PLANT FOSSILS FROM PARSORA IN THE SOUTH REWA GONDWANA BASIN, INDIA

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ABSTRACT

The paper contains a description of plant impressions collected from Parsora in the South Rewa Gondwana Basin. Four new species are ascribed to *Neocalamites, Samaropsis, Pterophyllum* and *Araucarites* respectively. Certain leaves strongly suggest the presence of *Taeniopteris spatulata*. Besides, further contributions to the knowledge of *Thinnfeldia odontopteroides* and *Thinnfeldia* (*Danaeopsis*) *Hughesi* have been made and the occurrence of *Noeggerathiopsis Hislopi* and *Glossopteris* has been confirmed. Attempt has been made wherever possible to study the epidermal characters of the fossils under strong incident light. The entire fossil evidence brings to light for the first time the presence of an undoubted and perhaps strong Mesozoic (Upper Gondwana) element in the Parsora flora occurring with certain Lower Gondwana (Palaeozoic) forms. It seems more probable now that the Parsora beds represent a younger horizon of the Triassic period, probably Middle to Upper Triassic.

INTRODUCTION

THE fossil impressions from Parsora described here represent a part of a collection made by me from several localities of the South Rewa Gondwana Basin during 1952-54. The exact place (23°26′ : 81°5′30″), about five and a half miles N.E. of the village Pali (Birsinghpur Ry. Station; Katni-Bilaspur line), is situated on the east bank of the Ghorari Nala (locally called Kamrai Nala), N.W. of the deserted site of the South Parsora village (Ref. Topo Sheet 64 $\frac{E}{3}$). The description given by Hughes (1881, p. 134) leaves no doubt regarding the close agreement between his fossiliferous spot and mine. It is, however, worthwhile to note that the Parsora fossil locality as given by Fox (1931, p. 185; viz. 23°24′5″ : 81°5′30″) is situated about two miles south of the Parsora village. Similarly, the typed notes sent by the Geological Survey of India (1933) to Prof. Sahni which were based on Aiyengar's field work in the South Rewa area show that although the Parsora locality has been correctly marked on the original map of Aiyengar, the reference to its latitude and longitude is misleading. Saksena's reference (1952, p. 8) to the geographical location of the Parsora fossil locality is also a mistake which he has now acknowledged.

My collection is strictly confined to a single bed about 1 ft. thick, of a compact, fine-grained, dark red-brown, ferruginous, micaceous sandstone (apparently like a shale) which at its base is distinctly ochre yellow, both zones being fossiliferous. This bed is overlain at the spot by a coarse-grained, ferruginous, loose, unfossiliferous sandstone and underlain by a purplish-white, rather mottled, fine-grained sandstone which also did not yield any fossils. The section of rocks is, however, better exposed in the adjacent gorge, where fairly thick intercalations of mottled shale, sandstone and occasional ironstone bands are visible, attaining a thickness of about 40 ft. The dip is gentle towards north.

DESCRIPTION

(1) Genus — *Neocalamites* Halle

Neocalamites Foxii sp. nov.

There are in my collection about 35 specimens of equisetalean stems. Commonly the stems are narrow (PL. 1, FIG. 2) but a few of them are considerably broad and long (PL. 1, FIGS. 6, 7). The fossils are devoid of leaves or leaf-sheaths.

A typical specimen shown in Pl. 1, Fig. 7, is 18·7 × 3·6 cm., with one node and two incomplete internodes; internodes traversed by parallel, regular, conspicuous ridges and grooves, about 13-14 per centimetre, continuous from one internode to the other although somewhat interrupted at the nodal region which is about 4 mm. wide.

Pl. 1, Fig. 2, shows a narrow type of stem with one internode.

A large stem, (G.S.I. Coll.), 37 × 11 cm., is shown in Pl. 1, Fig. 6. There are two distinct nodes separating three ribbed internodal regions. The internode measures 17·3 cm.; the nodal region is about 6 mm. wide.

Comparisons — The Parsora forms are comparable to *N. ferganensis* Krysht. described by Kryshtofovich (1933, PL. 5, FIG. 4) from the Mesozoic of the Angara group, but *N. Foxii* differs in having larger and broader stems. *N. Foxii* also shows a good deal of resemblance in the general form and frequency of ridges with *N. carrerei* (Zeiller) Halle recorded by Sze (1933, p. 24) and P'an (1936, p. 9) from the Mesozoic of China and also with *N. carcinoides* Harris (1931, p. 25, PL. 6, FIG. 5) and recorded by P'an (ibid; p. 9; PL. 3, FIGS. 4, 5). Both these species, however, differ in having much shorter internodes.

Stem impressions referred to *Phyllotheca* and *Schizoneura* found in the Lower Gondwanas of India are also ribbed and the ribs are continuous at the nodes. However, the Parsora specimens are much larger and the frequency of ridges and grooves is much more than in *Phyllotheca* and *Schizoneura*. The leafless stems do not show many characters for comparison, but they confirm the presence of *Neocalamites* at Parsora. Since Fox (1931, p. 190) was first to refer to the occurrence of *Neocalamites* at Parsora, the species has been named after him as *Neocalamites Foxii* which furnishes the first record of the genus from India.

Diagnosis

Neocalamites Foxii sp. nov.

Stems fairly long and broad; internodes long, grooves and ridges prominent, varying from 10-20 but with an average from 12-14 per centimetre, continuous from one internode to the other with some wide interruption at the node.

Holotype — No. 5104 (PL. 1, FIG. 7) B.S.I.P. Collection.

(2) Genus — *Glossopteris* Brongniart

Glossopteris? *Browniana* Bgt.

The occurrence of *Glossopteris* at Parsora had hitherto remained open to doubt. Cotter (1917, pp. 34, 30) reported *Glossopteris* from Daigaon which he incorporated in his ' Parsora Stage '. Sahni (1922, pp. clxii-clxiii), following Cotter's term and his list of fossils was also led to similar contentions. Fox (1931, pp. 93, 94) doubted the presence of *Glossopteris* at Parsora. Later, Saksena (1952, p. 8) reported a doubtful *Glossopteris* from Parsora itself. However, I believe that Saksena's fossils may be fragmentary and ill-preserved fronds of *Danaeopsis*. I have now been able to obtain from Parsora a single impression of an almost complete frond which can be undoubtedly referred to *Glossopteris*.

