THE LOWER PERMIAN FLORA OF THE OSLO REGION

BY

OVE ARBO HØEG

WITH 5 TEXT FIGURES AND 28 PLATES

On September the 8th, 1931, Professor Olaf Holtedahl, leading an excursion from the Oslo University, found the first plant fossils in the scree above the farm Semsvik on the western side of the lake Semsvannet, Asker, about 20 km from Oslo. Details about the discovery were given in a report which appeared in the Norsk Geologisk Tidsskrift some months later (HOLTEDAHL 1931 *a*).

Since then intensive collecting and search for new localities have been carried out. Besides Professor Holtedahl personally, Dr. Leif Størmer has played an important part in this work, and to him and his brother Mr. Per Størmer are due many of the best discoveries. Dr. A. Heintz has visited the place repeatedly, chiefly in search of fish remains, and collecting has also been carried on by several others, who have visited the locality occasionally.

Personally, I have collected in Asker repeatedly, from shortly after the first discovery and every year since, except the summer 1934, when I confined myself to some other occurrences of Permian strata in the Oslo Region.

Besides the localities in Asker strata of the same age in other parts of the Oslo Region have been found to contain plants. From a paleobotanical point of view they are much less important, and they will be mentioned separately at the end of this paper.

It is not necessary here to go into details as to the stratigraphy, which has been described and discussed by HOLTEDAHL (1931 *a*); but in order to give an idea of the situation, the profile of the most important locality in Asker is reproduced here from his paper (text-fig. 2). The plants occur in various horizons and in different kinds of rock. There is a greenish grey, rather dark argillaceous

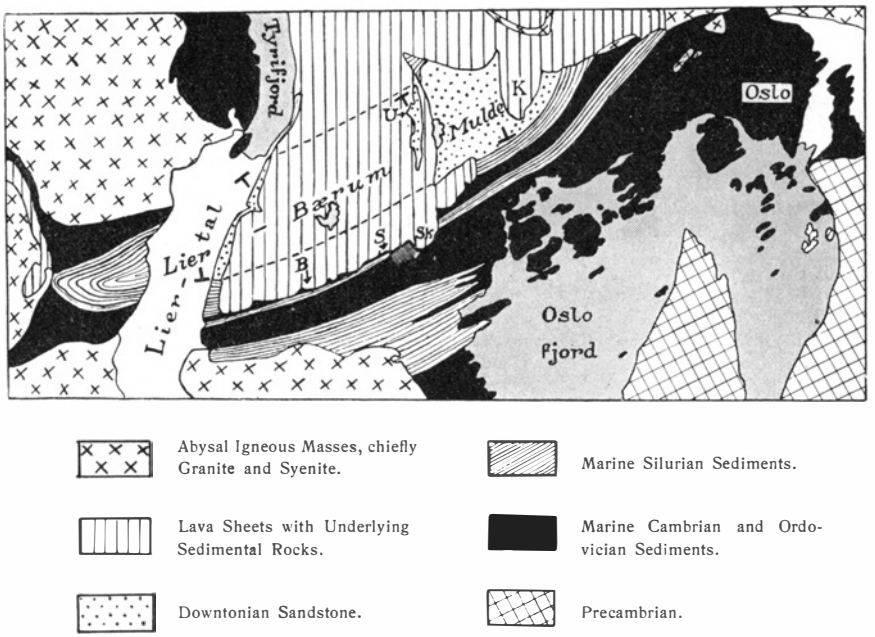


Fig. 1. Geological map of the region west of Oslo (diagrammatical after BRØGGER and SCHETELIG 1923). B = Bergsmarken, S = Semsvik, Sk = Skaugumsås, U = Ulselven, K = Kolsås. (From HOLTEDAHL 1931 *a*).

shale, which is fine-grained enough to give a satisfactory preservation, and in this shale most of the best specimens have been found, in the talus or *in situ*, often in very restricted occurrences; usually it is difficult to get it in large slabs, and many specimens of *Asterophyllites*, *Calamostachys*, fern-like leaves, and similar more delicate organs, have only been found in small fragments of this shale. A red shaly sandstone, rather coarse and sometimes friable, has yielded the best fish-remains, but only poor specimens of plants, chiefly *Calamites* and *Walchia piniformis*, the latter often in the shape of bad impressions of large branches and twigs. — *Ernestiodendron filiciforme* was found in dark shaly sandstone, rather micaceous; it has not been traced in solid rock, and unfortunately no more specimens have turned up than those good ones which were collected by Professor Holtedahl and his companions on the day of the first discovery, September 8th, 1931. Finally, there is a red, very fine-grained sandstone, which splits up in large, heavy slabs, with the so-called

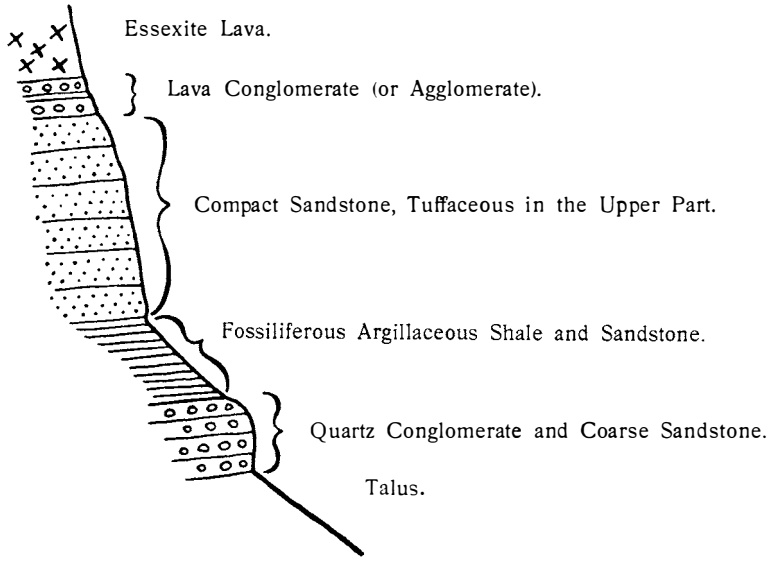


Fig. 2. Profile at Semsvik in Asker (From HOLTEDAHL 1931 *a*).

Walchia imbricata on the surface. It is remarkable and important, because it belongs to a horizon above the lava (HOLTEDAHL 1934, p. 35); it is best developed some km to the W of the first locality at Semsvik, namely on the southern side of the mountain called Hagahugget, where it was discovered by Mr. Per Størmer, in May, 1933.

The preservation is not very good, a fate which is shared by so many other floras of this age. There are practically only impressions left; the leaves are without any remains of cuticle, and only exceptionally spore preparations could be made from the fructifications. But the impressions are often relatively good, and in so far the preservation can match many well known localities of Rotliegendes.

Preparation chiefly had to be carried out in the mechanical way, by means of needles and small chisels, with a constant use of moistening with alcohol. Photographing was often difficult on account of the slight difference in colour between the fossil and the matrix (as in Pl. XIV fig. 2). Immersion in xylol proved, in many cases, to be far better than alcohol. When the specimen was to be photographed in a dry state, to show the relief of the surface only, it

was sometimes advantageous to give it a white cover of sublimated chloride of ammonia (for instance Pl. V fig. 1).

The determination has partly been worked out in foreign museums. In order to make a comparison with the German Rotliegendes I brought photographs with me to Berlin; here I had the good fortune to be able to study the collections in the Museum of the Preussische Geologische Landesanstalt, and to borrow some specimens for further study at home; my thanks are due to Professor W. Gothan for his kindness and valuable help. In addition I have had the opportunity to see the collections of Permian plants in several other German and French museums. I have also repeatedly visited the Paleobotanical Department of the Riksmuseum, Stockholm, where I have studied the extensive collections, made use of the unique library, and had the privilege to discuss the results with Professor T. G. Halle and Dr. R. Florin, for which I am greatly indebted.

On this occasion I also wish to express my gratitude to Professor Holtedahl, who handed over to me the material collected by himself and his students, and who has supported my work in every other way from the very start.

The study has been made possible through grants from the foundation "Fridtjof Nansens Fond".

Literature. The Permian flora and fauna of the Oslo Region have been mentioned in a few papers before. The discovery was first related by HOLTEDAHL in Norsk Geologisk Tidsskrift (1931 *a*), where the more important plant species then known are listed and illustrated, and their bearings upon the Geology of Norway discussed. A popular account was given by the same author in a handbook (1931 *b*), and in a guide for the excursion of the British Geologists' Association (1934), where a more complete, but not final, list of species was given. The fish remains, few but interesting, have been described by HEINTZ (1934), while the poorly preserved *Lamellibranchia* have not yet been named; it is also doubtful whether their preservation is good enough to allow of accurate determinations[1].

In the present paper I have mentioned the specific characters of the more important species, hoping that it may be of some use to non-specialists collecting plant fossils in the Oslo Region.

---

[1] After this manuscript was finished the paper by DIX & TRUEMAN (1935) on the Lamellibranchs was published.

For various reasons I have desisted from quoting the collector of each specimen described or figured in this paper. It may suffice to mention that a very considerable number of them, comprising many of the most interesting specimens, are due to Professor Holtedahl and his companions, above all to the brothers Leif and Per Størmer. In the collections which they brought together during the first days after the discovery, in the autumn 1931, all more important species were represented, and only the smaller things like fructifications could be added to the list during the subsequent detailed studies in the field. A great many specimens have been discovered in slabs broken out by our assistant on the spot, Georg Semsvik, while others have been found in the laboratory on splitting up specimens of apparently slight value.

Fossils from Semsvik and Neighbouring Localities in Asker.

Ferns and Pteridosperms.

Plate I.

Fern-like fronds are not common among the fossils from Asker, and they are poorly preserved and very fragmentary. In no case has it been possible to arrive at a specific determination beyond doubt, and in so far these specimens are of slight value; the best ones are figured here on Pl. I.

PA 1034, Pl. I figs 7 8, is a detached pinnule of *Neuropteris* sp., 2,2 cm long, but incomplete, the base and apex being lost. It is rather triangular in shape, somewhat oblique, attenuating regularly from the base, which does not seem to have been auriculate. The margin is very finely denticulate, perhaps, however, only as the result of decay before fossilization. The veins are numerous. A determination to species is impossible. — *Neuropteris* chiefly belongs to the Carboniferous, with a great number of species, but has also several times been recorded from the Rotliegendes.

PA 1073, Pl. I figs 5 6, consists of a number of pinnae, the bases of which have been lost together with the rachis. The pinnules have a very faint middle nerve, and the nervation has, at least partly, been odontopteroid, to judge from some of the best preserved pinnules. There is some resemblance to certain forms of *Callipteris*, but, apart from the fact that the middle nerve is rather too faint, even the generic

determination would be uncertain so long as the presence of pinnules on the rachis (Zwischenfiedern) is not proved. Another fragment, probably belonging to another species, is PA 971, Pl. I figs 3 4. It could be compared with *Callipteris conferta* (STERNB.) BRONGN. This species, however, is usually large and rather robust, and in spite of its alethopteroid venation the median nerve of the pinnules is usually very prominent. *Alethopteris* might also come into consideration.

PA 918 *a* and 1071 are some other small fragments, figured here only in magnification, Pl. I figs 1 and 2. They are not determinable with certainty even to genus. They resemble *Pecopteris*, but may rather belong to *Callipteridium*.

Calamites SUCK.

Pith casts of Calamite stems aerial and rhizomatic are among the commonest fossils at Semsvik in Asker, occurring at various levels and in various kinds of rock. In the coarse red sandstone they are very poor and as a rule indeterminable. On the other hand, in the more fine-grained argillaceous shale of predominantly grey colour they are far better preserved, although mostly quite fragmentary; in such specimens the characteristic anatomical details necessary for determination may be visible: The relative length and breadth of the internodes, the terminations of the ribs, their surface ornamentation, the tubercles at their upper ends, the shape and distribution of branch and root scars (if any) etc. But as is usual when one is dealing with this group of plants, the great majority of the specimens do not show these characters, and only a few of them, if regarded alone, are determinable with full certainty.

At the first discovery of Calamites in Asker it was natural to compare many of the specimens with *C. Suckowii* BRONGN., which is a very common species widely distributed in the Upper Carboniferous and also occurring, at least in some regions, in the Lower Permian. My first impression was that the species was common in this flora, and it was therefore also included in the first flora lists published by Professor Holtedahl, in most cases according to determinations carried out or at least controlled by myself. Later, however, with a better and more comprehensive material, I have had to change my opinion as to this species.

There is no doubt that many of our specimens are specifically identical with a great number of specimens figured in the literature as *C. Suckowii* or kept in the museum collections under that name. But, as is well known, a very considerable part of what has been called *C. Suckowii* has been shown by KIDSTON & JONGMANS in their monograph of the genus (1917, compare JONGMANS 1915) to belong to *C. undulatus*, and this is also the case in the flora under consideration.

By far the greater part of our Calamites can be arranged in two groups either of which forms a more or less continuous chain, referable to *C. undulatus* as aerial stems, respectively rhizomes. The determination of the individual specimen may often be doubtful; but if compared with the whole lot its position in most cases will be clear.

The result is that I have not been able to point out any indubitable examples of *C. Suckowii* at all; although it is possible that this species is a member of the flora, the decisive proof has not been given up to present (compare below p. 16).

Calamites undulatus STERNB.

Plates II—XI, some of them only partly.

Specific Characters. — Pith casts of aerial stems have rather broad ribs, often but not always flexuose, with a delicate cross-hatching on the surface, and terminating in more or less rectangular points at the nodes. The tubercle at the upper end of each rib oval or nearly circular. Branch scars in verticils at varying vertical distances; the nearest ribs converge towards the scars. The internode above the verticil usually much shorter than the other ones. — Casts of the rhizomatic parts have narrower ribs, with cross-hatching usually restricted to the median part of the rib. Root scars disposed irregularly at the nodes, circular, not influencing the direction of the ribs.

As mentioned above a great number of specimens are referable, with varying degree of certainty, to this species. They will be described and discussed separately below.

a. *Aerial stems.*

PA 909 (Pl. II figs 1 2) has only one complete internode, 7,3 cm long, and it is not preserved with its whole original breadth. The ribs are broad (4 mm), flexuose, showing very distinctly the transverse wrinkles on the surface. (The furrows between the ribs are sometimes substituted by a prominent straight ridge, longitudinally striated; in a few cases this ridge is placed on top of the rib instead

of in the furrow). The structure of the ribs at the nodes is unsatisfactorily preserved. In most cases the terminations seem to be blunt, rounded or even square, while in a few other cases (visible about the middle of the upper node on the photograph) they have rectangular points. The tubercles are indistinct, but seem to have been small.

This specimen may be regarded as a typical representative of *C. undulatus*.

It is connected with several similar ones, which have broad ribs, usually straight (somewhat undulating: PA 994), with distinct cross-hatching; the ends are blunt or short-pointed, the tubercles large. The length of the internodes varies; it is long in several specimens, like PA 999 (Pl. III fig. 2), 981, etc., and shorter in other ones, like PA 975 (Pl. III fig. 1) and PA 1002.

In connection with these specimens may be mentioned a few others with a slightly different appearance. One of them, PA 967, Pl. IV fig. 3. is of special interest:

It is a slightly concave impression without any remains of organic matter. The ribs are broad and straight, with pointed ends (about rectangular or somewhat more acute), the tubercles small (although not so small as they appear to be on the photograph at the lowest node, where only a central part of each tubercle is preserved). At the lowest node is a verticil of branch scars, and, as is regularly the case at such verticils, the length of the internodes is highly varying: The one above the verticil is very short, and the next ones increase rapidly. The scars themselves are not very distinct, but their presence is revealed by the marked convergence of the ribs in the internode above. At the third node from below there is a depression which could scarcely be but a root scar.

The convergence of the ribs and the reduced length of the internode above a verticil of branch scars are features common in *C. undulatus*. The presence of both root and branch scars in one specimen is rather rare, but not unique; KIDSTON & JONGMANS figure some examples (1917 Pl. III fig. 3.)

A similar specimen, but without root scars, is PA 987 (Pl. IV fig. 2). The tubercles at the upper ends of the ribs have been displaced owing to pressure; but for that the preservation is fairly good. On the surface the typical cross-hatching is exceptionally well developed. The lowermost internode is very short with ribs converging towards

Fig. 3. Aerial stems of *Calamites undulatus*, on the left hand side with branch scars. — PA 984. Nat. size.

branch scars, which must have been on the node below, not preserved in the fossil. The following internodes are much longer.

Also this specimen is a typical *C. undulatus*.

In another series of specimens the variation goes towards lesser breadth of the ribs and large oval infranodal tubercles; the extreme links in this series are rather different from some of the first-named specimens with their broad and often flexuose ribs.

PA 984 comprises fragments of two stems (text-fig. 3). In both of them the ribs are rather narrow, with indistinct cross-hatching, although this ornamentation is observable in some places together with a longitudinal striation. The furrows between the ribs are straight and very conspicuous, often bordered by a double line. The terminations of the ribs are acute, the tubercles oval, often rather elongate. On the left hand specimen the lowest node bears a verticil of branch scars, two of which are visible; four ribs above and below each scar converge towards it. The internode above this verticil is much shorter than the other ones.

Other specimens have the same (or larger) size of the ribs, large tubercles, and distinct or indistinct cross-hatching. Among these is the one figured by HOLTEDAHL 1931 p. 331 (PA 992), consisting of fragments of some pith casts. It has straight ribs, with large oval tubercles at the upper ends; in some cases a small tubercle is also visible at the lower end, just above the node (Pl. II fig. 4). The ribs terminate in short points, which are about rectangular.

The large oval tubercles make it natural to compare these specimens with *C. Suckowii*, but the terminations of the ribs are, upon the whole, more acute than is usual in this species, and above all, the verticil of branch scars in PA 984 (which became visible only during the preparation in the laboratory) shows definitely that an identification with that species is out of the question. On the other hand the specimens seem to fall within the range of variation in *C. undulatus*, at least in the wide sense in which it is defined by KIDSTON & JONGMANS.

A more different type is represented by a small number of specimens of a uniform appearance (as illustrated in Pl. V). They resemble rhizomes in their narrow ribs and in the small size of their tubercles (the latter character in contrast to those just described). But their nature as aerial stems is shown by the presence of verticils of branch scars, followed above by an internode of very reduced height.

On account of the narrow ribs and the elongate tubercles some of these specimens might be suspected to belong to *C. Cistii*, a species which might well be expected to occur here. But, apart from other proofs, the verticillate branch scars exclude this possibility. On the other hand, even these specimens seem to range within the field of variation of *C. undulatus*, and a good support for this is found in the typical cross-hatching. Such ornamentation in exceptionally good development is also found in PA 993 (Pl. V fig. 3), whose real nature otherwise is less certain on account of its fragmentary preservation.

A thick stem rising from another axis, probably also representing the aerial part of a stem (or possibly a rhizome) is found in PA 913, Pl. VI figs 1 2.

The ribs of the main axis are broad and straight. Only one node is clearly observable; it can be traced just where the branching

takes place. The branch is as thick as the main stem. Its pith cast tapers towards the point of attachment (which is situated at some distance from the margin of the mother stem); but this conical base is surrounded by a thick coat, which at the junction expands so as to form a kind of cushion. The pith cast has straight ribs, rather broad, with distinct cross-hatching; the terminations are rounded or obtusely pointed, the tubercles at the upper end of the ribs have a considerable size (Pl. VI fig. 2). At the same node to which this branch belongs, there is also a scar (on the white spot in the upper right corner of the figure) which has probably been the base of another similar branch.

