DANMARKS GEOLOGISKE UNDERSØGELSE
II. Række. Nr. 103
Geological Survey of Denmark. II. Series. No. 103

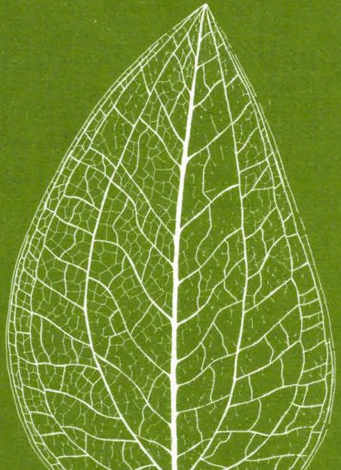
The Søby Flora: Fossil plants from the Middle Miocene delta deposits of the Søby-Fasterholt area, Central Jutland, Denmark. Part I.

BY

Erik Fjeldsø Christensen

DANSK SAMMENDRAG

Søby Floraen: Fossile planter fra de mellem miocæne delta aflejringer i Søby-Fasterholt området, Midtjylland, Danmark



I kommission hos C. A. Reitzels Forlag. København 1975

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D. G. U. II. rk. nr. 103
er sat med Linotype Times
og trykt i 1650 eksemplarer
hos Andelsbogtrykkeriet i Odense.
Klicheerne er fremstillet af
Tutein & Koch og fototavlerne af
F. Hendriksen's Eftf.
Bogen er trykt på ekstraglittet 250–41, 120 g
og plancherne på Top-Cote 106, 120 g
fra a/s De forenede Papirfabrikker.
ISBN 87 421 0641 9

With 10 plates

Date of publication: 1975–04–18

The author's address:
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DK-8000 Århus C
Denmark

Vignetten på omslaget er tegnet af Joan Lützhöft.

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Abstract

In 1969 a new Danish fossil flora was found in the Søby-Fasterholt area near Herning. The fossil flora, called the Søby Flora, is found in a clay bed at the top of the Odderup Formation. The bed is succeeded by the Middle Miocene Hodde Clay, itself overlain by Upper Miocene Glauconite Clay. The Gram Clay, containing marine fossils is found a few km further south, and forms a biostratigraphical indicator level. The fossil plants, and especially the leaves, are well preserved. This paper is the first part of the systematic description, treating the following species: *Pinus thomasiana* (Goepp.) Reichenbach, *Taxodium dubium* (Sternb.) Heer, *Smilax weberi* Wessel and *Comptonia acutiloba* Brongniart. In the present paper the reader will find the epidermis of *Smilax weberi* and that of *Comptonia acutiloba* described for the first time.

Introduction

During the years 1969–1973 the Phytopalaeontological Department, Geological Institute, Aarhus University, concentrated its efforts on a field project in the Søby open-cast mining area SE of Herning, Central Jutland (fig. 1). The purpose was to collect the basic date for a geological and palaeobotanical investigation of the browncoal bearing sequence before the last mines were closed down. This work was supported by The Danish Natural Science Research Council (Statens naturvidenskabelige Forskningsråd) under the heading: "The Søby-Fasterholt Browncoal Project".

While he was a participant in this project the author discovered a very rich fossil flora in the mining section "Damgaards leje" in the abandoned open-cast mine "Damgaard N", fig. 1 (Koch et al. 1973). This fossil flora, called the "Søby Flora", consists of fossil leaves, seeds and fructications in a good state of preservation.

This paper is the first of a number of publications in which the author will describe the Søby Flora. Hence this and some of the following papers will be mainly descriptive and will concentrate on the taxonomical problems and the collection of the information on which the final conclusions will be founded.

In the present paper no attempt will be made to reach any general conclusions about the stratigraphic distributions of the species which are described. In the literature the identification of many fossils is entirely based on external morphology, so that identifications are subject to doubt, and since in many cases no work has been done on the cuticula, it is difficult to compare the species described in the present paper with earlier – often inadequate – descriptions. In addition, the dating of the limnic deposits which contain such fossils is difficult and often imprecise, so that on this account too, there are far too many possibilities for error, to justify a general conclusion.

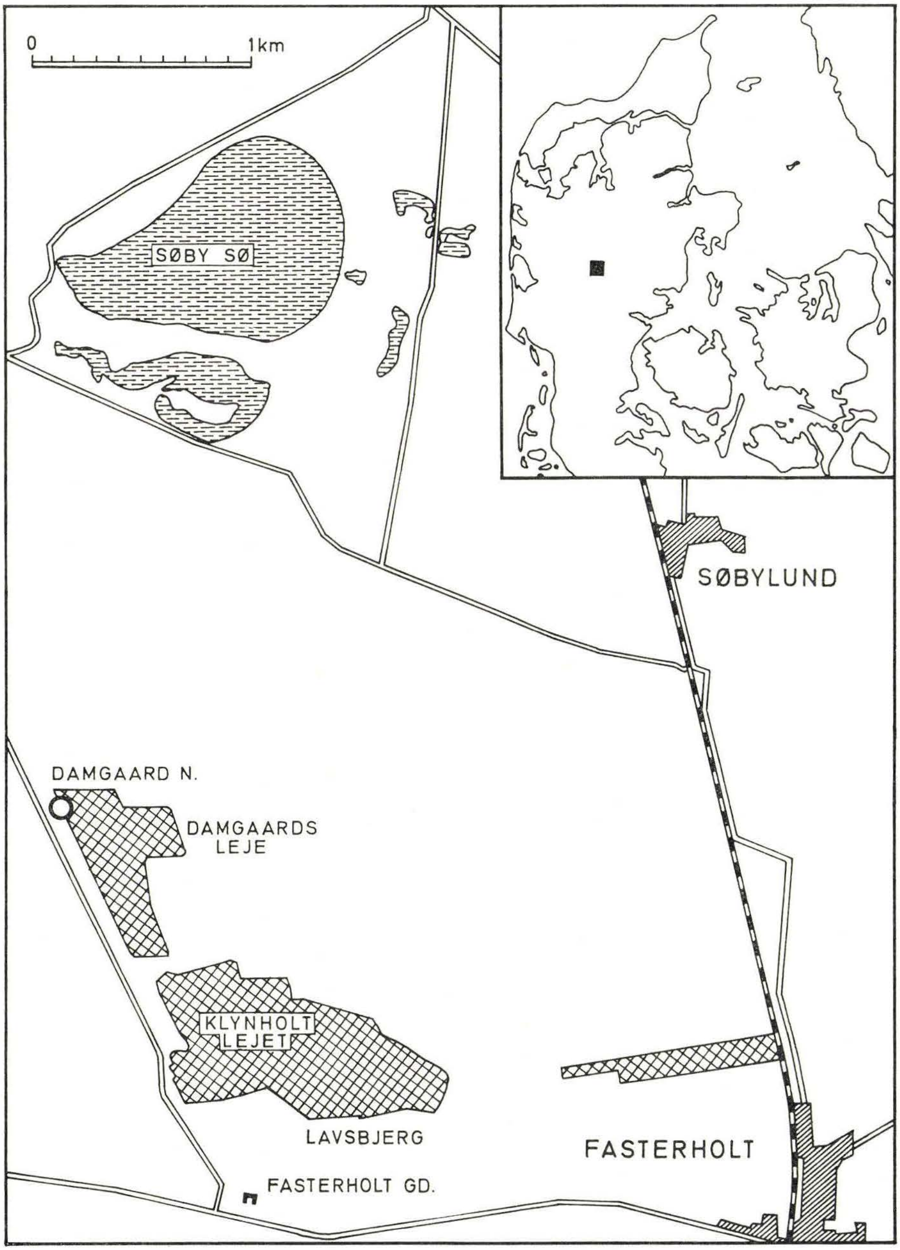
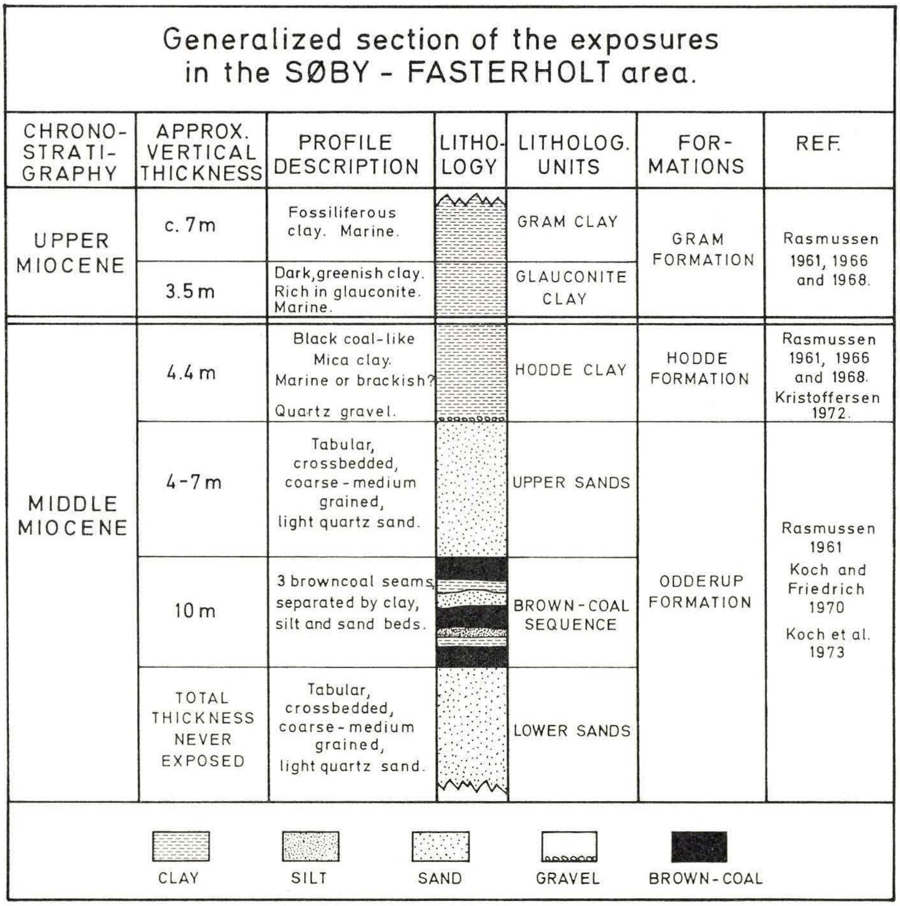


Fig. 1. Location map of the Søby-Fasterholt area. The locality of the Søby Flora is marked by the black ring.

Geology

1. Composition of the sequence

The Søby-Fasterholt mining area is the largest continuous lignite field in Denmark (about 15 km²). A general description of the geology of this area has not yet appeared, but a few preliminary reports in German language (Koch & Friedrich, 1970) and in Danish (Koch et al. 1973) have been published. Hence a map of localities (fig. 1), the general geological sequence in the Søby



Generalized section of the exposures in the SØBY - FASTERHOLT area.

CHRONO-STRATI-GRAPHY	APPROX. VERTICAL THICKNESS	PROFILE DESCRIPTION	LITHO-LOGY	LITHOLOG. UNITS	FOR-MATIONS	REF.
UPPER MIOCENE	c. 7 m	Fossiliferous clay. Marine.	▤	GRAM CLAY	GRAM FORMATION	Rasmussen 1961, 1966 and 1968.
	3.5 m	Dark, greenish clay. Rich in glauconite. Marine.	▤	GLAUCONITE CLAY		
MIDDLE MIOCENE	4.4 m	Black coal-like Mica clay. Marine or brackish? Quartz gravel.	▤ ◌	HODDE CLAY	HODDE FORMATION	Rasmussen 1961, 1966 and 1968. Kristoffersen 1972.
	4-7 m	Tabular, crossbedded, coarse-medium grained, light quartz sand.	░	UPPER SANDS	ODDERUP FORMATION	Rasmussen 1961 Koch and Friedrich 1970 Koch et al. 1973
	10 m	3 browncoal seams, separated by clay, silt and sand beds.	■ ▤ ▒ ■ ▒ ▤ ■	BROWN-COAL SEQUENCE		
	TOTAL THICKNESS NEVER EXPOSED	Tabular, crossbedded, coarse-medium grained, light quartz sand.	░	LOWER SANDS		

▤ CLAY ▒ SILT ░ SAND ◌ GRAVEL ■ BROWN-COAL

Table 1. Idealized profile based on the various sections exposed during the years 1968–1974 in the Søby-Fasterholt area.

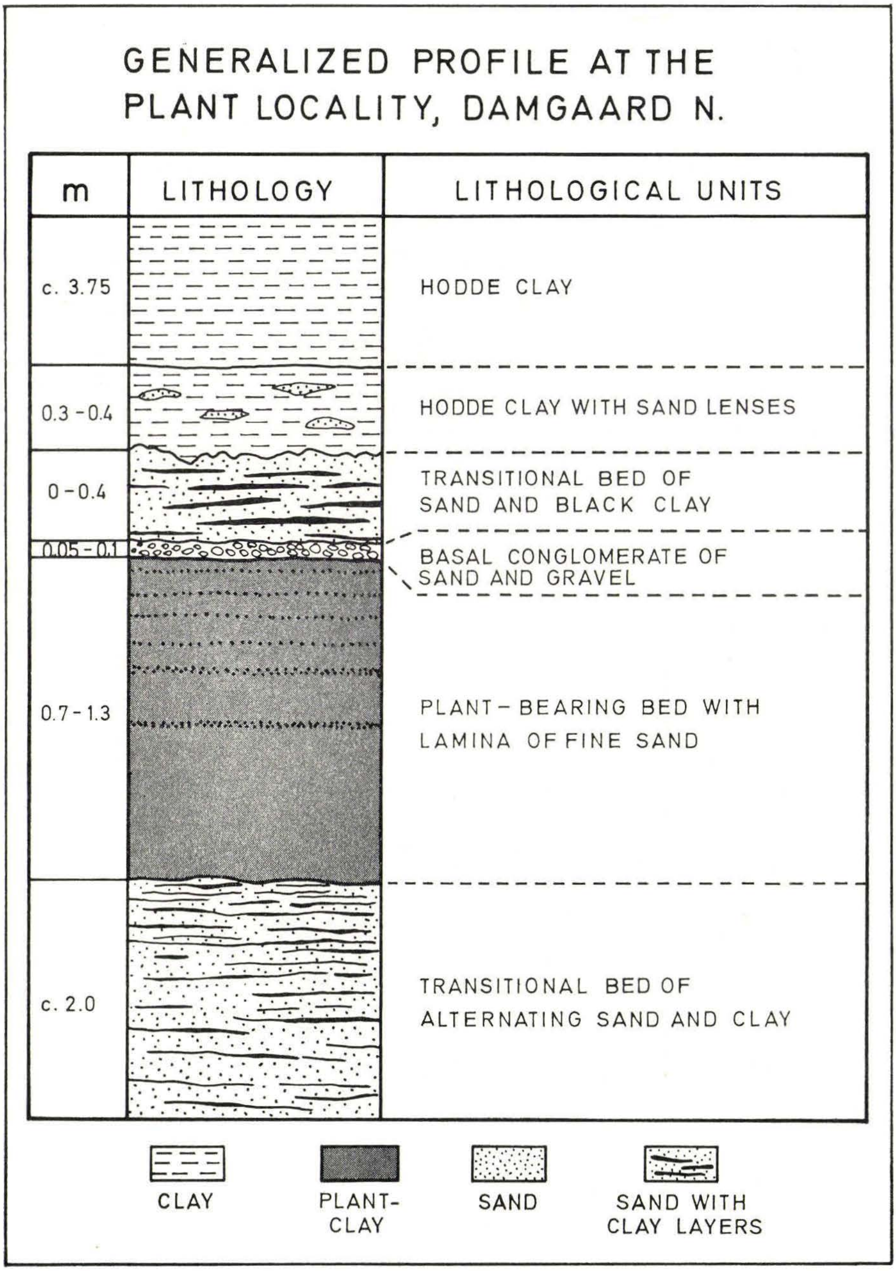


Table 2. Generalized section showing the transition from the Odderup Formation to the Hodde Formation at the fossiliferous locality Damgaard N.