The frond (PL. 2, FIG. 21) is almost complete, narrow, linear, spathulate, measuring 2·7 cm. in length and 1 cm. in breadth. Apex obtuse; midrib about 1 mm. broad, distinct for most part except near the apex where it fades out. A fragment of the counterpart (PL. 2, FIG. 18) shows clear secondary veins, slightly arched near midrib, oblique, reaching the margin at an open angle. Network fairly open, meshes of medium breadth, elongate polygonal, comparatively broader and occasionally shorter in the neighbourhood of the midrib; towards the margin the secondary nerves tend to bifurcate, the anastomoses getting narrower.

The nature of the network coupled with the obtuse shape of the apex and spathulate form of the leaf are strongly suggestive of *Glossopteris Browniana*. I have, therefore, included the frond under the species *Glossopteris Browniana* Bgt.

(3) Genus — *Thinnfeldia* Ettingshausen

(i) *Thinnfeldia* (*Danaeopsis*) *Hughesi* (Fstm.) Seward

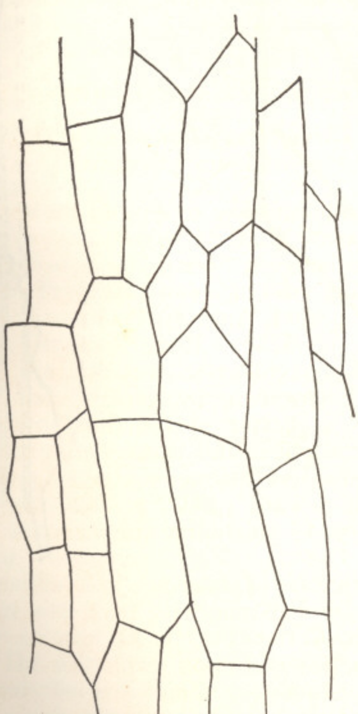
It is unnecessary to go into the history of controversy that has existed over the distinction between *Thinnfeldia* and *Dicroidium* for which reference can be made to Seward (1903, p. 50), Antevs (1914) and Du Toit (1927, p. 328). There seems to be no general agreement in this matter and the choice between the two generic names is still largely a matter of individual discretion. I have adopted the name *Thinnfeldia* in a comprehensive manner as used by Du Toit (Ibid.), Seward (1932, p. 242) and Arber (1917, p. 48) including the forms of *Dicroidium*.

Thinnfeldia (*Danaeopsis*) *Hughesi* was described by Feistmantel (1882, p. 25) from Parsora. Cotter (1917, p. 32), while overhauling Hughe's collection (which was described by Feistmantel) found specimens of this species from another locality, Barhut, which is situated 10 miles W.N.W. of Parsora.

There are about forty specimens of *Thinnfeldia* (*Danaeopsis*) *Hughesi* in my collection from Parsora, some of which are considerably large in size and exhibit a dichotomizing thick rachis. The species has already been elaborately described by Feistmantel. However, its epidermal structure is not known which is described below.

Epidermal Characters — Cuticular preparations from these fronds could not be made. The epidermal structure is, however, discernible to a certain extent under strong incident light. In some fronds portions of the rachis and pinnules are covered by a thin crust, probably of a ferruginous substance. This crust shows over its surface what appears to be imprints of epidermal cells. Cellular pattern is also visible below the level of the crust. It is interesting to find how the epidermal cells have left their imprints in a ferruginous substance which has hitherto been regarded as a bad preservative.

The cells of the main rachis (PL. 2, FIG. 26; TEXT-FIG. 1) are usually polygonal in shape, commonly 4-6 sided, elongated, straight walled and arranged in longitudinal rows. The dimension of these cells shows a range from about 43 to 101 μ in length and from about 30 to 43 μ in breadth.



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TEXT-FIG. 1 — *Thinnfeldia* (*Danaeopsis*) *Hughesi*. Epidermal cells of the rachis. × 300.

The cells of the midrib of the pinnules (PL. 2, FIGS. 8, 10) are more or less similar to those of the rachis. The dimension of the cells varies from about 58 to 116 μ in length and from about 36 to 51 μ in breadth. In certain cases the midrib shows the presence of some structures which, due to their slightly different appearance and orientation, are suggestive of stomata. However, due to unsatisfactory preservation it is difficult to confirm this observation.

The cells of the lamina of the pinnules (PL. 2, FIG. 15) are polygonal, more or less equidimensional, 4-6 sided, straight walled and follow the direction of the secondary veins. Along the margin of the leaf the cells may, however, be somewhat more elongated. The cells along their longer axis show a range from about 43 to 72 μ.