The size and form of the ribs, their terminations, although rather blunt, and their surface ornamentation, are all characters making it probable that the specimen belongs to *C. undulatus*. Similar cases of ramification are known from this species (and others), although not very common. The main stem should be expected to be a rhizomatic part rather than an aerial stem; its broad ribs are in contradiction with this, but the state of preservation does not permit of any certainty about this point.

b. *Rhizomes*.

Among the Calamitean remains there are a fair number of specimens which may be regarded as rhizomatic parts of *C. undulatus*. A good representative is PA 990, text-fig. 4. It shows some of the characteristic features, the ribs are narrower than in the aerial stems of the same size, the cross-hatching seems to be restricted to a zone along the middle part of each rib (a feature said by KIDSTON & JONGMANS to be characteristic of the species), and the tubercles are rather elongate. But the determination is not unquestionable on account of the lack of root scars (a specimen like PA 982, Pl. V fig. 2, might also have been regarded as a rhizome of this species if the uppermost internode had not been preserved, the branch scars of which show that it is an aerial stem).

A similar specimen is PA 1012 (Pl. VII), which, by a length of about 20 cm and a breadth of about 9 cm, has four internodes, slightly constricted. Ribs rather narrow and slightly flexuose, with some cross-hatching visible in a few places. The tubercles at the upper ends of the ribs seem to have been elongate; at the lower end of some of the ribs there is also a tubercle (compare the next

Fig. 4. Rhizome of *Calamites undulatus*. — PA 990. Nat. size.

specimen, PA 1049). Root scars are observable at the second and third node, one in the middle of each of them; they are circular, 5—6 mm across, and placed just above the nodal line, the ribs converging slightly or not at all towards them.

An interesting specimen is PA 1049 (Pl. VIII figs 1 2) which resembles the preceding ones as to ribs etc. It is a rhizome with three nodes; the lowest one is poorly preserved and is not shown in the photograph (which is 5,5 cm shorter than the specimen). The internodes are of equal length, about 4,5 cm, by a breadth of 6 6,5 cm. At the uppermost node a root is still seen attached to the rhizome, leaving it at about right angle. It is 5 mm broad, longitudinally striated. The same node shows the terminations of the ribs fairly well: They are long and acute, at least some of them, and the tubercles at their upper ends seem to have been elongate. At the lower end of some of the ribs there is a small nodular tubercle, strongly reminiscent of the small rootlet scars of the rhizomes of *C. Suckowii* (as described by KIDSTON & JONGMANS). In contrast to the latter they are not, however, placed on a nodal band between the ends of the ribs, but, as far as it can be ascertained, within the ribs themselves, at their lower ends, so that the resemblance is rather superficial.

Our specimen is of the same nature as several others which have been figured in the literature, for instance the rhizomes of *C. undulatus* in the monograph by KIDSTON & JONGMANS (1917 Pl. XXVI fig. 3 and Pl. XXXV fig. 4), and those figured by ZEILLER from the Lower Permian of Brive (1892 Pl. X) under the name of *C. leioderma*, but referred by KIDSTON & JONGMANS to *C. undulatus*; all of them show similar roots in the same kind of organic connection with rhizomes.

Detached roots are found in several specimens. They are inarticulate, 5 12 mm across, with fine longitudinal striations, usually straight, measuring 10 cm and more in length. A short fragment is seen alongside the leaf of *Cordaites* on Pl. XVII fig. 1, and another specimen, probably also representing a root of *Cal. undulatus*, is shown on Pl. XXV figs 5 6. It is 11 cm long. At the base it has a characteristic funnel-shape, a widening which seems to be due only to the external, cortical tissue, while the diameter of the central strand is nearly unaltered (Pl. XXV fig. 6).

c. *Unusual forms.*

A very large and interesting specimen is PA 1014 (Pl. IX X). Its preservation, however, is not quite satisfactory, although the matrix is a fine-grained argillaceous shale; when immersed in alcohol the external form of the fossil is fairly clear, but the details indispensable for a specific determination are barely visible.

It consists of part of a stem, preserved in a length of about 24 cm, while the breadth has been at least 9 cm. The internodes are short in relation to the breadth of the stem, mostly 1,5 2 cm. The ribs are 2,5 4 mm broad, straight, in some places with a fairly distinct transverse wrinkling; they end in short points, about rectangular or slightly more acute. In most cases the tubercles at the ends of the ribs are not preserved; only a few places are more favourable (Pl. X fig. 2), and then the tubercle can be seen to have an oval shape and a considerable size.

The most conspicuous feature are the large rhizomatic organs which are still attached to the stem, forming an angle to it of about 30 45°. There are at least four of them, rising from different nodes; but in addition a number of scars from other similar organs are visible. The rhizomes, which are unbranched and straight or slightly curved, even in their present fragmentary state attain a length of more than 25 cm and have certainly been much longer, by a breadth of about 2,5 cm. They are thin at the base, sometimes attenuating as if fixed to the stem by what looks like a stalk; they then gradually grow thicker outwards, and for most of their extension have a constant diameter. They are longitudinally striated, and show no indication of articulation. — The scars are very large, about 2 cm in diameter, and influence the direction of the ribs very considerably.

Affinity. At first sight one might regard the lateral organs as branches. That they really are root organs or rhizomes in a downward direction is, however, certain enough; this is proved as well by the structure of the fossil itself as by a comparison with a similar case described in the literature.

The question of what is up and what is down of the fossil is settled by the position of the tubercles. Certainly they are not very distinct (Pl. X fig. 2), but they give a reliable evidence.

This is corroborated if comparison is drawn with the specimens from Commentry described and figured by RENAULT (1888 1890,

Pl. LVII fig. 1 and others) under the name of *Arthropitys gigas*; they are later discussed by JONGMANS (1911 p. 158) and some of them refigured by KIDSTON & JONGMANS (1917, p. 33, Pl. XXVII figs 2 4, Pl. XXVIII fig. 1); these authors referred them to *C. undulatus*, although with doubt.

The specimens from Commentry also consisted of a thick stem with large cicatrices and in some cases with the lateral organs still attached to them. The size and position of the scars are as in our specimen, and, as the French specimens are better preserved than ours, the morphological interpretation is certain enough, especially as to the orientation of the fossil.

Our specimen is in other respects rather different from the French ones, which are very large and have, in most cases, long internodes and extraordinarily broad ribs; but it is most probable that also our specimen belongs to *C. undulatus*. With its subacute rib ends, the cross-hatching, however faint, the form of the tubercles, etc., it is really more typical than those from Commentry.

The specimen was first discovered by Professor Holtedahl in one of the slabs broken out by our assistant at Semsvik.

In connection with the specimen just described (PA 1014) may be mentioned another, which has some features in common with it:

PA 969 (Pl. XI) is about 7,5 cm broad, with very short internodes, only about 1,5 cm. The pith cast occupies the greater part of the fossil, but a zone representing the woody cylinder is seen on both sides of it. The pith cast has a marked relief, with elevated nodes and concave internodes, causing the alternating light and dark spots on the photograph, Pl. XI fig. 1. The ribs are relatively broad; the form of their ends is not visible, but white markings, which must represent the infranodal tubercles, are conspicuous in several places (as shown in Pl. XI fig. 4), giving evidence about the correct orientation of the fossil. On the right hand side are seen some (probably three) lateral organs in connection with the stem, directed downwards at an angle of about 45°. Large scars are scattered over the pith cast; two of them, from the first and second node from below, are shown in figs 2 and 3 on Pl. XI.

The preservation is poor, but probably the fossil is of the same nature as the preceding specimen.

Age and Distribution. *Calamites undulatus* is very frequent and widely distributed in the Upper and Middle Carboniferous of Europe, and is also a member of many floras of Lower Permian age. Further it is found in North America, in beds corresponding to the same part of the Carboniferous.

Calamites cf. *Suckowii* BRONGN.

Pl. IV fig. 1.

The specimen showing the closest resemblance to *C. Suckowii* is PA 972 (Pl. IV fig. 1). The internodes are very short, about 1,2 2 cm by a breadth of more than 8 cm. The ribs are broad, the tubercles at their upper ends very large, although their shape, which appears to be nearly round, to some extent may be due to pressure. The ribs seem to terminate in quite blunt ends, square or rounded, a fact strongly suggestive of *C. Suckowii.* But as the specimen has been somewhat pressed and the nodes slightly deformed, the terminations may have been somewhat different from what they now appear to be; subacute pointed ribs are still visible in some places, and this fact and the very distinct cross-hatching on some of the ribs make the determination uncertain, although the general appearance of the specimen is that of *C. Suckowii.*

Calamites cf. *multiramis* WEISS.

PA 915 (Pl. XII figs 1 2) is a part of a large stem; the fossil is now 35 cm long and, as a maximum, nearly 10 cm broad. It has 11 nodes, which are rather conspicuous, thanks to their peculiar structure: Parallel to the node itself there are two lines, one above and one below it, at a distance between them of 7 8 mm. In some cases the ribs seem to stop at these lines, but sometimes they can be traced across them. Infranodal tubercles cannot be seen with certainty, although some elongate-oval elevations found in some places (Pl. XII fig. 2) may be remains of such structure. Between the lines there is sometimes a series of small conical or semiglobular nodules, at least often corresponding in number to the ribs. The ribs are about 2,5 mm broad. The internodes vary regularly in length; number three from below is less than 1,5 cm, and from here they increase towards the upper part, where they measure 3,5 4 cm.

No convergence of the ribs is observable with full certainty at any of the nodes.

With its prominent nodal lines the fossil reminds of *C. multiramis*, but on account of the lack of the characteristic numerous branch scars the question of an identity must be left quite open at present.

C. multiramis is a species characteristic of the Lower Permian and the uppermost parts of the Carboniferous, and it would not be surprising if it were discovered as a member of this flora.

Calamites spp.

There are a number of specimens which are specifically indeterminable, at least until more material of the same forms has been found, but which are mentioned here to demonstrate the variation of the Calamitean flora or because they exhibit features of morphological interest.

Species *a*. PA 1052 (Pl. XII figs 3 4) is a small specimen, the original breadth of which is not observable any longer; in its present state it measures 3,8 cm by a length of 6 cm. There is only one complete internode, with two nodes bearing remarkable scars; there are two of them at the lower node, while a third one, at the upper node, is more dubious. These scars are dome-shaped, with radiating furrows, and towards each of them the ribs converge in a very marked manner. They are situated just above the nodal line.

The ribs are straight and of median width, terminating in subacute points (about rectangular); at the lower node the lines between them become much more prominent towards the ends. Infranodal tubercles indistinct.

Branch scars of this shape and in this state of preservation have been found in *C. undulatus* (compare, for instance, ZEILLER 1886 Pl. LIV), but this fact alone does not suffice for a determination; *C. multiramis* and other species might also come into consideration.

Species *b*. PA 1050 (Pl. XIII fig. 1) is a cast which chiefly shows the external surface, or at least a section from the outer part of the stem; but an ordinary pith cast with ribbing is visible at a deeper level in a few places where some parts of the fossil have been split off (for instance near the uppermost node). There are three complete internodes, of about equal length and breadth, and four nodes; the latter are conspicuous on account of a raised band, the

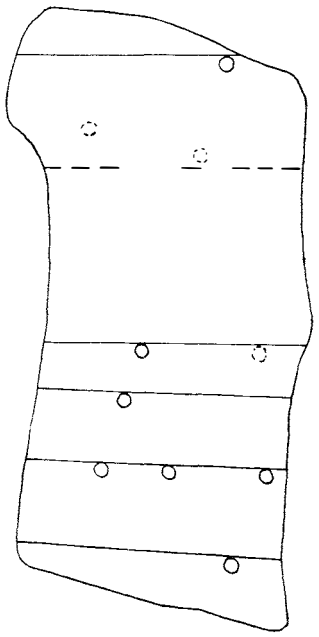


Fig. 5. Diagrammatical drawing of *Calamites* sp., showing nodes and root scars. Compare Pl. VIII fig 3. — PA 1008.

surface of which is rugged with numerous small nodosities. Their number seems to be at least twice that of the ribs, but the proportion is not certain. It is probable that some long markings on the surface of the internodes may represent the leaves; they are subulate and reach from one node nearly up to the one above.

The specimen reminds, in some ways, of *C. multiramis* WEISS, but does not show the characteristic branch scars.

There are also a few other specimens possibly belonging to the same species as PA 1050, although indeterminable so far. One of them, PA 1057, is figured on Pl. XIII fig. 2. It is characterised by its short internodes, the lengths of which (1,5 2 cm) decrease upwards. Ribs straight and rather narrow, longitudinally striated, nodes prominent; rib endings and other details unobservable.

Species *c*. PA 1004 (Pl. VIII fig. 4), which is a poorly preserved impression in a micaceous grey shale, is the pith cast of a slender Calamite, less than 2 cm broad. Although it is 8,5 cm long it has only a single node, one of the internodes being more than 6,5 cm long. The ribs are straight, longitudinally striated, the tubercles at their upper ends elongate. The specimen might be compared with *C. Cistii*, but the characters observable are far from sufficient for a definite determination.

Species *d*. PA 1008 (Pl. VIII fig. 3, text-fig. 5) is a flat impression of a rhizome with root scars, 7,5 cm long, nearly 4 cm broad. The internodes, which are distinctly observable only in the lower half of the fossil, have varying lengths. The ribs are straight and rather narrow, and have more or less rectangular points at their ends; no alteration in their course is caused by the circular root scars, which are placed irregularly (in a number of 1 to 3) at the nodes.

The specimen would certainly be covered by the old name *C. varians*; but the forms thus designated have now been distributed on various species, among them *C. undulatus*. Our specimen may belong to the latter, but it could scarcely be said with certainty.

Problematical Remains of Calamites.

PA 1082 (Pl. VI fig. 5) probably shows the external surface of a Calamite, but unfortunately in a very poor preservation. As seen on the photograph there are two parallel stems, either of them about 1 cm broad. The best one (on the right) has two nodes; it is covered with black filiform impressions which may represent remains of leaves.

PA 926 (Pl. VI figs 3 4) may be an incomplete phragma of a Calamite stem.

PA 1051 (Pl. XIII figs 3 4) is a flat cast of some plant organ which seems to have had a considerable thickness; it can be traced discontinuously for about 7,5 cm, by a breadth of 1,5 cm; the limitation on one side is somewhat undear. The surface is wrinkled. It has longitudinal striations, about 5 per millimeter; they are caused, in most cases, by fine and sharp furrows with convex ridges between them, straight and continuous over long distances. This system is crossed by more irregular transversal furrows, so as to form a reticular structure.

The real nature of this fossil is obscure. Attention may be drawn to its striking resemblance to roots of *Calamites Suckowii*, which have just this reticular surface, in contrast to those of *C. undulatus* (compare KIDSTON & JONGMANS 1917 Pl. LXXXII); but with its 1,5 cm it is three times as broad as they use to be.

Asterophyllites BRONGN.

Asterophyllites equisetiformis (SCHLOTH.) BRONGN.

Pl. XIV figs 1 5.

Specific Characters. — In contrast to *Annularia* the linear leaves of *Asterophyllites* are always directed more or less upwards; they are, in *A. equisetiformis*, about 10—15 mm long.

Most of our specimens are rather fragmentary and of poor preservation. They are found in the fine-grained argillaceous shale, and in some occurences of very limited extension they could be collected in a considerable number. Only some better specimens are figured here.

PA 951, Pl. XIV fig. 1, is an interesting specimen, in so far as it shows the connection between foliage-shoots and main axis. The latter is 5,5 cm long and about 7 mm broad, finely striated. In the middle there is a node bearing long leaves (nearly 3 cm) and two branches, which are typical *A. equisetiformis*. Other typical shoots are PA 1000 and 908, as illustrated on Pl. XIV figs 3 5.

A branched shoot in a juvenile state of development is illustrated in Pl. XIV fig. 2. The curved main axis is very slender and somewhat more than 6 cm long when measured along the curve. It has at least 7 nodes, each bearing a verticil of long linear leaves and one or a few branches. The latter are more or less bud-like, with quite short internodes and densely packed young leaves. The specimen is really beautiful but rather indistinct on account of the slight contrast between the fossil and the matrix.

Affinity. Our specimens are quite typical examples of what is known as *Asterophyllites equisetiformis*. Specimens like PA 951 (Pl. XIV fig. 1), showing the connection between the foliose shoots and the main axis with its longer leaves have also been mentioned and figured fairly often in the literature, and are represented in museum collections in a considerable number.

Age and Distribution. This "species", which in its usual delimitation certainly comprises the leaves of several species of Calamites, has a wide extension in the Upper Carboniferous and more rarely in the Middle or even Lower Carboniferous; outside Europe (and Asia Minor) it has been recorded from the Carboniferous of the United States, from beds corresponding to the Westphalian C. Further it is common in the lower and middle part of the Lower Permian of Europe.

Calamostachys SCHIMPER.

Calamostachys germanica WEISS.

Pl. XIV figs 6—7, Pl. XV, Pl. XVI figs 1—3.

Specific Characters. Small fructifications with articulate axis, bearing whorls of sterile bracts about twice the length of the internodes, often very strongly curved; sporangiophores placed between the nodes (in *Palaeostachya* in the axils of the bracts).

Specimens of calamite fructifications, mostly referable to this species, are not rare at Semsvik in Asker, usually in occurrences of a very restricted extension. They are found in the soft shale,

and the preservation of the details is not bad; but usually they are fragmentary, and the contrast between the impressions and the matrix is inconspicuous; in most cases very little is left of the organic matter.

PA 899 (Pl. XV figs 1 2) is a fairly complete specimen; it shows a character of generic importance, viz. the scars left by the sporangiophores, which had their places in the internodes, about straight between the verticils of sterile bracts. The sporangia and their pedicels are lost, as is usually the case in this species, but the scars are indistinctly visible, for instance in the lower part of the magnified figure. The sterile bracts were at least two to three times the length of the internodes, which were about 3 mm long. They were curved, although not so much as in some other specimens.

The position of the sporangiophores is more distinctly seen in PA 964 (Pl. XV figs 5 6), but in other respects this specimen is poorly preserved.

PA 1020 *a* (Pl. XV figs 3 4) does not show the scars of the sporangiophores with certainty, but it is of interest on account of the shape of the sterile bracts. These are very strongly curved, leaving the axis in a downward direction, and then turning upwards so as to be parallel to it. They are about two or three times as long as the internodes, which measure about 2,5 mm.

PA 1075 (Pl. XVI figs 1 2) is a nearly complete strobilus, the base of which seems to be connected with a thicker axis by means of a curved stalk, a few millimeters long. The main axis is delicately ribbed and articulate like a small Calamite. The poor preservation does not give full certainty to the interpretation, but it is rather probable.

PA 1054 (Pl. XVI fig. 3) is slightly larger than the other specimens, and the bracts in the lower part are rather large and rigid-looking; but in the upper part they are more similar to those of the specimen just mentioned, and they have the same curve.

