert (1855). B₁—B₂ — involucre of present-day *Carpinus betulus*. Original

A — „*Fructus Carpinii*“. Według Goepperta (1855). B₁—B₂ — okrywa owocowa współczesnego *Carpinus betulus*. Oryginalna

compression seemed to be one-lobed. Goeppert was not sure of their specific appurtenance. Berger (1953, 1) suggested that this was a *Carpinus* from the group *Tschonoskii* similar to the *Carpinus Zabuschii* Berger from Wien-Laaerberg (Fig. 17, I). I am of the different opinion on account of the regular form of the fruit-lobes in Fig. 16 A. It seems to be more probable that it was a *Carpinus* cf. *betulus* of such type as the involucre B in Fig. 16. which is not rare among present-day involucres of our hornbeam or a normal involucre of this species with damaged lateral lobes.

No involucres of a different type have been discovered so far in Sośnica.

Fig. 17. Involucres of *Carpinus* from the Pliocene in Europe: A₁—A₃ — and D₁ — type *orientalis*; A₄ — E₅ — type *betulus*; F₁ — J — type *Tschonoskii*. Details on page 37

Okrywy owocowe *Carpinus* z pliocenu w Europie: A₁—A₃ i D₁ — typ *orientalis*; A₄—E₅ — typ *betulus*; E₁—J — typ *Tschonoskii*. Szczegóły na str. 37

2. Involucres from the Pliocene

Let us now proceed to a discussion of the Pliocene hornbeams, the involucres of which are grouped in Fig. 17. The latter figure is of a slightly different character than Fig. 8 which represents hornbeams from the Oligocene and Miocene. As a matter of fact, the 30 involucres shown in Fig. 8 came from 17 localities, while the 30 involucres in Fig. 17 come from but four localities: five from France, one from Rumania, one from Germany, and the remaining 20 from Austria. Of the latter, three have been described by Berger from Brunn-Vösendorf near Vienna, and 17 by the same author from Vien-Laaerberg. We cannot, therefore, compare the percental participation of the morphological types in Fig. 8 with the percental participation of the appropriate types in Fig. 17. The names under which the above-mentioned involucres have been described, the localities from which they come, and the pertinent literature are given below. Analogically as in respect to Fig. 8, involucres coming from the same localities are designated by the same letters in Fig. 17, in the list, and on the map in Fig. 20. The only departure from the accepted plan is that the involucres found by Berger at Vien-Laaerberg have been designated here not by one letter, but by the letters E—J. This has been done in order to make more conspicuous the species newly described by Berger. Fig. 17 is supplemented by involucres H and I in Table II.

Involucres of *Carpinus* from the Pliocene in Europe (Fig. 17)

- A₁—A₃ *Carpinus orientalis* Lam. — Varennes (Mt. Dore). Boulay A. "Flore pliocene du Mont-Dore" Paris 1892. T. 3. f. 5—7.
- A₄—A₅ *Carpinus betulus* L. ibidem f. 2—4.
- B *Carpinus grandis* Ung. — Borsec. Pop E. "Flora pliocenica dela Borsec" (East Carpathians) Univ. Ferd. Nr 1.1936, T. XII, f. 9.
- C *Carpinus betulus* L. fossilis. — Reuver. Laurent L. et Marty P. "Flore foliaire pliocene des Argiles de Reuver", Pl. X, f. 3.
- D₁ *Carpinus praejaponica* Berger — Brunn-Vösendorf b. Wien. Berger W. "Die altpliozäne Flora der Congerienschichten von Brunn-Vösendorf". Palaeontographica 92 B, Stuttgart 1952, Abb. 28.
- D₂—D₄ *Carpinus grandis* Unger, ibidem, Beil. I. f. 26, 27 and 97 B, 1955, f. 1.
- E₁—E₅ *Carpinus pyramidalis* Gaud — Wien-Laaerberg. Berger W. "Die altpliozäne Flora des Laaerberges in Wien". Palaeontographica 97 B, Stuttgart 1955, Abb. 37—41.
- F₁—F₃ *Carpinus vindobonensis* Berger. Wien-Laaerberg. Berger W. "Studien zur Systematik und Geschichte der Gattung *Carpinus*" Bot. Not. Lund 1953, 1, Abb. 11 D—F.
- G₁—G₇ *Carpinus kisseri* Berger, ibidem, Abb. 11 G—M.
- H *Carpinus polzeri* Berger, ibidem, Abb. 11 Q.
- I₁—I₂ *Carpinus zabuschi* Berger, ibidem, Abb. 11 N, O.
- J *Carpinus knolli* Berger, ibidem, Abb. 11 P.

In the upper part of Fig. 17 are shown four small involucre, distinctly differing from the following ones. The first three, marked A_1 — A_3 , were found by Boulay in the older Pliocene in the vicinity of Mont Dore in central France, and described under the name of *Carpinus orientalis* L. am. There is no reason to question the latter determination. Doubts may be harboured only in respect of the involucre marked D_1 , described in 1952 by Berger from Brunn-Vösendorf near Vienna under the name of *Carpinus praejaponica*. Berger writes in his quoted paper on page 87 that similar involucre are encountered in *Carpinus orientalis* L. am. (= *C. duinensis* Scop.); the central lobe,

Fig. 18. Present-day involucre of *Carpinus orientalis* from 8 localities. After Berger (1953, 1)

Współczesne okrywy owocowe *Carpinus orientalis* z 8 miejscowości. Według Bergera (1953, 1)

however, is more distinctly marked in the latter species, and as a whole it is more asymmetrical. Nevertheless, if we observe closely the eight involucre of *Carpinus orientalis* from eight different localities (Fig. 18), copied from Berger's work (1953, 1), then we perceive that in the discussed species forms may occur which range from elongated to almost round ones; the nervature, from pinnate to palmate; the dentation, from acute to completely obtuse. If no correlation exists between the above-mentioned characters, the latter species is capable of also producing such involucre as the one discovered by Berger. This is clear to every student of variability in living nature. The author does not claim that the discussed involucre absolutely belongs to the species *orientalis*, but she does consider that there is no sufficient basis for claiming that it does not belong. On the other hand, in view of the fact that the presence in Europe of Japanese hornbeams from the section *Distegocarpus* has been proved neither on the basis of involucre, nor on the basis of fruits, the

author is of the opinion that it is better to be circumspect and not to hurry with such a classification that would change fundamentally our concept of the historical geography of hornbeams, if the only argument is a single fragment. Consequently for the time being the author includes the above-mentioned involucre in the type *orientalis*, considering the question, however, as still open.