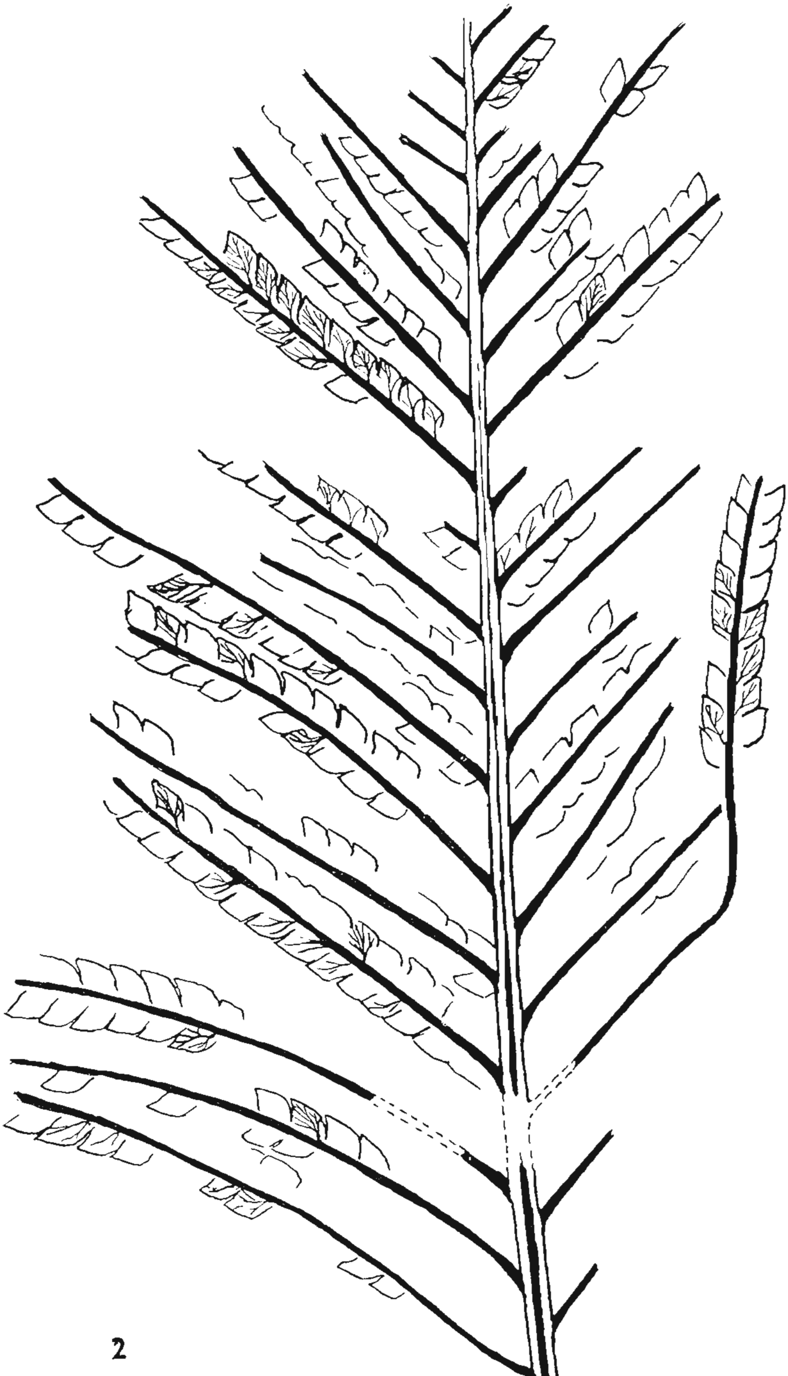
Occasionally, cells are also observable below the general level of the crust (PL. 2, Fig. 24) which in their shape and dimensions bear close similarity with those of the crust.

There are certain structures recalling stomata (PL. 2, FIGS. 12, 14) found in the epidermis of the pinnules. They are distinguished by their comparatively bigger size, oval to round appearance, ? irregular orientation and sometimes by certain crescent shaped cells (? guard cells) which appear to enclose a longitudinal pore (PL. 2, FIG. 12).

(ii) *Thinnfeldia odontopteroides* (Morr.) Fstm.

The specimens described by Feistmantel (1882, p. 30) from Parsora as *Thinnfeldia odontopteroides* (Morr.) Fstm. are incomplete, ill-preserved and do not show any details of the venation of the pinnules. I have now obtained a fairly large and complete frond of *T. odontopteroides*.

Frond (PL. 1, FIG. 4; TEXT-FIG. 2), bipinnate, almost complete, large in size, 19 cm. long and 12 cm. broad at the broadest part. Rachis stout, tapering gradually from base upwards, 3·5 mm. broad at the base, with a median longitudinal groove distinct in the basal part, tending to be less prominent in the middle and disappearing in the apical region. Pinnae alternate, usually about 1 cm. apart, but tend to be slightly closer and shorter in the apical region; one of the complete pinnae at the basal end measures 10·5 cm. in length. Midrib of the



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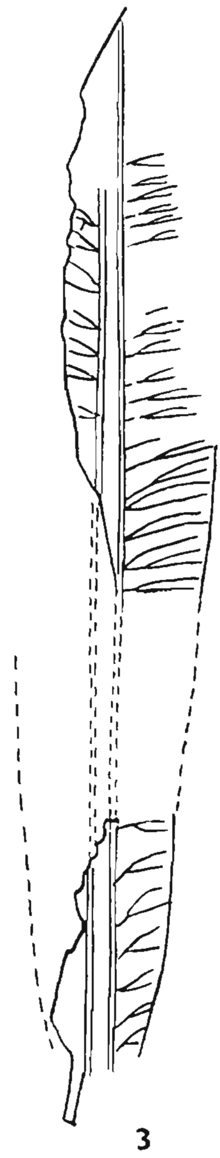

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TEXT-FIGS. 2, 3 — 2, *Thinnfeldia odontopteroides* Morr. Nat. size. 3, *Taeniopteris spatulata* McCl. × *ca.* 2·5.

pinnae distinct, about 0·5 mm. broad, slightly curving down near its attachment with the main rachis. Pinnae given out at about 40° from the main rachis. Pinnules (Pl. 1, Fig. 5) more or less rhomboidal, sub-opposite, attached by the whole of their bases, contiguous, cohering near the base and usually slightly free at their apex due to partial indentation which in some cases is not distinct due to unsatisfactory preservation. The main rachis does not appear to bear directly any individual pinnule as described by Feistmantel. Each pinnule has an identical venation (Pl. 1, Fig. 5). Usually a vein bifurcates at or very close to its emergence from the midrib of the pinna. One of the veins resulting from bifurcation supplies almost $\frac{3}{4}$ of the pinnule while the other is confined to a small area closer to the lower margin. There are about 10-12 ultimate veinlets in a pinnule.

Comparisons — The specimens of *Thinnfeldia odontopteroides* figured by Feistmantel (1882, Pls. 8, 20) from Parsora show certain differences between themselves and only add to the known variability of the genus *Thinnfeldia*. His Parsora forms are also not exactly comparable to those recorded by him (1881, p. 87; Pl. 23A, Figs. 7-9) from the Ramkola coalfield. On the other hand, his Parsora specimens bear striking resemblance to *T. odontopteroides* recorded by Seward (1903, Pl. 7, Fig. 1; Pl. 8, Fig. 7; Pl. 11, Fig. 2) from Cape Colony, by Walkom (1917, Pl. 3, Fig. 1) from the Mesozoic of Queensland, by Antevs (1914, Pl. 4, Fig. 2) and recently by Gordon and Brown (1952, Pl. 1, Fig. 3) from the Triassic of Brazil.

