

SOME FERNS FROM THE LOWER CRETACEOUS OF MADHYA PRADESH-1

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ABSTRACT

Fossil plants of the families Gleicheniaceae (*Gleichenia nordenskiöldii*) and Matoniaceae (*Phlebopteris polypodioides*) are described here together with an unclassified fern *Weichselia reticulata* from the Lower Cretaceous (Jabalpur Stage) of Bansa and its neighbouring areas of the Shahdol district of Madhya Pradesh.

INTRODUCTION

RECENTLY short notes on the fossil ferns from Bansa, Chandia and the surrounding areas have been published by Bose and Sukh Dev (1959, 1961) and Sukh Dev (1961). The first two notes deal with two genera, *Onychiopsis* and *Weichselia* with a single species each. In the third note, the aforesaid *Weichselia* species is again mentioned along with some other plants belonging to the genera *Todites*, *Gleichenia*, *Phlebopteris*, *Hausmannia*, *Cladophlebis* and *Sphenopteris*. Later, Bose and Sukh Dev (1961a) described in detail the above mentioned single species of *Onychiopsis* as *O. paradoxus* n. sp.

I now identify *O. paradoxus* and the other species of *Onychiopsis*, e.g. *O. capsulifera* (Velenovsky'), *O. elongata* (Geyler) Yokoyama and *O. tenuissima* Prinada as *O. psilotoides* (STOKES & WEBB) Ward (Reading University Ph.D. Thesis 1965). After the study of the English specimens, I have observed keel on the "elliptical fertile pinules" of the Indian specimens having a lump of spores but no separate sporangia. The "concave prolongation" along the fertile body and the "keel" are one and the same thing. The "elliptical fertile pinnule" represents a monosporangiate unilocular structure. A comprehensive account of *O. psilotoides*, as I interpret, is given in a separate paper (in press).

In the present paper, a detailed account of three more ferns, viz., *Gleichenia nordenskiöldii*, *Phlebopteris polypodioides* and *Weichselia reticulata* is given.

Fossiliferous localities—In the South Rewa Gondwana basin the outcrops of the

Jabalpur Stage (Lower Cretaceous), which are rich in plant fossils, are exposed near the village of Bansa (Long. 80° 39' 20", Lat. 23° 36' 45", TEXT-FIG. 2G) and in the surrounding areas, Shahdol district, Madhya Pradesh. The majority of the specimens here described were found in the carbonaceous shales, cropping out at three different places in the Machrar river; the first (A) about ½ mile NNW, second (B) about ¼ mile NNW and the third (C — Marwar Ghat) about ½ mile NE of Bansa. Some specimens were also collected from the freshly dug out quarries near Patparha (F — about 5 miles EEN of Bansa) and Tekan (G — about 9 miles NE of Bansa).

The figured Indian specimens and slides are preserved at the Museum of the Birbal Sahni Institute of Palaeobotany, Lucknow. The figured slide of the English specimen of *Weichselia reticulata* is preserved at the British Museum, Natural History, London.

DESCRIPTION

Family — GLEICHENIACEAE

Genus — *Gleichenia* Smith

Gleichenia nordenskiöldii Heer

Pl. 1, Figs. 1-5; Text-fig. 1A-D

1. Indian specimens:

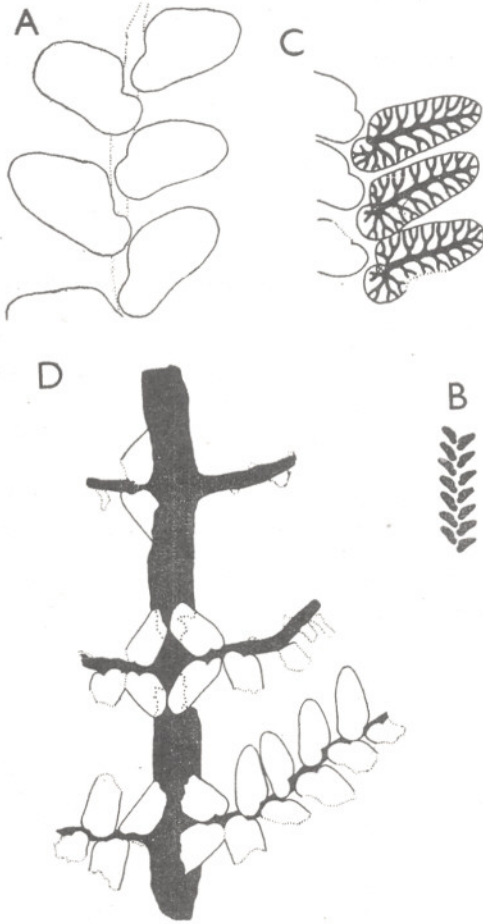
1961 *Gleichenites indicus* Sukh Dev, p.3 75 (Brief description. L. Cretaceous, Bansa & Patparha, Shahdol dist.)