There are also some juvenile fructifications, of which two examples are figured on Pl. XIV (figs 6 7, PA 1055 and 1020). In the case of the more slender one, PA 1020 (fig. 7) we have in all probability a young specimen of the same kind as those just described, while this may be somewhat more uncertain as to the other; the latter resembles the coarser form of which a specimen (PA 1054, Pl. XVI fig. 3) was described above.

Affinity. At least most of the specimens here described seem to belong to one species, and when combining the characters observable in the various specimens one can form a good idea of this fructification. It corresponds completely to *Calamostachys germanica*, as this name is used by JONGMANS (1911), GOTHAN & FRANKE (1929), and others, and also to the original diagnosis by CH. E. WEISS (1876). It resembles *C. tuberculata* (STERNB.) WEISS (which is the fructification of *Annularia stellata*), but the length of the bracts and their strong curve are very characteristic and form a safe point of distinction.

Specimens of the same type of fructification have often been described in association with the foliage of *Asterophyllites equisetiformis* (compare, for instance, ZEILLER 1886 Pl. LVIII, STERZEL 1907 Pl. XVIII and JONGMANS & KUKUK 1913), and they can safely be regarded as belonging together.

Age and Distribution. The species was established by WEISS on material from the Saar Basin and Lower Silesia, and it occurs in several areas of the Upper Carboniferous, although its distribution could scarcely at present be stated. NOÉ (1925 Pl. V fig. 4) has figured a specimen from the Pennsylvanian of Illinois, which, however, is considerably larger than ours. In beds of a Lower Permian age it is common, at least in some districts, for instance in the German Rotliegendes.

Palaeostachya CH. E. WEISS.

Palaeostachya sp. *a.*

Pl. XVI figs 4 5.

Pa 1048 is a small, gracile fructification, of which the top and the base are not preserved. It is articulate, with internodes about 3 mm long. Sterile bracts long, more than twice the length of the internodes, strongly curved, sometimes even in a half-circle, so that the tip touches the axis. Sporangia sessile in the axils of the bracts, about 2,5 mm long, obovate, forming an angle of about 45° to the axis.

The position of the sporangia is that of *Palaeostachya*, but the entire lack of any sporangiophore is a peculiar feature; on the enlarged photograph it seems to be observable with full certainty, although the preservation upon the whole is far from good. It is just upon this character that the genus *Volkmannia*, first established by STERNBERG, has been delimited by WEISS (1876 p. 112) and by

JONGMANS (1911 p. 339). Our specimen has a close resemblance to the only species maintained by JONGMANS: *V. tenera* WEISS (l. c.), from Silesia (which KIDSTON 1886 assumed to be identical with *V. pseudosessilis* GRAND'EURY), but the material is too scanty for a safe determination, and for stratigraphical reasons an identity is not probable.

Palaeostachya sp. *b.*

Pl. XVI figs 6—7 (10).

We have a small number of specimens all referable to one species of cone. The best one is figured on Pl. XVI figs 6 7 (PA 1038). Of the stalk a part of about 6 mm is preserved, and the fructification itself, of which the upper part has been lost, is about 4 cm by a breadth of 7 mm. The verticils are closely together, with a distance of 2,5 mm; they consist of sterile bracts, which, at least apparently, are filiform, and of numerous sporangia. The latter distinctly give the impression of being placed in the axils of the bracts, directed obliquely upwards, and they are preserved with a prominent relief.

The state of preservation does not make it possible to ascertain beyong doubt whether the insertion of the sporangiophore is that of *Palaeostachya* or *Calamostachys*, although the former seems to be the more probable, and attempts at a determination as to species must be entirely desisted from.

Spores could be isolated from cones of this type. Those figured on Pl. XVI are from one specimen, PA 900, which was fragmentary and in a poor preservation as to the external form. Parts of it had been attacked by a fungus, of which some hyphae are shown in Pl. XVI fig. 10.

Further studies of the spores of this and other Calamitean fructifications will be postponed until more material has been collected.

Cordaites UNGER.

Cordaites principalis (GERMAR) GEINITZ.

Pl. XVII, Pl. XXV figs 1 2.

Specific Characters. — The huge leaves, which are usually found as fragments, are characterised by having more than one interstitial stria between the principal veins.

Specimens of *Cordaites* are not very rare in Asker, although they by no means belong to the commonest fossils. (Specimens from other parts of the Oslo Region are mentioned below, p. 35).

PA 916, Pl. XXV fig. 1, is a part from near the base of a leaf, about 9,5 cm long and 3,4 cm broad. The striation between the principal nerves is well visible. PA 894, Pl. XVII fig. 1, is another fragment, which shows the same feature clearly, as is illustrated in magnification on Pl. XXV fig. 2.

In some other specimens of large size the veins are farther apart and often rather coarse. An extreme case is PA 941, Pl. XVII fig. 2. It is no less than 8 cm broad, by a length of nearly 18 cm. The principal veins are prominent and far apart, numbering only about 8 per centimeter; forking is observable in some places. The number of interstitial striae is often three. In other specimens (like PA 914) there are about 12 14 principal veins per centimeter.

A dubious specimen which may be mentioned in this connection, is PA 978, Pl. XVIII fig. 1. It seems to have been rather thick, and the venation is less distinct than in the specimens described above, and less typical.

Affinity. The two first named specimens are certain enough, in so far as species of *Cordaites* can be distinguished at all. The largest specimen is beyond the size which is ordinary in *C. principalis*, and the ribbing is far more distant; on account of the latter feature the specific identity may be doubted, although there are more specimens which seems to form a series of transition to the usual form.

Age and Distribution. *C. principalis* is widely distributed as a common fossil in the Upper Carboniferous and perhaps even down to the lower part of the Lower Carboniferous, but it has also been found in the lower part of the Lower Permian in several places, chiefly in Germany (compare the flora lists of POTONIÉ 1893, LIPPS 1927, and REICHARDT 1932). Also in France and Portugal it occurs in beds of this age (CARPENTIER 1932, DE LIMA 1890). Further it has been recorded by CARPENTIER from the Lower Permian of Morocco, and by HALLE and GOTHAN & SZE from the corresponding beds of China.

Samaropsis GÖPPERT.

Samaropsis Holtedahlii n. sp.

Pl. XVIII figs 2 4.

Diagnosis: Platyspermic seed, consisting of a central nucule surrounded by a wing. Nucule ovate, slightly longer than broad, gradually tapering towards the apex, which has a short bifid beak; abruptly contracted at the base, which is usually prolonged into a point reaching the margin of the wing. The latter is broad, of the same outline as the nucule, except that the sides in the upper part are more concave, and the base sligthly cordate; apex emarginate and bifid. Nucule 4 5 mm long and broad; wing about 1 mm wide in the upper part, until 2,5 mm at the base.

The nucule has a delicate striation converging towards the apex, with a dark median line starting from the groove in the bifid tip, and sometimes continuous nearly to the base. The margin of the nucule is surrounded by a dark zone, which is broadest and most prominent in the upper part.

These seeds are not very common, but when occurring they are usually present in a very great number, lying crowded on the surface of the slab. They have only been found in the fine-grained shale at Semsvik in Asker.

Affinity. It seems probable that this species is identical with the one from Thuringia figured by POTONIÉ (1893 Pl. XXXI fig. 12) under the name of *Samaropsis* typ. *orbicularis* (v. ETTINGSH.) POT. There is a complete agreement in size and form. They cannot, however, belong to *S. orbicularis*, as v. ETTINGSHAUSEN'S species, which is now usually regarded as a synonym to *S. emarginata* (BERGER) KIDST., has twice the size of ours, and this is a character which varies only very slightly.

Our specimens have a certain resemblance to *S. fluitans* (DAWS.) WEISS, as it is described and figured by many authors. Especially comparison should be drawn with CH. E. WEISS 1868 72 Pl. XVIII figs 24 30. These specimens are, however, generally more oval and narrower in outline, as is also explicitly said in the description, and this is also the case with the type specimens of DAWSON (his figure is reproduced by SEWARD 1917 p. 350, fig. 502 A). On account of this a specific identity is scarcely possible.

S. ulmiformis GÖPPERT (1864 1865, p. 177, Pl. XXVIII figs 10 11 and 19) is said to have wings attenuating towards the base and ending there in a small point, and broader in the upper part. For the rest there is considerable resemblance.

LESQUEREUX (1879) has described and figured a number of platyspermic seeds from the coal fields of Pennsylvania. Some of them compare well with our form, but much better evidence would be required if a specific identity should be assumed.

Upon the whole it seems to be impossible to combine our form with any species previously described. On the other hand it is so characteristic that it deserves a specific name.

Samaropsis is widely distributed in the Carboniferous and Lower Permian. At least some of the species represent the seeds of *Cordaites*; but *C. principalis* is held to have seeds of the type called *Cordaicarpus Cordai* (GEIN.) ZEILL.

Walchia STERNB., emend. FLORIN.

These Conifers, which are among the oldest ones known, have twigs spreading in one plane only (like those of *Araucaria*, with which there is a striking but quite superficial resemblance). The leaves are spirally arranged, needle-like, usually appearing rather narrow, because they are mostly seen in longitudinal section, but really of varying breadth and with a mid-nerve. On the main branches they are often larger. Bracts with bifurcate tips (*Gomphostrobus*), as known from Germany and France, have not yet been found with certainty in our material, neither in their original position nor isolated. As to the reproductive organs, see descriptions by FLORIN (1927).

Walchia piniformis (SCHLOTH.) STERNB.

Pl. XIX fig. 1; Pl. XX figs 1 4; Pl. XXI; Pl. XXII; Pl. XXV figs 3—4(?).

Specific Characters. When well preserved the species is easily recognised by its curved leaves, more or less erect, about 5—7 mm long.

There is a considerable number of specimens of this species, varying very much according to the state of preservation, and its appearance is very different in the various kinds of rock.

In the fine-grained, argillaceous shale the preservation is best, and here the leaves and twigs may well be studied in detail, although,

unfortunately, no cuticle is left. PA 914 (Pl. XIX fig. 1) is poorly preserved, but shows a strong branch with twigs spreading in one plane. PA 1044 (Pl. XX figs 1 2) is another branch showing distichally arranged twigs. The leaves on the main branch, which seem to have been very numerous and crowded, are often long, at least 7 mm, acute and falcate, while those on the twigs are generally shorter and broader. — A surface view is seen on a small fragment, PA 1072 (Pl. XX fig. 4): The leaf is 4 mm long or slightly more, 1 mm broad, the nerve strong but scarcely more than 0,25 mm broad; when regarded this way, from the flat side, the leaf is rather blunt, in contrast to the long linear points which are seen in most other specimens exhibiting longitudinal sections of the leaves.

The plant has quite a different aspect when preserved in the coarse-grained, red sandstone. Here are often found impressions of branches of a considerable length. The largest specimen in our collection (PA 932) is 50 cm long, with twigs and leaves at least partially visible in the upper portion, while in the lower end only the main branch can be seen. In this sandstone, however, the preservation is usually very poor; nothing is left of the organic matter, and details of the impression are rarely observable.

A peculiar specimen is PA 1024 (Pl. XXII). It is a partial impression of a branch with twigs and buds, in a fine-grained, red sandstone. The main axis is only seen as a faint marking in the lowermost part. The most conspicuous feature are the buds, which are seen in two parallel rows, one on each side of the branch and at equal distances from it. At least in some places the twigs, bearing these buds, can be traced towards the branch; but the connection is nowhere seen, and usually the twigs are only represented by series of leaves, preserved as superficial mouldings (compare the so-called *W. imbricata* below).

At the first glance the specimen has rather the appearance of a trail, but its real nature is beyond doubt. Buds on the twigs of *W. piniformis* are not rare in other countries where this species occurs, although they are not always placed so regularly at the end of each twig as in this specimen.

In a very fine-grained red sandstone *W. piniformis* (and other species) has, upon the whole, an appearance widely different from that in the argillaceous shale; it is usually found in the state of preservation called *W. imbricata* SCHIMPER (Pl. XXI, Pl. XXV figs 3 4). Very often the twigs are isolated, about 3 5 cm long, lying scattered but

in great number on the slabs. In the most typical cases the leaves are seen as convex scales, broad and short, disposed densely in spirals and partly covering each other. The appearance is then very different from the typical *W. piniformis*, and the species *W. imbricata* might seem to rest on a safe base. Dr. Florin, Stockholm, is, however, of the opinion that *W. imbricata* cannot be maintained as a species (compare PURKYNĚ 1929 p. 34), and having seen the large material from the new Norwegian locality and from German collections, I quite agree.

The characteristic appearance is only due to the fact that the rock splits along the surface of the twigs, instead of through the median axis, the leaves consequently showing the flat side and not the longitudinal section. In our material transitional stages can be seen (Pl. XXI).

It is, however, remarkable that in this state the twigs are nearly constantly found isolated. It is a rare thing to find them in their original connection with the branches; it does occur in the German Rotliegendes, but it is never the case in the material from Asker (apart from PA 1024, see above). Perhaps the explanation lies in the fact that *W. imbricata* is practically always, in Asker and elsewhere, found in a special kind of rock, a red sandstone of very fine grain; probably the conditions of sedimentation have favoured the fossilization of detached twigs. As a matter of fact, SCHIMPER'S type specimen (1869—74, Tome II p. 239, Pl. LXXIII fig. 3) from Autun was not preserved in this kind of rock, but in a compact black shale, and here the twigs were still in connection.

Together with the numerous twigs of the *imbricata* type clearly referable to *W. piniformis*, are also found specimens of a more different form. Most important of this is the one figured on Pl. XXV fig. 3. It has been split longitudinally; the leaves are squarrose, at right angle to the axis, but with a bend of about 45° in the outer third. Specimens of this type are not rare in other localities as well (in the German Rotliegendes) and they have often been referred to *Ernestiodendron* (*Walchia*) *filiciforme*. They are, however, much too slender to belong to this species; on the other hand they differ considerably from the ordinary *W. piniformis*, and it seems quite possible that they represent a separate species, not yet named. If preserved as *imbricata* it will be indistinguishable from *W. piniformis*.

The sandstone containing *Walchia* in this state of preservation belongs to a somewhat higher horizon than most of the plant beds

in Asker; it was discovered by Mr. Per Størmer on the southern side of the Hagahugget, where it is best developed.

Age and Distribution. *Walchia piniformis*, like the other species of the genus, was for a long time regarded as a fossil particularly characteristic of the Lower Permian, and in beds of this age it is common in most parts of Europe in Central Europe, England, France, and Southern Europe; it is also recorded by CARPENTIER from the Lower Permian of Morocco, while many references to this species from other parts of the world seem to be based on doubtful identifications as to the species. The species, however, also appears in the Upper Carboniferous, being known from the Stephanian of England, France, Germany, and Czechoslovakia; usually it is scanty in the Carboniferous, but greater abundance is also known, for instance at Saint-Etienne (BERTRAND 1919).

Walchia linearifolia GÖPPERT.

Pl. XIX figs 2--3.

Specific Characters — Differs from *W. piniformis* in having more slender twigs, and in the shape of the leaves, which are straight, usually more erect than in the other species, and apparently very slender.

In Asker it is much less common than the preceding species, and there are only few typical specimens, the best one (PA 1022) being reproduced here as Pl. XIX figs 2 3; it is fairly well preserved, although the shale is rather micaceous. It consists of an imperfect branch with three twigs, all directed to one side, and only partly preserved. The leaves appear to be very narrow and are nearly straight, mostly about 7 mm long.

Affinity. *W. linearifolia* might be thought to be only *W. piniformis* in a certain state of preservation; but they seem to be very well separated, and usually, in the collections from the German Rotliegendes, they are easily distinguishable. Our specimen is a typical representative of the species.

Age and Distribution. *W. linearifolia* occurs in the Lower Permian of Central Europe (Bohemia, Germany, and France), but, as it seems, always much less common than *W. piniformis*, and in contrast to the latter it has never with certainty been met with in the Carboniferous. It has also been recorded by CARPENTIER (1930) from the Lower Permian of Morocco, and by HALLE (1935) from the Nanshan region of China, although with a "cf.".

Walchia hypnoides (BRONGN.) BRONGN.

Pl. XIX figs 4—6.

Specific Characters. Very slender and delicate, the leaves short, strongly curved.

We have a few specimens from Asker (Semsvik), referable to this species and showing the characteristic features very distinctly. In PA 1039 (Pl. XIX figs 4 5) there are four parallel branchlets which clearly belong together. The leaves are about 2 mm long (not measured along the curve); they are bent in S-form, with the tip pointing towards the axis. They are fairly broad, and there is, in some of them, a distinct nerve. The base is decurrent along the axis; this latter feature is still more conspicuous in another specimen, PA 937 (Pl. XIX fig. 6).

Affinity. The species has a considerable resemblance to *W. piniformis*, and its systematical value has often been doubted (GÖPPERT 1864 1865 p. 235, SEWARD 1919 p. 281, KIDSTON 1886 p. 15, and other authors). Usually, however, it is very well characterised and can be determined without hesitation, and it should certainly be kept up until there is a definite proof to the contrary.

Our specimens have a close resemblance to the type figured by BRONGNIART (1828 Pl. 9 *bis*) and seem to correspond in all essentials to this and to specimens from German localities.

Age and Distribution. *W. hypnoides* has been found in the German Rotliegendes (Ilfeld), but it seems to be more common in the French deposits of the same age, although it is nowhere really frequent. It is recorded by DE LIMA (1890) from Portugal. In some places in France (Saint-Etienne, according to GRAND'EURY; le Creusot, according to ZEILLER) it has been found in strata below the limit of the Permian, but apparently always as a great rarity. Further it has been recorded by ZALESSKY (1927) from the Artinskian (Lower Permian) of the Government of Perm, and by CARPENTIER (1930) from the Lower Permian of Morocco; whether these specimens are identical with the Norwegian one may be subject to doubt. HALLE (1927) has figured a small fragment from the Upper Shihhotse Series (Lower Permian) of Shansi, which he compares with *W. hypnoides*, although with strong reservation, and the same author has also, according to preliminary determinations, recorded it with a "cf." from the Nanshan

region (HALLE 1935). A specimen which WHITE (1929) has recorded from the Hermit Shale of the Grand Canyon (correlated with the Upper Rotliegendes) has been referred by the said author to *W. hypnoides*, but with a note of interrogation, and it cannot be taken as a valid proof of the existence of the species in America.

Walchia sp.

In connection with *Walchia* should be mentioned two specimens which are rather problematical, but interesting:

PA 980, which consists of grey shale with very fine grains of mica, had been collected for the sake of some branchlets of *Walchia linearifolia*, but turned out to contain also some remains of another organ, which could be prepared out (Pl. XXIV figs 2 3).

This fossil, which is only partly preserved, is about 5,5 cm long and consists of a central axis bearing lateral short shoots, apparently in opposite or verticillate disposition; the vertical distance between them is not larger than that they touch each other. Each of these lateral shoots looks like a dense tuft of bracts, borne on a very short branch (not so long as the diameter of the central axis). The bracts are very strongly curved, and they seem to be broad, although in most cases they are only seen in longitudinal section. Their shape can be fairly well studied in one case, visible on Pl. XXIV fig. 3, on the left hand side of the axis, in the third branch from below: The lateral shoot is at right angle to the main axis, and on its upper side are two leaves with a backward bend at the base and then curving up.