My specimen differs from those of Feistmantel from Parsora in the following respects.

(i) In his case the pinnules are distinctly shorter and blunt towards the lower part of the frond and become more regular towards the apical region; while in my specimen the pinnules are rather bigger in the lower region and they invariably maintain a regular shape throughout the entire frond.

(ii) In Feistmantel's Parsora specimens, the pinnules are opposite while in my case they are sub-opposite, with a tendency to become occasionally alternate.

(iii) The dichotomy of the entire frond is not clearly borne out by Feistmantel's specimens, which show a rachis dichotomizing into two pinnae at acute angles. My frond does not show such a character and it is a distinctly bipinnate frond. In this respect my specimen is very much similar to the one recorded from the Molteno Beds of South Africa reproduced by Seward (1910, p. 540; Fig. 357) and another recorded by Gordon and Brown (1952; Pl. 1, Fig. 5) from Brazil.

(iv) The rachis, in Feistmantel's specimens directly bears pinnules. This feature is, however, entirely absent from my specimen in which case the main rachis bears only alternate pinnae.

Despite these dissimilarities between Feistmantel's specimens and mine, they can be regarded as specifically identical. It should be, however, mentioned that my Parsora specimen is almost similar to those recorded from the Ramkola coalfield by Feistmantel. The Ramkola specimens can be regarded as representing just a pinna of a bipinnate frond. The pinnules in these specimens, however, seem to be sub-opposite and not opposite as regarded by Feistmantel.

(4) Genus — *Samaropsis* Goeppert

Samaropsis Srivastavai sp. nov.

The Parsora bed seems to be rich in winged seeds which can be assigned to the genus *Samaropsis*. The collection includes over 100 specimens all of which are referable to a single new species.

The seeds (Pl. 2, Figs. 11, 19) are commonly oval to round in form, showing a variation in size from 0·8 to 2 cm. in length and 0·6 to 1·7 cm. in breadth. The nucule is large and has an outline closely agreeing with that of the wing. Some of the better preserved specimens show fine longitudinal striations on the surface of the nucule. The sarcotesta forms a single, comparatively much narrow papery wing-border around the nucule, about 1-2 mm. broad and uniform in well preserved specimens (Pl. 2, Fig. 19), with a well-marked sinus at the apex. But commonly the fossils show practically no distinction between the nucule and the border which is, I think, chiefly due to the deposition of a white substance all over the seed which masks the details. The most significant character exhibited by these seeds is the presence of two conspicuous hook-like, rather acute projections of the wing at the apex enclosing a sinus. In some cases the sinus may be relatively narrow due probably to the mode of preservation.

Comparisons — The Parsora specimens are quite distinct from the known species of *Sama-*

ropsis from India described from the Talchir-Karharbari groups (FEISTMANTEL, 1879a, 1881a) and the Raniganj and Panchet groups (FEISTMANTEL, 1880, 1881).

The species *S. Milleri* (Fstm.) Seward and Sahni (1920, p. 9), the occurrence of which is also known from the Karharbari beds of South Rewa (Feistmantel, 1882, p. 43) is easily distinguishable from the Parsora seeds by its larger size. The other species, *S. indica* (Zeiller) Seward, recorded from the Karharbari beds of India is much bigger in size and finds no comparison with the Parsora specimens.

Seward and Sahni (1920, p. 8; PL. 2, FIG. 12) have described *Samaropsis raniganjensis* obtained from the Raniganj group from a locality between Karkoti and Malhadu which, I believe, is in the South Rewa Gondwana basin and located about 4 miles south of Parsora. Feistmantel (1882, p. 10) has mentioned the occurrence of seeds at this spot. *S. raniganjensis* is, however, comparatively smaller, has more conspicuous border and does not show apical horns.

Saksena (1950, p. 16) has reported two new species of *Samaropsis* from the Ganjra nala beds (Lower Gondwana) from South Rewa. His species, *S. johillensis* differs in having two large, lateral and inclined wings. The other species, *S. ganjrensis*, although resembling in general outline to a certain extent, has two wings and shows no hook-like apical projections which characterize the Parsora seeds.

To a certain extent the Parsora specimens are comparable to the figure of *Samaropsis acuta*, Lind and Hutt. reproduced by Seward (1917, p. 171, FIG. 444) in the presence of apical hooks. The Parsora seeds are, however, comparatively bigger in size, possess a uniform breadth of the border all around the nucule and show no evidence of vascular strand.

In the absence of identity with any of the known species of *Samaropsis*, the Parsora seeds are assigned to a new species, *Samaropsis Srivastavai* in memory of my friend, the late Dr. P. N. Srivastava.

Diagnosis

Samaropsis Srivastavai sp. nov.

Seeds oval to round, 0·8-2 cm. in length and 0·6-1·7 cm. in breadth; nucule oval or round, large, agreeing closely with the outline of wing; wing single, papery, narrow, uniformly all around the nucule and produced into two hook-like apical horns enclosing a sinus.

Holotype — No. 8744 (PL. 2, FIG. 11).
Paratype — No. 8769 (PL. 2, FIG. 19).
B.S.I.P. Collection.

(5) Genus — *Noeggerathiopsis* Feistmantel

Noeggerathiopsis Hislopi (Bunb.) Fstm.

Feistmantel (1882, p. 41; PL. 9, FIGS. 1, 3) recorded *Noeggerathiopsis Hislopi* from Parsora. Doubts have, however, been ex-press ed by certain workers (FOX, 1931, p. 190) regarding the occurrence of this species at Parsora, but there seems to be no justification for this.

Seward and Sahni (1920, PL. 3, FIG. 30) have reproduced from Parsora, *Danaeopsis Hughesi* occurring with a *Noeggerathiopsis Hislopi* on the same block, although they have made no remarks on the latter species. On closer scrutiny, I am inclined to think that Feistmantel's *Noeggerathiopsis* shown on his Pl. 9, Fig. 1, is the same as that reproduced by Seward and Sahni (loc. cit.). Feistmantel, for reasons unknown, omitted the *Danaeopsis* which occurs along with *Noeggerathiopsis* on the same block. This specimen reproduced by Seward and Sahni has been seen by me which enables me to confirm Feistmantel's identification of *Noeggerathiopsis Hislopi*.