2. Greenland specimens:

1874 *Gleichenia Nordenskiöldi* Heer, p. 50, Pl. 9, Figs. 6, 7, 9, 10, 11a, 12.

Pecopteris Andersoniana Heer, p. 41, Pl. 3, Fig. 7.

1880 *Pecopteris* (*Polypodium* ?) *Andersoniana* Heer: Heer, p. 4, Pl. 1 Fig. 10b; Pl. 2, Figs. 5-9.



TEXT-FIG. 1—*Gleichenia nordenskiöldii* Heer. A, showing the asymmetrical base of pinnules overlapping the pinna rachis, 31164, $\times 7$. B, pinna fragment, 31165, $\times 1$ (Specimen consumed). C, venation, the circle marked with cross (X) represents the point of attachment to the underlying rachis, 31693, $\times 6$. D, bipinnate fragment as seen from above, 30769, $\times 3$. A, D, Patparha; B, C, Bansa (Loc. B).

1926 *Gleichenites Nordenskiöldii* Heer: Seward, p. 74, Pl. 6, Figs. 22, 25, 26; Pl. 10, Fig. 97.

1932 *Gleichenites Nordenskiöldii* (Heer) Seward: Tutin, pp. 506-507 (details of sori, sporangia and spores).

Seward (1926) included the following specimens under *G. nordenskiöldii*, but the figures are inconclusive:

1874 *Gleichenia longipennis* Heer, in part, p. 46, Pl. 8, Figs. 1-3 (according to Seward "Fig. 1 is inaccurately drawn

and is no doubt referable to *G. Nordenskiöldii*").

Gleichenia nervosa Heer, p. 53, Pl. 11, Figs. 3-6.

2. The following are possibly identical but the figures are inconclusive:

1874 *Gleichenia Nordenskiöldii* Heer, p. 50, Pl. 9, Fig. 8 (Greenland).

1876 *Pecopteris (Cyatheides) tenera* Feistmantel, p. 26, Pl. 3, Fig. 5 (Doodye-Kutch, India, Lower Cretaceous).

Emended diagnosis — (Based on Heer 1874, Seward, Tutin and my own material). Frond (dichotomous ?) bipinnate, rachis about 3 mm. wide. Pinnae about 5 cm. long, making an angle of 75° - 90° to the rachis, broad at the proximal end and narrowing very gradually towards the apex, arising at intervals of about 5-13 mm. on the same side. Pinnules ovate or oblong-ovate, typically 3-4 mm. long, 1.5-2 mm. wide, thick, leathery, slightly convex above, concave below, crowded, contiguous, occasionally overlapping slightly, or sparse and separated by a gap less than 1 mm., attached to the top of the pinna rachis (mid-rib making an angle of 50° - 90°) with only a small portion of the base near the midrib. Basal acroscopic edge of pinnule making a short narrow sinus; basal basisopic edge longer and larger than the acroscopic one, symmetrically rounded, covering usually the entire width of the pinna rachis and frequently projecting slightly beyond it, and fitting into the concavity formed by the shorter acroscopic basal edge of the pinnule of the opposite side. Margin entire, thickened, curved downwards and sometimes slightly recurved. Apex obtuse or rounded. Basal two pinnules of each pinna normally slightly longer and broader than the rest (sometimes of the same size or smaller), bent backwards and overlapping the rachis (sometimes at right angle to the pinna rachis or occasionally turned towards the distal end of the pinna). Midrib of upper pinnules forming a distinct groove on the upper side, slightly undulate and breaking up near the apex into 2 or 3 unforked veins. First lateral vein arising at about right angle or slightly over a right angle from the midrib at its point of emergence on the side of the rachis (catadromic venation), forking more than twice and supplying the entire enlarged basal edge of the pinnule. Subsequent laterals arising at a wide angle, forking once and twice,

sometimes one of the sister arms forked and the other remaining unforked, ending at the margin at a concentration of about 42 veins per centimetre. On under side of pinnule midrib and laterals forming ridges but sometimes inconspicuous. Larger basal pinnules probably possessing similar venation.

Fertile pinnules similar to sterile ones. Sori many (? 6 per pinnule), borne over the anadromic branch of a lateral vein. Sorus of 2-3 sporangia (Tutin) or 4 sporangia (Heer). Sporangium about 0.36 mm. (Seward) \times 0.3 mm. (Tutin), annulus complete (Seward), containing about 128 spores (Tutin). Spores 30 μ wide (Tutin).