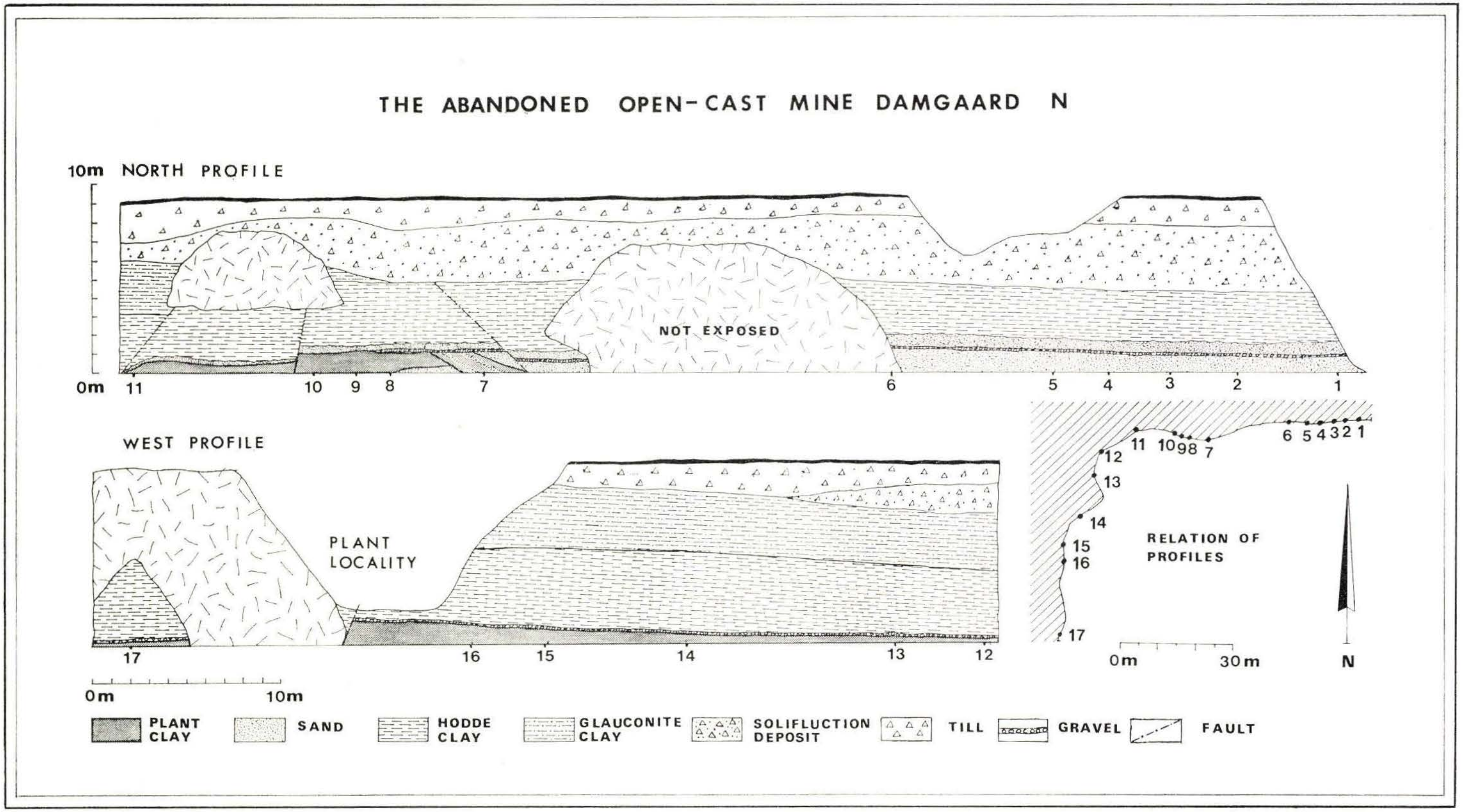


Fig. 2. The profiles at the fossiliferous locality Damgaard N. The numbers mark the vertical sections where the profiles have been measured and where lithological samples have been collected. The base of the profile corresponds to the water table in 1972.

area (table 1) and the profiles in "Damgaard N" (table 2, fig. 2 and fig. 3) are presented.

During the Weichsel glaciation meltwater streams making their way to the North Sea completely removed the Gram and Hodde Clays (table 1) from the northern and eatsern part of the field area. Hence in the southern and western periphery of the Søby area where the fossiliferous locality in question is situated, this upper part of the standard section is only represented by an erosional relict structure.

The upper sands at the locality of the Søby Flora (table 2) grade upward into a finely laminated sediment with alternate laminae of brown clay and of fine sand. The number of clay lamina increases upward and the sediment ultimately grades into the dark brown clay bed containing the Søby Flora (table 2 and fig. 2). This local plant-bearing bed terminates the Odderup Formation (table 1) in the Damgaard N pit (Koch et al. 1973).

The transition from the "Plant bed" to the Hodde Clay is marked by a basal gravel layer followed by a bed of sand containing black clay layers (table 2). The basal part of the Hodde Clay contains sand lenses, and it differs from the normal black micaceous Hodde Clay in being brown, looking rather like browncoal.

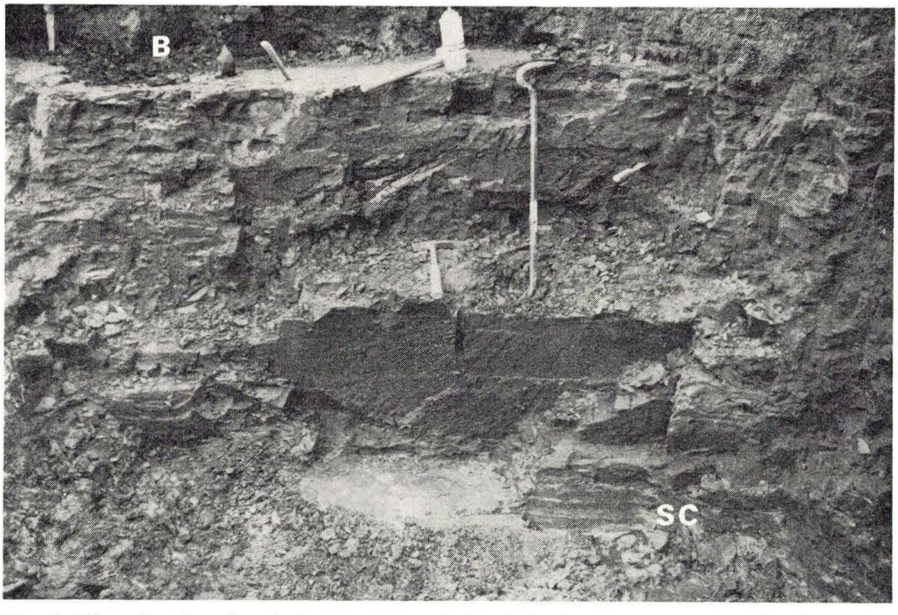


Fig. 3. The plant-bearing bed. The lower half of the bed is compact while the upper half contains thin sand laminae. The hammer marks a sand surface along which the large sample blocks were allowed to split. SC: Liminated sand and clay. B: The basal gravel of the Hodde Clay. Photo: author.

At the Damgaard N locality the Hodde Clay has not yielded marine fossils. In fact, with the sole exception of a site at the pits of the Brande brickworks (at Hundehøj, some 8 km further south), the Hodde Clay has proved to be unfossiliferous in the entire Herning region. The Glauconite Clay (table 1 and fig. 2), which overlies the Hodde Clay at Damgaard N, is also unfossiliferous. But for the first time in the Søby-Fasterholt area, the Gram Clay proper has recently been found at Lavsbjerg, some 2 km to the South of Damgaard N. It is fossiliferous, and Rasmussen has identified the fauna (personal communication). Hence a biostratigraphical indicator level is found in the Søby profile a few meters above the level of the Søby Flora.

The relation of the Hodde and Gram Formation to the International Stages outside the North Sea Basin is unclear (Rasmussen 1966). In his fig. 3 Rasmussen (1961, p. 31) correlates the Hodde Formation with Reinbek-Stufe in North Germany. The lower Gram Clay is correlated with the North German Langenfelde-Stufe, and the upper Gram Clay with the Gram-Stufe. Rasmussen (1966, p. 337) cites the views expressed at the "Internationale Symposium zur Stratigraphie des Miocäns im Northseebecken" in 1961, where the Reinbek-Stufe is referred to the Helvetian, the Langenfelde-Stufe is referred to Tortonian and where the Gram-Stufe probably belongs to the uppermost Tortonian. These correlations are only poorly supported by the evidence to date and they must be considered very provisional.

2. The plant-bearing bed

The plant-bearing bed consists of a brown mica clay rich in organic components (10–15 %). Freshly exposed the clay is light brown, but quickly it turns dark grey through oxidation. The bed contains 6 laminae of fine sand in the upper half, while the lower half is compact (table 2 and fig. 3).

Leaves are the most common fossil plant remains and they are in a good state of preservation. The fossil seeds and fruits are strongly compressed and often damaged. Plant remains can be found throughout the whole bed, but seven zones with a specially high concentration have been found. A preliminary quantitative analysis has been made in these levels in order to recognize a possible vertical variation in the composition of the flora. But no such variation has been found.

The maximum thickness of the "Plant bed" (130 cm) has been found, near to point No 16 (fig. 2). The thickness decreases laterally and at point No 8 it is only 70 cm. This bed has not been found in exposures or drillholes elsewhere in the area, and hence it may represent a local pond in the delta.

Between points No 7 and No 8 (fig. 2) the plant bed is cut by an eastward-

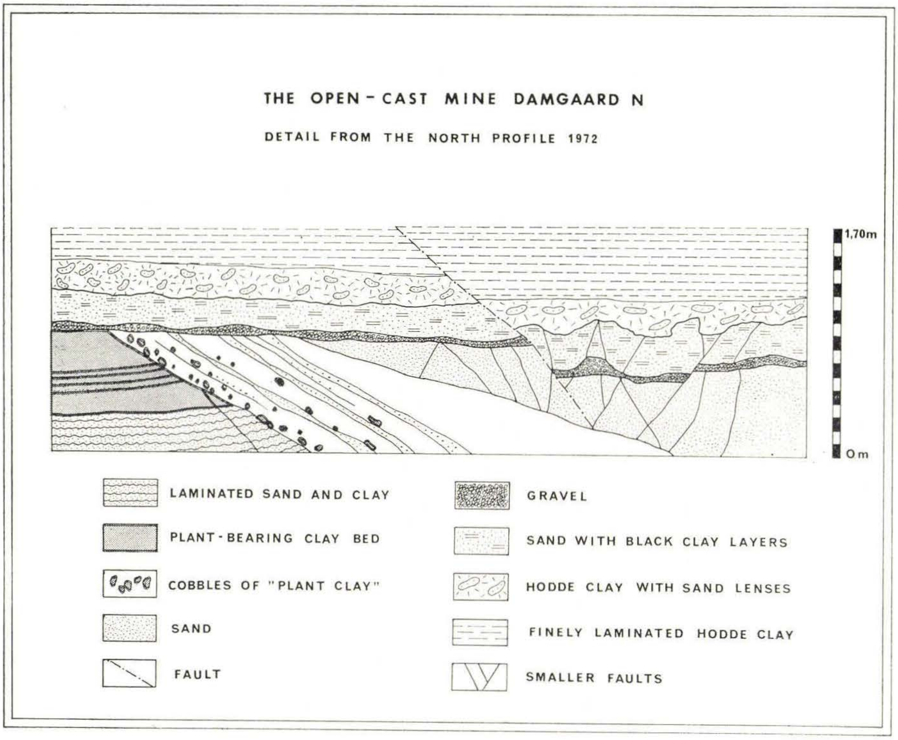


Fig. 4. Detail from the North Profile at point No. 7 (fig. 2). On the left, the laminated sands and clays grade into the plant-bearing clay. Both sets of beds are cut by an eastward-dipping unconformity. The following deposit is parallel to the unconformity. This bed consists of mixed sands and clays, but at its base it also contains rounded cobbles of the plant-bearing clay. This bed, with its re-deposited erosion products, is followed on the right by cross-bedded fluvial sand, which is the normal sediment type in the upper part of the Odderup Formation (upper sands of Table 1). All the above-mentioned delta deposits are discordantly overlain by the gravels which form the base of the Hodde Formation. The gravels are followed by a transitional series of sands with black clay inclusions and black clays with sand lenses, ultimately to grade into the Hodde Clay proper.

dipping unconformity (fig. 4). The unconformity is followed by a "conglomerate" containing cobbles of rounded "plant clay" in a matrix of clay and sand. This is followed by cross-bedded quartz sand. This succession indicates the presence in the delta, of an active river branch, which has eroded the margin of the pond, after the deposition of the plant-bearing clay. The products of the erosion have come to rest along the unconformity before the sedimentation of fluviatile sand.

The development was brought to a close by a complete or partial draining of the basin. Occasional plant roots, 0.2 to 5.0 cm thick, penetrate the plant bed from the top, often branching and forming a horizontal network. There are no signs of the swamp having become overgrown and the draining seems to have been rather sudden.

