

SVERIGES GEOLOGISKA UNDERSÖKNING

SER. C.

N:o 547.

ÅRSBOK 50 (1956) N:o 3.

ON THE STRATIGRAPHICAL VALUE
OF THE MEGASPORES
OF LYCOSTROBUS SCOTTII

PRELIMINARY REPORT OF
SOME NEW FINDS AND THEIR INTERPRETATION

BY

BRITTA LUNDBLAD

WITH ONE PLATE

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The General Morphology of *L. scottii*.

Lycostrobus scottii was originally described by Nathorst in 1902 (op. cit., pp. 5—6; Pl. 1, Figs. 1—4) under the name »*Androstrobus Scottii*«. It was then interpreted as the male flower of a »Cycadophyte« showing close agreement with the recent *Cycadales*. Only a few years later Nathorst took up the »maceration« method which led him to revise Mesozoic material consisting of flowers and leaves characterised as »Cycadophytean« on account of their external morphology. Among the most striking results of these studies — mainly recorded in the series »Paläobotanische Mitteilungen« (1907—1912) — was the reinterpretation of the strobilus mentioned above as a plant ascribable to the *Lycopodiales* (*Lycopsidea* in the sense of, for instance, Engler 1954) [Nathorst 1908]. It was the result of Nathorst's recognition that the supposed Gymnospermous pollen-sacs were actually megaspores, and was supported by the discovery of clusters of microspores. He used Eau de Javelle for the oxidation of the material. Nathorst was of the opinion that the closest affinities of the plant within the *Lycopodiales* were with the *Isoëtineae* (*Isoëtales* in Engler 1954). The circumstances of the discovery of the single strobilus of *L. scottii* as recorded by Nathorst are of considerable interest. In his 1902 paper the following information is given by the author: »Das Exemplar wurde vor mehreren Jahren bei der Erweiterung des Hafens der Stadt Helsingborg im sandigen Schiefer gefunden.« (op. cit., p. 6). According to Halle (1938, p. 566) the specimen was found in an isolated block in the harbour, and it has been suggested that this might have been obtained from a cargo of coal, originating from the British Carboniferous. However, the finding of *L. scottii* megaspores in Greenland (Harris 1926 a, p. 50) settled any doubts of this kind (cf. Harris 1935, p. 154).

The new Swedish material consists of a strobilus, and a few finds of detached megaspores, mainly in borings. The strobilus belongs to a collection from Helsingborg kept at the Museum of Gothenburg. I owe my knowledge of this material to professor T. G. Halle, who, when visiting the Gothenburg Museum in September, 1950, heard about it, and kindly arranged that the material was sent to Stockholm for investigation. The specimens are only provided with labels indicating the locality as »Helsingborgs hamn«. No information was available about the collector and the time when the material was obtained — it seems to have been unknown to Nathorst. The general assemblage of species indicates a Liassic age. A provisional list of the plant remains is given below:

Lycostrobus scottii NATH.

Equisetites sp.

Marattiopsis hoerensis (SCHIMPER) THOMAS

Todites goeppertianus (MÜNSTER) KRASSER

Cladophlebis sp.

Phlebopteris angustiloba (PRESL) HIRMER & HOERHAMMER

Clathropteris meniscioides BRGN.

Thaumatopteris schenkii NATH.

Dictyophyllum nilssonii (BRGN) GOEPP.

Stenopteris sp.¹

Pterophyllum subaequale (HARTZ) HARRIS¹

Ginkgoites hermelinii (HARTZ) HARRIS¹

Stenorrhachis dubius ANTEVS.

The new material of *L. scottii* consists of a fragmentary strobilus, about 10 cm long. Neither apex nor base is preserved, but it is on the whole very similar to the type specimen. Of great interest is the presence in the collection of a fragmentary Lycopsidean stem about 12 cm long, and 1—2 cm wide. It does not show the «chess-board» structure characteristic of *Grammaephloios* HARRIS (1935, p. 151), which it resembles in size, but its association with *Lycostrobus* is worth noting.

Material is thus available for a re-study of *L. scottii* from a morphological point of view. Of particular interest would be a re-investigation of the sporophylls, and the sporangia, to elucidate whether there is a true connection with the *Isoëtales* (and *Pleuromeia*). There is also a need for modern descriptions of both the microspores and the megaspores. The variation in size of the latter should preferably be studied by means of histograms. As pointed out by Prof. Erdtman, a closer study of the spore wall by the aid of microtome sectioning might be a profitable enterprise.