I have also been able to collect as many as 15 specimens which in spite of their incompleteness and unsatisfactory preservation are referable to *Noeggerathiopsis Hislopi*. These leaves (PL. 2, FIG. 25) appear to have been comparatively larger and bear striking resemblance to those described by Feistmantel from Parsora as well as from Karharbari horizon in South Rewa (1882, PLS. 14, 15). So far as dichotomy of the veins is concerned, Feistmantel's specimen (1882, PL. 9, FIG. 1) brings it out more clearly than my specimens in which case dichotomy is traceable only at certain places. Most of the specimens also show the presence of interstitial veins as distinguished from true veins.

(6) Genus — *Pterophyllum* Brongniart

Pterophyllum Sahnii sp. nov.

The occurrence of *Pterophyllum* in the Parsora bed has already been recorded by me

(1953, p. 1193). Two specimens of this frond were collected by me and there is still another identical specimen belonging to the Aiyengar collection of the Geological Survey of India. The specimens suggest much bigger fronds which have been incompletely preserved.

The type specimen (PL. 1, FIG. 1) is an incomplete, pinnate frond with a stout and straight rachis measuring 17 cm. in length and 6 mm. in breadth. The pinnae are linear, usually parallel-sided, closely set, more or less equal in breadth (with one exception), attached to the rachis at right angles and by the whole of their bases. The exceptionally narrow pinna shows slight contraction near the base but this is not a regular feature. Complete pinna is absent. Judging from the broad, parallel sides of the segments the apex of the pinnae appears to be somewhat truncate. The maximum length measured of a pinna is 10 cm. and average breadth 3 cm. Veins are many, averaging 50, distinct, 0·5 to 0·8 mm. apart, usually bifurcating close to their emergence where they take a narrow curve and then run parallel to the edge of the pinna, rarely showing bifurcation again.

The G.S.I. specimen (PL. 1, FIG. 3) is much larger, measuring 27 cm. in length and 21 cm. in breadth. Unlike my specimen, this frond shows slight expansion at the base of one pinna. The contraction or expansion of the pinna base is, however, not a distinct character of the species.

When cuticular preparations are not available, the attachment of the pinnae to the rachis is generally regarded as a character of primary importance in distinguishing fronds of *Pterophyllum* from those of *Nilssonia*. The Parsora fronds do not yield any cuticle. The specimens available for study are also limited. It is, therefore, difficult to say whether on the other side of the fronds, which is not exposed to view, the pinnae are continuous over the rachis as is characteristic of *Nilssonia*. However, the pinnae in all the three specimens seem to be laterally attached as in *Pterophyllum*. In addition to this, the bifurcation of the veins close to their emergence and the presence of almost equal pinnae are strongly suggestive of *Pterophyllum*. I am, therefore, inclined to believe that these fronds belong to *Pterophyllum*.

The Parsora fronds differ from all the known Indian species of *Pterophyllum*. A species, viz. *Pterophyllum* cf. *Braunianum* (Goepp.) Schenk recorded by Prynada (1933, p. 23) from the Jurassic of Transcaucasia shows some semblance in general form but differs in having somewhat inclined pinnae. The Parsora fronds show some agreement with *P. Braunsii* Schenk recorded from the Mesozoic of Pamir by Prynada (1934, p. 37) in the shape of the pinna. However, Pryanada's text figure shows only one pinna without any rachis which makes any detailed comparisons impossible. Antevs (1919, p. 31) has also recorded *P. Braunsii* Schenk which he compares with *Nilssonia princeps* (Old. & Morr.) Seward. Antevs' specimens show some agreement with the Parsora forms in having broad pinnae attached almost at right angles to a stout rachis, but the characteristic bifurcation of veins close to the rachis as in the Parsora fronds is absent in *P. Braunsii*.

Diagnosis

Pterophyllum Sahnii sp. nov.

Fronds large, pinnate; rachis stout; pinnae broad, linear, closely set, more or less uniform in width, apparently lateral, attached by the whole of their base and nearly at right angles to the rachis, apex of the pinnae probably truncate; veins clear, 0·5-0·8 apart, usually bifurcating close to their emergence with a curve and then running parallel to the edge of the pinna rarely showing bifurcation again.

Holotype — No. 5100. (PL. 1, FIG. 1). B.S.I.P. Collection.

(7) Genus — *Taeniopteris* Brongniart

Taeniopteris? spatulata McCl.

There are three fragmentary specimens of a narrow linear frond which are probably identical with or very closely allied to the species *Taeniopteris spatulata* McCl., abundantly known from the Jurassic rocks of the Rajmahal group of India.

The specimen in Pl. 2, Fig. 16, and Text-fig. 3 probably represents the middle portion of the leaf and measures 9·5 cm. in length and 1·2 cm. in breadth. It has a conspicuous broad midrib about 2 mm. in breadth, longitudinally striated and giving out secondary veins nearly at right angles. Veins are commonly forked at or near their emergence with a frequency of about 15 per cm. Cross-connections between the veins are not seen.

In another specimen (PL. 2, FIG. 23), a part of the lamina is exposed on one side of a comparatively broader and stouter rachis which extends much beyond the exposed lamina. The veins (PL. 2, FIG. 28) are commonly forked, or simple; at one place two adjacent lateral veins close to their emergence, rejoin to form a single vein. This character is, however, not unknown in this species (RAO, 1943; PL. 11, FIG. 76). It is also found in *T. crassinervis* (FEISTMANTEL, 1877b, p. 51; DU TOIT, 1927, p. 351) and is regarded as a constant feature in *T. Dunstani* Walkom (1917, p. 37).