As regard the classification of the following twelve involucres of Fig. 17 as belonging to the type *Carpinus betulus*, there is no doubt whatever. The first two (A_4 — A_5) are from the vicinity of Mont Dore in France, and Boulay determined them directly as *Carpinus betulus* L. The Rumanian involucre (B) was included by Pop in the species *Carpinus grandis*, although it was identical in all respects with involucres of the species *Carpinus betulus*; the only reason for this, as the latter author writes, was the fact that the leaves found in the same flora were not, in his opinion, fully identical with the species *Carpinus betulus*. Involucre C was called by Laurent et Marty also *Carpinus betulus*. Berger too, stresses the identity of shapes of involucres D_2 — E_5 with involucres of *Carpinus betulus*, and he considers the names applied to them (i. e., *Carpinus grandis* Ung., for involucres D_{2-4} , and *Carpinus pyramidalis* Gaud. for involucres E) as appropriate for the protoplasts of the above-mentioned species, depending on the presence or absence of teeth on the lobe margins*. The lack of foundations for retaining such a division will be discussed below.

An interesting novelty in palaeobotany was the discovery by Berger, in the old Pliocene at Laaerberg near Vienna, of 14 involucres of a type not encountered in the present-day flora of Europe. Species corresponding to this type are to be found at present only in the Far East among species, the chief representative of which is *Carpinus Tschonoskii*. The fossil involucres discovered by Berger are markedly asymmetric. One of their sides is narrow, almost completely devoid of teeth, while the other is strongly developed, with undulate or dentate margins. In all, with the exception of G_3 , the central nerve is distinctly noticeable, and from it the lateral nerves branch out.

A detailed description of the above-mentioned involucres, their drawings and their specific names are given by Berger in his "Studies on the Taxonomy and History of the Genus *Carpinus*" (1953, 1) and in the „Old Pliocene Flora from Laaerberg“ (1955). He described them under

* Berger writes in his paper (1952 p. 87) as follow: Die Cupulae sind dreilappig mit mehr oder weniger spitzen Lappen. Das eine Exemplar (Abb. 26 = D_3 in Fig. 17) hat locker gezähnten Rand, ein anderes schlechter erhalten (Abb. 27 = D_4 in Fig. 17) dagegen ganzrandigen. Solche ganzrandige Formen wurden von älteren Autoren als *C. pyramidalis* Gaud bezeichnet.

five specific names, listed on page 37. The main basis for distinguishing these species are the following characters: position of the widest part, ratio of length to width, concavity or convexity of the narrower side of the involucre, character of the nervature, etc. *E. g.*, involucre F are widest in their lower haft, while a common character of the seven involucre G is said to be the position of their widest part, approximately in the middle of their length. Involucre I are long and almost linear, while involucre J is widest in its upper half. However, upon close observation of the nine present-day involucre of the species *Carpinus Tschonoskii* in Fig. 19, collected at nine localities and copied

Fig. 19. Present-day involucre of *Carpinus Tschonoskii*. After Berger (1953, 1)
 Współczesne okrywy owocowe *Carpinus Tschonoskii*. Według Bergera (1953, 1)

from Berger's aforesaid paper we perceive that, without illustrating the whole scale of variability of the discussed species, they do indeed include all of the above-mentioned characters. Among the involucre we observe falciform and straight forms, forms with the widest part situated in their upper half or at their base, forms that are almost linear or short and wide, forms that are elongated into an acute apex or terminated obtusely, with a pinnate or almost palmate nervature, etc. Neither by their dimensions do the involucre from Laaerberg differ from present-day ones. Only in two fossil involucre is it possible to distinguish characters that are absent in Fig. 17. One of them, involucre G₃, has no distinct main nerve and the other, involucre H, has a kind of lateral lobe. The comparative material being so scanty, we cannot

exclude the possibility that such forms may also exist in the present-day species *Carpinus Tschonoskii*. It seems, therefore, that Berger was too prompt in describing the above-mentioned involucre under five specific names. At the same time he proceeded in the manner which he himself criticizes in others, when proving in 1953 that numerous palaeobotanical species of the genus *Carpinus* can be reduced to a small number of morphological types which hardly differ at all from present-day types. It appears to be much more proper to confer on the involucre from Laaerberg one common name: *Carpinus* cf. *Tschonoskii* or *Carpinus Tschonoskii* aff., leaving their eventual division into separate species till the moment when, on the one hand, more abundant fossil materials are available and, on the other hand, the present-day species are elaborated in greater detail and their variability is determined. If we proceed in palaeobotanical studies as we did a hundred years ago, when even the slightest deviations from type were sometimes deemed sufficient to describe a new species, we shall never find our way out of the blind alley.

The discovery of the abundant material of involucre of the type *Carpinus Tschonoskii* in the older Pliocene near Vienna confirms the author's conviction that Steger's determination of the involucre from the Lower Miocene at Kokoszyce as also belonging to the same type was correct (see p. 33—34). In such case there would be no foundation for Berger's hypothesis about two migratory waves of hornbeams to Europe: in the Oligocene and in the Pliocene.

There remains to be discussed the map in Fig. 20. The circles denote the older (Oligocene and Miocene) localities where involucre of the type *Carpinus betulus* were discovered; the black discs designate the same for Pliocene finds. Analogically, the white and black triangles denote the type *Carpinus orientalis*, the white and black squares mark the type *Carpinus Tschonoskii*. The crosses designate involucre of the type *Carpinus caroliniana* from the Oligocene and Miocene. Moreover, marked in a schematic manner are the distributional areas of the present-day species *Carpinus betulus* and *C. orientalis*. The number of finds shown in the map is too small to draw reliable conclusions; nevertheless, some facts attract attention in a striking manner. The first fact is that, up to the present moment at least, all the finds of involucre of the type *Carpinus caroliniana* come from the Oligocene or Miocene, and all are from the northern part of Central Europe, if we recognize as type *Carpinus betulus* the involucre discovered by Ettingshausen near Leoben in Styria (Fig. 8, H). Another interesting fact is that involucre of the type *Carpinus orientalis* have not been found hitherto to the north of the mountain-chain of the Carpathians and Sudety. All the localities with

fossil finds are not far from the present distributional area of *Carpinus orientalis* in Europe.