Lectotype—Specimen figured by Heer (1874; PL. 9, FIG. 6).

Occurrence:

Jabalpur Stage — South Rewa, Marwar Ghat about $\frac{1}{2}$ mile NE, about $\frac{1}{4}$ mile and $\frac{1}{2}$ mile NNW of Bansa and Patparha.

? Umia Stage — Kutch, Doodye.

World distribution — *Gleichenia nordenskiöldii* is recorded from the Lower Cretaceous of the South Rewa basin. It probably occurs in Kutch also. Outside India it is known only from the Lower Cretaceous of Greenland.

Description — Fragments of *G. nordenskiöldii* are preserved near Bansa and Patparha as compressions, some of which are carbonised. Balsam transfers were made from two specimens but both proved sterile. No dichotomously branched rachis was found in this area. In my specimens the hairs or scales are absent on either side of the rachis and pinnules. Specimens described by Heer (1874, 1880) were not accessible and Seward's specimens preserved at the British Museum (Natural History) which are well preserved are apparently without either hairs or scales.

Comparison and discussion — *Gleichenia nordenskiöldii* first described by Heer (1874) from Lower Cretaceous of Greenland, was revised by Seward (1926). Seward gave some details of sori and sporangia to which Tutin (1932) further added his observations.

My specimens are sterile and in the habit of a bipinnate frond, shape and size of the pinnules and their asymmetrical base and venation are identical with Seward's speci-

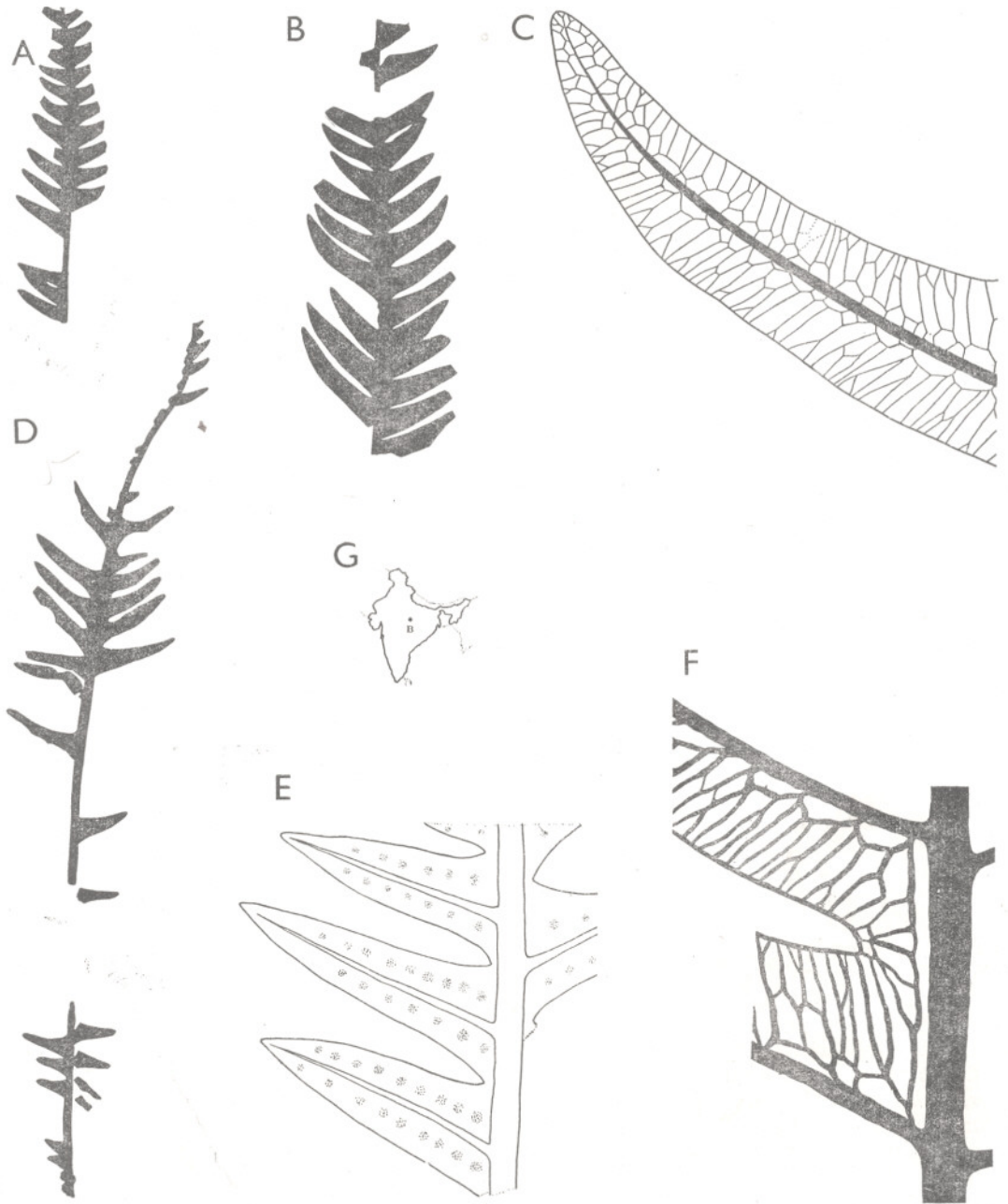
mens. In both the basal two pinnules are longer, bent backwards and overlap the rachis. However, Seward's specimens are relatively much thinner which may be due to conditions of preservations. Heer's specimens were not accessible but his description and illustrations agree well with mine in essentials. In *G. nordenskiöldii* a dichotomously branched rachis has not so far been found in connection with the pinnae although it is found lying close to the frond fragments on the same slab in the Greenland specimens.