The fossil plant-remains have not been damaged by transportation, and leaves, fruits and seeds from the same plant are often found together in the plant bed. This indicates that these remains of an ancient flora represent a local association.

Working methods

1. Field-work

On exposure, the plant remains were rapidly destroyed by oxidation. Hence it was necessary to collect the plants in large clay blocks. The size of the blocks was determined by the sand laminae, along which the splitting took place. More than 5 tons of clay blocks were brought home from the field and dried very slowly in the laboratory.

Through digging in the "plant bed" it became clear that the vertical distribution of the fossil plants was variable. Seven zones with a specially high concentration of fossil plants were found. The zone number was painted on the blocks as they were collected.

To get data on the composition of the fossil flora special quantitative sampling was undertaken. Thus the plant fossils were counted in the field and assigned provisionally to genera. Each zone was treated separately during this quantitative investigation. The most important quantitative information is mentioned in Koch et al. (1973, p. 43). At the same time different morphological characteristics which are independent of the taxonomy were counted in order to gain information on the palaeo-climate. More than 2000 fossil plants were counted in this way.

It was necessary to undertake the quantitative analysis of the fossil flora before the final taxonomical determination, because the water table in the browncoal pit was rising constantly after the closure of the last mine in the area, and the inundation of the fossiliferous locality was imminent.

2. Preparation of the fossils

After 2–3 months of slow drying in the laboratory the clay blocks were split, and the plant fossils were carefully prepared. By means of the slow drying the destruction of the material was avoided, but the leaves had lost the original light brown colour, contrasted by a dark brown venation (like freshly fallen autumn leaves). They appeared black and without contrast. Experiments were made to try to reestablish the former subtile differences and a successful method was developed. This is described below as the Collodium-film method:

1. The surface of the leaves is cleaned by gently blowing with high-pressure air, and coated by means of a paint brush with 4 to 6 layers of collodium (dissolved in ether). Bubbles are carefully avoided.
2. Immediately before the last collodium layer has dried completely, the object is placed in running luke-warm water. After 5 to 10 minutes the collodium film with the attached leaf can be gently removed from the sediment.
3. The preparate is washed in water and the collodium film is cut clean at the edges with a pair of scissors.
4. The clay still attached to the leaf is removed by treatment with 30–40 % hydrofluoric acid for about 10–15 minutes and then washed in water.
5. The preparate is washed by gentle brushing with absolute alcohol whereby the last dirt and some organogenic material are removed, and the leaf appears bright and transparent. This last treatment has to be carried out very quickly, as the collodium film is dissolved in alcohol after a few minutes.
6. The cleaned and dehydrated preparate is washed successively in alcohol-xylene, xylene-alcohol and pure xylene.
7. The preparate can now be mounted in Canada balsam between two glass slides and dried for 24 to 48 hours in a drying oven at 60° C. Finally the slides are framed with black paper tape.

This method has proved very useful. It makes a detailed examination of the venation possible and yields material very suitable for photographs. What is most important is that it gives the first impression of the cuticle and its state of preservation. In this way it is possible to select the areas where the cuticle is best preserved, and to cut them out when the examination of leaf morphology has been finished.

In the further preparation of the cuticular material a 0.5 to 1.0 % sodium hypochlorite solution is used for bleaching (2 to 5 minutes), but chrome trioxide in a 10 % solution may also give good results (1 to 2 hours). If the cuticle is well preserved it is not necessary to use the collodium film material.

The preservations are never stained, but they are examined by a differential-interference-contrast microscope after Normarski and all the microphotos in the Plates have been photographed this way with a photomicroscope (Zeiss & Co.).

Systematic palaeobotany

1. Class Coniferopsida

Family Pinaceae
Genus *Pinus* L.
Pinus thomasiana (Goepp.) Reichenbach
(Pl. 1, figs. 1–4)

1845: *Pinites thomasianus* Goeppert – Goeppert et Berendt, p. 92–95, pl. 3, figs. 12–21.
1869: *Pinus laricio thomasiana* (Goepp.) Heer – Heer, p. 22–25, pl. 1, figs. 1–18.
1909: *Pinus laricio thomasiana* (Goepp.) Heer – Hartz, p. 55–56, pl. 3, fig. 2.
1917: *Pinus thomasiana* (Goepp.) Reichenbach – Reichenbach in Kräusel, p. 115, pl. 10, figs. 29, 30.

Material: Two almost complete strongly compressed cones, one fragmentary cone, with only half of the cone preserved, and a disintegreted cone represented by a collection of loose cone scales.

Description

Cone. (Pl. 1, figs. 1–4). The cone is elongate ovoidal or conical, 5.0 to 6.5 cm long and 2.5 to 3.1 cm broad. The cone-axis is straigth or bent. The cone-scales are a little more than 2 cm long. The apophyses are normally rhombic, occasionally irregularly pentagonal. The largest cone scales have apophyses 13 mm broad and 7 mm long, the smaller ones are 6 to 7 mm broad and 6 mm long. The apophysis is transversely carinate. Upper and lower halves of the apophysis are of the same size both at the base and in the middle of the cone, and the gradients of the two surfaces are equal. Toward the cone apex the upper part of the apophysis becomes smaller than the lower part and its gradient increases. The apophysis is finely radially sculptured and the lower half is occasionally divided by a weak, longitudinal keel continuing down the dorsal side of the cone scale.

The dorsal umbo on the middle of the transversal keel projects and is 3 to 5 mm broad and 1.5 to 2.0 mm long. The upper margin of the umbo is wedge-shaped, the margin making an obtuse angle (approx. 120°). Behind the upper margin a small persistent mucro is found. The lower margin is crescent-shaped.

Discussion

The size of the best preserved fossil cones from Søby lies within the size variation of *Pinus thomasiana* given by Heer (1869, p. 22), and the Søby fossils are to be considered as medium-sized cones. The cones are strongly compressed, slightly damaged and the base of the largest cone is partly covered with sediment which cannot be removed. Hence it is difficult to define the shape of this cone. Nevertheless, the cones in question seem to correspond to the variant of *P. thomasiana* described under d) by Heer (1869, p. 23).

The fragmentary cone with a bent cone-axis is of the same type as illustrated by Heer (1869, pl. 1, fig. 4). A cone with a bent cone-axis is also illustrated by Goeppert (1845, pl. 3, fig. 17).

The length of the cone scales, a little more than 2 cm, corresponds with the length given by Heer for medium sized cones of *P. thomasiana*. The size, form and sculpture of the apophyses of the Søby cones are identical with the apophyses of *P. thomasiana*. The smaller size and larger gradient of the upper half of the apophyses toward the cone apex also corresponds to type d) (Heer 1869, p. 23).

Only one cone of *Pinus thomasiana* has previously been found in the Tertiary of Jutland. This was at Sønderskov (Silkeborg area), in a mica-rich gyttja underlaying the browncoal proper. This well preserved cone is described by Hartz (1909, p. 55, pl. 3, fig. 2). The determination has been confirmed by Kirchheimer (1938, p. 405). The cone from Sønderskov is more cylindrical than the Søby cones, but there can be no doubt that the two species are identical.

Pinus thomasiana has been compared with the recent *Pinus laricio* Poir. by Goeppert (1845) and Heer (1869). The Søby species shows a high degree of similarity to *P. laricio,* but the two species cannot, as claimed by Heer (1869, p. 24), be considered as identical.

Family Taxodiaceae

Genus *Taxodium* Rich.

Taxodium dubium (Sternb.) Heer

Pl. 2, figs. 1–4; pl. 3, figs. 2, 4, 6; pl. 4, figs. 1–13; text-fig. 5).

1823: *Phyllites dubius* Sternb. – Sternberg, p. 37, 39, pl. 36, fig. 3.
1853: *Taxodium dubium* Heer – Heer, p. 136.
1855: *Taxodium dubium* Heer – Heer, p. 49, pl. 17, figs. 5–15.
1869: *Taxodium distichum miocenium* Heer – Heer, p. 18, pl. 2, figs. 1–26, pl. 3, figs. 6–7.

For further information and discussion of the synonyms see Walther 1964, p. 10–12.

Material: A large number of short-shoots (compressions), many seeds, eight shoots bearing staminate cones, three pistillate cones and some loose cone scales.

Description

The shoots. (Pl. 2, figs. 1–4). Only short-shoots have been found. They are normally unbranched, but one specimen carries two lateral side shoots 1.5 cm long. The stems of the short-shoots are slender. The leaf bases show spiral attachment, but the leaves are arranged distichous with an alternate placement with uneven intervals. The leaves are linear-lanceolate, slender and the length is highly variable, 0.6 to 3.0 cm in the middle part of the shoot. The apex is acute or obtuse. The leaves are contracted at the base, sessile or shortly petiolate. The decurrent base is inconspicuous and parallel to the shoot axis. The midvein is distinct, and the leaves at shoot base are reduced and scale-like.

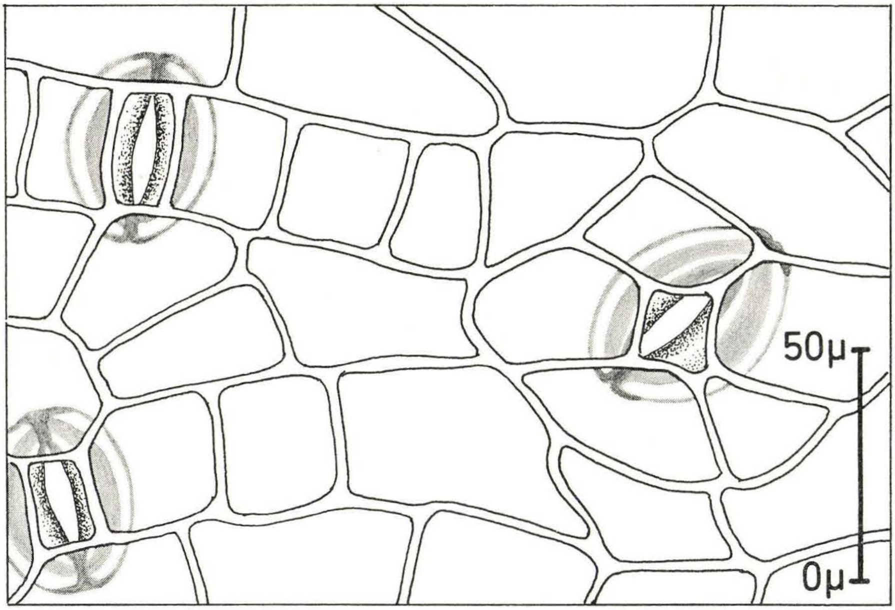


Fig. 5. *Taxodium dubium* (Sternb.) Heer. Lower cuticle showing arrangement of stomata. The midvein is parallel to the lower edge of the diagram.

Epidermis. (Pl. 3, fig. 2; text-fig. 5). The stomata are arranged in two stripes in upper and lower epidermis, the stripes being the broadest in the lower epidermis. Cells outside the stomatal stripes are mostly rectangular and arranged in rows. The cell length/breadth ratio is 1/1 to 4/1. The cells in the upper epidermis are generally shorter and broader than in lower epidermis. The cell walls are straight, unpitted and 2 to 3 microns thick. The stomata are closely set and variously orientated, but with a clear tendency toward being perpendicular to the midvein. This results in an irregular arrangement of the accessory cells. There are 4 to 6 accessory cells differentiated into 2 to 3 polar cells and 2 to 3 lateral cells. Where five or more accessory cells are present, a rosette arrangement is formed. The stomata are depressed, 40 to 48 microns long and 30 to 38 microns broad. The stomatal slit is about 45% of the stomatal length. The apices are non-retuse with a T-shaped piece.

The mesophyl is sometimes preserved. It appears undiffirentiated and the elongated cells run as transversal lamellae from the leaf margin to the transfusion tissue enclosing the midvein.

Staminate cones. (Pl. 4, fig. 1). The staminate cones are found on specialized branched shoots. The ovoidal, short stalked cones are spirally arranged and attached in the axils of widely spaced scale-like leaves. The detailed structure is not known.

Seeds. (Pl. 3, figs. 4–6; pl. 4, figs. 3–13). The size of the seeds is highly variable, 5 to 12 mm long and 3 to 7 mm broad. The shape is irregularly triangular or ovate, with marked longitudinal ridges, which in the larger seeds are developed as thick low wings.

The outer cuticle of the testa is easily removed from the seed. It consists of large, thick-walled irregular cells more than 100 microns long. The cell walls are straight with a fine undulation in the sides of the walls. The exotesta consists of a few layers of stone cells, each cell is 20 to 30 microns long. The mesotesta is composed of rather thin-walled parenchymatous tissue with finely pitted cell walls. This tissue is normally completely squashed on the fossils. The nature of endotesta and inner cuticle is never disclosed in the fossil material.

Pistillate cones. (Pl. 4, fig. 2). The compressed cones are circular in outline, 1.8 to 2.5 cm in diameter. The best-preserved cone consists of about 20 cone scales, 8 to 10 mm high and 10 to 12 mm broad in the central part of the cone. Each scale consists of a rhomboidal plate divided into an upper part with sculptures, and a lower part which is triangular and smooth. The edges of the scales fit together without overlapping. Toward apex and base the scales become small and imperfect. On the reverse side of the cone-scales, yellow stripes of resin can be seen.

Discussion

The fossil short-shoots from the Søby Flora show a clear affinity to the genus *Taxodium*. The morphology of the shoot is, according to Chaney (1951), characteristic of *Taxodium* and it differs from the morphology of *Sequoia* and *Metasequoia*. The *Taxodium* characteristics (Florin 1931) are additionally found in the epidermis of the Søby fossils. As shown by Florin (1931), it is distinct from *Glyptostrobus*.

The presence of *Sequoia* and *Glyptostrobus* was expected in the Søby Flora, as these genera have been described by Mathiesen (1970) from the Neogene tertiary lignites of Central Jutland, and they have been reported by Koch et al. (1973) from the Fasterholt Flora. This flora is geographically and stratigraphically close to the Søby Flora. But so far, *Sequoia* and *Glyptostrobus* have not been found in the Søby Flora.

The presence of *Taxodium* is also confirmed by the existence, in the deposit, of pistilate cones, seeds and staminate cones referable to *Taxodium* as well. Fertile organs of *Sequoia* and *Glyptostrobus* have not been found.

All the organs described can be ascribed to the fossil species *Taxodium dubium* (Sternb.) Heer.

Comparison with recent material

The Søby material is best compared with *Taxodium distichum* (L.) Rich. and *Taxodium mucronatum* Ten. The general structure of the epidermis is the same, but by measuring the stomata the following results are obtained (average of 50 measurements for each species):

Table 3.