The pictures of European involucre, grouped together and described herein by the author, are supplemented by Fig. 21, showing involucre of hornbeams from the Miocene and Pliocene of Eastern Asia, copied from Berger's paper (1953, 1).

The fossil involucre of *Carpinus* from East Asia (Fig. 21)

- A₁—A₂ *Carpinus laciniobracteata* Hu & Chaney — Shanwang, Schantung.
 B₁—B₂ *Carpinus oblongibracteata* Hu & Chaney — Shanwang.
 C *Carpinus mioturczaninowii* Hu & Chaney — Shanwang.

Fig. 20. The localities where fossil *Carpinus* involucre have been found in Europe. Details in the lists on page 21 and 37. Corresponding drawings in Figs. 8 and 17.

They are marked there with the same letters as on the map
 Stanowiska, gdzie znaleziono w Europie okrywy owocowe *Carpinus*. Szczegóły w spisach na str. 21 i 37. Rysunki okryw znajdują się na ryc. 8 i 17. Są one oznaczone tymi samymi literami co stanowiska na mapie

- $D_1 - D_3$ *Carpinus Tschonoskii* Maxim. Miki — Itirizuka.
 $E_1 - E_2$ *Carpinus subyedoensis* Konno — Shinano.
 F *Carpinus heigunensis* Huzioka — Heigun.
 G *Carpinus megabracteata* Hu & Chaney — Shanwang.
 $H_1 - H_2$ *Carpinus kodairaebrecteata* Huzioka — Tyosen, Korea.

Fig. 21. Fossil involucres of *Carpinus* found in East Asia. The list of their names is one page 42. After Berger (1953, 1)

Kopalne okrywy owocowe *Carpinus* znalezione w Azji Wschodniej. Spis ich nazw zamieszczono na str. 42. Według Bergera (1953, 1)

I	<i>Carpinus shanwangensis</i> Hu & Chaney — Shanwang.
J	<i>Carpinus simplicibracteata</i> Huzioka — Tyosen.
K ₁ — K ₄	<i>Carpinus erosa ellipticibracteata</i> Huzioka — Abura.
L ₁ — L ₂	<i>Carpinus subjaponica</i> Nathorst — Shiobaramura.
M	<i>Carpinus</i> " <i>carpinoides</i> Mak." Miki — Osusawa.

Although the Asiatic material is scanty, a glance at Figs 8, 15 and 17 on the one hand, and at Fig. 21 on the other, suffices to perceive that already in the Miocene there was an enormous difference between the hornbeams growing in Europe and the ones in Eastern Asia. At that time they were linked together only by the type *Carpinus Tschonoskii* and perhaps by a small number of forms of the type *Carpinus caroliniana*. Although all botanists with one accord maintain that the homeland of the genus *Carpinus* is in Eastern Asia, where at present there exists the greatest concentration of its numerous species, nevertheless for the time being it is difficult to say where and when was the beginning of such types as *Carpinus betulus* or *Carpinus orientalis*, and by what routs did they migrate to Europe. Every conjecture on this subject is hitherto nothing else than a hypothesis that has no foundation in scientific facts.

GENERAL REMARKS

Several matters, mentioned above, remain to be discussed. One of these is the question, whether it is proper to divide fossil hornbeams from the group *Carpinus betulus* into two species: *Carpinus grandis* Ung., with involucre that have dentate margins, and *Carpinus pyramidalis* Gaud., with involucre that have entire margins. This division was accepted by Berger (1953, 1), who based it on the supposition that hornbeams possessing involucre with entire margins occurred in the Tertiary much more often than at present and that they could belong to a separate species. One of his arguments was the fact that even the present-day form of *Carpinus betulus* with entire involucre has been described as a separate species: *Carpinus carpinizza* Kib. The monographer of hornbeams Winkler, however, recognized the latter species neither as a variety, nor even as a form of *Carpinus betulus*, and he quotes the name among its synonyms. With regard to the involucre of *Carpinus betulus* the latter author writes in his diagnosis on page 30: "...lobo medio... integro vel sparsi minute serrato, lateralibus subaequalibus obtusiusculis integris vel 1—2 serratis". This signifies that he does not by any means consider the form with an entire margin to be rarer than the dentate form.

The author has no special interest in the variability of hornbeam involucre, as her studies of hornbeam were restricted exclusively to the variability of nutlets. However she endeavoured to collect some data for

a general idea on this subject. She investigated three samples: The first was composed of 252 involucre collected from 84 trees (3 involucre from each tree). The second was composed of 100 involucre from one forest (10 involucre from one tree), and in the third there were 300 involucre from one tree. The teeth were counted very accurately with the help of the magnifying glass. The data obtained were as follows.

Carpinus betulus L.

Locality Miejscowość	Number of trees Liczba drzew	Number of invo- lucre Liczba okryw	Number of teeth in the central lobe of involucre Liczba ząbków na środkowej klapie okrywy														
			0	1	2	3	4	5	6	7	8	9	10	11	12	13	
Białowoda near Nowy Sącz	84	252	97	47	41	19	17	6	11	8	0	2	2	0	1	1	
Białowoda koło Nowego Sącza																	
Ojców near Kraków	10	100	46	24	13	5	6	2	2	0	2						
Ojców koło Krakowa																	
Botanical Garden in Kraków	1	300	17	21	34	50	34	39	34	22	23	14	4	6	2		
Ogród Botaniczny w Krakowie																	

The corresponding graph is given in Fig. 22. We see, that the number of teeth is a character, which is variable not only within a forest but also within an individual.