Comparisons — The Parsora specimens, although rather unsatisfactorily preserved and incomplete appear to be identical with the Indian Jurassic species, *Taeniopteris spatulata* McCl. recorded by Oldham and Morris (1863) under *Stangerites* and by Feistmantel (1877, 1877b, 1879) under *Angiopteridium*. A specimen from the outliers of the Madras Coast (FEISTMANTEL, 1879; PL. 2, FIG. 3, 3a) shows very close agreement with the Parsora specimen reproduced in Pl. 2, Fig. 16, particularly in the character of the secondary veins. To a certain extent the Parsora specimens compare with *T.* (*Oleandridium*) *tenuinervis* Brauns described by Nathorst (1878-86, PL. 10, FIG. 5) in having a broad midrib and lamina.

(8) Genus — *Araucarites* Presl.

Araucarites parsorensis sp. nov.

From Parsora, for the first time, I have obtained as many as about 22 specimens of detached ovuliferous scales which can be referred to the genus *Araucarites*.

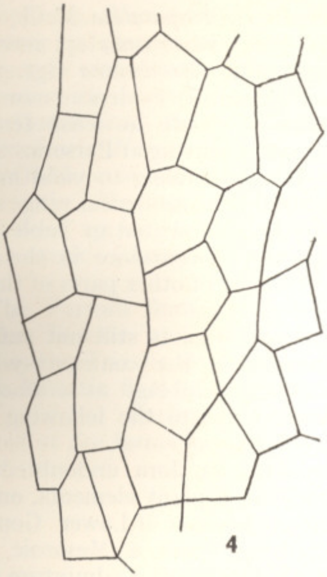
The ovuliferous scales (PL. 2, FIGS. 13, 20, 22) are characterized by a broadly triangular form, measuring 1·1 × 1·2 cm. in average dimensions, one or two specimens being smaller. The ovule which is roundly triangular or pear-shaped occupies almost the whole length of the scale and is broader towards the distal end. The tip is not preserved. On the surface of the seed are seen longitudinal, slightly divergent veins showing forking. Frequently the ovule shows the presence of a longitudinal groove-like depression. The scale appears to be fleshy, thick, broadest near the distal part and gradually tapering towards the proximal end. The proximal end of the ovule reaches almost right up to the base of the scale. The scale part extending beyond the distal end of the ovule is usually broken and in well-preserved specimens is slightly raised in the middle. It appears that the tip of the scale turns up slightly and is drawn out into a spine as in *Araucarites cutchensis*. The spine is not preserved, although one specimen (PL. 2, FIG. 27) seems to represent the distal end of the scale. It is, however, difficult to determine precisely the nature of the spine until more complete specimens are available.

Epidermal Characters — Under strong reflected light, the Parsora specimens almost invariably exhibit a cellular pattern all over the surface of the seed as well as on the scale region beyond the ovule. The epidermal cells in the two regions, however, appear to be different.

The epidermal cells of the ovule (PL. 2, FIG. 17) are usually polygonal, 4-6 sided, straight-walled, elongated and arranged in parallel rows along the proximo-distal axis of the ovule. They show an approximate variation from 43 to 87 μ in length and from 29 to 58 μ in breadth. In one specimen, however, the cells (PL. 2, FIG. 17) are much longer showing a range from about 101 to 174 μ in length; the difference in the breadth is little. It was also observed that cells near the margin of the ovule are usually longer and narrower than those of the middle region.

The epidermal cells of the scale region (PL. 2, FIG. 9; TEXT-FIG. 4) beyond the ovule are also polygonal, 4-6 sided and straight-walled but they are less elongated, occasionally somewhat equidimensional and arranged in more or less parallel rows which are inclined to the proximo-distal axis of the scale. They show an approximate range from 43 to 72 μ in length and from 29 to 43 μ in breadth.

Comparisons — The Parsora specimens no doubt recall some of the forms of *Araucarites cutchensis* Fstm., especially those recorded from the Jabalpur group (FEISTMANTEL, 1877a; SAHNI, 1928, p. 31; PL. 5, FIGS. 65, 67). But a closer survey of all the specimens figured by Feistmantel (1876, 1877a, and 1879) shows that unlike the Parsora forms, they are usually longer than broad, the same feature being found in the ovules which are narrower in comparison to their length. The ovule in case of *A. parsorensis* reaches



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TEXT-FIG. 4 — *Araucarites parsorensis* sp. nov. Epidermal cells of the scale region. × 300.

up to the proximal end of the scale, while in *A. cutchensis* the ovule appears to be smaller in length.

The only other species which shows some resemblance with the Parsora scales is *Araucarites phillipsi* Carruthers (1869, p. 1; PL. 2, FIGS. 8, 9), so far as the triangular form is concerned. The ovule in *A. phillipsi*, however, seems to be quite longer than broad which distinguishes it from the Parsora scales. For these reasons, I have referred my specimens to a new species, *Araucarites parsorensis*.

Diagnosis

Araucarites parsorensis sp. nov.

Scales broadly triangular, almost as long as broad, broader towards distal end and gradually tapering proximally; ovule broadly triangular, occupying the whole length of the scale, surface of ovule with longitudinal, forking veins; epidermal cells of the ovule polygonal, 4-6 sided, elongated, and arranged in proximo-distal rows; cells of the scale region similar but less elongated and arranged in somewhat parallel rows which are inclined to the proximo-distal axis.

Holotype — No. 8711 (PL. 2, FIG. 13). B.S.I.P. Collection.

DISCUSSION

Ever since Hughes (1881) collected fossils from Parsora, the controversy over the age and affinity of the plant-bed has remained unsolved.

Feistmantel (1882, p. 5) included the Parsora beds in the Middle Gondwana (Triassic) which was proposed on the evidence of certain strata with Upper Gondwana aspect but with Lower Gondwana fossils. Evidently, Feistmantel did not lay stress on the admixture of plant elements in the beds.

Cotter (1917) introduced the term Parsora stage for rocks of Parsora and Daigaon localities. The stage was grouped in the Lower Gondwana and was regarded as Rhaetic.