Review of Recent Finds of *L. scottii* Megaspores from Scania.

The first new find of *L. scottii* in N.W. Scania was made in 1948, when the present author discovered a megaspore of this kind (the one shown in Fig. 2, Pl. 1) in a cuticle preparation of a leaf of the *Pterophyllum aequale* type (Nat-horst 1878, Pl. 6, Fig. 10), which belongs to the younger flora of Höganäs. As pointed out by me in 1950 (op. cit., p. 56), the concept «*P. aequale*» is heterogeneous; the leaf in question was redetermined as *P. subaequale* (HARTZ) HARRIS after microscopical examination. According to the stratigraphic table published in Harris 1937 (Table 1) this species occurs in the *Thaumatopteris* Zone of Scoresby Sound, and in the transitional region between this and the *Lepidopteris* Zone. The exact stratigraphical position of the «younger» Höganäs

¹ Determinations confirmed by microscopical examination of the cuticle.

flora is unknown (Nathorst 1878, p. 35 *et seq.*, and Troedsson 1951, p. 37) but the general assemblage of plants (presence of *Th. schenkii*) corresponds to that of the *Thaumatopteris* Zone of Scoresby Sound (cf. Harris 1937, Table 2).

The other finds of *L. scottii* in Scania were made in material obtained from borings submitted to maceration in bulk according to the method of Harris (1926b). There is one record from the Stabbarp district, in a boring (No. 74) carried out by the Höganäs-Billesholm Co. In 1952 Dr. E. Bölau¹ sent me for examination a sample from this boring. A number of typical megaspores of *L. scottii* (cf. Pl. 1, Fig. 3) were obtained together with cuticles of *Stachyotaxus septentrionalis* (C. A. AGARDH) NATH. This material is referred to in Bölau 1954, p. 230 (read »Flora» for »Fauna» on line 7).

L. scottii has been observed in material both from the »Höllviken II» boring (cf. Brotzen 1950), and the more recent Svedala boring, which were carried out by Sveriges Geologiska Undersökning under the leadership of Dr. F. Brotzen.

The find in the »Höllviken II» boring was obtained at the levels 1422.08—1428.08 m, and 1433.81 m (Pl. 1, Figs. 7—8). This record is very remarkable from a stratigraphic point of view, and will be discussed on p. 9.²

The megaspores of the Svedala boring (Figs. 4—6, Pl. 1) were obtained at the levels 1531.10—1531.13 m, and 1531.25—1531.45 m. They were accompanied by Ginkgophycean remains, and by small fragments comparable with *Lepidopteris ottonis* (GOEPP.) SCHIMPER.

Review of Finds of *L. scottii* Megaspores from Districts outside Sweden.

East Greenland. — The occurrence of *L. scottii* in East Greenland has already been referred to on p. 3. Already in his first publication on the floras of Scoresby Sound, which was based on material collected by Hartz in 1900, Harris (1926a, pp. 50—51; Pl. 10, Fig. 1) gave indisputable evidence

¹ Dr. Bölau has kindly supplied some additional information about the boring (letter of August 13th, 1956): The bore-hole (No. 74) is situated immediately north of the old coal-mine of Stabbarp. The sample was obtained from a small coal-bed at a depth of about 5 m. This may possibly be ascribed to the strata of "Gamla övre gruvan", which comprise the coal-beds "John Ericsson", and "Jean Molin" (Basal Lias). Another possibility cannot be dismissed, however, viz. that the horizon may represent the coal-bed "Nya undre gruvan" (Rhaetic). For particulars of the stratigraphy of the Stabbarp district cf. Erdmann 1911—1915 and Johansson 1922.

² The plant remains from 1422.08—1428.08 m were examined preliminarily by me in 1947, and characterized as follows (Brotzen 1950, p. 35):

"bladrester av ginkgofyter
epidermis-fragment påminnande om dem hos *Sagenopteris*
pteridofytsporer
pollen av barrträd".