Only a detailed study of the variability of hornbeam involucre throughout the distributional area can create a basis for determining the percentage in which *Carpinus betulus* occurs at present with involucre possessing entire margins, and whether this property occurs uniformly throughout the distributional area of the above-mentioned tree, or is it associated with special ecological conditions or climate. Until this is carried out, it is better to refrain from introducing into palaeobotany the division into two species that differ from one another only by the presence or absence of teeth on the margins of the involucre; all the more should one refrain from drawing conclusions of a palaeohistorical nature.

It must be added that the name *Carpinus pyramidalis* Gaud. was used by Gaudin to designate the long and narrow leaves found at

Montaione, and also the leaves from Sośnica, described by Goeppert as *Ulmus pyramidalis* and *Ulmus longifolia*. These leaves were identified by later authors as belonging to the genus *Ulmus* (Reimann 1920 p. 62), and thus no basis remained for retaining the fossil species *Carpinus pyramidalis*. The fact that Gaudin discovered simultaneously at

Fig. 22. Number of teeth in the middle lobe of involucre of present-day *Carpinus betulus* (compare p. 45)

Liczba ząbków na środkowej klapie okryw owocowych współczesnego *Carpinus betulus* (porównaj tabelę na str. 45)

Montaione a hornbeam involucre with entire margins, is no sufficient reason for reviving the latter name which is already buried in palaeobotany.

Another matter that the author wishes to discuss here is the occurrence in the European Tertiary of a species similar to the present-day *Carpinus caroliniana*. Some doubts connected with this matter have been already discussed on page 28—29. Involucres of the type *caroliniana* were found in the older Neogene much less often than involucres of the type *Carpinus betulus*. Among the twelve localities from which involucres of the type *Carpinus betulus* are shown in Fig. 8, only at two (Kreuzau on the Rhine and Sośnica) discovered simultaneously were involucres of

the type *Carpinus caroliniana*, and at one locality (Swoszowice) was there found only a single involucre which was probably of the type *caroliniana*; involucre H from Leoben is not taken into account here, inasmuch as its morphological determination is uncertain. Moreover, it should be remembered that the involucres of the type *caroliniana* shown in Fig. 8 are all of the specimens of this type described in Europe, while the involucres of the type *betulus* shown alongside are only a part of those found, the fact being that many authors give a picture of only one or two involucres of the type *Carpinus betulus*, while writing that many had been found. E. g., G o e p p e r t gave in 1855 drawings of three involucres from Sośnica, while the present author has added 24 more in Fig. 15, all from the same locality. All this indicates that hornbeams with involucres of the type *caroliniana* occurred in the European Tertiary in an extremely small minority in relation to hornbeams with involucres of the type *Carpinus betulus*. There may have been two different species which with their strangely unchanged form of involucre have survived since the Tertiary until the present day, but, what is more probable, there could have also been a single species with a wide scale of variability of its involucres.

Within this variability could have been contained — as today — in a small percentage also the type with involucres manifesting a tendency to produce two lateral lobes on one side of the central lobe, such as are shown on the left-hand side of Fig 8, in Fig. 14 and in Table II. For the time being this matter cannot be solved; one must wait for further fossil finds and, simultaneously, for the results of research on the variability of shape in present-day involucres of *Carpinus betulus*.

Finally, there is one problem more to discuss. In the present paper the author has mentioned several times that Tertiary involucres of the type *Carpinus betulus* differ neither by their shape, nor by their variability from present-day involucres. This is not altogether correct. Between them there does exist a difference which is striking even in the tables appended to this paper. If we observe on the one hand Figs. 10, 11 and 12, representing the involucres of present-day hornbeams, and on the other hand Figs. 8, 15 and 17, showing the involucres of fossil hornbeams from Europe, we then perceive that fossil involucres of the type *Carpinus betulus* are distinctly smaller than present-day involucres, while those of the type *Carpinus caroliniana* and *C. orientalis*, present-day and fossil ones alike, do not differ markedly as far as their dimensions are concerned. H. W i n k l e r states, in his monograph of *Betulaceae* (1904), that involucres of the species *Carpinus betulus* are 3—5 cm. long and these of *C. caroliniana* 2—3 cm. long. The length of the present-day involucres of *C. betulus* shown in Figs. 10 and 11 amounts to 2.5—4.7 cm.;

the most frequently encountered length is 3.5 cm. More accurate data gave us the measurements of the length of involucre of three samples, demonstrated in a graph in Fig. 23. They agree with the data of Winkler quoted above. On the other hand, the length of the

Fig. 23. Length of the present-day involucre of *Carpinus betulus* (compare Fig. 22)
Długość współczesnych okryw *Carpinus betulus* (porównaj ryc. 22)

undamaged fossil involucre shown in Figs. 8, 15 and 17 (i. e. involucre in which both the apex and the base are undamaged) amounts only from 1.7 to 3.7 cm., the most frequently occurring length being 3.0 cm. These statistical data are not, of course, strictly accurate, but they do suffice to impart a general idea. We see, consequently, that fossil involucre of the type *Carpinus betulus* and of the type *C. caroliniana* much more resembled each other by their dimensions than analogical present-day involucre do. This augments the possibility of accepting the hypothesis that both these types were included during the Miocene within the same species. The problem of the decrease in the dimensions of Tertiary involucre of the type *Carpinus betulus* will be taken up again in the next part of the author's studies on hornbeams, in the discussion of fossil fruits of the genus *Carpinus* in Poland.

SUMMARY

Summarizing the results arrived at by analysing the palaeobotanical literature, it must be stated that fossil involucre of the genus *Carpinus* in Europe can be divided into four morphological types, similar in shape to

the four types occurring in the present-day flora. Two of them are protoplasts of hornbeams growing at present in Europe, i. e. of the species *Carpinus betulus* and *C. orientalis*. The third is the type *Carpinus caroliniana*, growing to-day only in North America. The fourth is the type *Carpinus Tschonoskii*, now growing in eastern Asia.

All the above-mentioned European fossil species are old species which appeared in Europe in a morphologically differentiated form at the boundary-line between the Oligocene and Miocene.

The dominant hornbeam species in the European Tertiary, the same as at present, was a species from the group *Carpinus betulus*. Up to the present moment all the finds of this type correspond to the present-day distribution of *Carpinus betulus* in Europe.