Affinity. The fossil looks like a strobilus, but no traces of organs of reproduction are observable, and it is possible that it is only a sterile branch-system in a juvenile state. That it belongs to *Walchia* could scarcely be doubted, judging by the shape of the leaves. — A comparison suggests itself with what GÖPPERT (1864 1865, Pl. XLIX fig. 13) has figured as a male strobilus of *Walchia piniformis*. The question of the identity and the real nature of our fossil should, however, rather be left open at present.

PA 1005 (Pl. XXIII; Pl. XXIV fig. 1) is part of a fertile branch system, consisting of a strong main axis and a few lateral branches. The main axis is 11 cm long, broken at the top, about 0,8 cm thick, with a coarse and discontinuous longitudinal striation probably due

to the leaf-bases. Leaves are preserved in a few places (Pl. XXIII fig. 2); they are (at least some of them) straight and acicular. The side-branches are only found in the upper part; the lowest one on the right hand side is best preserved. At the base it is covered with needle leaves (Pl. XXIII fig. 3), shorter than those on the main axis and more curved. This and other branches (Pl. XXIII fig. 4, Pl. XXIV fig. 1) bear ovate bodies, about 3 4 mm long, in dense, spiral arrangement and surrounded, as it seems, by linear bracts. The nature of these bodies cannot be ascertained from direct observation, the preservation being extremely poor.

Affinity. The leaves as well as the appearance of the main axis (compare Pl. XIX fig. 1) show that our fossil is part of a *Walchia,* presumably *W. piniformis.* It certainly represents an organ of reproduction, but it could scarcely be given a right interpretation without comparison with more and better material. Probably it is of the same nature as a specimen from Autun described by RENAULT (1893 1896, p. 355, Pl. LXXIX fig. 1, previously also described by GRAND'EURY) as bearing female cones.

Ernestiodendron FLORIN.

Walchia filiciformis (SCHLOTH.) STERNB. was separated from Sternberg's genus by FLORIN (1927), who instituted a new, monotypical genus *Ernestia*, characterised by its female cones, the epidermal structure of the leaves, etc. Unfortunately, the name *Ernestia* proved to be invalid, being preoccupied for a living flowering plant, and Dr. FLORIN has now (1934) published a new name, *Ernestiodendron*, which has to be used in future.

Ernestiodendron filiciforme (SCHLOTH.) FLORIN.

Pl. XX figs 5 6, Pl. XXVI.

Lycopodiolithes filiciformis SCHLOTHEIM 1820 p. 414, Pl. 24.
Walchia filiciformis STERNBERG 1823 H. 4, pag. XXII.
Ernestia filiciformis FLORIN 1927 p. 4.
Ernestiodendron filiciforme FLORIN 1934 p. 468.

Specific Characters. — Leaves at about right angle to the branch, in the outer part with a strong curve upwards. Variable in size as well as in form, but usually larger and more robust than *Walchia piniformis.*

Our best specimen is PA 1041, Pl. XXVI figs 1 2, which is counterpart of the specimen of which HOLTEDAHL (1931 *a*, fig. 5) published a retouched photograph. It is a part of a branch, about 9 cm long and 1 cm broad, with three twigs on one side and one on the other. The twigs, which form open angles (about 65°) to the branch, appear to end in a kind of dilatation. The one on the lowest twig may be due to some deformation before fossilization, while in the second twig the bud-like appearance seen on the photograph is much less conspicuous when the light comes in another direction, and at least partly it is due to some colouring matter of no importance. The surface, as preserved now, is coarse and uneven. The leaves measure about 7 8 mm from base to apex (without allowance for the curve); they are uncinate, squarrose, leaving the branch at right angle or even bent backwards at the base.

There are a few more specimens which must be referred to the same species; they were all found in parts of the same slab.

PA 1042 (Pl. XXVI figs 3 4) is a simple branch, about 11 cm long. The structure of the plant, the size of the leaves and the association in the same slab strongly suggest that it belongs to the same species as the specimen just described. The leaves, however, are not only at right angles to the axis, but even revolute, the tips pointing towards the base. The tapering of the branch and the decreasing length of the leaves show that this orientation of the specimen is probably correct. It is a rather remarkable feature, but not unknown in this species.

A third specimen (PA 1043, Pl. XX figs 5 6) is still more peculiar. It has very long leaves; the base is directed slightly upwards, and then, about 5 mm from the stem, there is a sharp downward bend, so that the distal part of the leaf, 15 mm long or more, becomes nearly parallel to the axis.

Our entire material of this species was found in one slab of greenish shaly sandstone with a considerable amount of mica. It belongs to the first collection brought together by Professor Holtedahl and his companions, and in spite of special search no more specimens have been found.

Affinity. Although no cuticle preparations could be obtained the identity could scarcely be doubted. The most complete specimen (Pl. XXVI fig. 1) has the typical appearance of *Ernestiodendron filiciforme*. The fact that it is preserved in this micaceous sandstone shows that it has been rigid and resistant.

Age and Distribution. Together with *Callipteris* this species is the most typical index fossil of the Lower Permian, and, in contrast to the genus *Walchia,* it does not seem to occur in the Carboniferous at all. It is frequent in the Rotliegendes and in other deposits of corresponding age in Europe, and with some doubt it has been recorded from Morocco by CARPENTIER. The genus also occurs in the United States, according to FLORIN (1927 p. 14).

Problematicum.

PA 1081, Pl. XXIV fig. 4, is a strong axis, 11 cm long and nearly 1 cm thick, bearing laterally a great number of bracts or pedicels of uniform shape and size in seemingly irregular arrangement. They are somewhat more than 1 cm long and seem to have been rigid and stiff; they leave the axis at about half right angle, and in their upper parts often curve slightly upwards.

The fragmentary nature of this fossil makes a determination impossible at present. But certainly it represents the remains of some reproductive organ, and more material should be searched for.

Fossils from other Parts of the Oslo Region.

Traces of plants have been found in several cases in other parts of the Oslo Region, in sandstones corresponding to the beds at Semsvik. From the collections the following samples may be quoted according to their labels:

Calamites sp. in red sandstone: "1 3 m above the conglomerate. V. Skougum 9/9 31. Per Størmer".

Indeterminable remains: "*In situ.* Southern side of the Kvieberget, Asker. 13/10 31. Excursion, O. Holtedahl".

Remains, at least partly roots: "Under the lava, between the agglomerate and the quartz conglomerate. Dalen, Åsdøl, Lier. O. Holtedahl, May, 1932".

Better results have been obtained in other districts:

a. *Holmestrand.*

On September the 28th, 1932, Professor Holtedahl succeeded in finding fossils *in situ* a short distance to the north of the railway station of Holmestrand, on the upper side of the road. They were

impressions in sandstone occurring in thin layers within the lava. This stratigraphical position is interesting and of some importance to the exact dating of the beds, but a good preservation of the plants could not be expected under those circumstances. Most of them are longitudinally striated (Pl. XXVII figs 1 5), and in some cases it is above doubt that they represent *Cordaites* leaves. On the same slabs are found other traces, very indistinct, which may be impressions of *Walchia*. The best one among these poor objects is shown on Pl. XXVII fig. 6.

In August, 1933, I searched for fossils at Holmestand, partly together with Dr. A. Heintz. The limit between the red Permian sandstone under the volcanic rocks and the underlying red Downtonian sandstone is often difficult to find, and to a large extent the Permian is covered, so that the conditions, upon the whole, are unpromising. Indeterminable remains were found at "Reversen", the turning point of the railway to Vittingfoss.

b. *Skiensdalen.*

Along the eastern side of the Gjerpen Valley from Eidanger to north of Skien Permian sandstones are found between the igneous rocks above and the Ordovician limestones or Downtonian sandstones below[1]. Outcrops are found in several places, but fossils are very scarce.

There is only one known occurrence of relatively good fossils, first discovered by Professor Holtedahl, June, 1932. It is situated near the farm Ryggen, not far from the road crossing, and at the road branch towards the southwest. Between the lava and typical Downtonian there is a hard fine-grained sandstone of brownish-red colour splitting up in flat slabs. On the bedding planes are numerous impressions of *Cordaites* leaves, often crossing each other (Pl. XXVIII). They are very broad, measuring 5 or perhaps even 7 cm and more, with several interstitial striae between the veins. They are referable to the species *C. principalis*. Other fossils were not found, except for an obscure object resembling a seed (Pl. XXVIII fig. 4).

[1] The quartz conglomerate, which forms the base of the Permian, often rests directly on the Ordovician limestones. As a result of this contact it has sometimes been subject to a remarkable chemical alteration, the silica being more or less completely replaced by carbonates. There is a good exposure of this contact close by the farm Nygård.

Indeterminable remains were also found in some other places in the neighbourhood. Further I have found poor but indubitable remains of *Cordaites* in red sandstone at Kolrød, and, in a state not permitting of any positive determination, about 800 m east of Langerud.

Discussion of the Flora.

Age. According to the descriptions above the Paleozoic flora of the upper part of the Oslo Region has the composition as shown in the table, leaving uncertain forms out of consideration.

This is a plant community typical of the Lower Permian (Rotliegendes). As is evident from the table all species have been found in the Permian before. Two of them (or three, if the new species of *Samaropsis* is counted) are not known with certainty from Carboniferous beds at all, others, as the species of *Walchia*, are common and dominating in the Lower Permian and only exceptionally occurring in the Carboniferous. There is no species characteristic only of the latter formation.

It may be mentioned, on the other hand, that we still miss some plants which are now regarded as still more reliable index fossils of the Permian than the genus *Walchia*, namely *Callipteris*; but this may be a question of preservation (or habitat?), the poor remains of fern-like leaves found giving some hope of the discovery even of these forms in the future. The same may be said of *Gomphostrobus*, which is easily overlooked and should certainly be searched for.

For a more detailed determination of the age the negative evidence is of some importance: A flora from the base of the Lower Permian,

	Carboniferous		Lower Permian
	Westphalian	Stephanian	
Calamites undulatus	×	×	×
Asterophyllites equisetiformis	×	×	×
Calamostachys germanica	-	×	×
Palaeostachya spp.	-	-	-
Cordaites principalis	×	×	×
Samaropsis Holtedahlii	-	-	×
Walchia piniformis	-	×	×
— *linearifolia*	-	-	×
— *hypnoides*	-	×	×
Ernestiodendron filiciforme	-	-	×

as is known from Bohemia, Saar, and France, often comprises a large number of species in common with the Carboniferous. That the ferns and pteridosperms of more Carboniferous affinity are missing might be due to the conditions of preservation or to the ecological type of the flora. But *Lepidodendron* and *Sigillaria* etc. are also entirely absent; at least traces of them should have been expected if such plants had formed part of the flora when living.

This is no valid proof, but it is at least a fact making it probable that the beds may be slightly younger than the very lowest part of the Lower Permian.

On the other hand: All admixture of younger types, like the *Ullmannia* and *Voltzia* of the Zechstein, and *Pterophyllum* and *Baiera*, is equally missing. Further, such species as *Calamites undulatus* and *Cordaites principalis* generally do not ascend above the middle part of the Lower Permian, and if the presence of *Calamites Suckowii* should be definitely proved it will give further evidence in the same direction.

In consequence of this it may be stated as probable that the age of the flora is about the middle of Lower Permian.

Zones. A zonal differentiation within the flora cannot be pointed out. The fine-grained red sandstone with *Walchia "imbricata"* in Asker above the lava is rather different from the plant-bearing beds below; but that may be regarded as a difference in facies and no great difference in age. The plant remains found in the other parts of the Oslo Region (Holmestand, Skiensdalen), in so far as they are determinable at all, show a close connection with the flora of Asker; a difference in time would also be out of the question, the relation to the volcanic activities being quite clear.

Phytogeographical Relations. The flora has a very distinct connection with the Central European flora of the same age, especially with the German Rotliegendes and although less pronounced with some of the corresponding beds in France. There is no trace of foreign elements showing relation to the other biogeographical provinces which existed at this time: It is a flora of a typical "arcto-carbonic" character (GOTHAN) belonging to the phytogeographical province which extended, at the beginning of the Permian, over Europe (except the northeastern part of Russia) and the northern part of Africa (Morocco, CARPENTIER 1930), partly also including North America, where the flora, however, also developed a number of strange forms not found in Europe (WHITE 1929).

As to the conditions in Asia it is striking how the latest discoveries have revealed that the flora of the Carboniferous, even in Sumatra, China, and Turkestan, had a close relationship to the contemporaneous European flora (JONGMANS & GOTHAN 1925, ZALESSKY 1928, HALLE 1927), while, as is well known, the Lower Permian flora was divided into provinces with surprisingly well defined limits. It is worth noticing that in the Lower Permian of the Oslo Region there is not the slightest trace of influence from the eastern floras.

Biological Character. It is worth regarding the flora in view of the theory of GOTHAN & GIMM (1930) about the ecological types of the flora of the Rotliegendes. As is well known the authors proved that the different character of the flora in various occurrences in Germany was due not to difference in age, but corresponded to the difference in the growth conditions; the association of Pecopterids and Calamites (Flözbildner) is connected with coal seams and represent the flora of swamps, while the association of *Callipterides* and *Walchia* (Nicht-Flözbildner) belonged to drier places without any formation of coal. There are exceptions from this rule, as pointed out by the said authors themselves, and by REICHARDT; but GOTHAN & GIMM have shown that in those cases the plant deposits are allochthonous, the mixing being due to the transport to the place of plant remains from several other places.

The flora in Asker consists of a mixture of plants from both associations, and apart from the *Walchia* "*imbricata*" in the fine-grained red sandstone above the lava there is no correlation between the character of the sediments and their fossil contents, except as to preservation: In the coarse red sandstone or shale at Semsvik there are impressions both of stems of Calamites and branches of *Walchia*. On the other hand, in the beds of argillaceous shale Calamite stems are certainly dominating, at least in most places; but they are mixed with *Walchia* etc.

The explanation may be sought in the conditions of sedimentation: The character of the sediments, the lack of coal seams and root beds, and the state in which the plant remains are preserved, show that the deposit is not autochthonous; the plant débris have been transported to the spot, probably not over any very long distance, but far enough to render possible a mixing of plants from various habitats.

Bibliography.

ARNOLD, CH. (1934): A Preliminary Study of the Fossil Flora of the Michigan Coal Basin. — Contrib. from the Mus. of Pal., Univ. of Michigan, Vol. IV, No. 11, p. 177—204, Pl. I—VII. — Ann Arbor.

BERTRAND, P. (1919): Sur la flore du bassin houiller de Lyon (bassin houiller du Bas-Dauphiné). - Comt. Rend. Acad. Sci., t. 168 p. 174—176. — Paris.

BRONGNIART, A. (1828—1838): Histoire des végétaux fossiles ou recherches botaniques et géologiques. — Paris.

CARPENTIER, A. (1930): La flore permienne du Bou Achouch (Maroc Central). — Service d. Min. et de la Carte Géol. du Maroc. Notes et mém. p. 1—43, Pl. I—XII. — Grenoble.

— (1931): Quelques remarques sur la flore des schistes permiens de Lodève (Hérault). — Bull. Soc. géol. de France. Sér. 5, t. I, p. 189—194, Pl. X—XI. — Paris.

DIX, EMILY, & A. E. TRUEMAN (1935): Non Marine Lamellibranchs from the Upper Palæozoic Rocks of Semsvik in Asker. — Norsk Geol. Tidsskr. B. XV, p. 25—32. — Oslo.

FLORIN, R. (1927): Preliminary Descriptions of some Palaeozoic Genera of Coniferae. — Ark. f. Bot. Bd. 21 A, No. 13, p. 1—7. — Uppsala.

— (1934): Note on the Nomenclature of Palaeozoic Conifers. — Sv. Bot. Tidskr., Bd. 28, p. 468—469. — Uppsala.

FRENTZEN, K. (1914): Die Flora des Buntsandsteins Badens. — Mitt. d. Bad. geolog. Landesanstalt, Bd. VIII, p. 64—162, Taf. XI—XXIII. — Heidelberg.

GOTHAN, W. (1925), vide JONGMANS.

— (1930): Die pflanzengeographischen Verhältnisse am Ende des Paläozoikums. — Ber. d. deutsch. bot. Gesellsch., Bd. XLVIII, p. 63—65. — Jena.

— (1931): Der Wert der karbonischen und permischen Flora als Leitfossilien ("The Value of Carboniferous and Permian Plants as Stratigraphical Indices"). — Palaeontol. Zeitschr., Bd. 13, p. 298—309. — Berlin.

— & F. FRANKE (1929): Der westfälisch-rheinische Steinkohlenwald und seine Kohlen. — Dortmund.

— & O. GIMM (1930): Neuere Beobachtungen und Betrachtungen über die Flora des Rotliegenden von Thüringen. — Arb. a. d. Institut für Paläobot. u. Petr. der Brennsteine, Bd. 2, H. 1, p. 39—74, Taf. 9. — Berlin.

GOTHAN, W. & H. C. SZE (1930): Zu Schenks Publikationen über die Ostasiatische Permokarbon-Flora. — Mem. of the Nat. Research Inst. of Geol. Nr. IX, p. 1—55. — Shanghai.

GRAND'EURY, F. C. (1877): Flore carbonifère du Département de la Loire et du centre de la France. — Paris.

GÖPPERT, H. R. (1864—1865): Die fossile Flora der permischen Formation. — Palaeontographica, Bd. XII, p. 1—316, Taf. I—LXIV. — Cassel.

HALLE, T. G. (1927): Palæozoic Plants from Central Shansi. — Palæontologia Sinica, Ser. A, Vol. II, Fasc. 1, p. 1—316, Pl. I—LXIV. — Peking.

— (1935): On the Distribution of the Late Palæozoic Floras in Asia. — Geograf. Ann. 1935, p. 106—111. Stockholm.

HARTUNG, W. (1933): Die Sporenverhältnisse der Calamariaceen. — Arb. aus d. Inst. f. Paläobot. Bd. 3, p. 95—149. Taf. VIII—XI. — Berlin.

HEINTZ, A. (1934): Fischreste aus dem Unterperm Norwegens. — Norsk geol. Tidsskr. Bd. XIV, p. 176 194, Taf. I—III. — Oslo.

HESS VON WICHDORFF, H., & W. GOTHAN (1926): Zur weiteren Kenntnis der Steinkohlen-Lagerstätte im untersten Rotliegenden von Manebach in Thür. — Jahrb. d. preuss. geol. Landesanst. Bd. XLVII p. 433—457, Taf. XV—XVII. — Berlin.

HOLTEDAHL, O. (1931 *a*): Jungpaläozoische Fossilien im Oslogebiete. Eine vorläufige Mitteilung. — Norsk geol. Tidsskr., Bd. XII, p. 323—339. — Oslo.

— (1931 *b*): Hvordan landet vårt blev til. — Oslo.

— (1934): The Geology of Parts of Southern Norway: The Oslo Region and the Adjacent Sparagmite District. — (With additional papers by other authors). The Geologists's Association London, p. 1—70, Pl. 1—11. London.

JONGMANS, W. J. (1911): Anleitung zur Bestimmung der Karbonpflanzen West-Europas mit besonderer Berücksichtigung der in den Niederlanden und den benachbarten Ländern gefundenen oder noch zu erwartenden Arten. — Med. van de Rijksopsporing van Delfstoffen, No. 3, Bd. I, p. 1—482. 's-Gravenhage.

