

PTERIDOPHYTIC REMAINS FROM KUTCH AND KATHIAWAR, INDIA

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ABSTRACT

Equisetum rajmahalense (Oldh. & Morr.) Feistm., *Matonidium goepperti* (Ettingsh.) Schenk, *Phlebopteris* sp., *Weichselia reticulata* (Stokes & Webb) Ward, *Cladophlebis kathiwarensis* sp. nov., *Cladophlebis* sp. cf. *C. longipennis* Sew., *Onychiopsis psilotoides* (Stokes & Webb) Ward, *Sphenopteris specifica* (Feistm.) comb. nov. and *Sphenopteris* sp. cf. *S. hymenophylloides* Brogn. collected from the various localities in Kutch and Kathiawar form the subject of this paper.

INTRODUCTION

UNTILL now only a few species of Pteridophyta were known to occur in both Kutch and Kathiawar. Feistmantel (1876) reported the occurrence of *Pecopteris tenera* Feistm., *Cladophlebis* (*Alethopteris*) *whitbyensis* Brongn., *Actinopteris*?, stems (Rhizome?) of (Tree) Fern and a Fern stalk from Kutch. From Kathiawar the record of pteridophytic remains is still more meagre. Feistmantel (1880) recorded *Cladophlebis* (*Alethopteris*) *whitbyensis* Schimp., Fedden (1884) recorded *Pecopteris* sp. and later Rao and Vimal (1950) listed *Sphenopteris* sp., *Cladophlebis whitbyensis* Brongn., *Cladophlebis indica* Sahnî & Rao and *Cladophlebis* sp.

The present material was collected during the years 1960-62 from Kakadbbhit and Trambau, Bhajodi and Gadsisa in Kutch and from Songad in Kathiawar. All the species recorded here are impressions and they were studied under reflected light as such or sometimes under liquid paraffin immersion.

DESCRIPTION

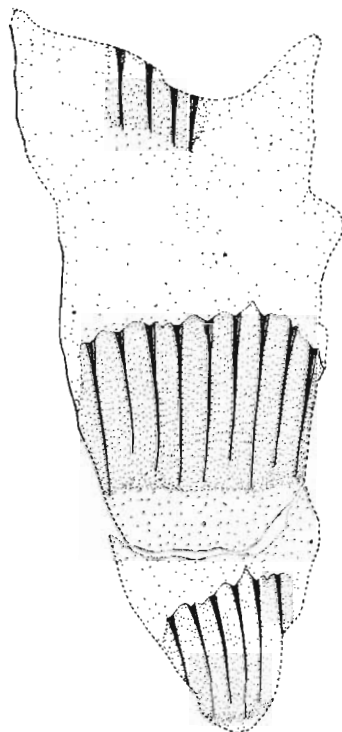
Equisetales

Genus *Equisetum* L.

Equisetum rajmahalense (Oldh. & Morr.) Feist.

Pl. 1, Figs. 1-2; Text-fig. 1

Description — Stem fragmentary, unbranched, articulate, 4.5 cm. long, near base



TEXT-FIG. 1 — *Equisetum rajmahalense* (Oldh. & Morr.) Feistm. No. 32725. $\times 2\frac{1}{2}$.

0.8 cm. in width, near apex 1.6 cm. Internodes smooth about 1.6 cm. long. Nodes with leaf-sheath; each sheath with approximately 16-25 segments, about 1 cm. long, composed of commissural flanges and raised leaf-segments; flanges broader at the top, about 0.5 mm. or less in breadth, tapering downwards. Leaf-sheath imperfectly preserved, where complete, tips acute.

Remarks — The present specimen is indistinguishable in leaf-sheath organization and in nodal character from *Equisetum rajmahalense* described by Oldham and Morris (1863, PL. 35, FIGS. 3-4) from the Rajmahal Hills, Bihar.

Locality — Kakadbbhit, Kutch.

Collection — Specimen no. 32725, Birbál Sahni Institute of Palaeobotany, Lucknow.