After *Carpinus betulus*, the second position in the European Tertiary was occupied, the same as to-day, by a species of the type *Carpinus orientalis*. At that period its distributional area extended slightly farther north than the distribution of the present-day *Carpinus orientalis*, but it probably did not pass the line of the Carpathians and Sudety.

The third position, as regards the number of finds, was occupied in the European Tertiary by the type *Carpinus caroliniana*, the relation of which to the type *Carpinus betulus* is not clear and demands clarification.

The fourth position belongs to hornbeams of the type *Carpinus Tschonoskii*, the involucre of which are hitherto known only from two localities: from the Lower Miocene and the Lower Pliocene. On the basis of the finds hitherto discovered, it seems that the latter species played a small role in the Tertiary mixed deciduous forests and its occurrence was rather sporadic.

All of the conclusions arrived at in the present paper are of a temporary character and are subject to change in connection with the progress of palaeobotanical research and the discovery of new fossil evidence. The conclusions presented above will be linked up with the results of research on fossil fruits of the genus *Carpinus* in Poland in the final part of the author's studies concerning the latter genus. There also, the author shall express her opinion with regard to the nomenclature of fossil species of European hornbeams.

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STRESZCZENIE

Historia rodzaju *Carpinus* w Europie, oparta na literaturze paleobotanicznej, jest drugą częścią studiów autorki nad kopalnymi owocami *Carpinus* i *Ostrya*. Część pierwsza została ogłoszona w r. 1953, zaś część

trzecia zawierająca szczegółowe opracowanie morfologiczne i anatomiczne kopalnych owoców znalezionych w Polsce zostanie niebawem oddana do druku.

Obecna rozprawa zawiera krytyczny przegląd europejskiej literatury paleobotanicznej, w której opisywano kopalne okrywy rodzaju *Carpinus*, zamieszczając obok opisu rysunek lub fotografię. Oparto się tutaj na okrywach owocowych, a nie na owocach, gdyż opisy i rysunki kopalnych owoców rodzaju *Carpinus* są w literaturze paleobotanicznej nieliczne i mało dokładne. Okrywy zaś są tak charakterystyczne, że ich przynależność gatunkowa budzi stosunkowo małe wątpliwości. Liści nie brano zupełnie pod uwagę, gdyż trudno czasem zdecydować, czy należą one do rodzaju *Betula*, *Carpinus* czy *Alnus*, a niekiedy i *Ulmus*, tym bardziej więc trudno określać ich przynależność gatunkową. (Reimann 1920, Nemejc 1949, Berger 1953, 1).

Pracę rozpoczyna krótki rzut oka na literaturę paleobotaniczną, w którym przedstawiona jest z jednej strony chronologia wiadomości o grabach kopalnych, z drugiej strony historia samego grabu uporządkowana podług epok geologicznych (str. 4—11).

W historii wiadomości o grabie uderza szybkość, z jaką tworzone w XIX w. w Europie coraz to nowe gatunki paleobotaniczne tego rodzaju. Od roku 1803, kiedy pierwszy raz pojawiło się w literaturze paleobotanicznej słowo „*Carpinus*“ do r. 1890 opisano 46 gatunków grabów kopalnych. Nagel podaje w r. 1916 już 56 gatunków (nie licząc odmian i form), od tego czasu przybyło ich jeszcze więcej. W XX wieku pojawia się też szereg nowych nazw grabów kopalnych na wschodzie dzięki rozpoczęciu tam badań paleobotanicznych. Znikoma część tych gatunków jest opisana na podstawie owoców, nieco większa odnosi się do okryw, zaś reszta — to liście, które wymagają krytycznego opracowania.

Mimo że szczątki kopalne rodzaju *Carpinus* były opisywane od r. 1803 — właściwa wiedza o grabach rozpoczyna się dopiero w r. 1855, kiedy to Goepfert opisał znalezione w osadach mioceńskich w Sośnicy na Śląsku 3 okrywy owocowe pod nazwą „*Alae fruct. Carp.*“ (ryc. 4). Dwie z nich uznał za identyczne z *Carpinus betulus*, o trzeciej pisze, że jest podobna do *C. americana* (*C. caroliniana*). Odpowiedni cytat przytaczam na str. 22. W tym samym roku znalazł Andrae w górnym mioceenie południowego Siedmiogrodu okrywę typu *Carpinus betulus*, którą nazwał „*Carpinus vera*“ na znak, że chodzi tu rzeczywiście o rodzaj *Carpinus* (ryc. 8 K oraz str. 23). Rok 1855 był więc przełomowym dla badań nad historią grabu w Europie. Pojawiające się od tego czasu coraz liczniejsze opisy i rysunki okryw owocowych rodzaju *Carpinus* dają dopiero konkretną podstawę do odtworzenia jego historii.

Jeżeli chodzi o historię samego grabu, to w starszym trzeciorzędzie nie

stwierdzono dotychczas jego okryw w Europie. Opisane przez Ungera we florze eoceńskiej w Sotzka okrywy rzekomych dwóch gatunków grabu należą, jak się pokazało, do rodzaju *Engelhardtia*, nie potwierdziła się też przynależność gatunkowa znalezionych równocześnie liści (str. 8, ryc. 1 i 2). Niechybne dowody istnienia grabu w Europie spotykamy dopiero na granicy oligocenu i miocenu dzięki znalezieniu okryw grabu w osadach, określonych jako górnooligocenyjskie w miejscowościach: Kreuzau nad Renem (Berger 1953, 3), Berand w północnych Czechach (Engelhardt 1898) i na Dolnych Łużycach (Menzel 1906). Są one bardzo podobne morfologicznie do okryw *Carpinus betulus*, *C. orientalis* i *C. caroliniana*, a więc gatunków, z których dwa rosną do dziś dnia w Europie, zaś trzeci jest jedynym gatunkiem grabu występującym w Ameryce północnej.