— (1915): List of Species of Calamites with Enumeration of the Figures as far as they are Doubtful or Indeterminable or belong to other Species. — Med. van 'sRijks Herb. No. 24, p. 1—41. — Leiden.

— & W. GOTHAN (1925): Beiträge zur Kenntnis der Flora des Oberkarbons von Sumatra. — Verhand. v. het Geol.-Mijn. Genootschap voor Nederl. en Koloniën, Geol. Ser., Deel VIII, p. 279—304. — 's-Gravenhage.

— & W. GOTHAN (1934): Florenfolge und vergleichende Stratigrafie des Karbons der östlichen Staaten Nord-Amerika's. Vergleich mit West-Europa. — Geol. Bureau voor het nederl. Mijngebied, Jaarverslag 1933, p. 17—44. — Heerlen.

— & P. KUKUK (1913): Die Calamariaceen des rheinisch-westfälischen Kohlenbeckens. — Med. van 'sRijks Herb. No. 20, p. 1—89. Atlas mit Tafeln 1—22. — Leiden.

KIDSTON, R. (1886): Catalogue of the Palæozoic Plants in the Department of Geology and Palæontology, British Museum (Natural History). — London.

— & W. J. JONGMANS (1917): A Monograph of the Calamites of Western Europe. — Med. van de Rijksopsporing van Delfstoffen, No. 7, p. 1—207, Atlas with Pl. 1—158. — 's-Gravenhage.

LESQUEREUX, LEO (1879—1884): Description of the Coal Flora of the Carboniferous Formation in Pennsylvania and throughout the United States. — Geol. Surv. of Penns. — Harrisburg, Pa.

DE LIMA, W. (1890): Noticia sobre as Camadas da Serie Permo-Carbonica do Bussaco. — Com. da Commissão dos Trabalhos Geologicos de Portugal, Tom. II, p. 129—152. Lisboa.

LIPPS, TH. (1927): Zur Rotliegendflora von Langwaltersdorf (Niederschlesien). — Jahrb. d. preuss. geol. Landesanstalt, Bd. XLVIII, p. 567—592, Taf. 26—28. Berlin.

NĚMEJC, F. (1929): On the Succession of Floras and the Stratigraphy of Coal Basins of Bohemia. — Zvláštní Otisk ze Sborníku Státního Geol. Ústavu Československé Rep. Svazek VIII. — Ročník 1928—1929, p. 349—379. — Praha.

— (1932): Preliminary Report about the Floristical and Stratigraphical Conditions of the Permocarboniferous below the Krkonoše (Riesengebirge) Mountains. — Zvláštní Otisk z Věstníku Státního Geol. Ústavu Československé Rep. Ročník VIII, p. 1—7. Praha.

— (1934): On the Kounov Coal Measure Series (— Upper Grey Beds —) from the Paleobotanical Point of View. — Zvláštní Otisk z "Hornického Věstníku", Rožník 1934, p. 1—11. — Praha.

NOÉ, A. C. (1925): Pennsylvanian Flora of Northern Illinois. — State of Illinois, Geol. Surv., Bull. No. 52, p. 1—18, Pl. I—XLV. — Urbana, Ill.

POTONIÉ, H. (1893): Die Flora des Rothliegenden von Thüringen. — Abhandl. d. Kgl. Preuss. geol. Landesanst. N. Folge, H. IX, Theil 2, p. 1—298, Taf. I—XXXIV. — Berlin.

PURKYNĚ, CYRIL (1929): Karbon a Perm v západním Podkrkonoší. — Rozpravy II. Třídy České Akademie Ročník XXXVIII, p. 1—34, Pl. I—VI. — Praha.

REICHARDT, W. (1932): Zur Stratigraphie des Rotliegenden in Thüringen. — Jahrb. d. Halleschen Verb. f. d. Erforsch. d. mitteldeutsch. Bodenschätze und ihrer Verwertung. Bd. XI, N. F., p. 121—184. — Halle a. S.

RENAULT, B. (1888—1890), in B. RENAULT & R. ZEILLER: Études sur le terrain houiller de Commentry. Flore fossile. — P. 1—746, Atlas de Pl. I—LXXV. — Saint-Etienne.

— (1893—1896): Bassin houiller et permien d'Autun et d'Epinac. Flore fossile. — Études des Gîtes min. de la France. P. 1—578, Pl. XXVIII—LXXXIX. — Paris.

SCHIMPER, W. PH. (1869—1874): Traité de paléontologie végétale. — Paris.

SCHLOTHEIM, E. F. VON (1820): Die Petrefactenkunde auf ihrem jetzigen Standpunkte ..... — Gotha.

SCHUSTER, J. (1908): Zur Kenntnis der Flora der Saarbrücker Schichten und des pfälzischen Oberrotliegenden. — Geognostische Jahresh. XX, p. 183—243, Taf. V—X. — München.

— (1909): Paläobotanische Notizen aus Bayern. — Berichte d. Bayerisch. Bot. Gesellsch. Bd. XII, p. 1—20, Taf. I. Ansbach.

SEWARD, A. C. (1888): On *Calamites undulatus* (STERNB.) Geol. Mag. Dec. III, Vol. V, No. 7, p. 289—290, Pl. IX. — London.

— (1917): Fossil Plants Vol. III. — Cambridge.

— (1919): Fossil Plants Vol. IV. — Cambridge.

DE STEFANI, C. (1901): Flore Carbonifere a Permiane della Toscana. — Publicaz. del. R. Ist. di Studi Super. in Firenze, p. 1—212, Tav. I—XIV. — Firenze.

STERNBERG, K. VON (1820—1838): Versuch einer geognostisch-botanischen Darstellung der Flora der Vorwelt. — Prag.

STERZEL, J. T. (1893): Die Flora des Rothliegenden im Plauenschen Grunde bei Dresden. — Abh. d. kgl. sächs. Ges. d. Wiss. math. phys. Cl. Bd. XIX, p. 1—172, Taf. I—XIII. Leipzig.

— (1901): Die Flora des Rothliegenden von Ilfeld am Harz. — Centralbl. f. Min., Geol. und Palaeontologie 1901, p. 417—427. — Stuttgart.

— (1907): Die Karbon- und Rotliegendfloren im Grossherzogtum Baden. — Mitt. d. grossh. bad. geol. Landesanstalt, Bd. V, H. 2, p. 347—892, Taf. XIV LXVIII. — Heidelberg.

— (1918): Die organischen Reste des Kulms und Rotliegenden der Gegend von Chemnitz. — Abh. d. Math.-phys. Kl. d. kgl. sächs. Gesellsch. d. Wissensch., Bd. XXXV, No. V, p. 205 315, Taf. 1—15. — Leipzig.

WEISS, CH. E. (1869—1872): Fossile Flora der jüngsten Steinkohlenformation und des Rothliegenden im Saar-Rhein-Gebiete. — Bonn.

— (1876): Steinkohlen-Calamarien, mit besonderer Berücksichtigung ihrer Fructificationen. — Abh. zur geol. Specialkarte von Preussen und den Thüringischen Staaten, Bd. II. H. 1, p. 1—149, Atlas mit 19 Tafeln. — Berlin.

WHITE, D. (1929): Flora of the Hermit Shale, Grand Canyon, Arizona. — Carnegie Inst. of Washington, Pub. No. 405, p. 1—118, Pl. 1—51. — Washington.

ZALESSKY, D. (1927): Flore permienne des limites ouraliennes de l'Angaride. Atlas. — Mém. du Com. Géol. N. S. Livr. 176, Pl. I—XLVI. — Leningrad.

— (1928): Sur la flore stéphanienne, découverte dans la crête Naryntaou au Turkestan (Russian). — Vestnik Geol. Komitet Vol. III, No. 5, p. 5 8, Pl. I—II. — Leningrad.

ZEILLER, R. (1886 1888): Bassin houiller de Valenciennes. Description de la flore fossile. — Études d. Gît. Min. de la France, p. 1 731, Atlas de Pl. I—XCIV. — Paris.

— (1890): Bassin houiller et permien d'Autun et d'Épinac. Fasc. II. Flore fossile. — Études d. Gît. Min. de la France, p. 1—304, Atlas de Pl. I—XXVII. — Paris.

— (1892): Bassin houiller et permien de Brive. Fasc. II. Flore fossile. — Études d. Gît. Min. de la France, p. 1—132, Pl. I—XV. — Paris.

— (1894): Notes sur la flore des couches permiennes de Trienbach (Alsace). — Bull. de la Soc. Géol. de France. T. XXII, S. 3, p. 163—182, Pl. VIII IX. Lille.

— (1899): Étude sur la flore fossile du bassin houiller d'Héraclée (Asie Mineure). — Mém. Soc. Géol. de France, 21, p. 1—91, Pl. I—VI. — Paris.

— (1906): Bassin houiller et permien de Blanzy et du Creusot. Fasc. II. Flore fossile. Études d. Gît. Min. de la France, p. 1—265, Atlas de Pl. I—LI. — Paris.

Index.

Printed November 5, 1935.

Explanation of the Plates.

All figures are from photographs without retouch.

The specimens belong to the Palaeontological Museum of the University, Oslo.

As to collectors, see p. 5 above.

Plate I.

From Semsvik, Asker.

Fern-like Leaves.

Fig. 1. Sp. indet. — × 3. PA 918 *a*, p. 6.
„ 2. Sp. indet. — × 3. PA 1071. p. 6.
Figs 3—4. Cf. *Callipteris* sp. — Nat. size and × 5. PA 971, p. 6.
„ 5 6. Cf. *Callipteris* sp. — Nat. size and × 3. PA 1073, p. 5.
„ 7—8. *Neuropteris* sp. Detached pinnule. — Nat. size and × 3. PA 1034, p. 5.

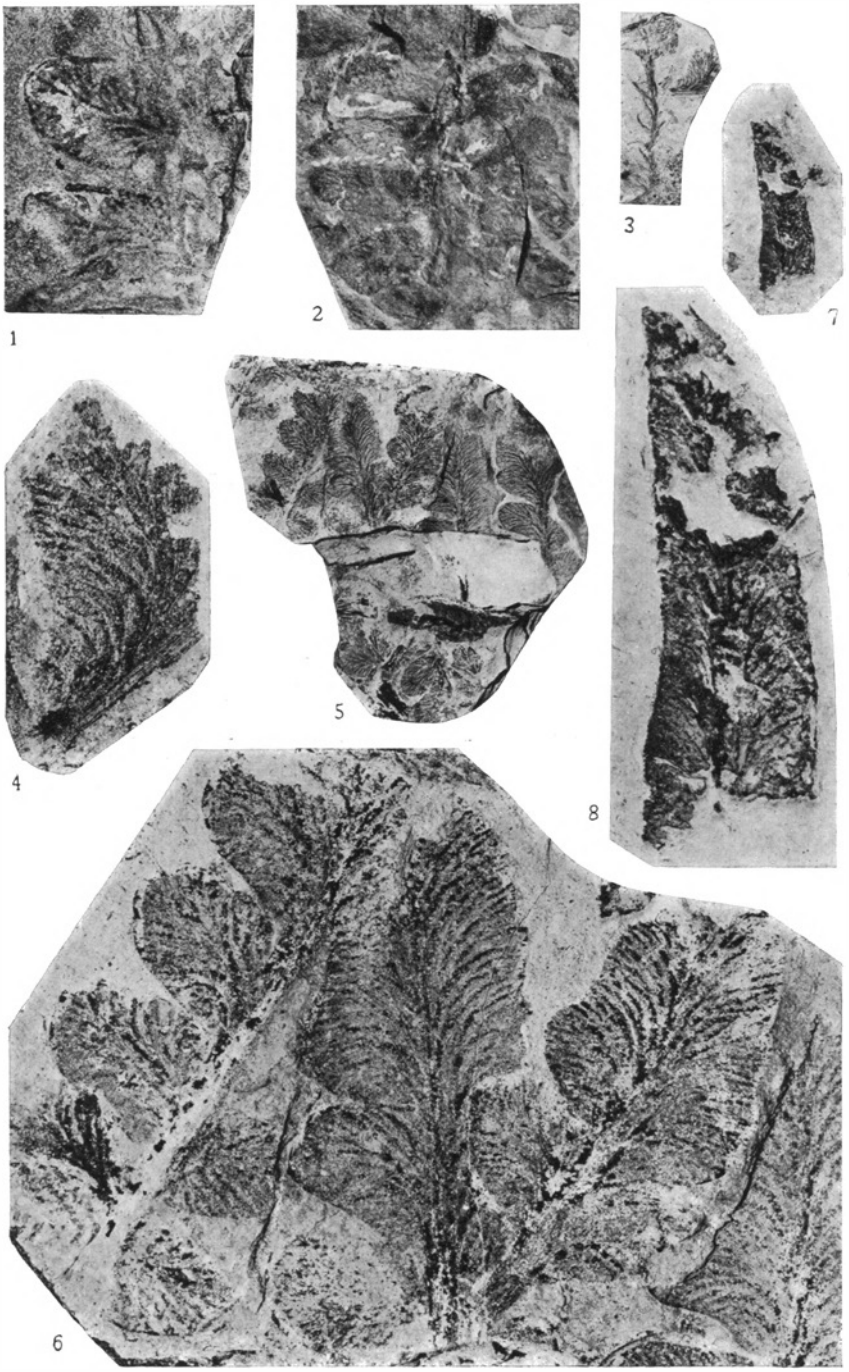

1
2
3
7
4
5
8
6

Plate II.

From Semsvik, Asker.

Calamites undulatus STERNB.

Figs 1—2. Typical specimen of aerial stem, with broad undulating ribs, subacute rib ends (visible only in a few places), and cross-hatching on the surface. — Nat. size and × 4. PA 909, p. 7.

„ 3—4. Aerial stems, fig. 4 showing the infranodal tubercles and the rib ends. — Nat. size and × 3. PA 992, p. 10.

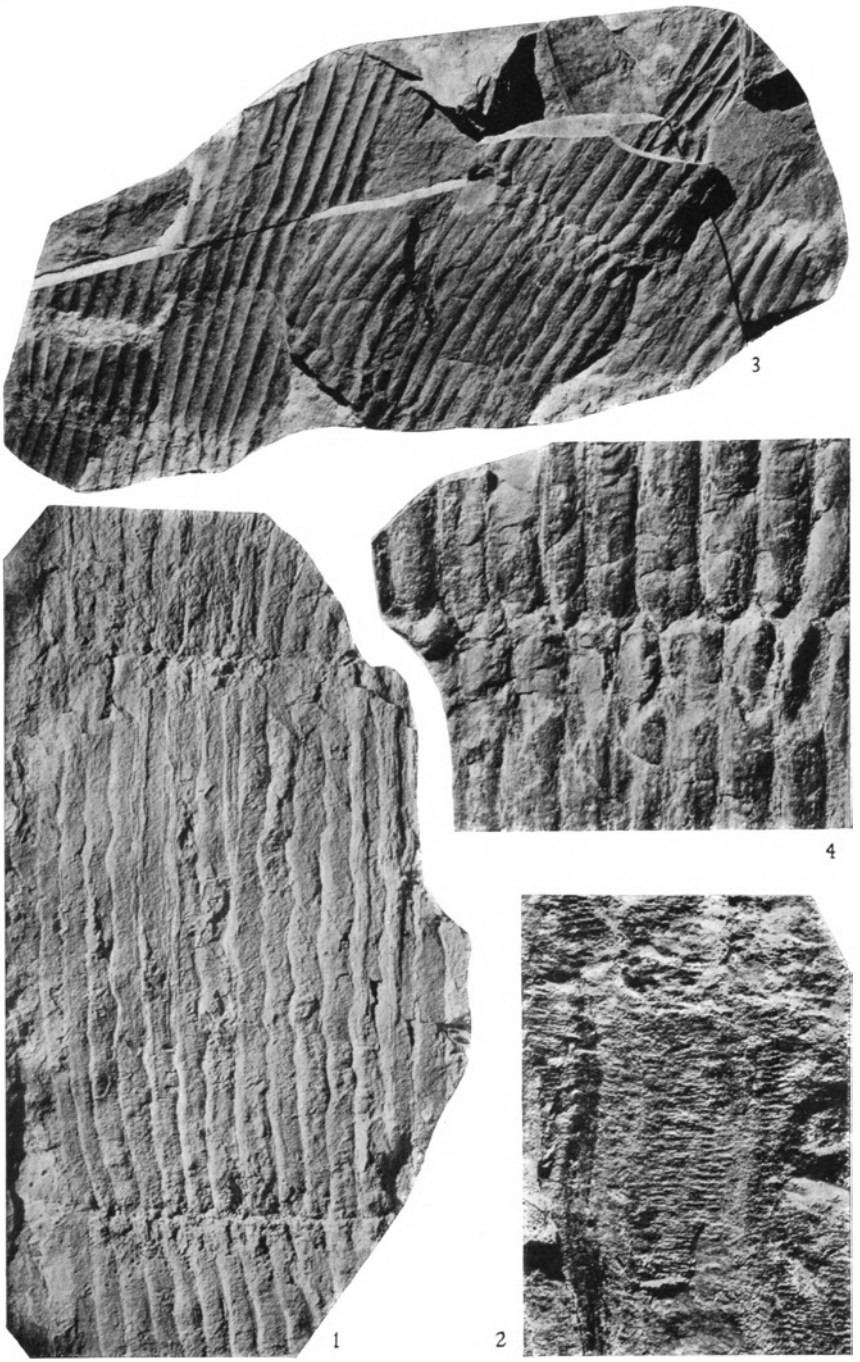

3
4
1
2

Plate III.

From Semsvik, Asker.

Calamites undulatus STERNB.

Figs 1—2. Broad-ribbed forms of aerial stems, with pointed ribs (visible only in a few places) and cross-hatching on the surface. — Nat. size. PA 975 and 999, p. 8.

1

2

Plate IV.

From Semsvik, Asker.

Fig. 1. *Calamites* cf. *Suckowii* BRONGN. Somewhat crushed. — Nat. Size. PA 972, p. 16.

„ 2. *Calamites undulatus* STERNB. Aerial stem with verticil of branch scars. — Nat. size. PA 987, p. 8.

„ 3. Same species. Aerial stem. At the lowest node a verticil of branch scars, at the third from below a single root scar. — Nat. size. PA 937, p. 8.