Gleichenia nordenskiöldii is comparable with some living species of *Gleichenia*. For example, bipinnate fragments of *G. nordenskiöldii* are similar in general form and arrangement to the pinnules of *Gleichenia polyodioides* (L.) Smith, *G. dicarpa* R. Br., *G. circinnata* Sw., *G. boryi* Kze., *G. semi-vestita* Lab., *G. alpina* R. Br. and *G. bancroftii* Hook. In all of these species the pinnule base is symmetrical and uncontracted. The lamina is attached to rachis by whole base. In *G. nordenskiöldii* the bases of the pinnules are asymmetrical and the lamina is contracted so that the midrib alone is attached. In *G. polyodioides*, *G. dicarpa*, *G. circinnata*, *G. boryi*, *G. semi-vestita* and *G. alpina* the pinnules are smaller and have only one sorus per pinnule. In *G. bancroftii* the pinnules are roughly of the same size and shape as in *G. nordenskiöldii* and have many sori with 2-4 sporangia in each. The sporangia are also about the same size. But in *G. nordenskiöldii*, besides the other differences mentioned above, the veins are much more divided. In *G. bancroftii* the pinnules are connected with one another by a narrow strip of lamina and possess simple venation. It is on the close resemblance of *G. nordenskiöldii* with many living species of *Gleichenia* that I describe this plant under the living genus as was done earlier by Heer (1874).

The present specimens are also very like *G. gleichenoides* in their small broad pinnules, with a leathery consistency and thickened margins. Their venation is similar (apart from the differences related to the size and shape of the pinnules), and in both the two basal pinnules of each pinna are enlarged and bent backwards. However, in the present specimens the pinnules are attached by the midrib alone but in *G. gleichenoides* they are attached by their whole base. In the present specimens the basal edge of each pinnule is much enlarged but in *G.*

gleichenooides no such regular enlargement is seen. Moreover, the pinnules of the present specimens attain a larger size (largest seen in present specimens 3.5×1.8

mm., and *G. gleichenooides* 2.2×1.5 mm.). However, much smaller pinnules also occur in both the species. The two species are mixed at Bansa (A, B, C) and Patparha



TEXT-FIG. 2 — *Phlebopteris polypodioides* Brongn. A, specimen no. 30723, $\times 1$. B, specimen no. 30318, $\times 1$. C, venation, 30318, $\times 7$. D, specimen no. 30734, $\times 1$. E, showing the position of placenta, 30363, $\times 5$. F, venation, 30318, $\times 10$. G, map of India showing location of the village of Bansa (B). A, D, Tekan; B (C, F, same specimen), E, Bansa (Loc. B).

(F) but in the other localities (Rajmahal hills), where *G. gleichenoides* occurs, nothing resembling the present specimens have been figured.

Family — MATONIACEAE

Genus — *Phlebopteris* Brongniart 1836: 371

Phlebopteris polypodoides Brongniart

Pl. 1, Figs. 6-9; Text-fig. 2A-F

1. Indian specimens:

- 1961 *Phlebopteris arcuata* Sukh Dev, p. 375. (Brief description. L. Cretaceous, Patparha, Shahdol dist.).
 ?1968 *Phlebopteris* sp., Roy, p. 110, Pl. 1, Figs. 6, 7; Pl. 2, Fig. 9; Text-fig. 4. (Fragmentary specimen. L. Cretaceous, Songad-Kathiawar).

2. Specimens from other countries:

See Harris 1961, pp. 101, 102.