W licznych miocenyjskich florach kopalnych występuje rodzaj *Carpinus* pod różnymi nazwami gatunkowymi. Najczęściej spotyka się tam nazwę „*Carpinus grandis* Unger”. Nagel podaje przeszło 100 prac paleobotanicznych, w których opisywano ten gatunek, przeważnie zresztą na podstawie liści. Nazwa ta stała się omal synonimem grabu charakterystycznego dla miocenyjskiego lasu w Europie. W związku z tym autorka postanowiła dojść na podstawie szczegółowego przestudiowania literatury, jak wyglądał „typ”, na podstawie którego Unger wyróżnił ten gatunek. Opis historii *Carpinus grandis* Ung. jest zamieszczony na str. 12—18, poparty ryc. 3—7. Jest on dobrą ilustracją tego, co przeżywa botanik, kiedy się chce zorientować w literaturze paleobotanicznej i w paleobotanicznym „typie”, który to typ, mimo swoich niejasności stał się główną podstawą do określenia licznych materiałów kopalnych.

Na typ „*Carpinus grandis*” składają się w pracach Ungera:

1. Dwa liście znalezione w Radoboju w Kroacji, narysowane przez Ungera w „Iconographia plantarum fossilium” (ryc. 3);

2. Jedenaście liści różnego kształtu, pochodzących z flor miocenyjskich w Kroacji, w Czechach i w Styrii oraz mocno uszkodzona okrywa owocowa typu *Carpinus betulus* (ryc. 5).

3. Okrywa i nieduży liść narysowane we florze ze Swoszowic (1849) jako *Carpinus macroptera* Brongn., które Unger uznał w „Geologie der europäischen Waldbäume” (1869) za należące do gatunku *Carpinus grandis*, uważając równocześnie ten gatunek za wychodnią formę dla współczesnego *Carpinus americana* (ryc. 6).

4. Dwie okrywy narysowane przez Ungera na Tab. 1 wyżej wymienionej pracy, pod nr 11 i 12 (ryc. 7), których pochodzenia nie podaje. Jeżeli się im przyjrzymy dokładniej, to zobaczymy, że okrywa nr 11 jest niechybnie przerysowana z pracy Goepfert'a o Sośnicy (ryc. 4 A), trudno bowiem przypuścić, aby znalazły się w różnych materiałach ko-

palnych dwie identyczne okrywy, nr 12 wygląda zaś jak okrywa ze Swozowic z dorobioną brakującą klapą (porównaj ryc. 6).

Widzimy, że gatunek *Carpinus grandis* Unger nie ma klasycznego miejsca występowania, a okazy, które należałoby uważać za klasyczne, pochodzą z różnych miejscowości, a czasem są niewiadomego pochodzenia.

Należy dodać, że ani opisane wyżej okrywy owocowe, ani liście podane przez Ungera jako typowe dla gatunku *Carpinus grandis* Unger nie są specjalnie duże i nic nie usprawiedliwia zatrzymywania dla nich nazwy „grandis”. Przyczyną tej nazwy były bowiem duże rozmiary okryw owocowych opisywanych przez Ungera w latach 1845—52 (ryc. 3), które, jak się potem okazało, należą do rodzaju *Engelhardtia*. Utrzymanie nazwy *Carpinus grandis* Ung. zawdzięcza Unger Heerowi (1856), który dał temu gatunkowi gruntowną podbudowę materiałową (Tabl. I). Dlatego Engelhardt proponował, aby dać powyższym materiałom kopalnym, zamiast nazwy „*Carpinus grandis* Unger”, nazwę „*Carpinus Heerii*”, co się jednak nie przyjęło.

Interesujące jest, że późniejsi paleobotanicy podawali jako typowe dla *Carpinus grandis* Unger materiały z Sośnicy, najbogatsze dotychczas znalezisko kopalnych grabów, opisane przez Goepperta pod nazwą: *Carpinus ostrioides*, *Carpinus alnifolia*, *Carpinites macrophyllus*, *Betula carpinoides* oraz „*Alae fruct. Carp.*”, choć Goepfert słusznie nie dopatrzył się podobieństwa między swoim materiałem a typem opisanym i narysowanym w r. 1852 przez Ungera. Poza tym okrywy i liście rodzaju *Carpinus* z Sośnicy uważane są ogólnie za prototyp *Carpinus betulus*, zaś Unger uważa swój *Carpinus grandis* za prototyp *Carpinus americana* (= *caroliniana*).

Wszystkie powyższe dane przytoczono jako dowód, że typ paleobotaniczny jest nieraz sam w sobie trudną do rozwiązania zagadką.

Po uwagach o literaturze paleobotanicznej przystępuje autorka do właściwego tematu pracy zestawiając rysunki wszystkich, o ile się udało odszukać, okryw grabu z różnych prac nad europejskim neogenem i z dostępnych jej materiałów trzeciorzędowych, i usiłując wyciągnąć z tych tablic wnioski dotyczące historii grabu w Europie.

I. Okrywy z górnego oligocenu i miocenu

Na ryc. 8 zestawiono okrywy znalezione w górnym oligocenie i w miocenie, ułożone w ten sposób, że w górnej i środkowej części ryciny zamieszczono rysunki okryw podobne do współczesnego gatunku *Carpinus betulus*, względnie *C. caroliniana*, u dołu zaś należące do innych gatunków. Materiały pochodzące z tych samych miejscowości są oznaczone tymi samymi literami. Te same litery znajdujemy też w spisie na str. 21

oraz na mapie na ryc. 20. Wiąże to ryc. 8, spis nazw okryw na str. 21 i mapę stanowisk na ryc. 20, które dzięki temu dopełniają się wzajemnie. U góry ryc. 8 mamy materiały najstarsze, pochodzące z górnego oligocenu względnie z przełomu oligocenu i miocenu. Okrywa R. została opisana również jako górnooligocenska.

Okrywy zamieszczone na ryc. 8 możemy zaliczyć do 4 typów morfologicznych, a mianowicie:

1. Typ *Carpinus betulus* (str. 22). Należy tu 17 okryw zamieszczonych w środkowej i prawej górnej stronie ryciny. Skala zmienności tych okryw jest stosunkowo mała, jeżeli weźmiemy pod uwagę, że pochodzą one z 12 miejscowości i z długiego okresu czasu, przy tym są zniekształcone fosylizacją, a czasem i niezupełnie wiernym odrysowaniem. Dla porównania zamieszczono ryc. 10 odrysowaną z pracy Bergera (1953, 1), ilustrującą zmienność współczesnego *C. betulus*, oraz ryc. 11, gdzie narysowano 12 okryw pochodzących z 1 drzewa. Wszystkie 17 okryw z ryc. 8 — gdybyśmy je znaleźli żywe — załączylibyśmy bez wahania do typu *Carpinus betulus*.