Filicales

MATONIACEAE

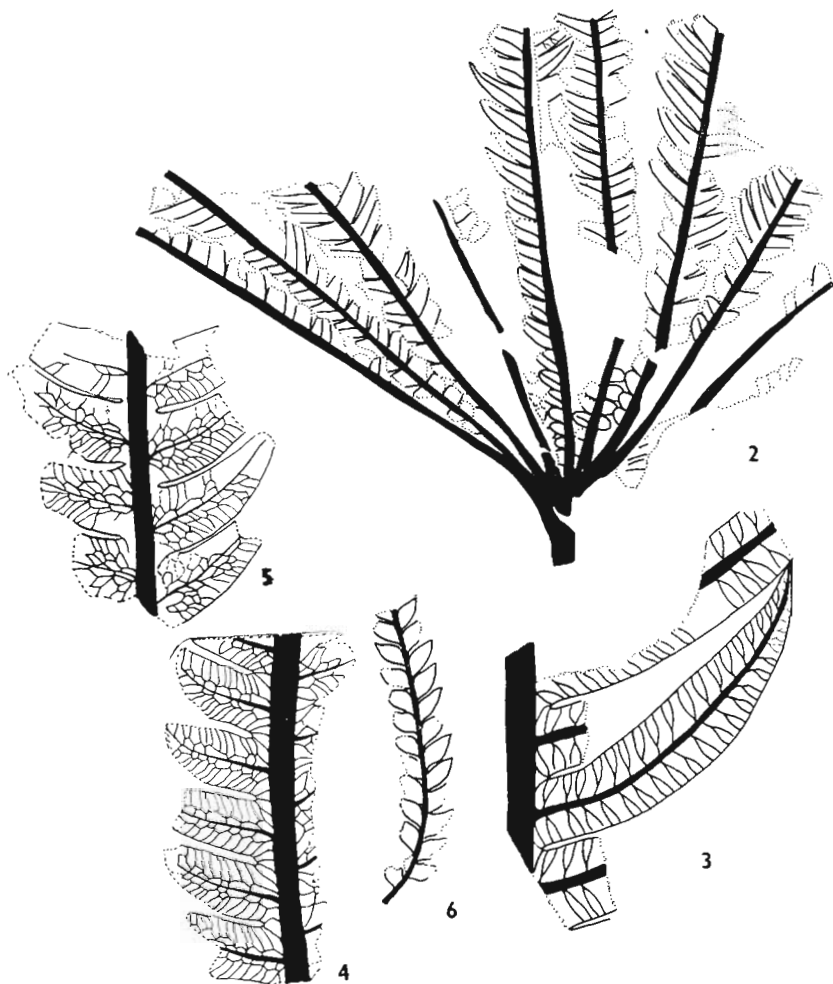
Genus *Matonidium* Schenk

Matonidium goepperti (Ettingsh.) Schenk

Pl. 1, Figs. 3-5; Text-figs. 2-3

1936 — *Matonidium indicum* Sahni, p. 153, Pl. 20, Figs. 1-7, Pl. 21, Figs. 1-6, Pl. 22, Figs. 1-4, Pl. 24, Fig. 1.

Description — Fronds showing pedate habit, available length 1.5-10.5 cm. Petiole incomplete, about 1.6 cm. long, 1 cm. broad at the lower end, expanding above in a fan-shaped manner. Pinnae radiating, about 18-20 in number. Pinna rachis prominent, about 0.2 cm. wide, in some a prominent median ridge is visible. Pinnae bases fused up to 0.3-0.6 cm. thin at narrow angles. Shape of pinnae as a whole lanceolate, about 0.4 cm. at base, 4.6 cm. near middle and 1 cm. near apex. Pinnules opposite or sub-opposite, variously shaped, deltoid at proximal end, measuring 0.3 cm. or less