Description — (Based on my material). Isolated pinnae, linear-lanceolate, maximum available length up to 13 cm., rachis up to 1 mm. thick, marked with fine longitudinal striations. Hair-bases probably present on the lower side of the rachis and the midrib. Pinnules thick, longer in the middle portion of the pinna and narrowing towards the base and apex, typically 2.4 × 0.3 cm., (range about 1 mm. to 3.5 mm. wide, base slightly wider; up to 2.5 cm. long), mostly falcate, sometimes straight, attached closely at a wide angle, appreciably enlarged at the base and narrowing gradually or abruptly towards the acute or obtuse apex. Bases of pinnules connected with a narrow lamina (up to 1 mm. wide) along the rachis. Pinnules of the same side originating at intervals of 1.5-6 mm. In sterile pinnules, upper surface flat or slightly convex, lower surface correspondingly flat or slightly concave. Fertile pinnules slightly convex above and concave below. Margin entire, flat or slightly recurved. Pinnules towards the base of pinna diminishing into short lobes with pointed or rounded apex and towards the apical portion becoming shortly triangular. Midrib with fine longitudinal striations, broad up to half or three quarters the length of pinnule and becoming feeble further on, persisting nearly to the apex, depressed on upper surface but projecting on lower surface. Lateral veins also projecting on lower surface. Veins originating from the

midrib at intervals of less than 1 mm. (rarely up to 1 mm.), forking immediately into forward and backward branches which unite with those of the adjacent ones forming polygonal primary arches on either side of midrib. Primary arches of varied size, mostly wider (in direction of midrib) than high; devoid of any internal branches. From the corners of the primary arches usually one but sometimes two veins run outwards, straight or with a slight bend, and meet the margin at an angle of 50°-70°; veins simple or forked, and sometimes anastomosing with the adjacent ones to form elongated meshes. Veins reaching the margin at a concentration of 40-66 per cm. Web connecting the adjacent pinnules show a strong forward running vein anastomosing with a backward running vein from the next pinnule close to the pinna rachis and giving off branches.

Sori arranged in a single row on each side of midrib. Sporangium about 550 μ long.

Occurrence:

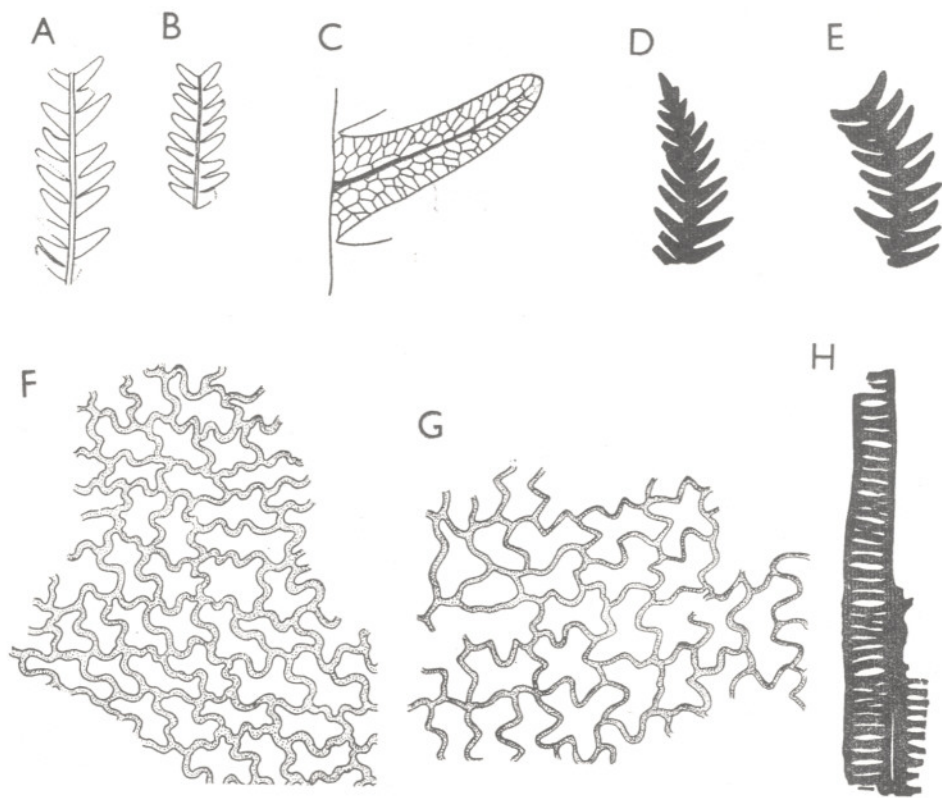
Jabalpur Stage — South Rewa, Marwar Ghat about $\frac{1}{2}$ mile NE and about $\frac{1}{4}$ mile NNW of Bansa, Patparha and Tekan.