2. Typ *Carpinus caroliniana*. Zaliczono tu 4 okrywy narysowane z lewej górnej strony ryc. 8. Nie tworzą one tak jednolitej grupy morfologicznej, jak poprzednie (str. 28). Dwie pierwsze pochodzą z oligocenu, okrywa D z miocenu ze Swoszowic, zaś E₁ z miocenu z Sośnicy. Na podstawie tak szczupłego materiału trudno rozstrzygnąć, czy mamy tu do czynienia z odrębnym gatunkiem, czy też z szeroką skalą zmienności trzeciorzędowego gatunku typu *Carpinus betulus*, tym bardziej że istnieją okrywy jakby pośrednie, jak np. okrywa H. Należy zaznaczyć, że podobny typ okryw spotyka się również u współczesnego *Carpinus betulus* (ryc. 14).

3. Typ *Carpinus orientalis*. Należy tu 7 okryw: oligocenska R oraz miocenska N₃—P. Autorzy, którzy je opisywali, uznają je zgodnie za należące do protoplastów współczesnego *Carpinus orientalis* (str. 30).

4. Typ *Carpinus Tschonoskii*. Zaliczono tu miocenską okrywę znalezioną przez Stegera w Kokoszycach na Śląsku (ryc. 8 L₁, Tablica II. G), którą Reimann określił prowizorycznie jako *C. Neireichii* (str. 31—32).

Procentowy stosunek powyższych typów przedstawia się na tle ryc. 8 następująco: typ *Carpinus betulus* 57—60% (zależnie od tego, czy zaliczymy tu, czy nie zaliczymy okrywy H), typ *C. caroliniana* 13—17%, typ *C. orientalis* 23%, zaś typ *C. Tschonoskii* 3%. Daje to pewne pojęcie o udziale powyższych typów w lasach miocenskich Europy. Autorka zwraca jednak uwagę, że okrywy typu *caroliniana* narysowane na ryc. 8 są to wszystkie okrywy tego typu, jakie opisano w Europie, zaś narysowane obok okrywy typu *betulus* są tylko częścią okryw znalezionych w oligocenie i miocenie. Wielu bowiem autorów podaje, że znaleźli liczne okrywy typu *C. betulus*, a rysują tylko jedną lub dwie (porównaj ryc. 8 i ryc. 15).

W rzeczywistości więc stosunek procentowy tych typów musiał się przedstawiać inaczej na korzyść typu *C. betulus*.

Uzupełnieniem ryc. 8 jest ryc. 15, gdzie zestawiono 27 okryw znalezionych w Sośnicy przez Goepperta, Kräusela, Meyera i Reimanna oraz przez polskich paleobotaników. W przeciwieństwie do ryc. 8 daje ona obraz lokalnej zmienności okryw typu *Carpinus betulus* (+ ew. *C. caroliniana*), pochodzących z 1 miejscowości i ze stosunkowo krótkiego okresu czasu.

II. Okrywy z pliocenu

Rycina 17, na której zestawiono rysunki okryw plioceńskich grabów (prawie wyłącznie z dolnego pliocenu), ma inny charakter niż ryc. 8. Okrywy z ryc. 8 pochodziły z 17 miejscowości, zaś okrywy z ryc. 17 pochodzą tylko z 4 miejscowości, w tym 5 okryw z Francji, jedna z Rumunii, jedna z Holandii, zaś pozostałe 23 z okolic Wiednia. Udział procentowy typów morfologicznych okryw z ryc. 17 nie może być więc wyrazem procentowego udziału typów morfologicznych rodzaju *Carpinus* w dolnopliocieńskich lasach Europy. Nazwy, pod którymi zostały opisane powyższe okrywy znajdują się na stronie 37, zaś stanowiska na mapie na ryc. 20. Analogicznie do ryc. 8 znaczone tu tymi samymi literami okrywy pochodzące z tych samych miejscowości na ryc. 17, na spisie na str. 37 oraz na mapie ryc. 20. Zrobiono tu tylko to odstępstwo od przyjętego schematu, że okrywy znalezione przez Bergera w Wien-Laaerberg znaczone nie jedną literą, ale literami E—J, aby lepiej uwidocznic opisane przez niego gatunki.

Okrywy ryc. 17 należą do 3 typów:

1. Typ *Carpinus orientalis*. Zaliczono tu trzy okrywy opisane przez Boulay z Francji pod powyższą nazwą (A_1 — A_2) oraz prowizorycznie okrywę D_1 opisaną przez Bergera jako *C. praejaponica*. Wobec bowiem dużej zmienności okryw współczesnego *C. orientalis* (por. ryc. 18) i tego, że nie stwierdzono dotychczas zupełnie obecności w Europie grabów z sekcji *Distegocarpus*, autorka uważa, że trzeba być ostrożnym i nie spieszyć się z klasyfikacją zmieniającą zasadniczo pogląd na geografie historyczną grabów, gdy opieramy się na jednym jedynym szczątku (str. 38).

2. Typ *Carpinus betulus*. Przynależność zamieszczonych na ryc. 17 okryw A_4 — E_5 do tego typu nie ulega wątpliwości.

3. Typ *Carpinus Tschonoskii*. Należy tu 14 okryw znalezionych przez Bergera, w starym pliocenie w Laaerberg pod Wiedniem (Berger 1953, 1, 1955), które opisał on pod pięcioma nazwami gatunkowymi. Autorka rozprawy uważa tego rodzaju postępowanie za niesłuszne. Nie ma tu

bowiem dostatecznych podstaw do podziału na gatunki, tym bardziej że nie jest znana zmienność okryw dzisiejszego gatunku *C. Tschonoskii* i jego pokrewnych. O tym, że mają one dużą zmienność, mówi najlepiej ryc. 19 podana za Bergerem, gdzie można odszukać wszystkie typy morfologiczne zamieszczone na ryc. 17 pod literami F₁ — J. Wydawałoby się dużo właściwsze nadanie powyższym okrywom z Laaerberg wspólnej nazwy — *Carpinus* cf. *Tschonoskii* lub *C. Tschonoskii* aff. pozostawiając ew. ich podział na gatunki do czasu, gdy z jednej strony znajdą się liczniejsze materiały kopalne, z drugiej strony zostanie opracowana zmienność współczesnych gatunków tego typu. Postępując w paleobotanice tak, jak postępowano przed 100 laty, kiedy każda drobna różnica morfologiczna dawała podstawę do opisywania nowych gatunków, nie wyjdziemy nigdy ze ślepej uliczki.