TEXT-FIGS. 2-6 — 2. *Matonidium goepperti* (Ettingsh.) Schenk. No. 32489. $\times 1$. 3. *M. goepperti*, a few pinnules enlarged, showing venation. No. 32457. $\times 5$. 4. *Phlebopteris* sp., showing venation. No. 32536. $\times 5$. 5. *Weichselia reticulata* (Stokes & Webb) Ward, showing venation. No. 123/527. $\times 5$. 6. *Cladophlebis* sp. cf. *C. longipennis* Seward. No. 32317. $\times 1$.

in length and 0.2 cm. in breadth; falcate in middle and at apex, measuring 0.9-3 cm. in length and 0.3-0.4 cm. in breadth, attached by the entire base with the rachis. Margin entire. Mid-rib prominent, arising at an angle of 70°, continuing up to apex. Secondary veins arising almost at right angle, mostly once forked, but sometimes near base appear to be unforked.

Comparison — The specimens of *Matonidium goepperti* described here are structurally identical with the specimens earlier described by Sahni (1936) from the Himmatnagar sandstone as *Matonidium indicum*. In fact Sahni (*l.c.*, p. 158) has also pointed out "it is very closely allied to *M. goepperti*". The Indian specimens are indistinguishable from the specimens of *M. goepperti* (FIG. 37F) described by Harris (1961) from the Haiburn *Zamites*-bed in the mode of pinnae arrangement. In possessing only once forked veins the present specimens are also similar to the specimen of *M. goepperti* (TEXT-FIG. 5/6) described by Hirmer and Hoerhammer (1936).

In view of the fact that *M. goepperti* is very widely distributed in space and time and its structural identity with *M. indicum*, it is better to refer Sahni's specimens also under *M. goepperti*.

Localities — Songad, Kathiawar and Trambau, Kutch.

Collection — Specimen nos. 32444, 32457, 32463, 32466, 32468, 32478, 32479, 32487, 32499 and 31/391, Birbal Sahni Institute of Palaeobotany, Lucknow.

Genus *Phlebopteris* Brongniart

Phlebopteris sp.

Pl. 1, Figs. 6-7; Pl. 2, Fig. 9; Text-fig. 4

Description — Pinna detached, fragmentary, measuring 1.6 cm. in length and 0.8 cm. in breadth. Pinnules attached by their entire base, about 0.15 cm. or less wide, forming angle of about 80° with the rachis, alternate, slightly falcate. Margin entire. Mid-rib prominent, persisting up to apex. Secondary veins furcate, arising at an angle of about 80°, lateral connections on either side of the mid-rib forming single row of areole, occasionally lateral connections at other places in the pinnule as well. Apex incomplete, ? obtuse.

Remarks — Due to the fragmentary nature of the specimen, it cannot be determined specifically. Its venation, however, agrees with that of *Phlebopteris polypodioides* Brongn. (TEXT-FIG. 33G-H) described by Harris (1961).

Locality — Songad, Kathiawar.

Collection — Specimen no. 32536 of the Birbal Sahni Institute of Palaeobotany, Lucknow.

WEICHSELIAEAE

Genus *Weichselia* Stiehler

Weichselia reticulata (Stokes & Webb) Ward

Pl. 1, Fig. 8; Pl. 2, Figs. 10-11; Text-fig. 5

Description — Fronds pinnate, measuring 0.8-2.8 cm. in length, linear in shape. Rachis, smooth, less than 1 mm. broad. Substance of pinnules thick, sub-oppositely arranged, laterally attached by entire base at an angle of about 84° with the rachis, basiscopic margin, contiguous falcate. Margin entire. Mid-rib prominent from base to apex, lateral veins arising at an acute angle, anastomosing, forming a row of areole on either side of the mid-rib, further anastomosis form reticulum. Apex acute.

Comparisons — The present specimens resemble the specimen of *Weichselia reticulata* described by Sahni (1936) from the Himmatnagar sandstone. Also in general shape of the pinnules and their venation they are identical with *Weichselia* sp. described by Bose and Dev (1959) from the Jabalpur series of India.

Locality — Songad, Kathiawar.

Collection — Specimen nos. 32639, 32640, 32644, 32647 and 123/527, Birbal Sahni Institute of Palaeobotany, Lucknow.