? Umia Stage — Kathiawar, Songad.

World distribution — *Phlebopteris polypodoides* is widespread in Europe from the Rhaetic to the Middle Jurassic. It is also known from the Rhaetic of E. Greenland and Lower Jurassic of Manchuria and Korea. In India it occurs in the Lower Cretaceous.

Remarks — Many detached incomplete pinnae of *P. polypodoides* were found. Most of them are preserved as impressions. A few carbonised compressions were also collected but none yielded epidermis or other details. Imprints of the epidermal cells are poorly preserved. Only a single fertile specimen was found. It bears the imprints of placentae. A sporangium is visible at one place only.

Comparison and discussion — The present specimens are characterised by their venation of *Phlebopteris polypodoides* Brongniart but their pinnules are relatively narrower than in most previously described specimens. However, some of the specimens of *P. polypodoides* described from various places do resemble closely my specimens in the shape



TEXT-FIG. 3 — *Weichselia reticulata* (Stokes & Webb) Ward. A, B, fragments of pinnae, 30223, 30195, $\times 1$. C, venation, 30223, $\times 5$. D, E, fragments of pinnae, 32762, 31680, $\times 1$. F, G, upper epidermis, the two figures showing variation in the shape and size of the cells from two specimens, slide nos. 3852 (prepared from specimen no. 30195), 3853 (prepared from specimen no. 34021), $\times 200$. H, scalariform tracheids, slide no. 3854 (prepared from specimen no. 34020), $\times 1600$. A, B, C, D, F, Bansa (Loc. C); E, G, H, Bansa (Loc. A).

and size of their pinnules, e.g. Harris (1961, specimen no. V. 32518, England), Lundblad (1950, TEXT-FIG. 6, Sweden), Schenk (1867, PL. 13, FIG. 1, W. Germany), Hirmer and Hoerhammer (1936, PL. 7, FIGS. 1, 5, Germany), Möller (1902, PL. 4, FIGS. 2-4, Bornholm) and Kawasaki (1925, PL. 11, FIG. 41; PL. 12, FIG. 42, Korea). The concentration of veins in *P. polypodioides* from various localities (for synonyms see Harris, loc. cit.) is very variable (counted/estimated about 18-60 per centimetre at the margin of the pinnule, mostly 20-40). This variation is noticed in the specimens even from the same locality (about 18-43 veins/cm. at the margin in Yorkshire specimens, about 20-60 in the German specimens described by Hirmer and Hoerhammer, loc. cit.). In my specimens 40-66 veins/cm. occur at the margin of the pinnule and it is also the

same in the specimens of Möller and those of Lundblad too.

UNCLASSIFIED FERN

Genus — *Weichselia* Stiehler 1857

Weichselia reticulata (Stokes & Webb) Ward

Pl. 1, Figs. 10-15; Test-fig. 3A-H

1. Indian specimens (complete bibliography)

1936 *Weichselia reticulata*: Sahni, p. 155, Pl. 22, Fig. 5; Pl. 23, Figs. 1-7. (Fragments. L. Cretaceous, Himmatnagar).

1959 *Weichselia* sp.: Bose and Sukh Dev, p. 130, Figs. 1,2 (Pinna, venation. L. Cretaceous, South Rewa).