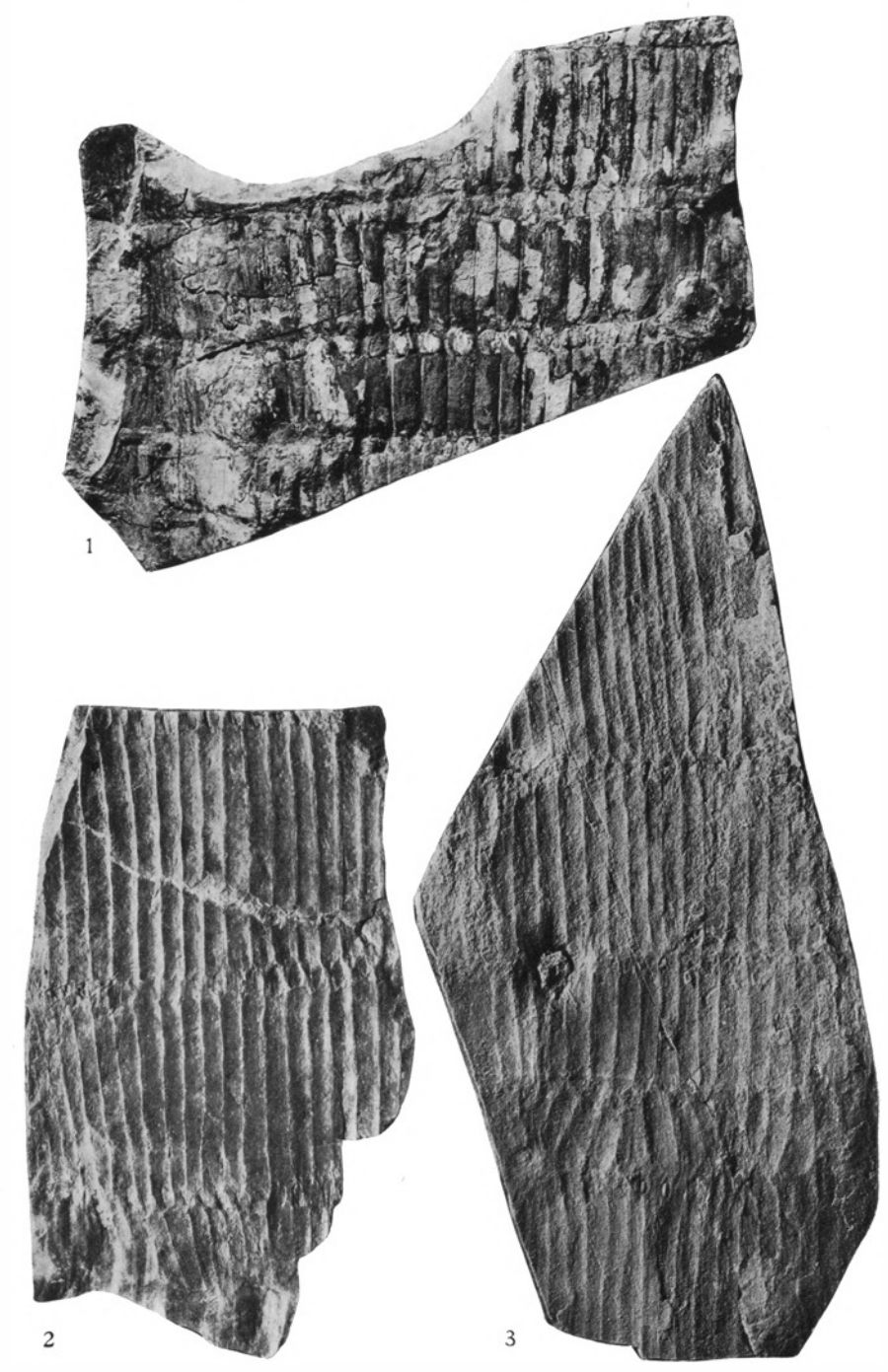

1
2
3

Plate V.

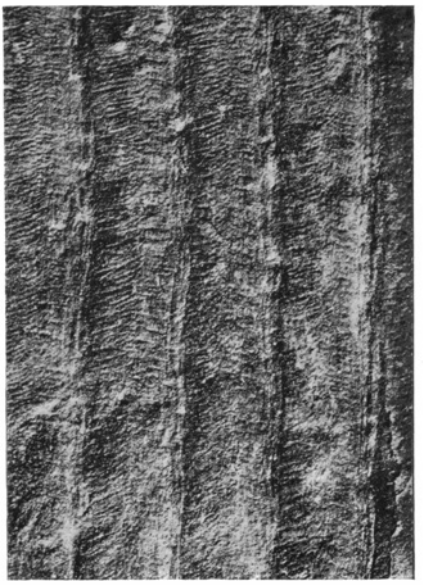
From Semsvik, Asker.

Fig. 1. *Calamites undulatus* STERNB. Aerial stem with narrow ribs. At the upper node a verticil of branch scars. Photographed with a cover of chloride of ammonia. — Nat. size. PA 1003, p. 10.

„ 2. Same species. Aerial stem, narrow-ribbed, with branch scars. · Nat. size. PA 982, p. 10.

Figs 3—4. *Calamites* cf. *undulatus*, with narrow ribs and very distinct surface ornamentation. — Nat. size and × 4,5. PA 993, p. 10.

1



4

3

2

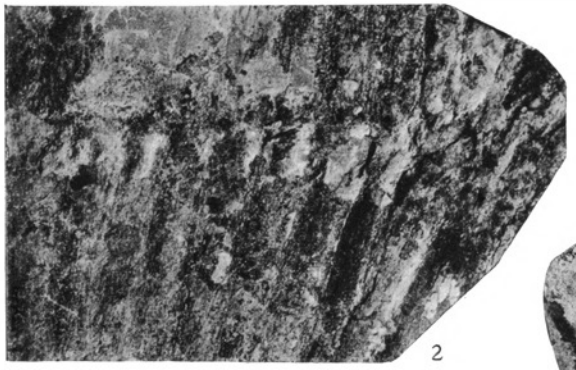
Plate VI.

From Semsvik, Asker.

Figs 1- 2. *Calamites* cf. *undulatus* STERNB. Branching stem. Fig. 2 shows a part of the branch (the upper corner of fig. 1). — Nat. size and × 3. PA 913, p. 10.

„ 3—4. Probably part of a phragma of a Calamite. Photographed with a cover of chloride of ammonia. — Nat. size and × 4. PA 926, p. 19.

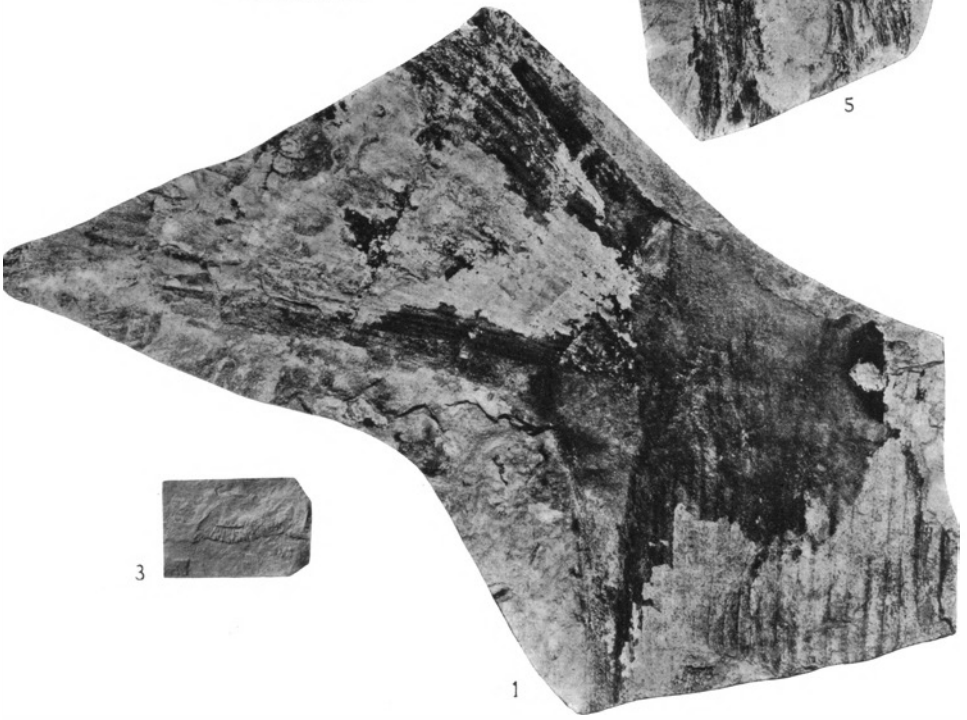
Fig. 5. Probably the external surface of a Calamite. — Nat. size. PA 1082, p. 19.



2

5

4



1

3

Plate VII.

From Semsvik, Asker.

Calamites undulatus STERNB. Rhizome with root scars. — Nat. size. PA 1012, p. 11.

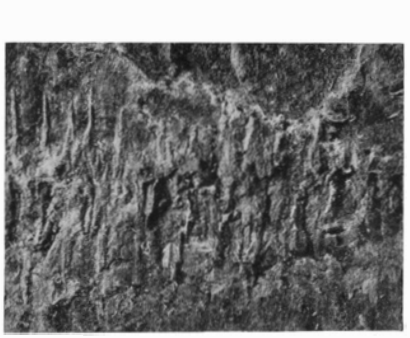
Plate VIII.

From Semsvik, Asker.

Figs 1—2. *Calamites undulatus* STERNB. Rhizome with root leaving the upper node. Fig. 2 showing details from the middle part of the upper node, with small tubercles at the ends of the ribs above. — Nat. size and × 3. PA 1049, p. 13.

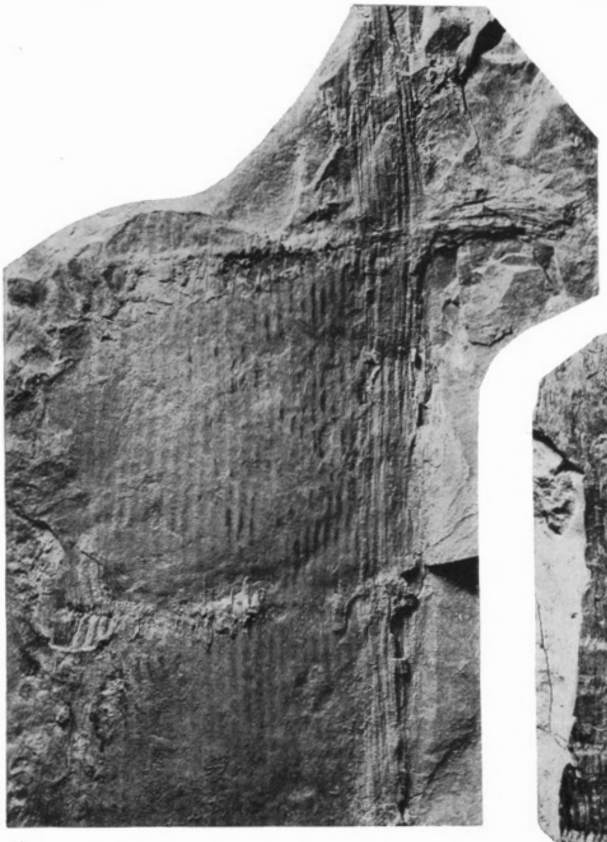
Fig. 3. *Calamites* sp. *d*. With root scars. Compare text-fig. 5. — Nat. size. PA 1008, p. 18.

„ 4. *Calamites* sp. *c*. — Nat. size. PA 1004, p. 18.



2

4



1

3

Plate IX.

From Semsvik, Asker.

Calamites cf. *undulatus* STERNB. Stem with rhizomatic branches. — Half nat. size. PA 1014, p. 14.

Plate X.

From Semsvik, Asker.

Figs 1—2. Same specimen as in Plate IX. Fig. 2 shows some details from the left hand side of the lower part of fig. 1. —Nat. size and × 2. PA 1014, p. 14.

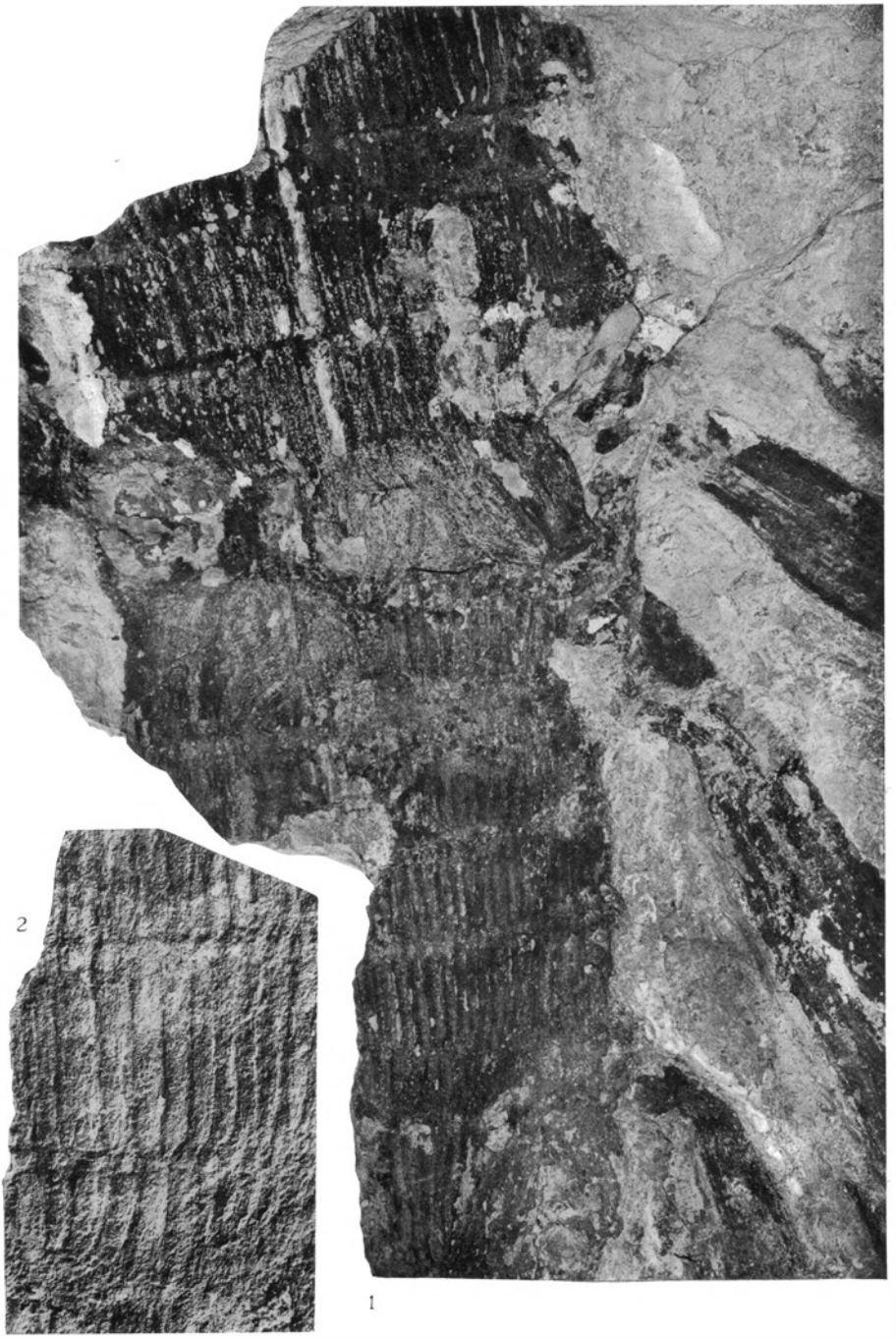

2
1

Plate XI.

From Semsvik, Asker.

Calamites cf. *undulatus* STERNB. Figs 1—3 are photographed with light from below, which was necessary to secure the details; they are better understood if regarded in a reversed position. Fig. 2 shows a scar on the lowest node, and fig. 3 another one indistinctly seen on fig. 1 in the middle of the second node from below. Fig. 4 is from the upper left corner of fig. 1. Nat. size (fig. 1), × 3 (figs 2 and 3), and × 2 (fig. 4). PA 969, p. 15.


3
4
2
1

Plate XII.

From Semsvik, Asker.

Figs 1- 2. *Calamites* cf. *multiramis* WEISS. Fig. 2 shows some details of the sixth node from below, on the right hand side. Half nat. size and × 3. PA 915, p. 16.

„ 3—4. *Calamites* sp. *a*. Fig. 4 is photographed with light from the right, in order to show some other details than fig. 3. — Nat. size and × 2. PA 1052, p. 17.

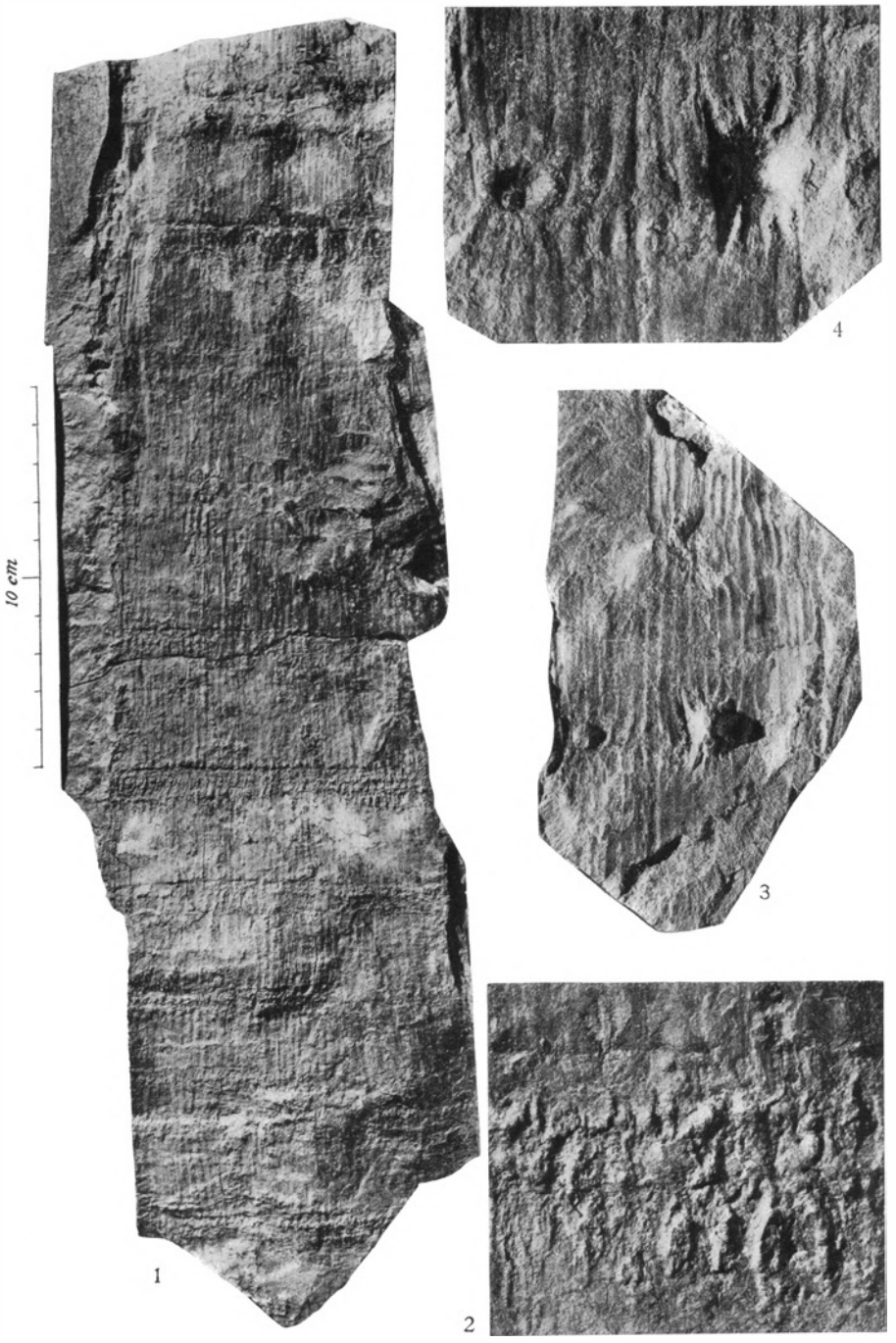

10 cm
1
2
3
4

Plate XIII.