Sahni (1922, pp. 162-163; 1926, p. 246; 1937, pp. 217-219) emphasized an admixture of Lower and Upper Gondwana forms in the Parsora flora. He believed that the whole assemblage had a strong Palaeozoic (Lower Gondwana) affinity. He classed the beds in the Lower Gondwana, assigning to them a Lower Triassic age. Fox (1931, p. 82) pointed out that Sahni had included under the ' Parsora Stage ' fossils from Daigaon and Karkati which represented a Raniganj age. Saksena (1952, p. 7) recorded more forms of Glossopteris flora from Karkati. However, in regard to the Daigaon flora, no further contribution has been made after Feistmantel (1882, pp. 6-7).

Fox (1931, pp. 83, 93, 190) was strongly opposed to any admixture of elements at Parsora. He doubted the occurrence of *Glossopteris* and *Noeggerathiopsis*, while stressed the presence of *Neocalamites* in the beds. According to him the Parsora fossils represented a distinct assemblage showing strong affinity with the Jurassic (Upper Gondwana) flora. The term Parsora stage was, therefore, restricted by him to beds around Parsora, and it was classed under Upper Gondwana to a Rhaetic age.

Seward (1932, p. 242), like Sahni, opined that the Parsora flora was not younger than Triassic.

Recently Saksena (1952, p. 9) on the evidence of a mixture of *Vertebraria* and *Thinnfeldia* groups the Parsora beds in the Middle Gondwana, regarding them as Lower Triassic.

It is obvious that the whole controversy involves two interdependent factors, viz.

(1) The geological age of the Parsora beds, and (2) the stratigraphical position of these beds in the Gondwana system of India. The cardinal basis for determining the age of the Parsora beds has been its floral assemblage. The previous contributions (FEISTMANTEL 1882; SAKSENA 1952) to the knowledge of this flora show that the total number of forms was too little to afford any satisfactory clue. The fossils known then were:

1. *Thinnfeldia* (*Danaeopsis*) *Hughesi* (Fstm.)
2. *Thinnfeldia odontopteroides* (Morr.)
3. *Cladophlebis denticulatata* Bgt.
   [SEWARD (1932, p. 237) regards it to be a *Thinnfeldia* sp.]
4. *Noeggerathiopsis Hislopi* Bunb.
5. A doubtful specimen of *Schizoneura* leaf (unfigured)
6. *Vertebraria indica* Royle.
   (No figures and description available).
7. ? *Glossopteris*.

The following forms have now been added to the above list:

1. *Neocalamites Foxii* sp. nov.
2. *Samaropsis Srivastavai* sp. nov.
3. *Pterophyllum Sahnii* sp. nov.
4. *Taeniopteris ? spatulata* McCl.
5. *Araucarites parsorensis* sp. nov.
6. *Glossopteris ? Browniana* Bgt.

The entire fossil evidence now known shows that there are at least ten recognizable genera occurring at Parsora. Further attempts are very likely to yield more and better forms. The geological range of these genera has been indicated in Table 1 which also shows their occurrence in the Triassic or Rhaetic strata in other parts of the Gondwanaland.

The Parsora flora is still not sufficiently known to decide the controversy finally; however, the assemblage as a whole as is now known, leads to the following contentions:

(1) The Parsora flora undoubtedly combined two sets of plant elements, one representing a Palaeozoic (Lower Gondwana) facies and the other a Mesozoic (Upper Gondwana) facies. The admixture is corroborated by my own findings which have been obtained from a *single bed* at Parsora.

(2) The Parsora flora definitely contains some of the well-known Mesozoic (Upper Gondwana) genera, viz. *Thinnfeldia*,

TABLE 1 — GEOLOGICAL RANGE OF THE PARSORA GENERA AND THEIR OCCURRENCE IN OTHER PARTS OF GONDWANALAND (DOUBLE LINES INDICATE MARKED ABUNDANCE OF THE GENERA DURING CERTAIN PART OF THEIR GEOLOGICAL HISTORY)

PARSORA GENERA	PERMO-CARBONIFEROUS	TRIASSIC	RHAETIC	JURASSIC	CRETACEOUS	AUSTRALIA (TRIASSIC & RHAETIC)	S. AFRICA (TRIASSIC)	NEW ZEALAND (RHAETIC)
1. *Neocalamites*		═══	═══	———		+	+	*Phyllotheca*
2. *Cladophlebis* (? *Thinnfeldia*)		———	———	═══	———	+	+	+
3. *Thinnfeldia*	———	———═══	═══	═══		+	+	+
4. *Glossopteris*	═══	———	———			+	+	
5. *Vertebraria*	═══	——						
6. *Samaropsis*	═══					Gymnospermous seeds (Carpolithes sp.)		
7. *Noeggerathiopsis*	═══	———	———				=? Phenicopsis (Cotter, 1917, p. 30)	
8. *Pterophyllum*	———	═══	═══	═══	——	+	+	
9. *Taeniopteris*	———	———	═══	═══		+	+	+
10. *Araucarites*		———	═══	═══	═══	+		+

(?) *Cladophlebis*, *Neocalamites*, *Pterophyllum*, *Taeniopteris* and *Araucarites* (*vide* TABLE 1). These genera are found to occur in the same bed with some typical Palaeozoic (Lower Gondwana) elements like *Glossopteris*, *Vertebraria*, *Noeggerathiopsis* and *Samaropsis*. On the evidence available at present, however, the Mesozoic elements in the Parsora flora appear to be stronger than the Palaeozoic (Lower Gondwana) elements.

(3) The Parsora flora can be compared with the Triassic and Rhaetic floras of Australia, the Triassic flora of South Africa and the Rhaetic flora of the New Zealand (*vide* TABLE 1). Such a comparison shows that most of the forms known from Parsora are represented in the Triassic or Rhaetic floras in other parts of the Gondwanaland. It also suggests that the Parsora flora may represent a younger horizon of the Triassic, probably Middle to upper Triassic. In this connection it may be pointed out that although Sahni emphasized the Palaeozoic affinity of the Parsora flora, he also suggested (1926, p. 246) that on the basis of the available forms, the Parsora beds can be equally classed as Upper Triassic.

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EXPLANATION OF PLATES

PLATE 1

1. *Pterophyllum Sahnii* sp. nov. × ½.
2. *Neocalamites Foxii* sp. nov. × 2.
3. *Pterophyllum Sahnii* sp. nov. × ⅓.
4. *Thinnfeldia odontopteroides* (Morr.) × ½.
5. Enlarged pinna of the above. × 3.
6. *Neocalamites Foxii* sp. nov. × ½.
7. *Neocalamites Foxii* sp. nov. × ½.