1966 *Weichselia reticulata* (Stokes & Webb) Ward: Surange, p. 130, Fig. 85A-D

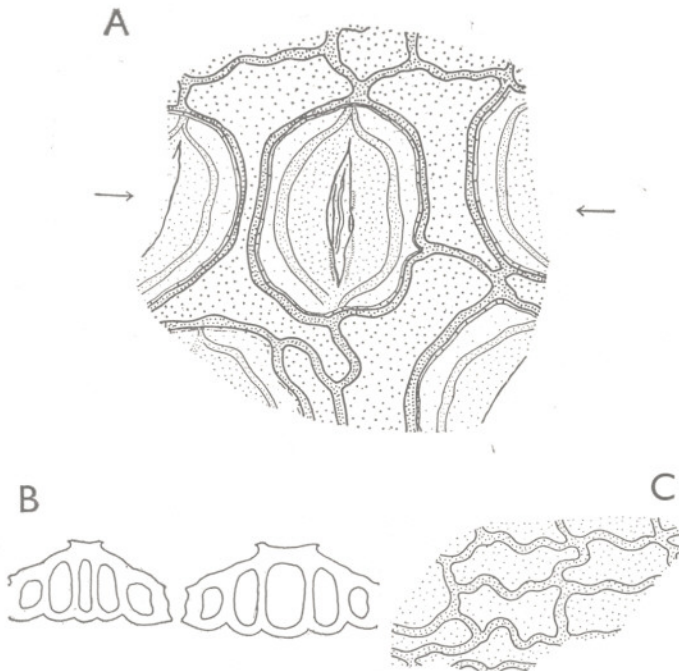
- (FIGS. B & C after SAHNI, 1936, Himmatnagar; A & D, Songad. L. Cretaceous).
- 1968 *Weichselia reticulata* (Stokes & Webb) Ward: Roy, p. 110, Pl. 1, Fig. 8; Pl. 2, Figs. 10, 11 — both figs. in Surange 1966, 85 A & D; Text-fig. 5 (Fragments. L. Cretaceous. Songad-Kathiawar).
2. Selected specimens from other countries (sterile leaves).
- 1824 *Pecopteris reticulata* Stokes & Webb, p. 423, Pl. 46, Fig. 5; Pl. 47, Fig. 3 (Pinnae, venation. Wealden, England).
- 1827 *Pecopteris reticulata*: Mantell, p. 56, Pl. 3, Fig. 5; Pl. 3*, Fig. 3 (Figures of Stokes and Webb reproduced).
- 1836 *Lonchopteris Mantelli*: Brongniart, p. 369, Pl. 131, Figs. 4, 5 (Bipinnate with good variation in pinnules, venation. Fig. 4 reproduced from Mantell. Fig. 5. L. Cretaceous, France).
- 1857 *Weichselia Ludovicae* Stiehler, p. 73, Pls. 12, 13. (Bipinnate. L. Cretaceous, Germany).
- 1871 *Lonchopteris recentior*: Schenk, p. 4, Pl. 1, Figs. 2-6. (Pinnae, venation. L. Cretaceous, Austria).
- 1876 *Asplenites klinensis* Trautschold, p. 209, in part, Pl. 20, Figs. 1-6, 8. (Bipinnate, venation not shown. L. Cretaceous, U.S.S.R.).
Polypodites (Lonchopteris) Mantelli: Trautschold, Pl. 19, Fig. 8 (Pinna, venation not shown).
- 1891 *Weichselia erratica* Nathorst, p. 23, Pl. 1, Figs. 3, 4, ?1 & 2. (Fragment. Cretaceous, ? Sweden).
- 1894 *Weichselia Mantelli* (Brong.) Seward, p. 114, Pl. 10, Fig. 3; Text-figs. 12, 13. (Bipinnate, venation. Wealden, England).
- 1899 *Weichselia reticulata* (Stokes & Webb) Ward, p. 651, Pl. 160, Figs. 2-4. (Pinnae, venation. L. Cretaceous, U.S.A.).
- 1900 *Weichselia Mantelli* (Brongn.): Seward, p. 20, Pl. 1, Figs. 3-16; Pl. 3, Figs. 41, 42, 47; Text-fig. 1. (Variation in pinnules. Fig. 56 rejected, being without pinnules. Wealden, Belgium).
- ?1907 *Weichselia Mantelli* (Brongn.) Seward: Neumann, p. 74, Pl. 1, Fig. 1. (Bipinnate. Not certain of venation and sori. L. Cretaceous, Peru.)
- 1910 *Weichselia Mantelli*: Bommer, p. 297, Pl. 1, Fig. 11. (Wealden, Belgium).
- 1910 *Weichselia reticulata*: Gothan, p. 1, Figs. 1-6. (Some bipinnate, venation. Neocomian, Gault, Germany).
- 1915 *Weichselia reticulata* (Stokes & Webb) Ward: Stopes, p. 4, Text-fig. 1. (Fragment. Aptian, England).
- 1919 *Weichselia reticulata* (Stokes & Webb) Ward: Florin, p. 305, Figs. 1, 2-5. (Leaf, stomata. L. Cretaceous, Germany, Belgium).
- 1921 *Weichselia reticulata*: Gothan, p. 772, Fig. 3. (Poor Figure. L. Cretaceous, Germany).
- 1923 *Weichselia*: Lipps, p. 337, Figs. 6-15. (Bipinnate. L. Cretaceous, Germany).
- 1925 *Weichselia reticulata* Stokes & Webb spec.: Hirmer, p. 3, Pl. 1, Figs. 1, 2. (Pinnae, Venation. Cenomanian, Bahariya Oasis — Egypt).
- 1926 *Weichselia reticulata* (Stokes & Webb): Edwards, p. 94, Figs. 1, 2. (Venation. L. Cretaceous, Sudan).
- 1927 *Weichselia reticulata* (Stokes & Webb) Ward = *W. mantelli* Brongt.: Carpentier, p. 52, Pl. 12, Figs. 6-10; Text-fig. 21. (Fragments. Wealden, France).
- 1928 *Weichselia reticulata*: Berry, p. 1, Fig. 1. (Bipinnate, pinnules on the main rachis, venation not clear. L. Cretaceous, Texas).
- 1929 *Weichselia reticulata* (Stokes & Webb) Edwards, p. 396, Pl. 6, Figs. 1, 2; p. 403, Pl. 6, Fig. 4 — Venation. (L. Cretaceous, Syria and Transjordan).
- 1933 *Weichselia reticulata*: Edwards (*Weichselia* and *Paradoxopteris*. Recorded *W. reticulata* from the Albion of England, p. 339).
- 1933 *Weichselia reticulata* (Stokes & Webb) Ward: Kryshstofovich, Pl. 6, Fig. 2. (Bipinnate. L. Cretaceous, U.S.S.R.).
- 1945 *Weichselia* sp.: Berry, p. 158, Pl. 11 (L. Cretaceous, Colombia).
- 1965 *Weichselia reticulata* Stokes & Webb: Reymanowna, p. 16, Pl. 1, Figs. 8, 11; Text-fig. 1A-H. (Fragments. Epidermis — Stomata. Papilla mentioned in Fig. 1B by Reymanowna is an abortive stoma. Similar structures, which are few in number, are seen in English specimens also in the slides prepared by me at