Znalezienie bogatego materiału okryw typu *Carpinus Tschonoskii* w starszym pliocenie pod Wiedniem potwierdza trafność określenia miocenijskiej okrywy Stegera z Kokoszyc jako należącej do tego typu (patrz str. 31). Tym samym upada podstawa hipotezy Bergera o dwóch falach migracji grabów do Europy: oligocenijskiej i pliocenijskiej (1953, 1).

Na zamieszczonej na ryc. 20 mapie znalezisk kopalnych okryw grabów uderzają dwie rzeczy: pierwszą z nich jest to, że wszystkie dotychczasowe znaleziska okryw typu *C. caroliniana* pochodzą z oligocenu i miocenu i wszystkie leżą na północ od Alp, Sudetów i Karpat, chyba że uznamy za typ *Carpinus caroliniana* okrywę znalezioną w Leoben (Fig. 8 H). Drugim interesującym zjawiskiem jest to, że wszystkie dotychczasowe stanowiska kopalne okryw *C. orientalis* są położone na południe od powyższych gór. Wobec małego materiału nie można wyciągać z tego na razie żadnych wniosków.

Uzupełnieniem historii grabów europejskich jest ryc. 21, gdzie zestawiono opisane dotychczas kopalne okrywy grabów z Azji Wschodniej. Widać tam, że już w miocenie była ogromna różnica między grabami europejskimi a grabami ze Wschodu. Toteż trudno na razie powiedzieć, gdzie i kiedy powstały takie typy jak *Carpinus betulus* lub *C. orientalis* i jakie były drogi ich wędrówek, nie mamy bowiem jeszcze na to żadnych dowodów naukowych.

W końcowych uwagach ogólnych rozważa autorka, czy słuszny jest wprowadzony przez Bergera podział kopalnego typu *Carpinus betulus* na dwa gatunki: *C. grandis* Unger o ząbkowych brzegach okryw i *C. pyramidalis* Gaud. o okrywach gładkich (1953, 1). Zdaniem jej, trzeba by najpierw zbadać dokładnie zmienność okryw współczesnego gatunku *C. betulus*, obliczyć, w jakim procencie występują w nim te dwa typy i czy nie są one związane ze specjalnymi warunkami zewnętrznymi. Póki to nie będzie zrobione, lepiej się powstrzymać od wprowadzania do pale-

obotaniki podziału na dwa gatunki różniące się jedynie obecnością lub nieobecnością ząbków na brzegach okryw, a tym bardziej od wyprowadzania z tego wniosków natury paleohistorycznej (str. 44, ryc. 22).

Na zakończenie zwraca autorka uwagę na to, że kopalne okrywy typu *Carpinus betulus*, choć nie różnią się morfologicznie od współczesnych, są od nich wyraźnie mniejsze (str. 47, ryc. 23) i zbliżają się rozmiarami raczej do okryw *Carpinus caroliniana*. Sprawa ta wiąże się ściśle z wynikami badań nad kopalnymi orzeszkami grabu, które będą ogłoszone w następnej części pracy.

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TABLE I — TABLICA I

1 *Betula Brongniarti*; 2—24 — *Carpinus grandis* Ung. After Heer. V.II, 1856. Tabl. 72. Reduced 0,6 times. Według Heera T. II. 1856, Tablica 72. Zmniejszone 0,6 razy

TABLE II — TABLICA II

A — *Carpinus grandis* Ung. — Oligocene (Raune near Senftenberg). After Kirchheimer 1937, Fig. 50 b; B — *Carpinus grandis* Ung. — Miocene (Erdöbénye). After Andréanszky 1955, Table 7, Fig. 24; C—D — *Carpinus grandis* Ung. — Miocene (Sośnica). After Reimann 1920, Table 3, Fig. 4 and 18; E—F — *Carpinus grandis* Ung. — Miocene (Sośnica). After the original specimens from the collection of „Muzeum Ziemi“ in Warsaw; G — *Carpinus Neilreichii* Kov. — Miocene (Kokoszyce, Stur 1867). After Reimann 1920, Table 3, Fig. 3; H. — *Carpinus betulus fossilis* — Pliocene (Reuver). After Laurent et Marty 1923, Pl. 10, Fig. 2; I — *Carpinus betulus* — Pliocene (Willershausen). After Strauss 1935, Table 33, Fig. 8; K—O — Four-lobed involucres collected from one specimen of *Carpinus betulus*. Natural dimensions

A — *Carpinus grandis* Ung. — oligocen (Rauno k. Senftenberg). Według Kirchheimera 1937, Fig. 50 b; B — *Carpinus grandis* Ung. — miocen (Erdöbénye). Według Andreanszky'ego 1955, Tablica 7, Fig. 24; C—D — *Carpinus grandis* Ung. — miocen (Sośnica). Według Reimanna 1920, Tablica 3, Fig. 4 i 18; E—F — *Carpinus grandis* Ung. — miocen (Sośnica). Według oryginalnych okazów w zbiorach „Muzeum Ziemi“ w Warszawie; G — *Carpinus Neilreichii* Kov. — miocen (Kokoszyce, Stur 1867). Według Reimanna 1920, Tablica 3, Fig. 3; H — *Carpinus betulus fossilis* — pliocen (Willershausen). Według Laurent et Marty, 1923, Pl. 10, Fig. 2; I — *Carpinus betulus* — pliocen (Willershausen). Według Straussa 1935, Tablica 33, Fig. 8; K—O — czteroklapowe okrywy owocowe zebrane z 1 okazu *Carpinus betulus*. Rozmiary naturalne

TABLICA II — TABLE II