PLATE 2

8. *Thinnfeldia (Danaeopsis) Hughesi.* Epidermal cells of the midrib of a pinnule. × 115.

9. *Araucarites parsorensis* sp. nov. Epidermal cells of the scale region. × 115.

10. *Thinnfeldia (Danaeopsis) Hughesi.* Epidermal cells of the midrib of a pinnule. × 115.

11. *Samaropsis Srivastavai* sp. nov. × 2.

12. *Thinnfeldia (Danaeopsis) Hughesi.* A stoma-like structure in the epidermis of leaf showing probable guard-cells, enclosing a longitudinal pore. × 220.

13. *Araucarites parsorensis* sp. nov. × 2.

14. *Thinnfeldia (Danaeopsis) Hughesi.* A stoma-like structure in the epidermis of leaf. × 220.

15. *Thinnfeldia (Danaeopsis) Hughesi.* Epidermal cells of the lamina. × 115.

16. *Taeniopteris spatulata* McCl. × 1·5.

17. *Araucarites parsorensis* sp. nov. Epidermal cells of the ovule. × 115.

18. *Glossopteris? Browniana* Bgt. showing anastomosing secondary veins. × 7·5.

19. *Samaropsis Srivastavai* sp. nov. showing a clear wing border. × 2.

20. *Araucarites parsorensis* sp. nov. × 2.

21. *Glossopteris? Browniana* Bgt. × Nat. size.

22. *Araucarites parsorensis* sp. nov. × 2.

23. *Taeniopteris? spatulata* McCl. × Nat. size.

24. *Thinnfeldia (Danaeopsis) Hughesi.* Epidermal cells of the lamina observed below the general level of the cellular crust. × 115.

25. *Noeggerathiopsis Hislopi.* × ½.

26. *Thinnfeldia (Danaeopsis) Hughesi.* Epidermal cells of the rachis. × 115.

27. *Araucarites parsorensis* sp. nov. Probable distal end with spine. × 2.

28. *Taeniopteris? spatulata* McCl. Enlarged to show venation. A small part of the midrib is exposed on the right. × 3.

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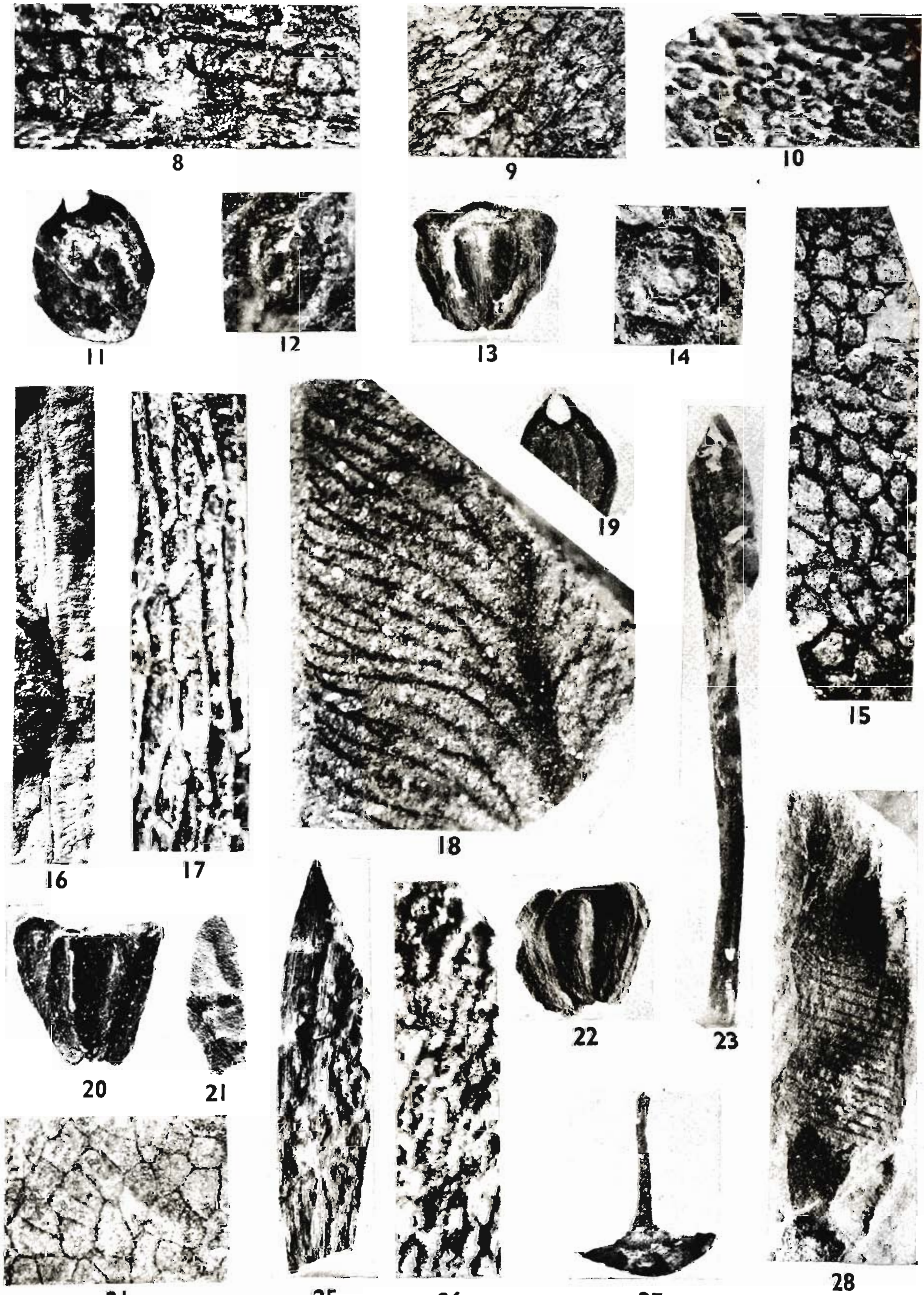
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