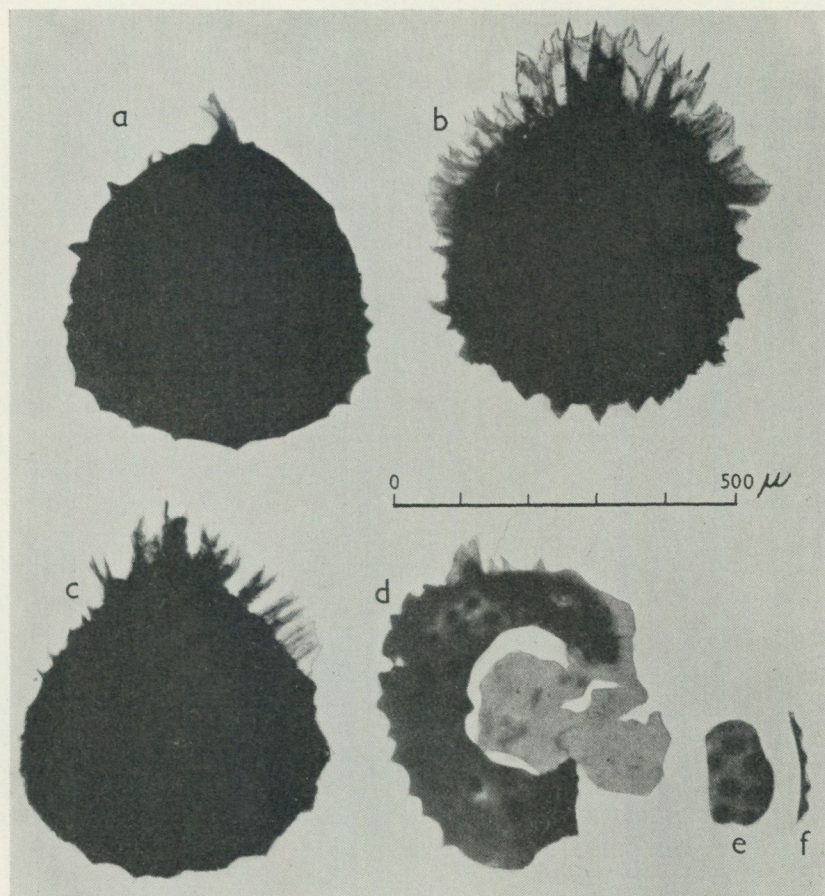
With my present experience of fossil cuticles, I would believe that the "*Sagenopteris*-like epidermal fragments" were obtained from *Equisetites* (or some allied genus), stomata-bearing fragments of which may occasionally show a superficial resemblance to *Sagenopteris*.

of the presence of *L. scottii* in this district. A further description of material of megaspores from Scoresby Sound, based on his own collections from the Lauge Koch expedition in 1926—27 was given in 1935, with an extended list of localities. The author writes (Harris 1935, p. 154), that »*L. scottii* has most characteristic megaspores, and no species is known with which it could be confused». He points out the perfect agreement between the Swedish and the Greenland material of *L. scottii*, and draws the conclusion that »It appears to be a useful zone fossil of the *Thaumatopteris* Zone (Upper Rhaetic and Basal Lias)». *L. scottii* occurs in three localities in the Scoresby Sound district, of which two belong to the *Thaumatopteris* Zone, and one to a bed transitional between this and the *Lepidopteris* Zone (Harris 1937, p. 12). In a paper from 1946 on material of »Liassic and Rhaetic Plants collected in 1936—38 from East Greenland» Harris (op. cit., p. 5; Pl. 1, Fig. 5) gives a new record of *L. scottii* megaspores, this time from the so-called »Upper Series» of Major Paars Dal (Jameson Land), which is characterized as »Lower Liassic (Probably basal Liassic)» on p. 34 of the publication just quoted.