Species	length	breadth
Taxodium dubium (Søby)	42.4 microns	33.2 microns
Taxodium distichum (herbarium)	43.6 microns	35.6 microns
Taxodium mucronatum (herbarium)	53.2 microns	39.6 microns

Table 3 shows that the size of the stomata is almost the same in *T. dubium* and *T. distichum*, whereas the stomata are markedly larger in *T. mucronatum*. The fossil staminate cones and the seeds seem to be closely related to

T. distichum, while (according to Mädler 1939, p. 40) the small size of the fossil pistillate cones must be taken as evidence of similarity with *T. mucronatum.* Thus the number of differentiating criteria seems to be too small to permit us clearly to decide whether *T. dubium* is closest related to *T. distichum* or to *T. mucronatum.*

2. Class Monocotyledoneae

Family Liliaceae
Genus *Smilax* L.
Smilax weberi Wessel
(Pl. 5, figs. 1–8; pl. 6, figs. 2, 4, 5, 6; text-fig. 6, A–F; text-figs 7 and 8.)

1847: *Smilacites grandifolia* Ung. – Unger, p. 129, pl. 40, fig. 3.
1855: *Smilax grandifolia* (Ung.) Heer – Heer, p. 82, pl. 30, fig. 8.
1855: *Smilax weberi* Wess. – Wessel et Weber, p. 127, pl. 21, fig. 1.
1855: *Smilax ovata* Wess. – Wessel et Weber, p. 127, pl. 21, figs. 2, 3.
1855: *Smilax obtusifolia* Wess. – Wessel et Weber, p. 128, pl. 21, fig. 4.
1860: *Smilax haidingeri* Ung. – Unger, p. 7, pl. 1, fig. 11.
1861: *Smilax grandifolia* (Ung.) Heer – Unger, p. 7, pl. 2, figs. 5–8.
1866: *Smilax grandifolia* (Ung.) Heer – Ettingshausen, p. 28, pl. 2, fig. 1, pl. 6, fig. 15, 16.

Material: 35 more or less fragmented leaves (compressions) have been collected. Of these are 8 complete.

Description

The leaf. (Pl. 5, figs. 1–8; text-fig. 6, A–F). The leaves are ovate and the apex is acute. The base is rounded, truncate or chordate. The chordate bases are often found among the larger leaves. The lamina is 4 to 9 cm long and 2.5 to 6.5 cm broad, but fragmentary material indicates lengths up to 18 cm and width up to 14 cm. The leaf margin is entire and the petiole is poorly preserved. The venation is camphylodromous. There are 5 to 7 primary veins, each forming an angle of 20 to 40° to the neighbouring vein at the leaf base. The central primary vein is strong, somewhat tapering along the length, straight or gently curved. The lateral primary veins are thinner, curving upward through the lamina, converging in the apex. The outer pair is evidently more slender than the rest, mostly ending in the middle or upper third of the leaf. Secondary veins are arising at 40 to 80° from both sides of the central primary vein and from the basiscopic side of the lateral primary veins, connecting directly with the nearest primary vein or occasionally curving upward, mutually lobate. Thereby an open network is

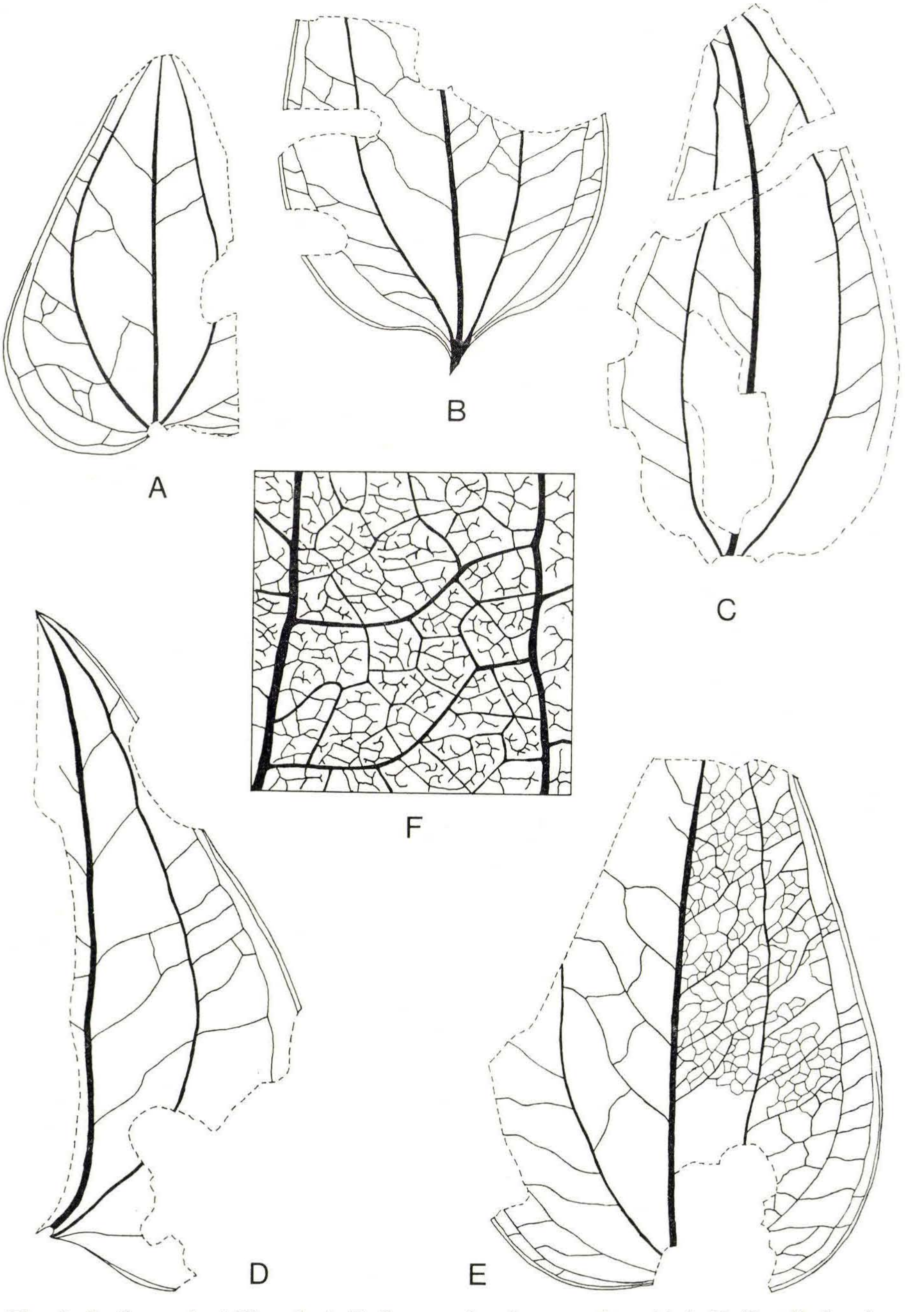


Fig. 6. *Smilax weberi* Wessel. A–E: Leaves showing venation, × 1. F: Detail showing venation between first and second lateral primary veins (1 cm²).

formed which laterally encloses regular transversal fields. There are 5 to 8 tertiary veins per cm secondary vein. The free vein endings are both branched and unbranched.

Epidermis. (Pl. 6, figs. 2, 4, 5, 6; text-figs 7, 8). The upper epidermis is composed of 70 to 110 cells per 0.1 mm^2. The cells over veins are more or less rectangular, elongated in vein direction and arranged in rows. The cell walls are with or without undulation. The finer veins are not reflected in the cuticle. The cells between veins are irregular in shape, 30 to 70 microns long. The cell walls are pitted, 2 to 3 microns thick and markedly undulate. There are 0 to 8 lobes per cell. The wave length is 14 to 28 microns and the range is up to 10 microns. The cells in the leaf margin are thickened, rectangular, elongated and arranged in 2 to 4 rows. The cell walls are not undulate.

The lower epidermis is composed of 60 to 100 cells per 0.1 mm^2. The cells over veins are more or less rectangular, elongated in vein direction and arranged in rows. The cell walls are with or without undulation. The cell surface over the veins has a marked longitudinal striation. The finer veins are not reflected in the cuticle. The cells between the veins are irregular in shape and 30 to 60 microns long. The cell walls are pitted, 2 to 3 microns thick and markedly undulate. They have 0 to 7 lobes per cell. The wave

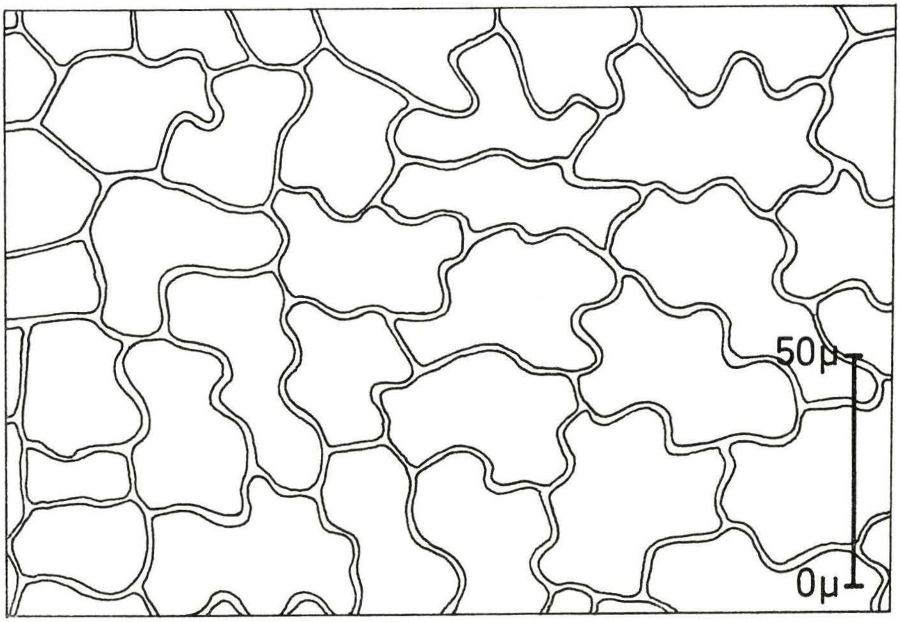


Fig. 7. *Smilax weberi* Wessel. Upper epidermis close to the leaf margin (left).

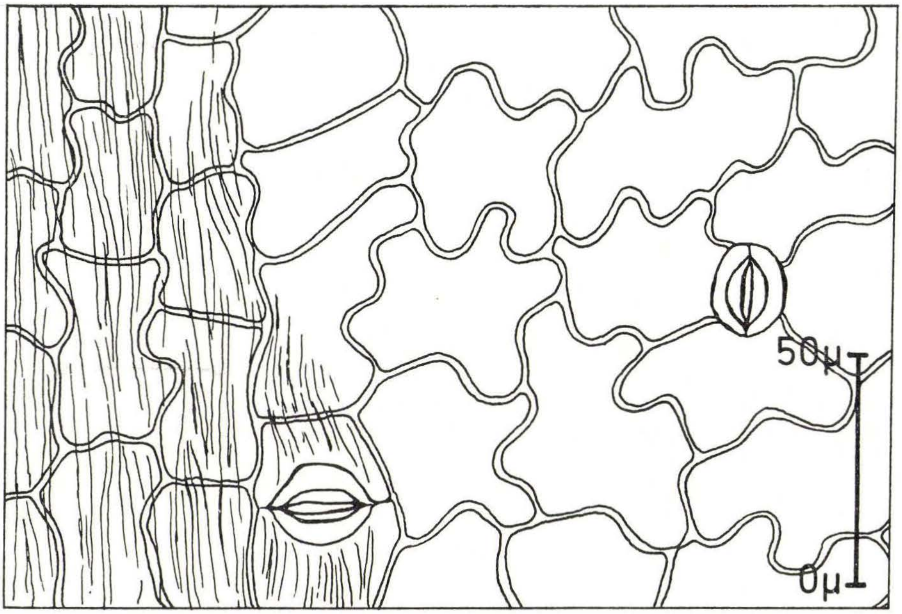


Fig. 8. *Smilax weberi* Wessel. Lower epidermis with stomata. The cells on the left, which (seen from the underside) overlie a vein, have a longitudinal striation.

length is 16 to 30 microns and the range is up to 12 microns. The cells in the leaf margin are thickened and arranged in 4 to 6 rows. The cell walls are not undulate and the cell surface has longitudinal striation. The stomata are parallel or variously orientated and there are 10 to 20 stomata per 0.1 mm^2. They are undepressed and more or less equidistant. The length is 18 to 20 microns and the breadth is 14 to 16 microns. The stomatal slit is 75 to 85% of the stomatal length. The dorsal walls of the guard cells are sometimes thickened and the apices are non-retuce. The accessory cells which are similar in size to the other cells in the epidermis, are not always well differentiated. If they are, there are 2 lateral cells and up to 2 polar ones.

Discussion

A large number of *Smilax* species within the variation of the examined material have been described from the European Tertiary. As it is very difficult to separate the species on the basis of external morphology, Weyland (1937, p. 77) tentatively proposed two form-groups, comparing the *Smilax* species in the floras of Rott and Oehningen. The first form-group contains leaves with a chordate basis. In the second, truncate or rounded leaf bases are found.

Hantke (1954) established *Smilax sagittifera* Heer sensu novo and included the species from Weyland's first form-group as synonyms (Hantke 1954, p. 82). The species from Weyland's second form-groups are treated by Bůžek as synonymous with *Smilax weberi* from the North-Bohemian Basin (Bůžek 1971, p. 89). Yet it still seems difficult to distinguish clearly between the two species, and a degree of uncertainty remains as to where to place some of the species earlier described.

There seems to be no doubt that the Søby species belongs to *Smilax weberi* Wessel. The leaves correspond fully to those described by Wessel (Wessel & Weber 1855). Furthermore, the variation of the Søby species is the same as that described by Bůžek (1971). This has been confirmed by Bůžek (personal communication).

To illuminate the difference between *Smilax sagittifera* Heer sensu novo and *Smilax weberi* Wessel, we can look at the epidermis. Only a poorly preserved cuticle from a single leaf of *S. sagittifera* has been described (Hantke 1954, p. 82). In spite of its bad state of preservation it is possible to point out certain differences between the species. *S. sagittifera* has cell walls bearing hemispherical, knotty projections (Zellwände knortig verdickt) and a finely granular cuticle (Kutikula fein gekörnelt) in the upper epidermis. In the lower epidermis the cuticle of the guard cells is markedly granular (Kutikula der Schlieszellen deutlich gekörnelt). None of these characteristics is observed in *S. weberi.*

Ferguson (1971) describes the cuticle from a single fragmentary leaf LXXII (sub. fam. Smilacoideae) from Kreuzau. The leaf is of the weberi-type and the epidermis is similar to *S. weberi.* Even if nothing is mentioned about striation above veins and in leaf margin, it cannot be excluded that the Kreuzau species belongs to *S. weberi.*

Comparison with recent material

Smilax weberi from Søby has by the author been compared morphologically, with 120 recent *Smilax* species found in the herbaria of the University of Copenhagen and the University of Aarhus. 18 species showing the greatest similarity to the fossil species have been selected for anatomical examination.