Filicales — Incertae—Sedis

Genus *Cladophlebis* Brongniart

Cladophlebis kathiawarensis sp. nov.

Pl. 3, Figs. 22-24; Text-fig. 7

Diagnosis — Bipinnate frond, pinnae attached with the main rachis at an angle of 35°. Rachis striated at places. Pinnae



TEXT-FIGS. 7-8 — 7. *Cladophlebis kathiawarens* sp. nov., showing venation. No. 32311. $\times 5$.
8. *Sphenopteris* sp., showing venation. No. 32587. $\times 4$.

alternate, linear, two alternating pairs of pinnae arising close to one another, the pair above them appearing at a distance of 3.5-4 cm. Pinnules alternate—subopposite, falcate, emerging at an angle of 80° from the rachis, free but lower basal margin of each pinnule slightly decurrent. Margin entire near base, crenulate or dentate near apex. Mid-rib prominent proximally, faintly discernible at apex. Secondary veins emerging from mid-rib at an angle of $\pm 45^\circ$, constantly once forked swept near apex undivided. Apex acute. Lower most pinnule of each pinna arising on basiscopic side slightly away than the others, smaller than the other pinnules, deltoid, placed closer to the main rachis from where pinna arises, nearly at right angle or slightly reflexed downwards.

Locality — Songad, Kathiawar.

Holotype — No. 32311, Birbal Sahni Institute of Palaeobotany, Lucknow.

Isotype — Nos. 32305, 32313, 32314 and 32315.

Description — The description is based on three specimens. Two have counterparts: The largest and the best preserved specimen is No. 32311 (PL. 3; FIG. 22). Here the main rachis is broader at the base, about 0.6 cm. broad, becomes gradually narrow upwards. At places the rachis show striations. Pinnae arising alternately from the rachis at an angle of 40° , measuring up to 15.4 cm. The alternating pairs are placed 0.9-1.2 cm. apart. Then after a gap of 3.4 cm. the second pair of pinnae arise. The distance between the succeeding pairs of pinnae reduces upwards. A basiscopic, deltoid, pinnule is always present near the angle between the rachis and pinnae. This pinnule either arises nearly at right angle or slight reflexed downwards. The subsequent pinnules of each pinna arise after a gap of 0.6-1 cm. They are

either alternate or sub-opposite, closely placed. Margin of adjacent pinnule never touch each other.

Comparison — Among the known species of Indian *Cladophlebis*, *C. indica* (Oldh. & Morr.) Sahni & Rao shows closest resemblance to *C. kathiawarensis*. Like *C. indica* in the present species also, the pinnules have either dentate or crenulate margin at the apices. In *C. indica* the veins arc often twice forked near the base of each pinnules, they are once forked in the middle region and unforked towards the apices; whereas in *C. kathiawarensis* the veins are contently once forked excepting near the apex where they are sometimes unforked. Moreover unlike *C. indica*, *C. kathiawarensis* has free pinnules; that is, the lower margin of the pinnule above is never in contact with the pinnule below. In *C. kathiawarensis* a basisopic, small, deltoid pinnule is always present closer to the main rachis from where the pinna arises which is never present in *C. indica*.

The present species is also comparable to the sterile fronds of *Todites denticulatus* (Brongn.) Krasser, *Cladophlebis denticulata* (Brongn.) Fontaine described by Harris (1961) from the Jurassic of Yorkshire in having pinnules with dentate margin which are alternately arranged. But *C. kathiawarensis* differs from *C. denticulata* in possessing a small, basisopic pinnule close to the place of emergence of the pinna from the main rachis. In the presence of basisopic pinnule the present species is comparable to *C. whitbiensis* var. *punctata* (PL. 25, FIG. 1) and *C. sulcata* (PL. 19, FIG. 4; PL. 26, FIG. 3) described by Brik (1953) from the Mesozoic of Russia. But these two Russian species differ from *C. kathiawarensis* in having both once and twice forked veins in the pinnules. Moreover, the shape and attachment of the pinnules in the Russian species are also different.