Germany. — The occurrence of *L. scottii* in Germany was first mentioned by Wicher (1938, p. 10), who discovered material of this species in connection with studies of the microfaunas of N. W. Germany. According to him, the boundary between the Rhaetic and the Lias is easily determined with the aid of megaspores. An assemblage of spores with »Ringwülste» (»arcuate lamellae» of Harris 1935) is characteristic of the Rhaetic, whereas *L. scottii* is the dominant type of the Lias. Few particulars are given about the geographical distribution of this megaspore, however, the only locality specially mentioned being Salzgitter (Lower Lias, op. cit., p. 13). Characteristic *L. scottii* spores from the Lower Lias are figured in a later publication by Wicher (1951, p. 758, Pl. 1, Figs. 1—2; locality »Bohring W. W. 12, 842, 3 bis 846, 1 m»). According to Will (1953, p. 36) Wicher's material of *L. scottii* represents the following localities: Bielefeld, Salzgitter (both in W. Germany), Lübeck, and Berlin (cf. Wicher 1938, 1939, 1951, and Wicher in Schott 1942, p. 76). Will (l. c.) gives an additional record from the neighbourhood of Celle in W. Germany (»limnischer Lias alpha bei Wesendorf und Wathlingen»). He figures a couple of unmacerated spores (op. cit., Pl. 20a, Figs. 27—28), but the copies studied by us (microfilm) were rather indistinct. — The later investigations by Wicher (cf. Wicher 1939, 1951, and Wicher in Schott 1942) confirm his assumption that the Rhaetic and the Lias may be separated with the aid of a study of the megaspores. Will (op. cit.) comes to the same conclusion, and distinguishes between a Rhaetic »Pinguis-Gemeinschaft Zone», and a Lower Liassic »Scotti-Gemeinschaft Zone», corresponding to the *Lepidopteris* and the *Thaumatopteris* Zones of Harris.

I know of only one record of megaspores of the *L. scottii* type from S. Germany, viz. some specimens described by Reissinger (1952) in the publication »Über den Ursprung der Angiospermen». ¹ This is not the place for a general

¹ Reissinger's paper was demonstrated in March 1956 by Prof. Erdtman during his course "Geological Palynology" at Stockholms Högskola, of which the present author was one of the participants. The resemblance between the supposed seeds figured by Reissinger and *L. scottii* was then immediately recognized by me and stimulated the present review.



Text-fig. 1. *Lycostrobus scottii* NATHORST. Lias α , Nuremberg district, Schnaittach.

Figs. 14—17 (a—d), and 19—20 (e—f), Pl. 2 in A. REISSINGER, „Über den Ursprung der Angiospermen" (1952), refigured. Figs. 14—17 may in my opinion be ascribed without reservation to *L. scottii* (cf. Figs. 1 and 4 in our Pl. 1), and the fragments seen in Figs. 19—20 — as such indeterminate — may well represent fragments from the spore coat of the same species.

review of the above paper (cf. Mägdefrau 1954, p. 97) but the structures in Figs. 14—16, Pl. 2 seem to me to belong to nothing but *L. scottii* although Reissinger (op. cit., p. 9) interprets them as »Drei vollentwickelte Samen» (cf. *Angiospermæ!*). The interpretation of the structures as megaspores is also supported by Fig. 17, Pl. 2, which bears a strong resemblance to the wall of the spore coat of *L. scottii* (Figs. 19—20, Pl. 2 may represent fragments of the megaspore wall of this species). Reissinger's material is stated to have been collected at the locality Schnaittach, E. of Nuremberg (Lias α); Wicher reported megaspores from the Rhaetic-Lias of Nuremberg in 1939 (op. cit., p. 2).

The illustrations quoted above are refigured in our text-fig. 1.

Poland. — In a recent publication on the Rhaetic and Lias between Cracow and Wielun Znosko (1955) gives a report of numerous profiles, representing both surface outcrops and borings, where extended use was made of megaspores in the stratigraphic interpretation of the material. He provides i. a. numerous photographs of *L. scottii* (Pl. 6, Figs. 1—6, 11—15(?); Pl. 7, Figs. 1—4, 16—18, 19—20(?). These are all unsatisfactory from a botanical point of view, but since Harris's papers on the East Greenland material (1926 a, 1935, 1937, 1946) have been available to the Polish author, there is nevertheless little reason to doubt the correctness of the determinations.

Znosko distinguished six zones from his studies of the megaspore assemblages. The lowest assemblage contained megaspores of the *Triletes* type, »almost exclusively types of megaspores which did not occur above» (Znosko, op. cit., p. 136). It is particularly stressed that no specimens of *Lycostrobus scottii* (as well as *T. ales* and *T. areolatus*, cf. below) were found in the Rhaetic. The higher assemblages contained mostly *L. scottii*, *Triletes ales* HARRIS (1 locality in East Greenland, transitional between the *Lepidopteris* and the *Thaumatopteris* Zone), and *T. areolatus* HARRIS (occurrence in East Greenland: *Thaumatopteris* zone down to a bed transitional to the *Lepidopteris* Zone). It is of interest that *L. scottii* was the dominant species of the upper assemblages. As a consequence of this, Znosko (loc. cit.) regards *L. scottii* as »an index megaspore for the Lias α ». The vertical distribution of the species in Poland extends from the lias α_1 . [Upper Helenowo (*planorbis*) beds] to the lias α_3 [(*Lysiec* (*arietites*) beds] at least.