The specific epidermis variation in the genus *Smilax* is small, and all the species examined are rather close to *S. weberi.* But careful examination shows that the fossil resembles two of the modern species more than the others. These are *Smilax hispida* Muhl. (pl. 7, fig. 5) from the Southeastern North America and *Smilax excelsa* L. (pl. 6, figs. 1, 3 and pl. 7, fig. 4) from East Europe and Central Asia. Both these species have the same cell configuration, but differ from *S. weberi* in some details.

S. hispida has the same striation in the lower epidermis as *S. weberi.* The striation of *S. hispida,* however, is not restricted to veins and leaf margin, but is also found in the areoles. Furthermore *S. hispida* normally carries short multicellular hairs in the leaf margin and over the larger veins in the lower epidermis. Hairs and hair bases are never observed in *S. weberi.* Multicellular hairs are rarer in *S. excelsa,* but this species has no striation in the lower epidermis at all.

It can be concluded that *Smilax weberi* in general is very close to the recent species examined as far as leaf morphology and epidermis structure are concerned, and it can hardly be doubted that the fossil species belongs to the genus *Smilax. S. weberi* is best compared with the recent *S. hispida* and *S. excelsa.* This statement is in good accordance with the opinion of Bůžek (1971, p. 91), but it must be stressed that the fossil species is not identical with any of the living species.

3. Class Dicotyledoneae.

Family Myricaceae
Genus *Comptonia* L' Heritier
Comptonia acutiloba Brongniart
(Pl. 8, figs. 1–7; pl. 9, figs. 2, 4, 6; pl. 10, figs. 2, 4, 5, 6; textfig. 9, A–I; text-figs. 10–12).

1821: *Asphlenium difforme* Sternb. – Sternberg, p. 33, pl. 24, fig. 1.
1828: *Comptonia acutiloba* Brongn. – Brongniart, pp. 141, 143, 209.
1851: *Dryandra acutiloba* (Brongn.) Ettingsh. – Ettingshausen, p. 27, pl. 4, figs. 2, 3.
1877: *Myrica acutiloba* (Brongn.) Schimp. – Engelhardt, p. 375, pl. 23, figs. 7–12.
1906: *Comptonia difforme* (Sternb.) Berry – Berry, p. 495–497.

Material: 76 more or less fragmented leaves (compressions) have been collected. Only 5 of these are complete.

Description

The leaf. (Pl. 8, figs. 1–7; text-fig. 9, A–I). The leaves are lanceolate in outline, shortly petiolate and pinnately divided. The smallest complete leaf is 2.7 cm long, the largest is 6.5 cm long, but fragmentary material indicates a length of up to 10 cm or more. The width in the middle part of the leaf is 0.5 to 1.9 cm. The typical lobe is deltoid in shape, with a forward pointed mucronate apex. The lobes are smaller toward base and apex of the leaf, and sometimes rhomboid near the apex. They are alternate or opposite, divided by deep incisions reaching or almost reaching the midvein. The lobes are closely set or gently distant and secondary incisions are rare. The

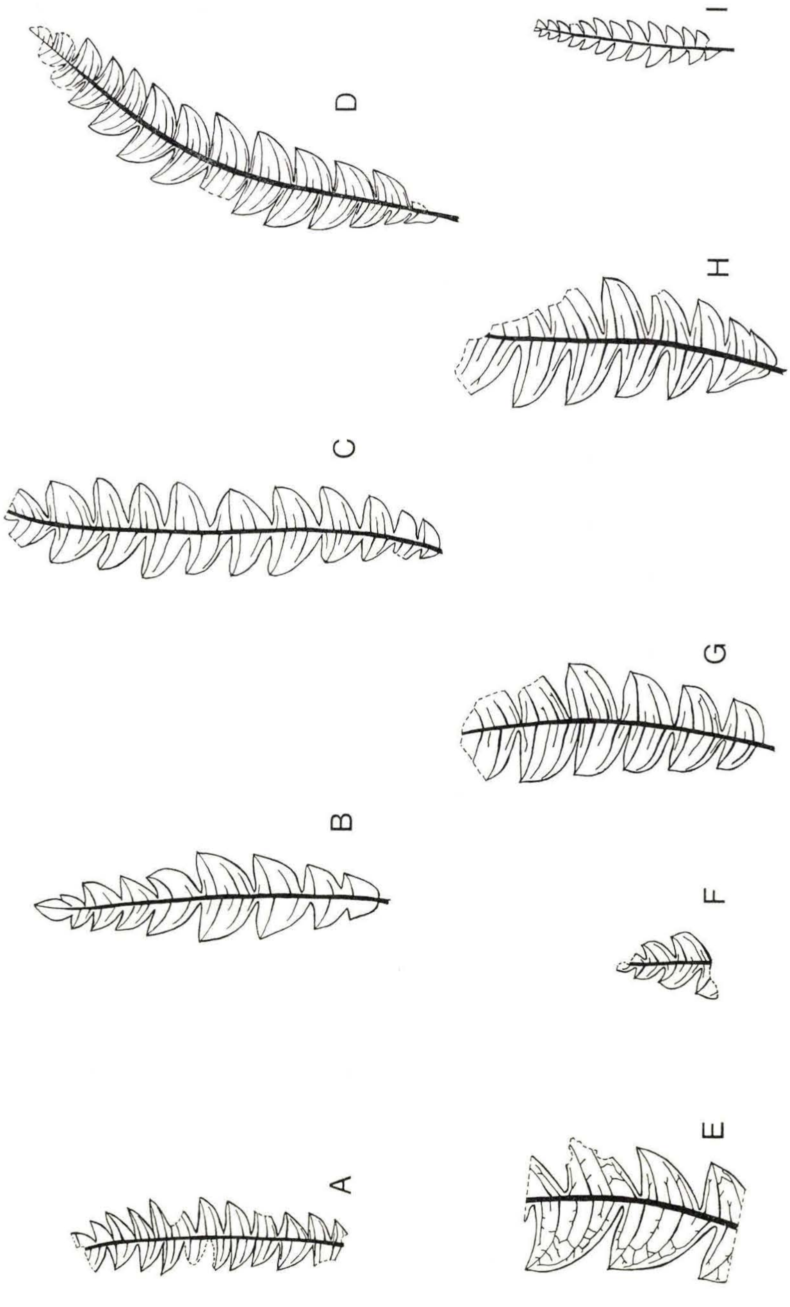


Fig. 9. *Comptonia acutiloba* Brongniart. H-I: Leaves showing venation and variation in size and shape of the lobes, × 1. E.: Lobes showing detailed venation, × 2.

lobes are normally a little longer than broad, and the length is becoming equal to breadth toward apex and base. The midvein is strong through the whole leaf finally tapering near the apex. There are 2, occasionally 3 secondary veins starting at an angle near 90°. The upper secondary vein slightly curves toward the lobe apex, and ends in the mucro. The lower secondary vein becomes somewhat more curved as it proceeds outward, curving upward to join a short downwardly directed lateral branch from the upper secondary. Normally 3 intermediate veins are present, one between upper lobe margin and upper secondary, one between the two secondaries and one between lower secondary and lower lobe margin. The latter forms festooned anastomoses with the lower secondary. The number and the length of intermediate veins is somewhat variable. The tertiary venation is finely reticulate, but it is not always preserved.

Epidermis and internal structures. (Pl. 9, figs. 2, 4, 6; Pl. 10, figs. 2, 4, 5, 6; text-figs. 10–12). The upper epidermis is 10 to 12 microns thick, and it is composed of 280 to 370 cells per 0.1 mm^2. The cells are polygonal, isodiametric or weakly elongate, 12 to 30 microns long. The cells over the veins are elongate. The cell walls are straight or weakly undulate, 1.0 to 1.5 microns thick and unpitted. The trichome bases are found both over the

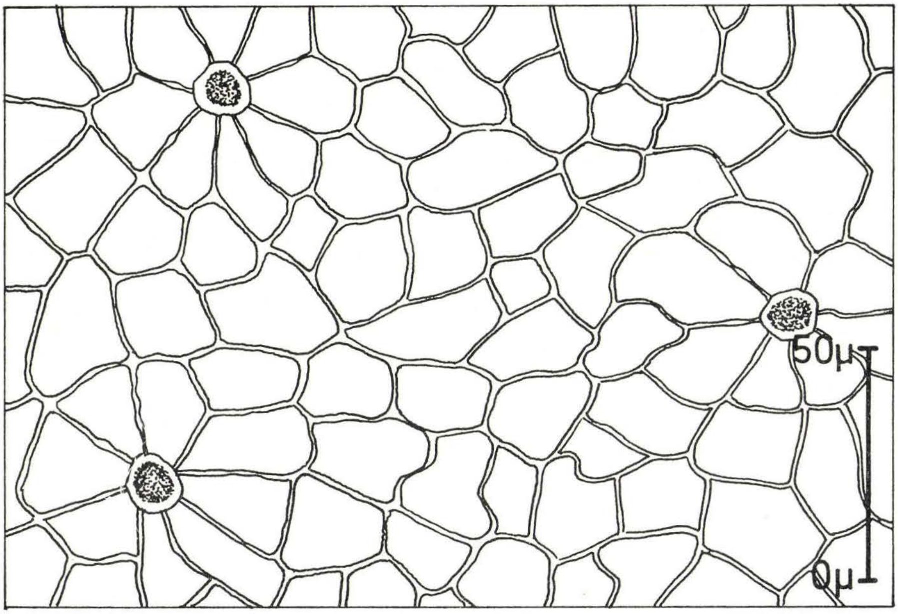


Fig. 10. *Comptonia acutiloba* Brongniart. Upper epidermis with trichome bases.

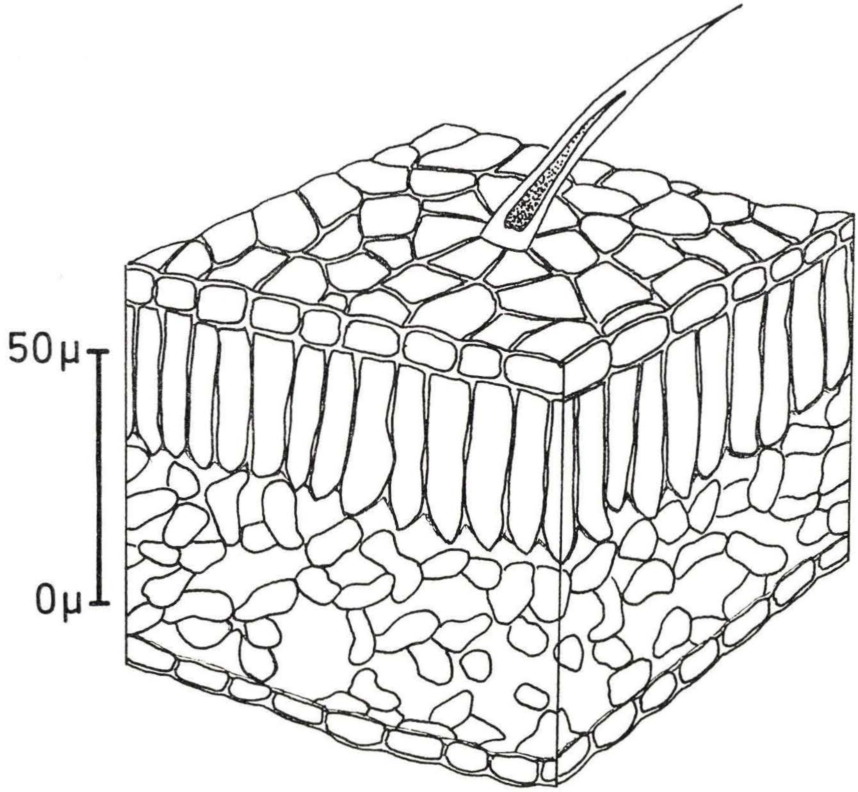


Fig. 11. *Comptonia acutiloba* Brongniart. Reconstruction of the anatomy of the leaf showing upper epidermis with hair, palisade, spongy mesophyl, and lower epidermis. The spongy mesophyl is never preserved in the Søby species.

veins and in the areoles. The bases consist of one occasionally two, thickened cells, and the diameter is 10 to 14 microns. It is surrounded by 6 to 8 associated cells. There are about 50 bases per 1.0 mm^2. The hairs are sometimes attached to the trichome bases. They are simple unicellular hairs more than 75 microns long. There is a rim of hair in the leaf margin with up to 30 hairs per mm.

The palisade under the upper epidermis consists of one layer of palisade cells, 40 to 50 microns thick. The cell diameter is 6 to 16 microns and there are 500 to 800 cells per 0.1 mm^2.

The spongy mesophyl is always collapsed. The lower epidermis is 8 to 10 microns thick, and it is composed of 300 to 400 cells per 0.1 mm^2. The cells are isodiametric or weakly elongate, 10 to 30 microns long. Cells over the veins are elongate. The cell walls are markedly undulate, the wave length is 8 to 12 microns and the range is 4 to 8 microns. There are 3 to 6 lobes per cell. The cell walls are 0.5 to 1.0 micron thick and unpitted. The stomata are variously orientated, undepressed and more or less equidistant. The length is 14 to 16 microns and the width is 10 to 12 microns. The stomatal slit is 65 to 75% of the stomatal length, and the apices are non-retuce. The accessory cells are poorly differentiated, 4 to 6 in number. The thichome bases are found both over the veins and in the areoles. The bases consist of one thickened cell 12 to 14 microns in diameter, surrounded by a ring of 7 to 9 associated cells. A few poorly preserved emergences have been found attached to the bases, they may be collapsed globose glandular hairs.

Comparison with recent material

The genus *Comptonia* is monotypic. The single species. *C. aspleniifolia* is confined to Eastern North America.