Fig. 1. *Calamites* sp. *b.* Nat. size. PA 1050, p. 17.
„ 2 *Calamites* sp. Nat. size. PA 1057, p. 18.
Figs 3—4. Problematicum. — Nat. size and × 4. PA 1051, p. 19.


4
3
2
1

Plate XIV.

From Semsvik, Asker.

Fig. 1. *Asterophyllites equisetiformis* (SCHLOTH.) BRONGN. Stem with one node bearing long leaves and two branches with whorls of shorter leaves. — Nat. size. PA 951, p. 20.

„ 2. Same species. Branch with young lateral shoots. — Nat. size. PA 1000, p. 20.

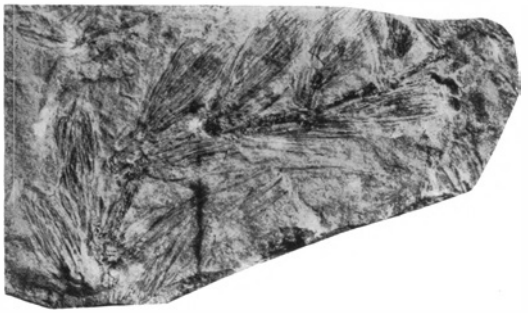
„ 3. Same species. — Nat. size. PA 908, p. 20.

Figs 4 5. Same species. — Nat. size and × 3. PA 1000, p. 20.

„ 6—7. Immature cones of *Calamites*, probably *Calamostachys germanica* WEISS. Nat. size. PA 1055 and 1020, p. 21.

1

5

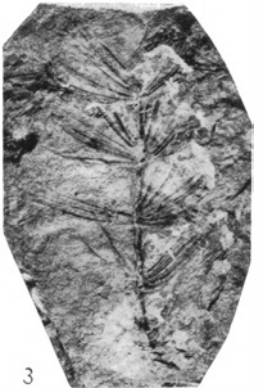


2

4

6

7



3

Plate XV.

From Semsvik, Asker.

Calamostachys germanica WEISS.

Figs 1 2. Nat. size and × 4. PA 899, p. 21.
„ 3 4. Nat. size and × 3. PA 1020 *a*, p. 21.
„ 5 6. Nat. size and × 3. PA 964, p. 21.

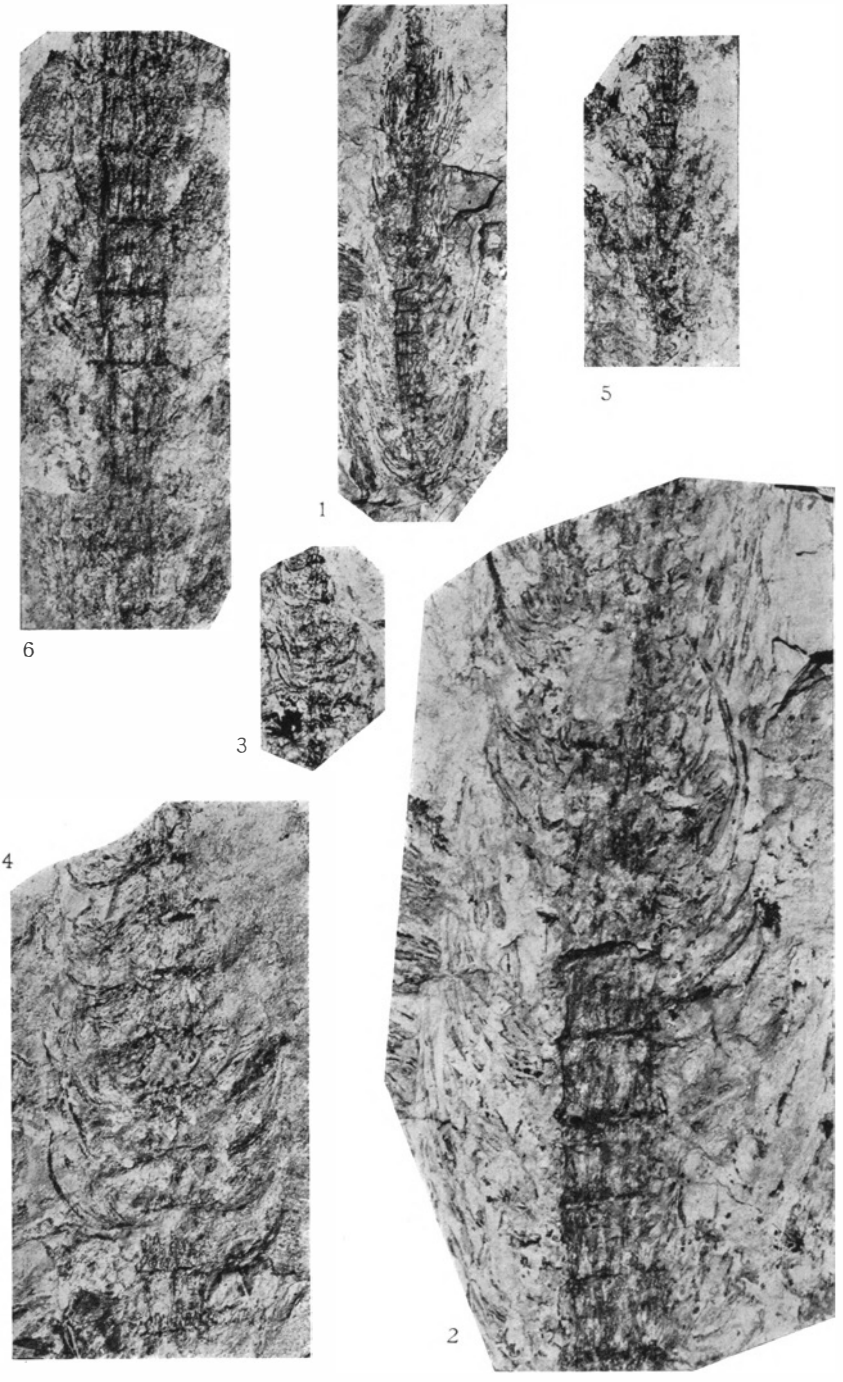

1
2
3
4
5
6

Plate XVI.

From Semsvik, Asker.

Figs 1—2. *Calamostachys germanica* WEISS, probably in connection with the thicker axis at the base. — Nat. size and × 3. PA 1075, p. 21.

Fig. 3. Same species. — Nat. size. PA 1054, p. 21.

Figs 4 5. *Palaeostachya* sp. *a*. — Nat. size and × 3. PA 1048, p. 22.

„ 6 7. *Palaeostachya* sp. *b*. Nat. size and × 3. PA 1038, p. 23.

„ 8—9. Spores from another specimen of the same species. — × 500. PA 900, p. 23.

Fig. 10. Hyphae of a fungus infesting the same cone. — × 500. PA 900, p. 23.

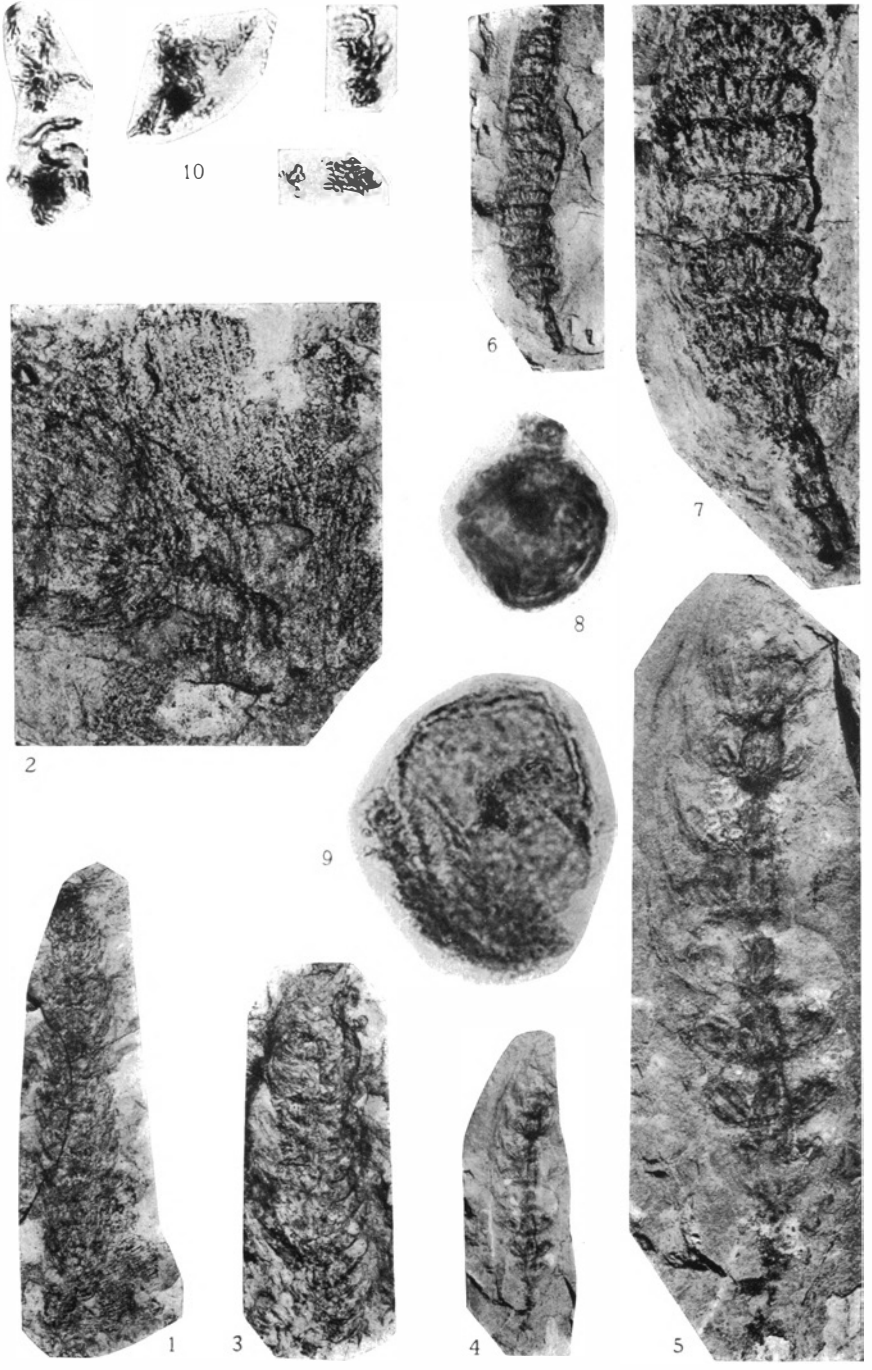

10
6
7
8
2
9
1
3
4
5

Plate XVII.

From Semsvik, Asker.

Fig. 1. *Cordaites principalis* (GERMAR) GEIN. Fragment of leaf. The long object alongside it probably a root of *Calamitus undulates*. Compare Pl. XXV fig. 2. — Nat. size. PA 894, p. 13 and 24.

„ 2. Same species. Nat. size. PA 941, p. 24.


1
2

Plate XVIII.

From Semsvik, Asker.

Fig. 1. *Cordaites* sp., probably *C. principalis* (GERMAR) GEIN. — Nat. size. PA 978, p. 24.

Figs 2—4. *Samaropsis Holtedahlii*, n. sp. — Nat. size and × 3. PA 1021, p. 25.

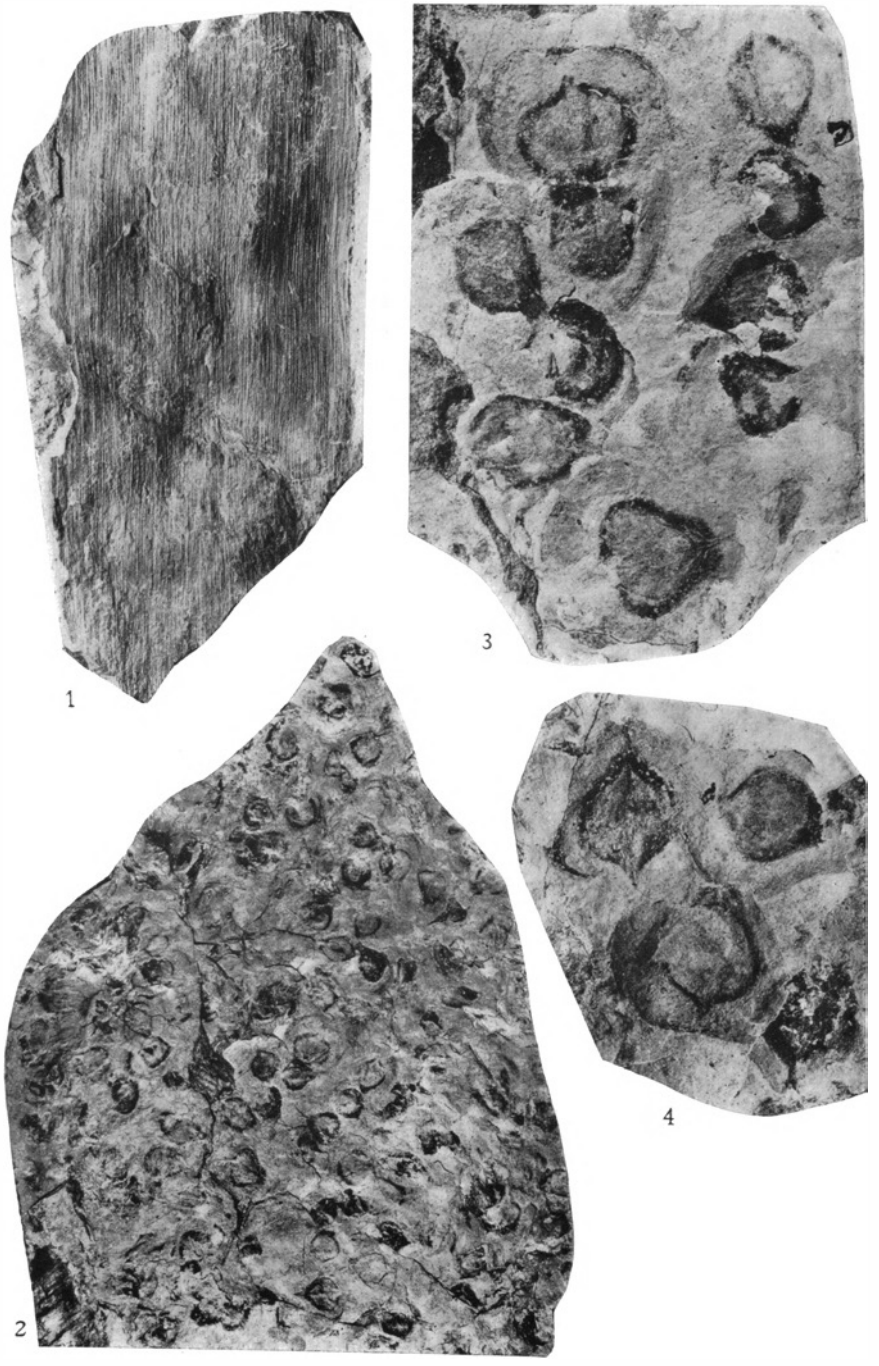

1
2
3
4

Plate XIX.

From Semsvik, Asker.

Fig. 1. *Walchia piniformis* (SCHLOTH.) STERNB. — Nat. size. PA 914, p. 27.
Figs 2—3. *Walchia linearifolia* GÖPP. — Nat. size and × 3. PA 1022, p. 29.
„ 4—5. *Walchia hypnoides* BRONGN. — Nat. size and × 4. PA 1039, p. 30.
Fig. 6. Same species. — Nat. size. PA 937, p. 30.

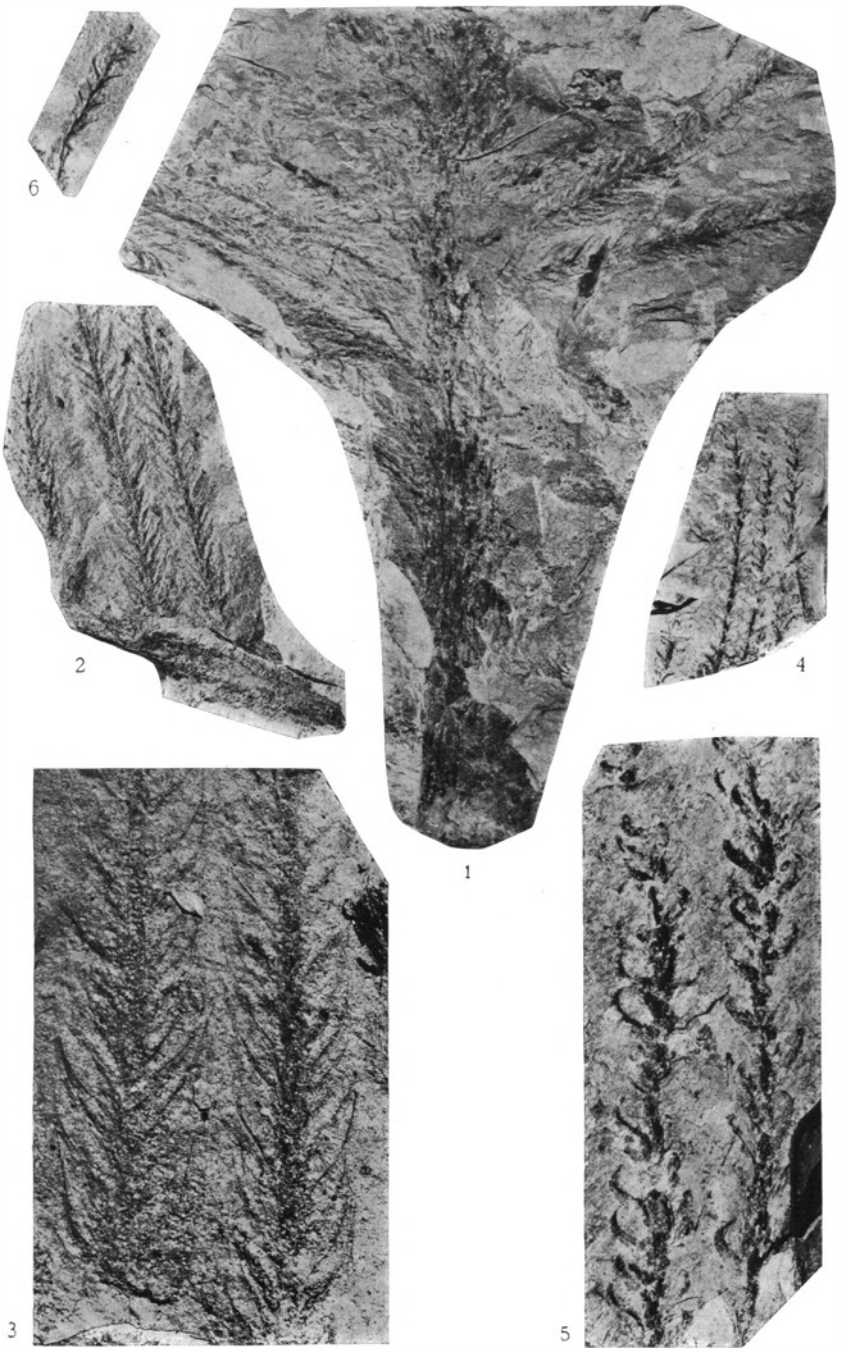

6
2
1
4
3
5

Plate XX.