Note. — Some material from the Liassic of Germany and Poland kept at Riksmuseets paleobotaniska avdelning was subjected to maceration in bulk by the present author, but no megaspores were found. The rock samples represented two localities in the Nuremberg district (Buchenbühl and Wolfshöhler Tonwerke), and one in the Krakow region (Grójec).

Summary and Conclusions.

1) *Lycostrobus scottii* is known from two localities in N.W. Scania, viz. Helsingborg and Höganäs. At the latter locality it occurs in the so-called »younger» flora (Nathorst 1878), which, as well as the Helsingborg one, represents an assemblage characteristic of the *Thaumatopteris* flora (lias α ; cf. Troedsson 1951, p. 126).

2) Material of *L. scottii* from Scoresby Sound, East Greenland has been thoroughly studied by Harris, who arrived at the conclusion that the species is »a useful zone fossil of the *Thaumatopteris* Zone (Upper Rhaetic and Basal Lias)» (Harris 1935, p. 154). It should be noted, however, that the occurrence in Greenland is not confined to the *Thaumatopteris* Zone itself but extends down to a bed transitional to the *Lepidopteris* Zone.

3) *L. scottii* is known from the Lower Lias of Germany but has not been reported from the Rhaetic of this country (Wicher 1938, 1951). As a result of this and other circumstances, German authors have used the megaspore assemblages for the determination of the Rhaetic-Liassic boundary.

4) On ample evidence from Poland it has been suggested that *L. scottii* is »an index megaspore for the lias *a*» (Znosko 1955, p. 136). *L. scottii* does not occur in the Polish Rhaetic; its vertical distribution extends from the lias *a*₁ into the lias *a*₃.

5) Besides the localities from N.W. Scania mentioned above, megaspores of *L. scottii* have been discovered in a number of borings in other parts of the province of Scania. At Stabbarp (near to the town of Eslöv in central Scania) they are accompanied by leaf cuticles similar to those of *Stachyotaxus septentrionalis* (C. A. AGARDH) NATH., a Conifer common in the Swedish *Lepidopteris* flora. At Svedala in S.W. Scania, where the megaspores occur at a depth of 1531 m, they are accompanied i. a. by small cuticle fragments comparable with *Lepidopteris ottonis* (GOEPP.) SCHIMPER. The »Höllviken II» finding (p. 5) does not agree with the interpretation of the geology of the strata in question given by Brotzen in 1950. I am personally inclined to interpret it as indicating a Rhaetic-Liassic, possibly lias *a* age of the plant-bearing horizon referred to the Wealden. Instances are known, however, where megaspores (and other microscopical plant remains) have been transported and embedded secondarily in younger deposits.

6) I do not know of any megaspore from the Mesozoic with which *L. scottii* may be confused (for Wealden megaspores see, for instance, Dijkstra 1951 and Hughes 1955). I agree with previous authors that the megaspores of *L. scottii* may be used with advantage as indicating strata of lias *a* age (and the transitional beds between the Rhaetic and Liassic) but its stratigraphical value in Sweden should be tested by studies of the vertical distribution of other megaspores as well as ordinary spores and pollen grains, as far as possible supplemented by specific or generic determinations from cuticle fragments.

Prints of the photographs of material from the »Höllviken II» boring (1433.81 m) reproduced in Figs. 7—8, Pl. 1 were sent to Dr. Dijkstra and to Mr. Norman Hughes. The former states definitely that »spores like *Lycostrobus Scotti* have never been found in the Wealden» (letter of August 3rd, 1956,) and the latter thinks that they are not close to any of the Wealden spores seen by him (letter of August 14th, 1956).

The greater part of the observations recorded here were made at Riksmuseets paleobotaniska avdelning, Stockholm 50, but the paper was written at Palynologiska laboratoriet, Bromma (director: G. Erdtman). My stay there has been made possible by a grant from Statens naturvetenskapliga forskningsråd.