A large number of fossil forms have been compared with *C. aspleniifolia,* and on the basis of morphological similarity they have been given the genetic name *Comptonia.* Some authors, however, prefer to use the form-genetic name *Comptoniphyllum* instead, because the morphological char-

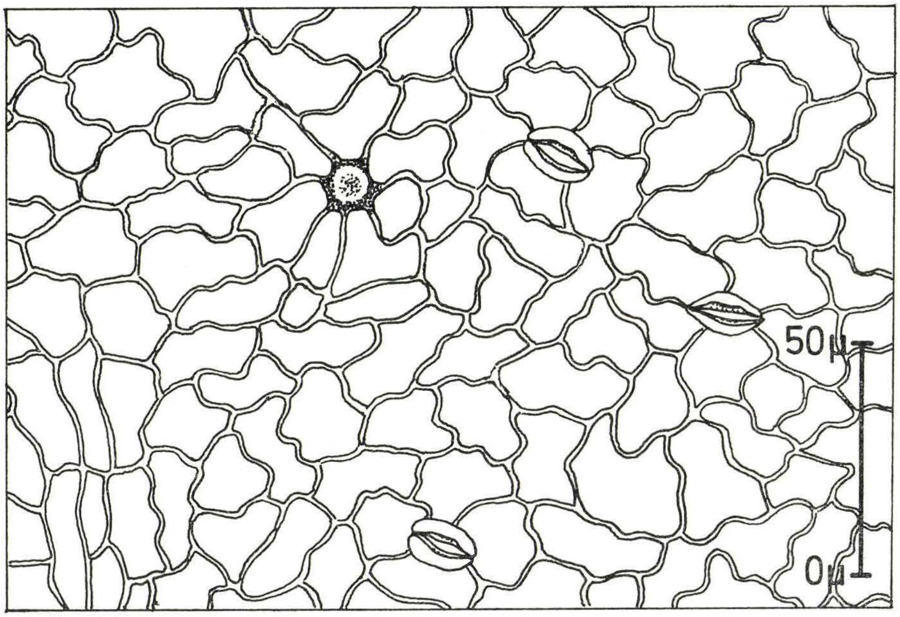


Fig. 12. *Comptonia acutiloba* Brongniart. Lower epidermis with stomata and trichome base. Elongated cells seen on the left overlie a vein.

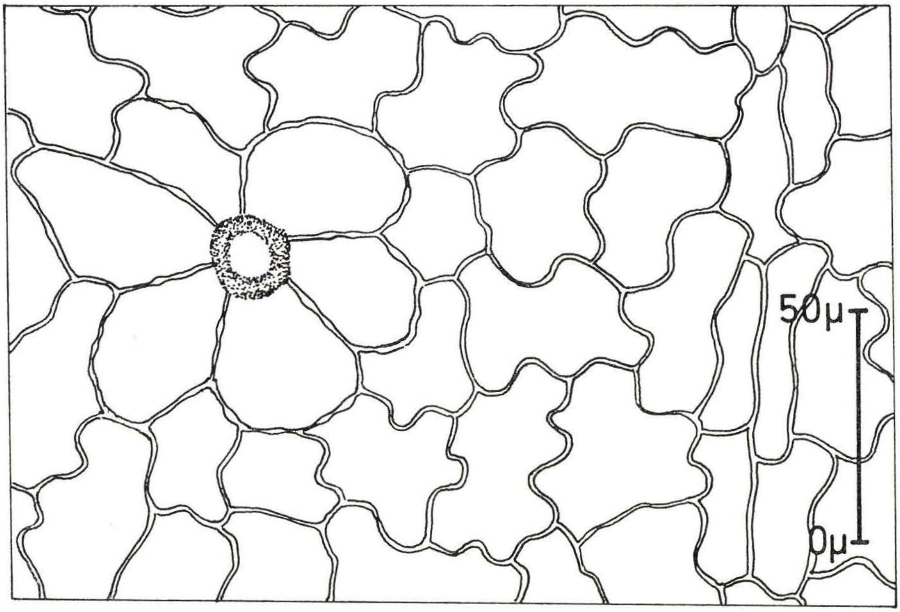


Fig. 13. *Comptonia aspleniifolia* (L.) Aiton. Upper epidermis with trichome base and elongated cells over vein.

acteristics are insufficient and ambiguous and do not allow assignments to *Comptonia* only.

It thus seems relevant to use an anatomical comparison in order to comfirm the assignment of the Søby species to the genus *Comptonia*. This comparison must start with an anatomical description of the leaf of *C. aspleniifolia*.

Comptonia aspleniifolia (L.) Aiton
(Pl. 7, fig. 1–3; pl. 9, figs. 1, 3, 5; pl. 10, figs 1, 3; text-figs. 13, 14).

The upper epidermis is 10 to 12 microns thick and it is composed of 120 to 150 cells per 0.1 mm^2. The cells are isodiametric or weakly elongate, 30 to 50 microns long. The cells over the veins are elongated. The cell walls are markedly undulate, the wave length is 15 to 20 microns and the range is 8 to 12 microns. There are 5 to 7 lobes per cell. The cell walls over the veins are straight, pitted and 1.5 to 2.5 microns thick. Trichome bases are confined to the veins, but they can occasionally be found in the areoles. The bases consist of one rarely two thickened cells and the diameter is 16 to 25 microns. They are surrounded by 6 to 7 associated cells and the radial walls are normally not undulated. There are about 25 bases per 1.0 mm^2. The trichome bases carry simple unicellular hairs, 100 to 250 microns long. There is a rim of hair in the leaf margin with up to 18 hairs per mm.

The palisade below the upper epidermis consists of one layer of palisade cells, 40 to 70 microns thick. The cell diameter is 8 to 16 microns and there are 600 to 750 cells per 0.1 mm^2.

The spongy mesophyl between palisade cells and lower epidermis is 50 to 90 microns thick.

The lower epidermis is 8 to 10 microns thick and it is composed of 90 to 130 cells per 0.1 mm^2. The cells are isodiametric or weakly elongate, 35 to 70 microns long. The cells over the veins are elongate. The cell walls are markedly undulate, wave length is 10 to 16 microns and the range is 8 to 12 microns. There are 5 to 7 lobes per cell. The cell walls are pitted and 1 to 2 microns thick. The stomata are variously orientated, undepressed and more or less equidistant. There are 12 to 24 stomata per 0.1 mm^2. The length is 25 to 30 microns and the width is 20 microns. The stomatal slit is 55 to 65% of the stomatal length and the apices are retuce. The accessory cells are poorly differentiated, 5 to 7 in number. The trichome bases are normally confined to the veins, but they can be found in the areoles. The bases consist of one thickened cell surrounded by 7 to 9 associated cells. A globose short stalked glandular hair, 30 to 35 microns long, is atached to the

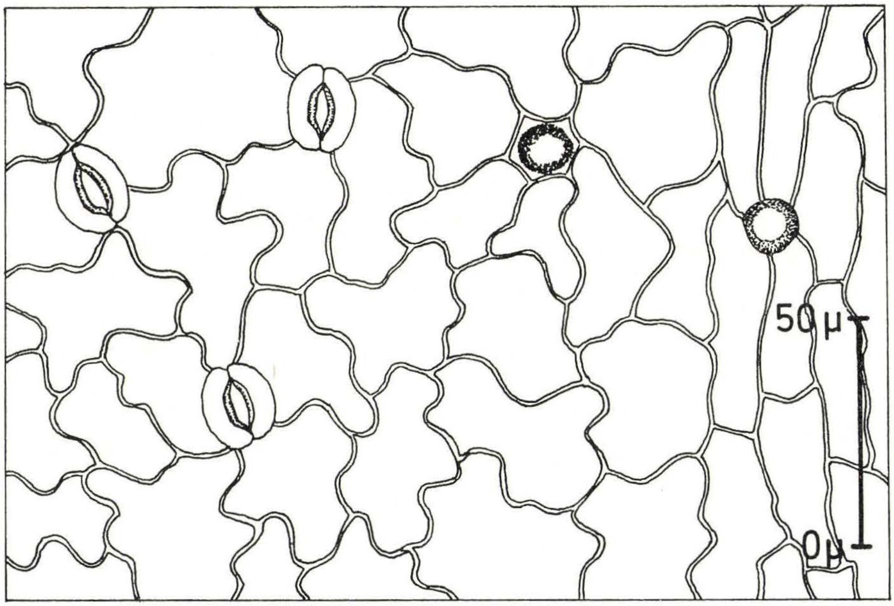


Fig. 14. *Comptonia aspleniifolia* (L.) Aiton. Lower epidermis with stomata and trichome bases. Elongated cells over vein seen to the right.

bases. The globose head consists of 4 cells and the diameter is 28 to 32 microns.

If the anatomical characteristics of the two leaves in question are compared, we find a high degree of similarity, summarised in the following items:

1. Upper epidermis equally thick in the two species. Lower epidermis equally thick in the two species.
2. Trichome bases and associated cells developed in the same way.
3. Hairs on the upper epidermis of exactly the same type, and concentrated near the leaf margin.
4. Palisade cells constructed in the same way, with the same thickness and the same number of cells.
5. Cells and cell walls in the lower epidermis of the same type.
6. Stomata and accessory cells of the same type.

But there are also differences:

1. Epidermis cells in the Søby fossils are considerably smaller than in *C. aspleniifolia.*
2. Cell walls in the upper epidermis in the Søby leaves are only weakly undulate, if undulate at all.
3. Stomata are smaller in the Søby leaves.
4. Concentration of trichome bases on the upper epidermis twice as big in the Søby leaves.

It seems clear that the similarity between the two species compared is so great that it can hardly be doubted that the fossil leaves from Søby belong to the genus *Comptonia.* For this reason it is convenient to use the genetic name *Comptonia* for the Søby fossil. The differences in the epidermis structure mark the specific characteristics distinguishing the fossil and the recent species.

Discussion

On examining the anatomy of the Søby leaf one can have no doubt that it belogns to the genus *Comptonia.* But as the epidermis of other fossil *Comptonia* species has never been described, the identification of the species must be based exclusively on external morphological characteristics.

The Søby species shows a great resemblance to *Asphlenium difforme* Sternberg (1821), but the author was not convinced of its identity until some excellent photographs of Sternberg's type specimen, kindly sent by Bůžek in 1973, were examined. Furthermore, the actual material corresponds to the following well illustrated species: *Myrica acutiloba* (Brongn.) Schimper, Engelhart 1877, pl. 4, figs. 7–12; *Comptonia difformis* (Sternb.) Berry, Kotlaba 1961, pl. 18 A and *Comptonia acutiloba* Brongniart, Bůžek 1971, pl. 9, figs. 1–8. To-day they are all considered to be *C. acutiloba* in accordance with Vassiljev & Zhilin (1968).

From the Japanese Neogene we know *Comptoniphyllum naumanni,* established by Nathorst (1888), and later worked on by, among others, Matsuo (1965) and Huzioka (1961) under the name *Comptonia naumanni.* These leaves from the Middle Miocene seem very similar to the Søby species. In particular, Matsuo (1965) has several photographs which seem to be identical with the Søby species.

Nathorst already mentioned the similarity between *Comptoniphyllum naumanni* and *Comptonia acutiloba* and at first he considered the Japanese species as a variety of the European species. Later he enumerated the following important criteria for distinguishing between the species: In *C. naumanni* the lobes are more deeply divided, the incisions reaching the midvein. The upper and lower margins are straighter, the lobe apex is more pointed in the Japanese species, and the lobes are said to be more broad than long.

These characteristics cannot be used in separating the Søby species from *Comptoniphyllum naumanni.* As the Søby species is considered to be *Comptonia acutiloba* it is not possible on a morphological basis to distinguish between the two species. But until the epidermis has been examined it is considered unwise to include a so well established species in *C. acutiloba.*

Acknowledgements. The present work has been supported by *The Danish Natural Science Research Counsil* (Statens naturvidenskabelige Forskningsråd) as a part of The Søby-Fasterholt Browncoal Project. I wish to express my sincers thanks to lektor *B. Eske Koch,* leader of the Phytopalaeontological Department in Århus, for helpful discussion and suggestions during the work. In the field I was assisted by the following students: *A. Grambo, J. Overballe* and *E. Thomsen.* The last named has been responsible for measuring the sections in Damgaard N. Mrs. *L. Thamdrup* assisted in the laboratory in making preparations of recent cuticles. Mr. *J. Sommer* prepared the photographs for the plates. The figures have been drawn by Miss. *J. Lützhöft* and the tables have been laid out by Mrs. *J. Gissel Nielsen.* The English text was corrected by lektor *C. C. Rokkjær* and Mr. *Aub-Robinson,* and the manuscript was typed by Mrs. *A. M. Kristensen.* My thanks are due to all these helpers. Director *J. C. Henriksen,* the owner of Fasterholt Gaard, kindly gave permission for the field work on his property. The Botanical

Museum, University of Copenhagen, and the herbarium of the Botanical Institute, University of Aarhus, made herbarium material available for comparison. Finally, I want to thank Dr. *C. Bůžek* (Praha) for sending me photographs of Sternbergs type-material, and to Dr. *D. Ferguson* (Antwerp) for lending me some of his preparates. The Danish Natural Science Research Counsil has also supported the printing of this work.

Dansk sammendrag

Søby Floraen: Fossile planter fra de mellem miocæne delta aflejringer i Søby-Fasterholt området, Midtjylland, Danmark

Indledning

I årene 1969–1973 arbejdede den Phytopalæontologiske afdeling ved Geologisk Institut, Aarhus Universitet, støttet af Statens naturvidenskabelige Forskningsråd, med indsamling af materiale til en geologisk palæobotanisk undersøgelse af den brunkulsførende lagserie i Søby-Fasterholt området sydøst for Herning. Som deltager i dette arbejde opdagede forfatteren en meget righoldig fossil flora i den nedlagte brunkulsgrav "Damgaard N". Den fossile flora er blevet kaldt Søby Floraen, og i dette og kommende arbejder er det forfatterens hensigt at beskrive floraen og fremlægge de oplysninger, der skal danne grundlag for de endelige konklusioner.

Geologi

Da der endnu ikke foreligger nogen samlet beskrivelse af geologien i Søby-Fasterholt området, præsenteres de generelle geologiske forhold i tabel I. Den sandaflejring, der overlejrer den brunkulsførende lagserie, går på fossillokaliteten gradvist over i det planteførende lerlag, som her afslutter Odderup Formationens deltaaflejringer. Formationen indledes med et basalt sand- og gruslag, der efterfølges af en overgangs lagserie med vekslende lag af sand og sort ler. Herefter følger det egentlige Hodde Ler, der ikke er fossilførende i området. Gram Formationen i området indledes med fossilfrit Glauconit Ler, der på lokaliteten Lavsbjerg overlejres af det egentlige Gram Ler. Dette har for nylig vist sig at indeholde bestembare marine fossiler. Søby Floraen har således kunnet placeres i den eksisterende lithostratigrafi og sættes i relation til det biostratigrafiske indikatorniveau, der udgøres af Gram Leret.