Cladophlebis sp. cf. *C. longipennis* Sew.

Pl. 2, Fig. 17; Text-fig. 6

Description — Detached pinnate (bipinnate fronds?), measuring about 1.5-4.5 cm. × 0.5-1 cm. length × breadth. Pinnae linear, rachis stout. Pinnules sub-opposite — alternate, separate, each measuring about 0.4-0.6 cm. × 0.2-0.4 cm. length × breadth.

Upper basal margin slightly constricted, lower basal margin travel downwards a little on the rachis. Margin entire. Mid-rib prominent at the base, faintly discernible upwards. Secondary veins at the base once forked? unforked distally.

Comparison — The present specimens are comparable to *Cladophlebis longipennis*, Seward (1894, PL. 11, FIGS. 1-1a), and *C. sp. cf. C. longipennis* Bose (1957, PL. 1, FIGS. 1-2) described from the Wealden of England and the Jabalpur Series of India respectively.

Locality — Songad, Kathiawar and Trambau, Kutch.

Collection — Specimen Nos. 32350, 32369, 32370, 32371 and 32380, Birbal Sahni Institute of Palaeobotany, Lucknow.

Genus *Onychiopsis* Yokoyama

Onychiopsis psilotoides (Stokes & Webb) Ward

Pl. 2, Figs. 12-14

Description — Sterile, bipinnate fronds, axis slender, available length 3.8-7.4 cm. Pinnae alternate, attached at acute angle, linear, rachis striated. Ultimate segments alternate, attached by constricted base, continuous with one another on the edge of the axis, irregularly segmented, lobed, wedge-shaped, repeatedly divided. Margin entire or serrate. Veins indistinctly marked, appears repeatedly forked, sphenopteroid. Apex obtuse.

Comparison — In the shape of the ultimate segments, their venation and in the general habit the present specimens are identical with the sterile segments of *Onychiopsis psilotoides* described by Bose (1958) from the Jabalpur series. The shape, size and general habit of the frond shows a close similarity with the specimens of *Onychiopsis psilotoides* described by Ward (1905) from Alaska and Seward (1894) from the Wealden of England.

Genus *Sphenopteris* Sternb.

Sphenopteris specifica (Feistm.) comb. nov.

Pl. 2, Fig. 18; Pl. 3, Fig. 19; Text-fig. 9

1876 — *Pachypteris specifica* Feistm., p. 32, Pl. 3, Figs. 6-6a.



TEXT-FIG. 9. — *Sphenopteris specifica* (Feistm.) comb. nov., showing venation. No. 32627. $\times 4$.

1876 — *Pachypteris brevipinnata* Feistm., p. 33, Pl. 3, Figs. 7-7a, Pl. 4, Figs. 1-3; Pl. 12, Fig. 2.

Diagnosis — Fronds bipinnate, maximum available length 5.4 cm., 3.1 cm. in breadth, flattened in plain. Main axis about 0.1 cm. broad, slender, smooth mostly, but sometimes a median ridge present. Pinnae linear, arising alternately from the main axis at an angle of 30-40°, imparipinnate. Pinnules alternate towards base, becoming sub-opposite at apex, arising at narrow angle from rachis about 0.5 mm. or less broad. Each pinnule measuring 0.5-0.6 cm. in length at base and in middle and 0.1-0.3 cm. broad, towards apical region of frond pinnules becoming smaller 0.3 cm. or less in length, ovate. Lower base of pinnules decurrent with the upper basal margin of the pinnules below. Margin entire. Apex obtuse. Basiscopic pinnules of most pinnae arising from place of emergence of pinnae. Mid-rib not discernible. Secondary veins faintly marked, sphenopteroid.

Comparison — The present congregation of specimens are structurally identical with *Pachypteris specifica* and *P. brevipinnata* described by Feistmantel (1876) from Kutch. These fronds, in general, show sphenopteroid habit and they do not afford any cuticular evidence. In view of this fact it is more appropriate to describe them as *Sphenopteris*.