From Semsvik, Asker.

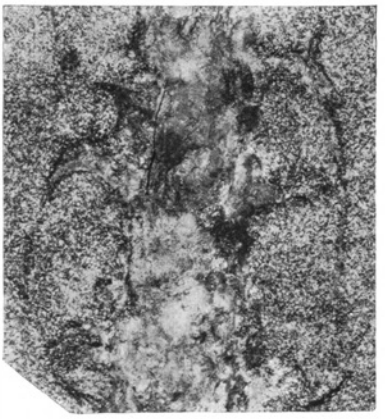
Figs 1—2. *Walchia piniformis* (SCHLOTH.) STERNB. — Nat. size and about × 3 PA 1044, p. 27.

Fig. 3. Same species. — × 4. PA 1010, p. 27.

„ 4. Same species. — × 4. PA 1072, p. 27.

Figs 5 6. *Ernestiodendron filiciforme* (SCHLOTH). FLORIN. — Nat. size and × 3. PA 1043, p. 33.

4



6

5

1

2

3

Plate XXI.

From the southern side of Hagahugget, Asker.

Walchia piniformis (SCHLOTH.) STERNB., preserved partly as *imbricata*. Nat. size.
PA 1023, p. 27.

Plate XXII.

From the southern side of Hagahugget, Asker.

Walchia piniformis (SCHLOTH.) STERNB. Buds at the ends of twigs.
Nat. size. PA 1024, p. 27.

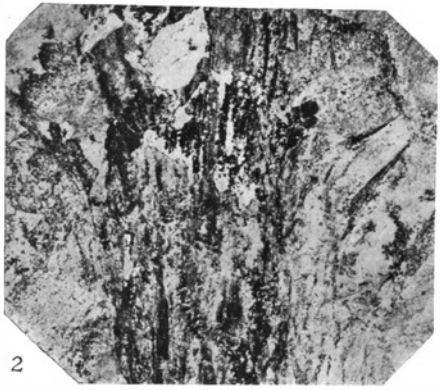
Plate XXIII.

From Semsvik, Asker.

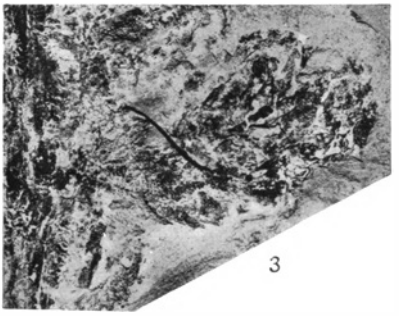
Figs 1—4. *Walchia* sp. For details, see also XXIV fig. 1. — Nat. size and × 3. PA 1005, p. 31.

1

4



2



3

Plate XXIV.

From Semsvik. Asker.

Fig. 1. *Walchia* sp. Detail of Pl. XXIII fig. 1. × 3. PA 1005, p. 31.
Figs 2–3. *Walchia* sp. Nat. size and × 3. PA 980, p. 31.
Fig. 4. Problematicum. — Nat. size. PA 1081, p. 34.

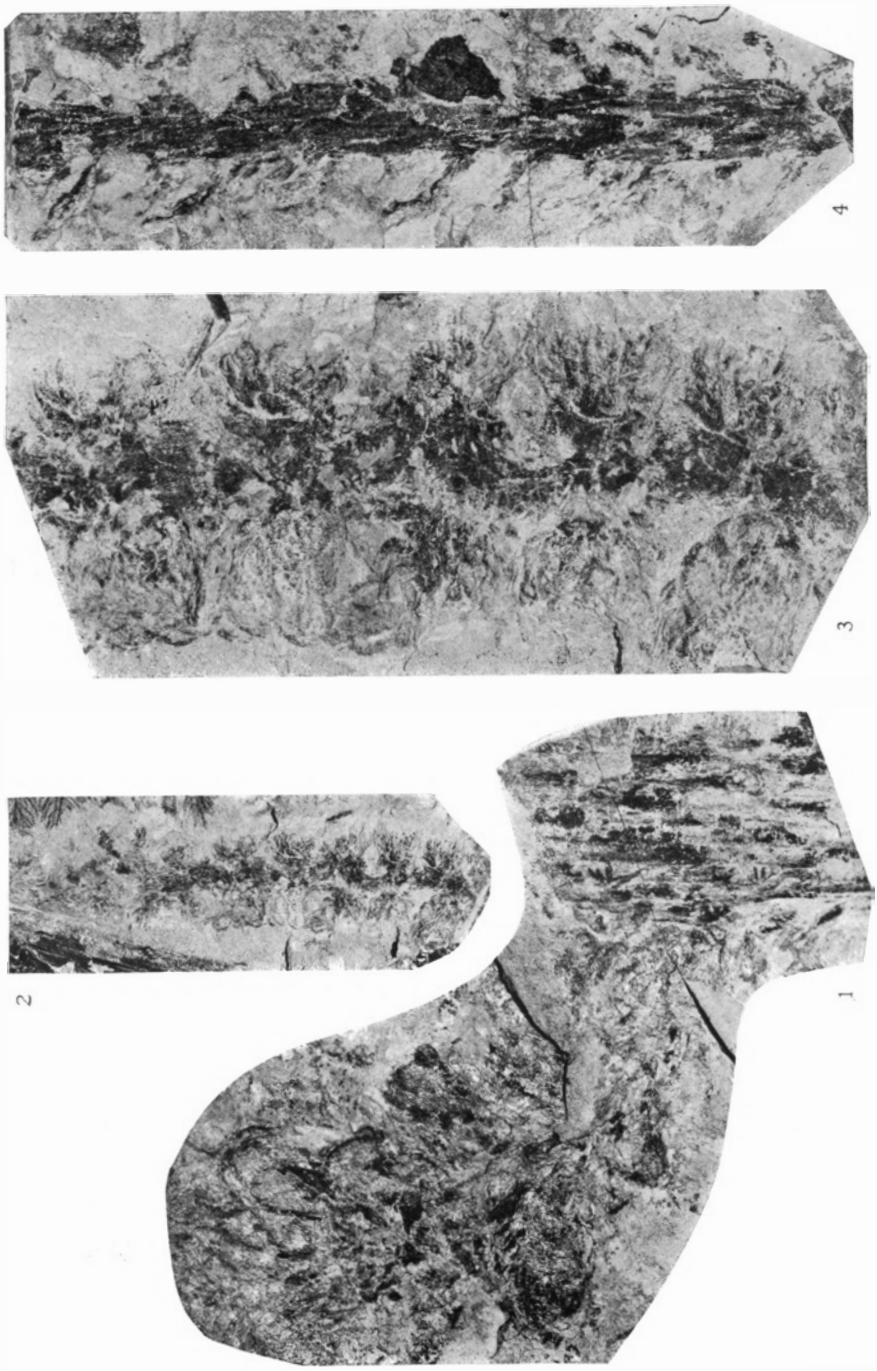

4
3
2
1

Plate XXV.

From Asker: Figs 1 2 and 5 6 from Semsvik, figs 3—4 from the southern side of Hagahugget.

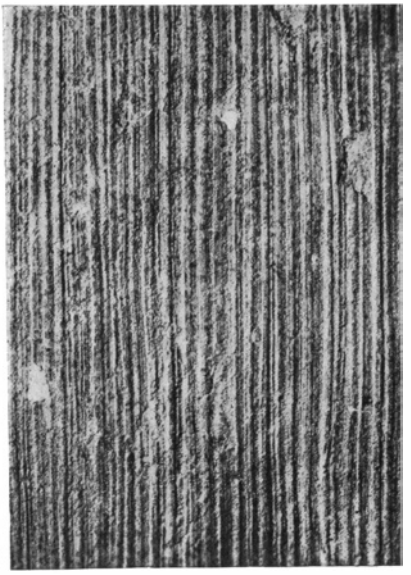
Fig. 1. *Cordaites principalis* (GERM.) GEIN., poorly preserved fragment of the lower part of a leaf. Nat. size. PA 916, p. 24.

„ 2. Same species. Detail of Pl. XVII fig. 1. — × 3. PA 894, p. 24.

Figs 3 4. *Walchia* sp. · Nat. size. PA 1026 and 1025, p. 28.

„ 5 6. Probably root of *Calamites undulatus*. Nat. size and × 3. PA 969, p. 13.


1


2


4


5


3

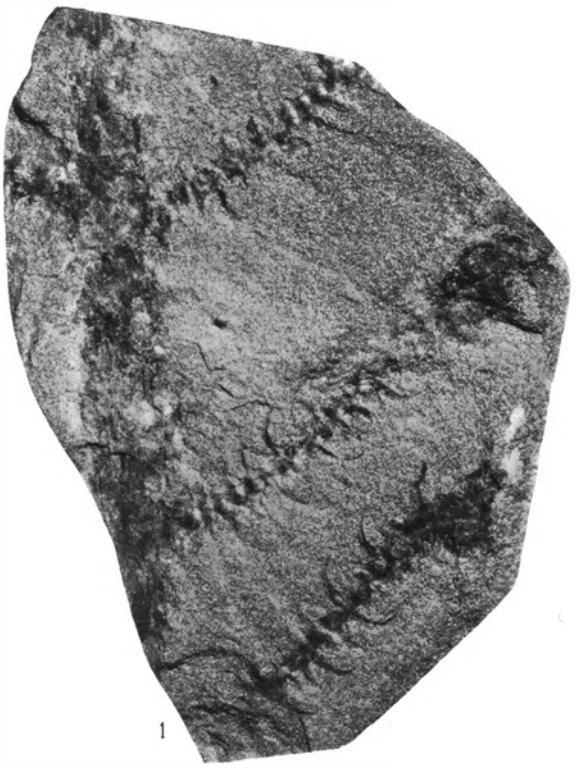

6

Plate XXVI.

From Semsvik, Asker.

Figs 1—2. *Ernestiodendron filiciforme* (SCHLOTH.) FLORIN. Nat. size and × 3. PA 1041, p. 33.

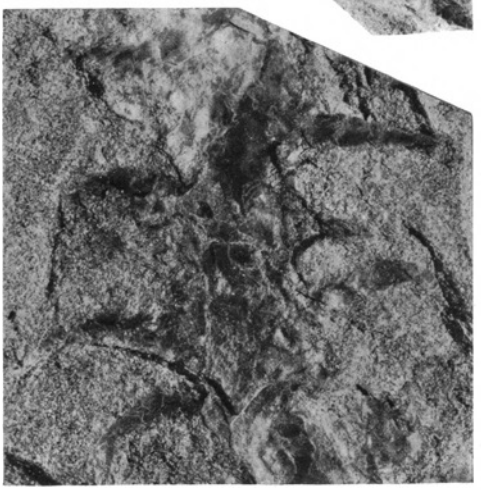
„ 3—4. Same species. Nat. size and × 3. PA 1042, p. 33.



1

3

2



4

Plate XXVII.

From Holmestrand: Sandstone within the lava.

Figs 1 4. Leaves of *Cordaites* (at least p. p.) Nat. size. PA 1092, 1093, 1090 1089, p. 35.

Fig. 5. Details of fig. 4. × 3.

„ 6. cf. *Walchia* sp. Photographed with light from the right. — Nat. size. PA 1090, p. 35.

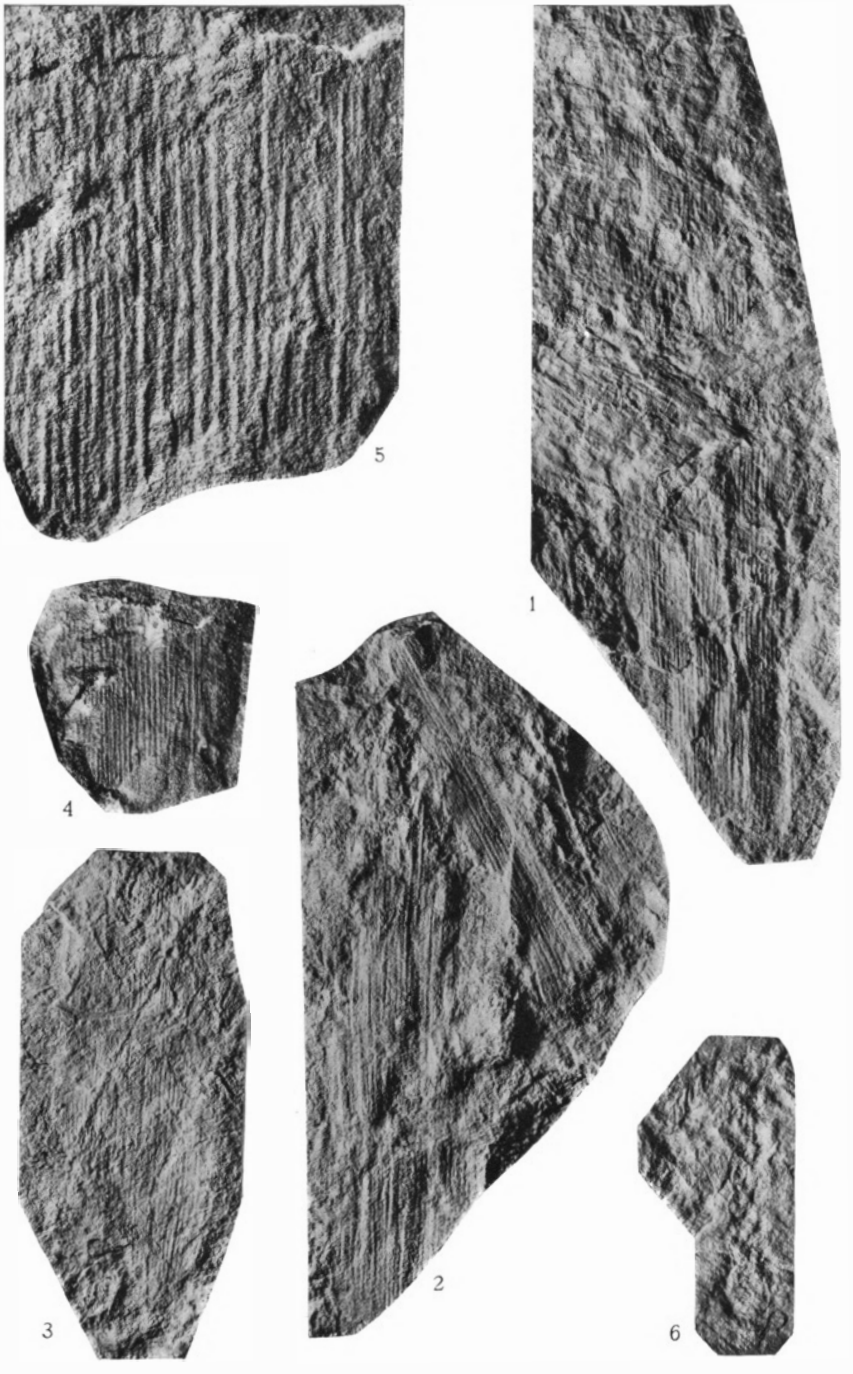
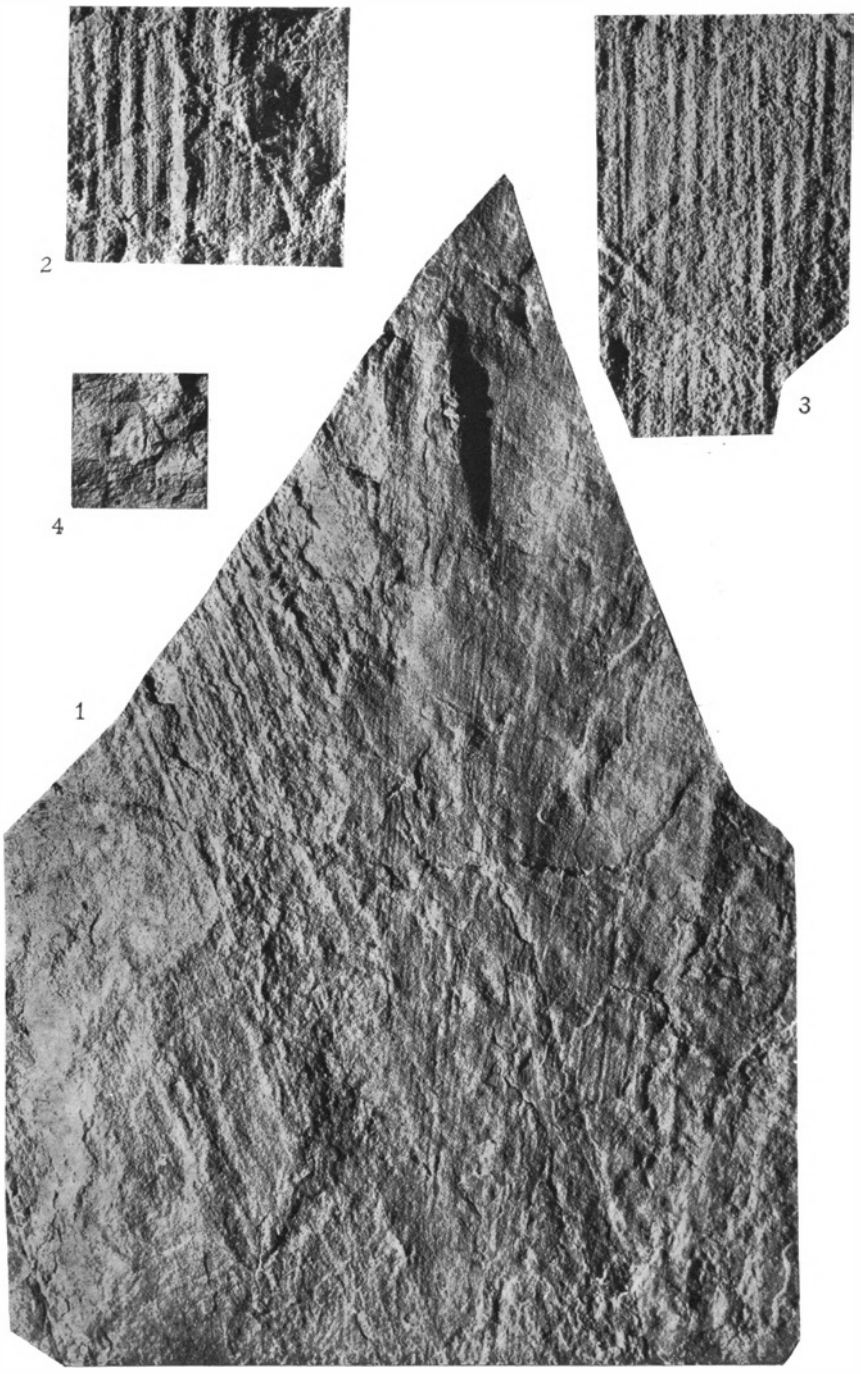

5
1
4
2
3
6

Plate XXVIII.

From Ryggen, district of Gjerpen near Skien.

Figs 1—3. *Cordaites principalis* (GERMAR) GEIN. — Nat. size and × 3. PA 954, p. 53.
Fig. 4. Seed? Nat. size. PA 1094, p. 35.


2
3
4
1