De fossile planterester findes i en lokal aflejring af brunt glimmerler med et stort indhold af organisk materiale. Blade er den mest almindelige og bedst bevarede af planteresterne, mens frø og frugter ofte er stærkt fladtrykte og ødelagte. Bevaringstilstanden og den fossile floras sammensætning tyder på at aflejringen repræsenterer en lokal floraassociation.

Arbejdsmetoder

Det fossile plantemateriale blev indsamlet i store lerblokke og refereret til 7 zoner med særlig høj plantekoncentration. Mere end 5 tons materiale blev indsamlet og bragt til laboratoriet til langsom tørring og senere udpræparation. For at få et indtryk af floraens sammensætning blev et stort antal planter optalt i felten og henført til provisoriske slægter. Der blev foretaget separate tællinger i hver af de 7 zoner. Parallelt med denne tælling blev der foretaget en bladmorfologisk analyse for at få oplysninger om de palæoklimatiske forhold. Lidt over 2000 veldefinerede planterester blev optalt.

Under laboratoriebehandlingen af plantematerialet blev en ny præparationsmetode taget i anvendelse. Metoden beskrives som Collodium-film metoden.

Systematisk palæobotanik

Et lille velbevaret koglemateriale beskrives og henføres til *Pinus thomasiana* (Goepp.) Reichenbach. Bestemmelsen er udelukkende baseret på morfologiske karakterer. *P. thomasiana* er tidligere fundet i det jydske Tertiær og beskrevet af Hartz. Den fossile art kan bedst sammenlignes med den recente art *Pinus laricio* Poir., uden der dog er tale om identitet.

Et meget stort Taxodiacee-materiale bestående af kortskud, frø, kogler og skud med hanlige kogler beskrives og henføres til *Taxodium dubium* (Sternb.) Heer. *Sequoia* og *Glyptostrobus* er ikke fundet i Søby Floraen. Anatomien hos blade og frø beskrives indgående, og der foretages sammenligninger med de recente *Taxodium* arter. En nærmere undersøgelse af spalteåbningernes størrelse viser klar lighed mellem den fossile art og *Taxodium distichum* (L.) Rich., mens de fossile koglers størrelse kan indicere lighed med *Taxodium mucronatum* Ten.

En lang række velbevarede monotyledon blade beskrives og henføres til *Smilax weberi* Wessel. Bladenes kutikula beskrives her for første gang, og der foretages sammenligninger med kutikulaen hos andre fossile *Smilax* arter af samme type. *Smilax weberi* er blevet sammenlignet morfologisk og anatomisk med en lang række recente arter. Den fossile art viser stor lighed med *Smilax hispida* Muhl. fra det sydøstlige USA og med *Smilax excelsa* L. fra Østeuropa og Centralasien uden dog at være identisk med nogle af disse.

Et stort antal velbevarede stærkt indskårne blade beskrives og henføres til *Comptonia acutiloba* Brongn. Bladenes kutikula, der her er beskrevet for første gang, sammenlignes med kutikulaen hos den monotype recente *Comptonia aspleniifolia* (L.) Aiton fra det østlige Nordamerika. Sammenligningen klargør at Søby-fossilet tilhører slægten *Comptonia*. Artsbestemmelsen bygger imidlertid udelukkende på ydre morfologiske karakterer, da der ikke tidligere er beskrevet kutikula hos fossile *Comptonia* arter. *Comptonia (Comtoniphyllum) naumanni* (Nathorst) Huzioka fra det japanske Neogen kan ikke på de morfologiske karakterer adskilles fra *Comptonia acutiloba,* men før der foreligger en undersøgelse af kutikulaen regnes det for utilrådeligt at inkludere den japanske art i *C. acutiloba.*

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Plates

Plate 1

Pinus thomasiana (Goepp.) Reichenbach
Fig. 1. Compressed cone, × 1.5.
Fig. 2. The same cone as fig. 1 viewed from the opposite side, × 1.5.
Fig. 3. Compressed cone, × 1.5.
Fig. 4. Fragmentary cone with bent cone axis, × 1.5.
Photo: J. Sommer

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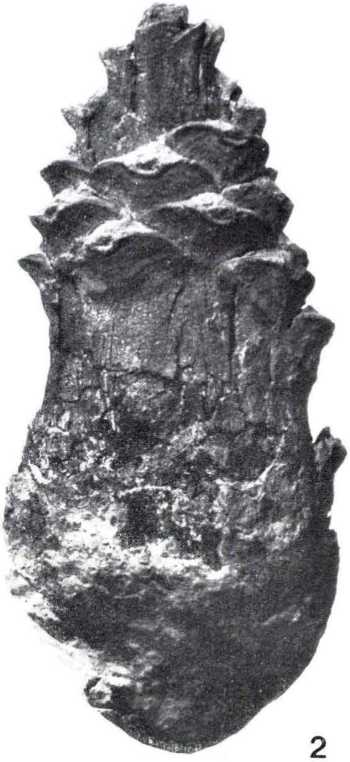

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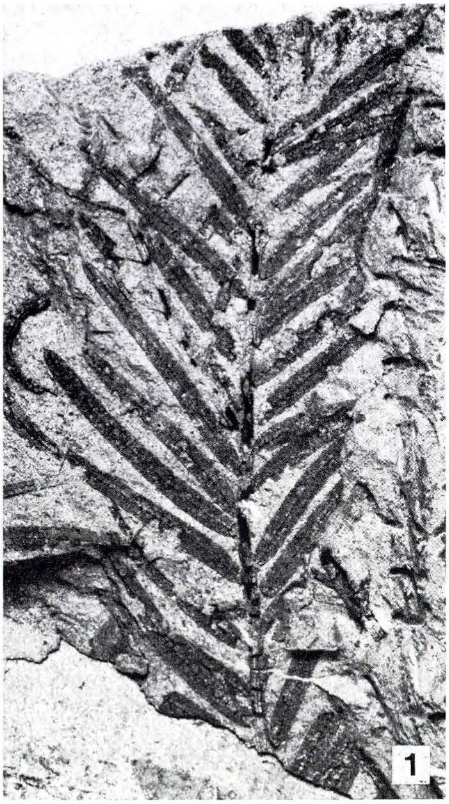
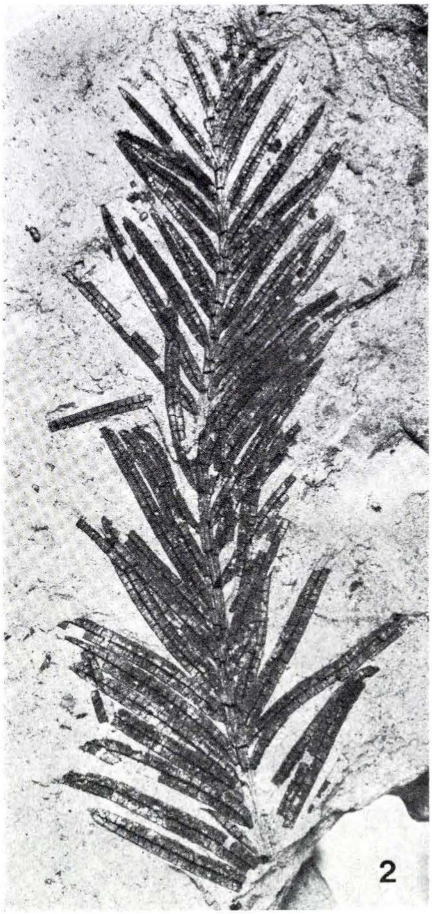
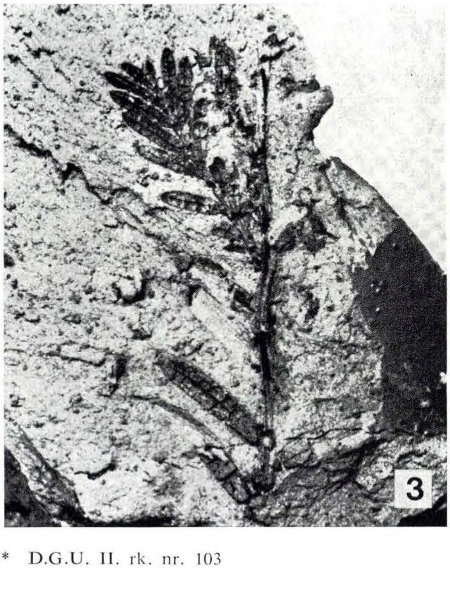
Plate 2

Taxodium dubium (Sternb.) Heer
Figs. 1–4. Short-shoots, × 2.
Fig. 3. Short-shoot with two lateral side shoots, × 2.
Photo: J. Sommer

Plate 2







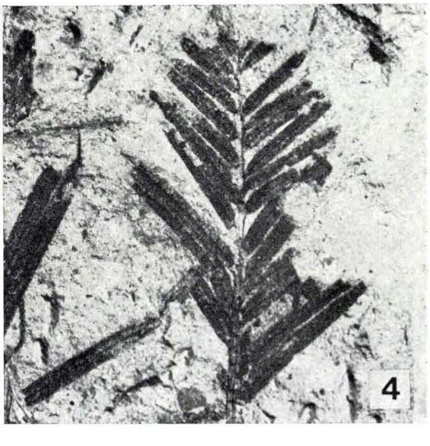
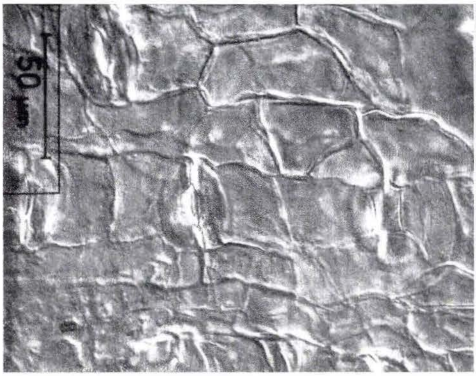


Plate 3

Taxodium dubium (Sternb.) Heer
Fig. 2. Lower epidermis with stomata orientated perpendicularly to the midvein.
Fig. 4. Stone cells from exotesta of the seed.
Fig. 6. Outer cuticle of the testa.

Taxodium distichum (L.) Rich.
Fig. 1. Lower epidermis with stomata orientated perpendicularly to the midvein.
Fig. 3. Stone cells from exotesta of the seed.
Fig. 5. Outer cuticle of the testa.
All pictures photographed with differential-interference-contrast after Nomarski (Photomicroscope II, Zeiss).



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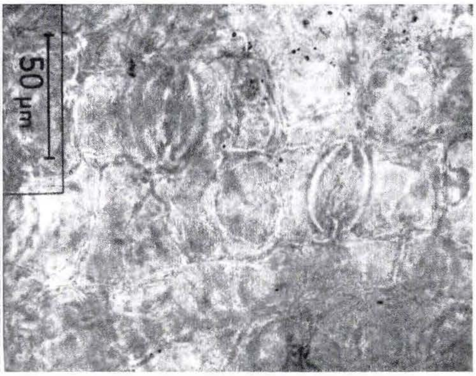

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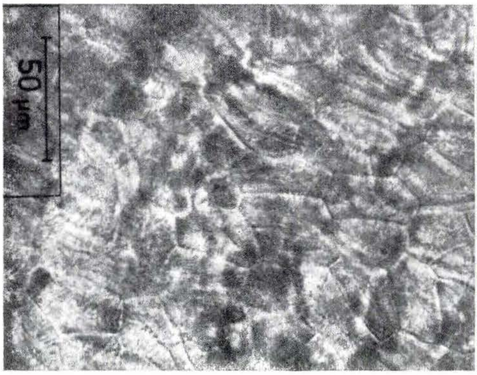

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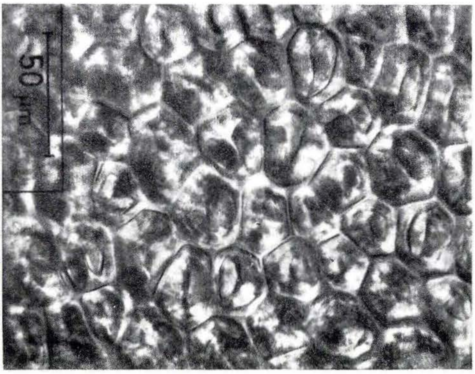

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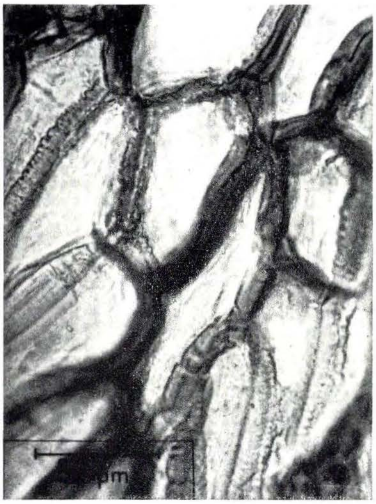

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Plate 4

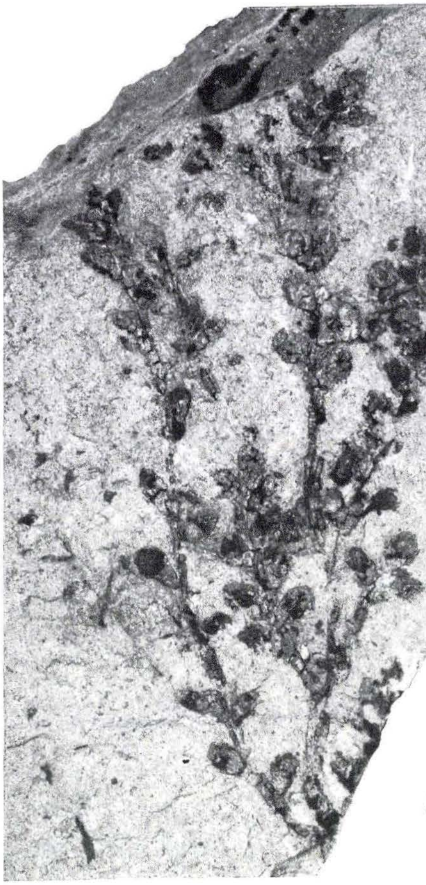
Taxodium dubium (Sternb.) Heer

Fig. 1. Staminate cones on branched shoot, × 2.

Fig. 2. Pistillate cone, × 2. The cone broke after it had been described.

Fig. 3–13. Seeds, × 3.