Locality — Kakadbhiti — Kutch.

Collection — Holotype No. 4792, Geological Survey of India, Calcutta. Specimen Nos. 32623, 32604, 32608, 32610, 32616

and 32627, Birbal Sahni Institute of Palaeobotany, Lucknow.

Sphenopteris sp.

Pl. 2, figs. 15-16, Pl. 3, Figs. 20-21; Text-fig. 8

Description — Fragmentary, pinnate fronds, measuring 3.9-4.4 cm. in length and 0.3-0.5 cm. in breadth. Rachis slender, about 0.1 cm. or less wide. Pinnules varying in size, measuring 0.3-0.5 cm. in length, arising at narrow acute angle from rachis, directed upwards, alternate to sub-opposite, attached by a contracted base. Wedge-shaped or lobed. Lobes blunt or acute, smaller pinnules distinctly trilobed. Veins radiating from base, mostly once forked, sometimes twice forked.

Comparison — Among many specimens collected from Kutch and Kathiawar showing sphenopteroid habit, there are a few which have lobate pinnules. Some variation in shape, size and angle of attachment exists in pinnules of this type.

The present specimens are comparable in their general organization and shape of the pinnules with *Coniopteris hymenophylloides* described by Halle (1913) from the Mesozoic of Grahamland, Sze (1933) from the Mesozoic of China, *Coniopteris* sp. cf. *C. hymenophylloides* by Bose (1958) from the Jabalpur series and *Sphenopteris hymenophylloides* of Möller (1902) from Bornholm.

Remarks — There are a few more genera which possess sphenopteroid habit. But they have been separated from the genus *Sphenopteris* on the character of the fertile structure. The present specimens being sterile they have been described here as *Sphenopteris* sp.

Locality — Bhajodi and Gadsisa, Kutch; Songad, Kathiawar.

Collection — Specimen Nos. 32583, 32592, 32595, 32597 and 32598, Birbal Sahni Institute of Palaeobotany, Lucknow.

DISCUSSION

The occurrence of *Weichselia reticulata* in Kathiawar and *Onychiopsis psilatoides* in Kutch and Kathiawar supports the view that the beds containing them are not older than Lower Cretaceous (=Wealden) for these two genera are commonly known to occur, in rocks of Wealdenage.

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EXPLANATION OF PLATES

PLATE 1

1. *Equisetum rajmahalense* (Oldh. & Morr.) Feistm. No. 32725. × 1.
2. The above specimen magnified. × 2.
- 3-5. *Matonidium goepperti* (Ettingsh.) Schenk. Nos. 32487, 32444 and 32479. × 1.
6. *Phlebopteris* sp. No. 32536. × 1.
7. The above specimen magnified. × 4.
8. *Weichselia reticulata* (Stokes & Webb) Ward. No. 32639. × 1.

PLATE 2

9. *Phlebopteris* sp. showing venation. No. 32536. × 10.
10. *Weichselia reticulata* (Stokes & Webb) Ward No. 32640. × 1.
11. *W. reticulata* showing venation. No. 123/527. × 10.

PLATE 3

- 12-13. *Onychiopsis psilotoides* (Stokes & Webb) Ward. Nos. 32709 & 32646. × 1.
14. A portion of specimen no. 32709 magnified. × 4.
15. *Sphenopteris* sp. magnified showing venation. No. 32583. × 5.
16. *Sphenopteris* sp. No. 32597. × 1.
17. *Cladophlebis* sp. cf. *C. longipennis* Seward. No. 32371. × 1.
18. *Sphenopteris specifica* (Feistm.) comb. nov. No. 32623. × 1.
19. *Sphenopteris specifica* (Feistm.) comb. nov. No. 32617. × 1.
- 20-21. *Sphenopteris* sp. Nos. 32599, 32587. × 1.
- 22-24. *Cladophlebis kathiawarensis* sp. nov. Nos. 32311, 32314 and 32336. × 1.