I am indebted to Professors T. G. Halle, O. H. Selling, and G. Erdtman for facilities of various kind during my work. The photographs were taken at Riksmuseets paleobotaniska avdelning by its technician, K. E. Samuelsson. I wish to express my sincere gratitude to Dr. F. Brotzen, Sveriges Geologiska Undersökning, for

permission to study and publish material from the borings at Höllviken and Svedala, to the Höganäs-Billesholm Company for the Stabbarp material, and to Prof. Halle for transferring to me the Gothenburg material.

I should like to thank Dr. Bölau (Höganäs-Billesholm Company), Dr. Dijkstra, and Mr. Hughes for information in letters quoted in the text. I owe to Dr. Dijkstra also the opportunity to study his material of Wealden megaspores (Dijkstra 1951) at one day's stay at Heerlen (Geologisch Bureau voor het Mijngedied) in the autumn of 1955, during a journey undertaken with a grant from »Lars Hiertas minne», Stockholm.

Miss Mabel Kendall, M.Sc., has made the necessary stylistic corrections of the manuscript.

Palynologiska laboratoriet, Bromma, September, 1956.

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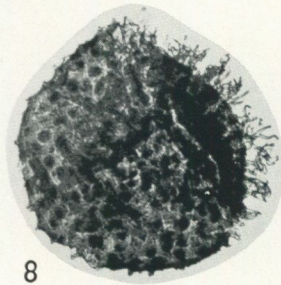
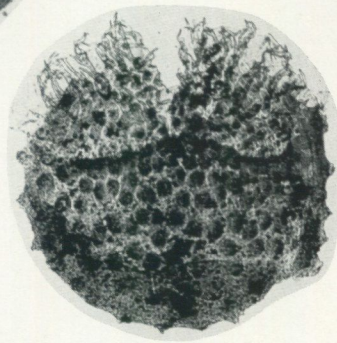
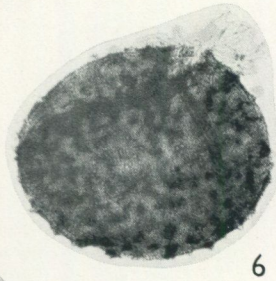
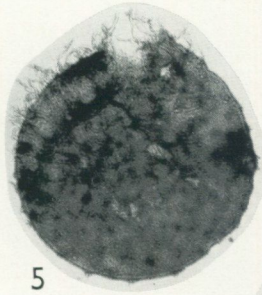
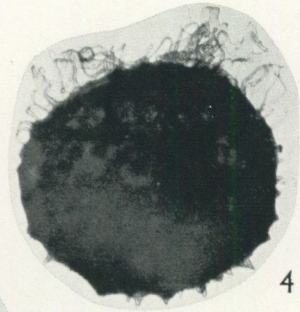
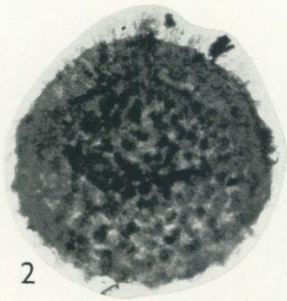
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Explanation of Plate 1.

The figured slides are the property of the Palaeobotanical Department of the Swedish Museum of Natural History, Stockholm. The photographs are untouched. All 50/1. — K. E. Samuelsson phot.

Lycostrobus scottii NATHORST (megaspores).

- Fig. 1. Lateral view (Nathorst 1908, Pl. 1, Fig. 13).
N. W. Scania, Helsingborg. Liassic.
- Fig. 2. Oblique view.
N. W. Scania, Höganäs, younger flora. Liassic.
- Fig. 3. Lateral view of crushed, probably overmacerated specimen.
Stabbarp, boring No. 74 (cf. p. 5). Liassic?
- Fig. 4. Lateral view.
S. W. Scania, Svedala boring, 1 531.10—1 531.13 m. Rhaetic-Liassic.
- Fig. 5. Oblique view.
S. W. Scania, Svedala boring, 1 531.10—1 531.13 m. Rhaetic-Liassic.
- Fig. 6. Oblique view.
S. W. Scania, Svedala boring, 1 531.25—1 531.45 m. Rhaetic-Liassic.
- Fig. 7. Lateral view.
"Höllviken II" boring, 1 433.81 m. Rhaetic-Liassic?
- Fig. 8. Polar view.
"Höllviken II" boring, 1 433.81 m. Rhaetic-Liassic?



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