Photo: J. Sommer



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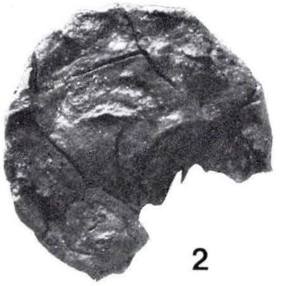

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Plate 5

Smilax weberi Wessel
Figs. 1–8. Leaves, all prepared after the collodium-film method, × 1.
Photo: J. Sommer


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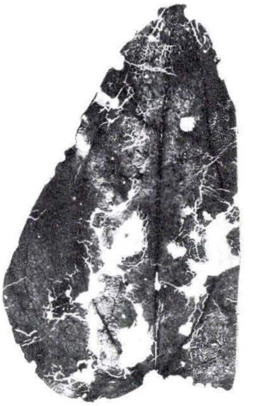
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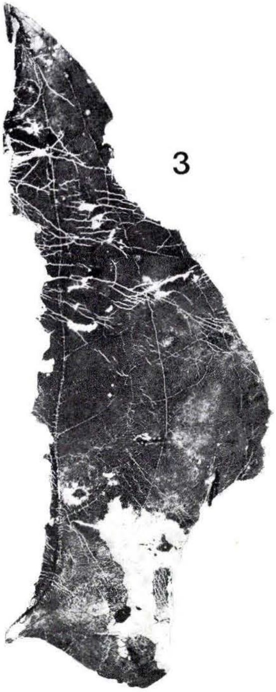
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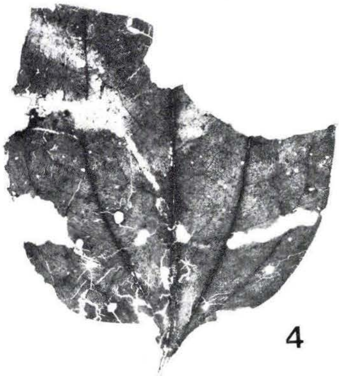
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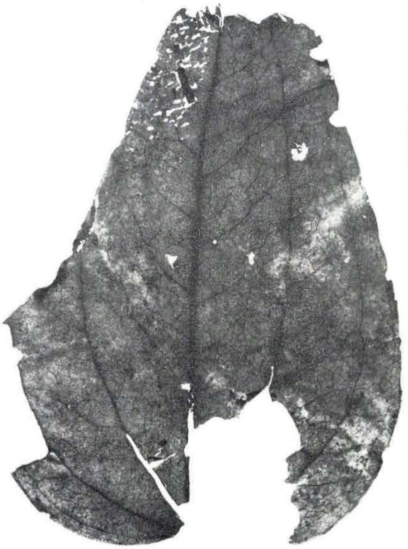
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Plate 6

Smilax weberi Wessel

Fig. 2. Upper epidermis showing cells between larger veins.

Fig. 4. Lower epidermis with stomata.

Fig. 5. Upper epidermis showing four rows of thickened cells in leaf margin.

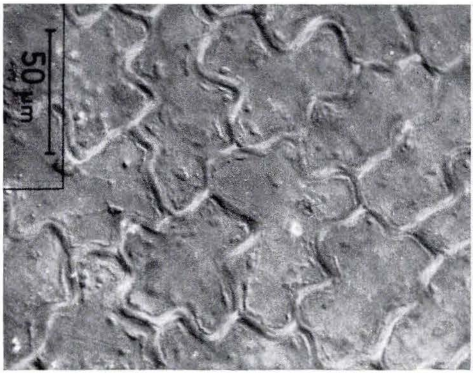
Fig. 6. Lower epidermis showing cells with a marked longitudinal striation over larger vein.

Smilax excelsa L.

Fig. 1. Upper epidermis.

Fig. 3. Lower epidermis with stomata.

All pictures photographed with differential-interferencecontrast after Nomarski. (Photomicroscope II, Zeiss).



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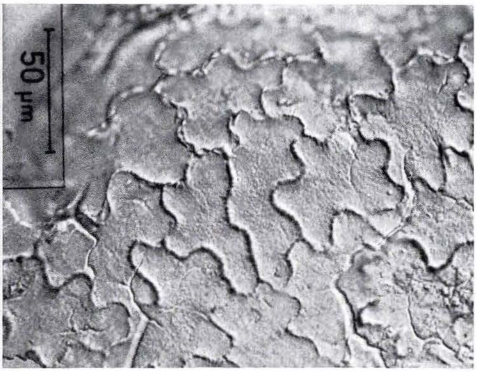

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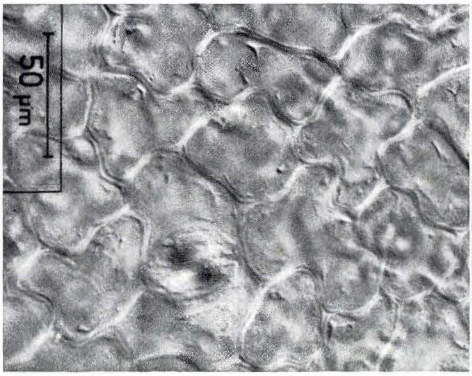

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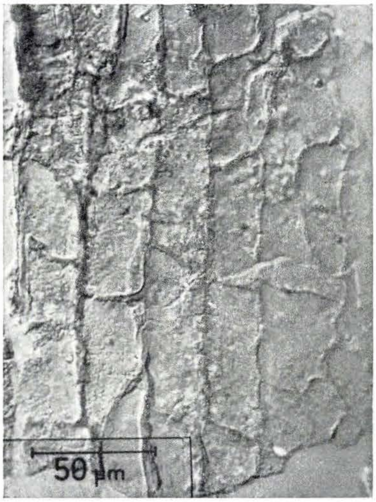

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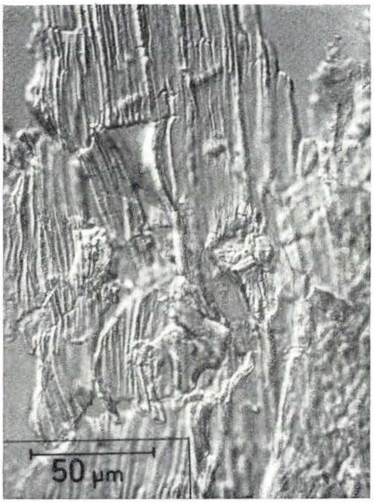

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Plate 7

Comptonia aspleniifolia (L.) Aiton.
Figs. 1–3. Recent leaves, × 1.

Smilax excelsa L.
Fig. 4. Recent leaf, × 1.

Smilax hispida Muhl.
Fig. 5. Recent leaf, × 1.
Photo: J. Sommer

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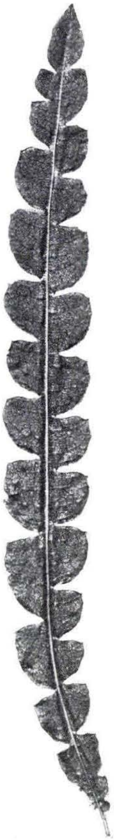

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Plate 8

Comptonia acutiloba Brongniart
Figs. 1–7. Leaves, all prepared after the collodium-film method, × 2.
Photo: J. Sommer

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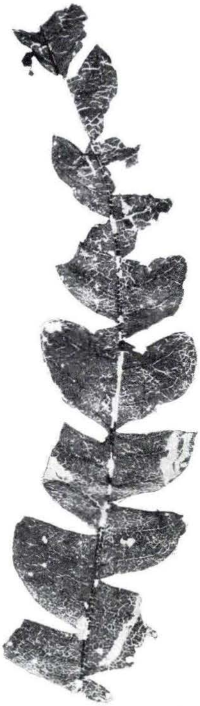

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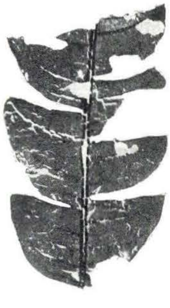

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Plate 9

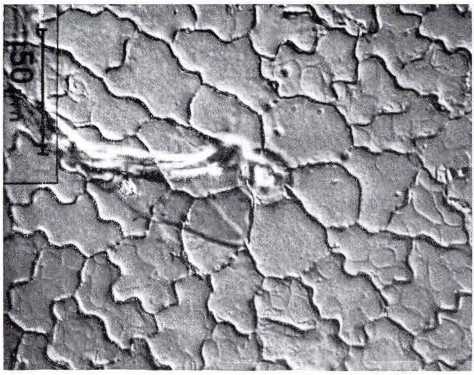
Comptonia acutiloba Brongniart

Fig. 2. Upper epidermis with two trichome bases.
Fig. 4. Palisade cells below upper epidermis.
Fig. 6. Simple unicellular hair in leaf margin.

Comptonia aspleniifolia (L.) Aiton

Fig. 1. Upper epidermis with trichome base.
Fig. 3. Palisade cells below upper epidermis.
Fig. 5. Simple unicellular hair in leaf margin.

All pictures photographed with differential-interferencecontrast after Nomarski. (Photomicroscope II, Zeiss).



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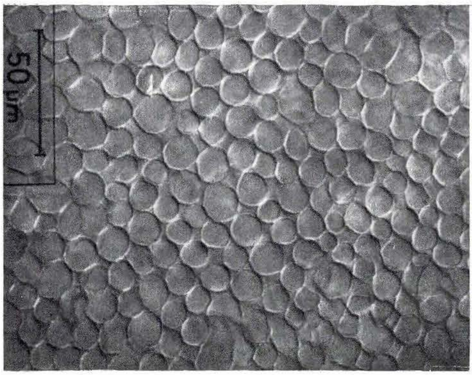

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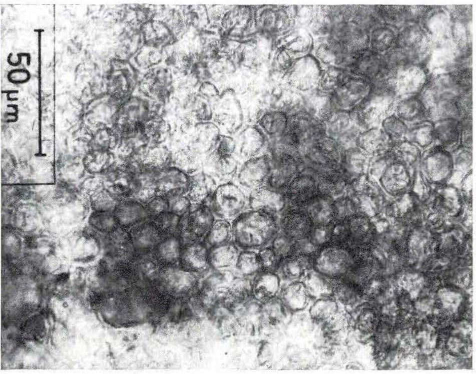

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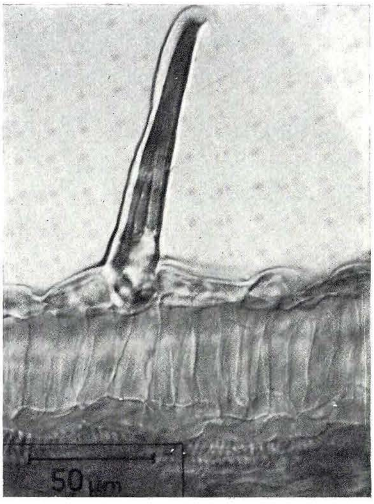

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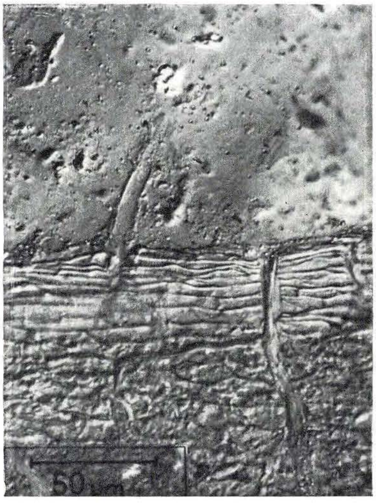

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Plate 10

Comptonia acutiloba Brongniart

Fig. 2. Lower epidermis, the stomata are not visible.

Fig. 4. Cross section of the leaf with upper epidermis, palisade, collapsed spongy mesophyl and lower epidermis.

Fig. 5. Lower epidermis with a single stomata.

Fig. 6. Lower epidermis with a trichome base to the right.

Comptonia aspleniifolia (L.) Aiton

Fig. 1. Lower epidermis with stomata and trichome base.

Fig. 3. Cross section of the leaf with upper epidermis, palisade, spongy mesophyl and lower epidermis.

All pictures photographed with differential-interferencecontrast after Nomarski. (Photomicroscope II, Zeiss).

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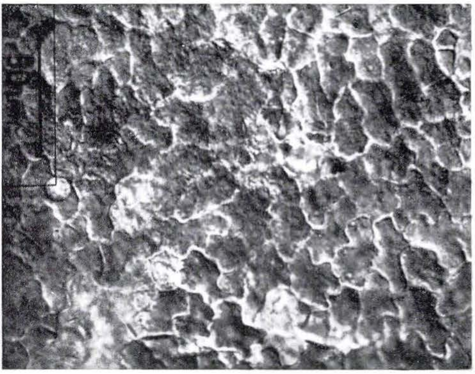

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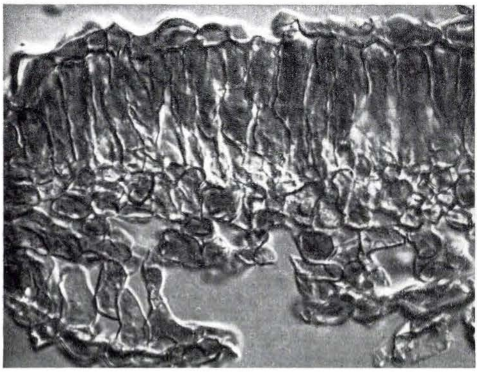

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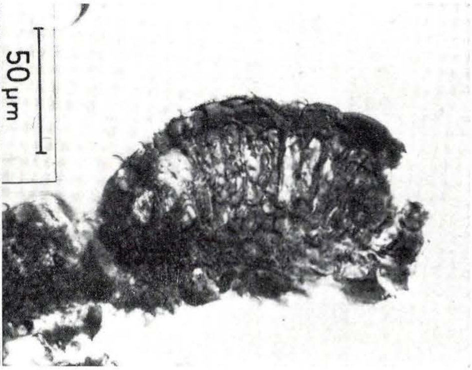

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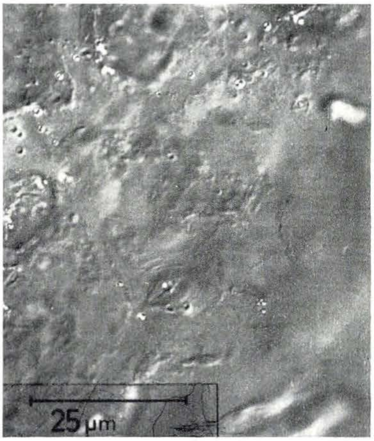

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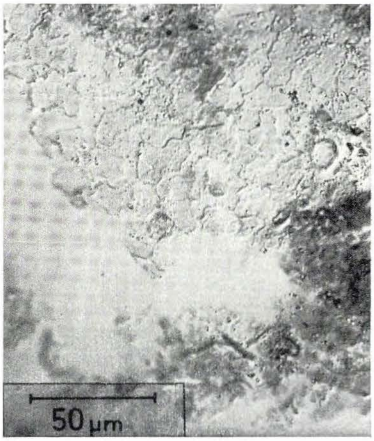

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