- the British Museum Nat. Hist. L. Cretaceous. Lipnik and Przenosza, Poland).
- 1968 *Weichselia reticulata*: Daber, p. 78, Pl. 1; Pl. 2, Figs. 2, 3; Text-figs. 3, 4, 6, 7 (very good leaves. L. Cretaceous, Germany).
- 1969 *Weichselia reticulata* (Stokes & Webb): Watson, p. 239, Pl. 6, Fig. 5. (Wealden, England).

Description — (Based on my material). Pinnae imparipinnate. Pinna rachis about 1 mm. wide. Hairs absent on rachis and pinnules. Pinnules typically 6×1.5 mm. (largest seen 9×2.5 mm.), slightly broader at the base, attached closely at an angle of 50° - 75° , in apical pinnules angle reduced to 40° , falcate, sometimes straight, entire, fleshy, usually connected at their base with a narrow web (up to about 0.5 mm. wide). Distal pinnules shorter and triangular, towards the base pinnules diminishing into small lobes with rounded apex. Margin curved downwards and slightly thick. Apex obtuse. Midrib thick, moderately undulate, disappearing near the apex. Secondary veins numerous, arising at an interval of

less than 1 mm. (sometimes at 1 mm. in the larger pinnules — size 9×2.5 mm.), forking immediately into forward and backward branches which on uniting with the adjacent ones form a single row of meshes on either side of midrib. Single veins given off from the angles of these meshes, which on further division and union with the adjacent ones form subsequent meshes in the lamina. Long axes of meshes next to midrib parallel with it while those of the rest sharply inclined towards margin. Usually two or three veins arising from the pinna rachis at the basal portion of the pinnule, and joining with others to form basal meshes. The basal veins of the adjacent pinnules usually united with one another. About 32-60 veins/cm. reaching the margin (about 32-42 in pinnules of 9×2.5 mm. size, and about 50-60 in pinnules of 4.6×1.5 mm. size).

Upper epidermal cells polygonal, elongate or as long as broad. Anticlinal walls thick (2.5 - 6.5μ), strongly looped. Loops smoothly rounded or pointed. Cells over the veins narrower, elongate. Anticlinal walls moderately undulate to almost straight.



TEXT-FIG. 4 — *Weichselia reticulata* (Stokes & Webb) Ward. A, lower epidermis, slide no. V2174 a-3, $\times 400$. B, reconstructed transverse section of stomata of the above along the line denoted by arrows. C, epidermal cells of the lower surface over the veins, slide no. V2174 a-3, $\times 200$. A, C, Ecclesbourne, England.

Occurrence:

Jabalpur Stage — South Rewa, Marwar Ghat about $\frac{1}{2}$ mile NE, about $\frac{1}{4}$ mile and $\frac{1}{2}$ mile NNW of Bansa.

Umia Stage — Kathiawar, Songad.

Lower Cretaceous — Western India, Himmatnagar.

World Distribution — *Weichselia reticulata* occurs in the Lower Cretaceous flora (Neocomian and Barremian) of England, France, Germany, Austria, Belgium, Poland, U.S.S.R., ? Sweden, U.S.A., ? Peru, Colombia, Sudan, Syria, Transjordan and India.

In the younger strata this fern is found in the Aptian of England and U.S.S.R., Albion of England, U.S.S.R. and Germany, and Cenomanian of Egypt (Bahariya Oasis).

Systematic Position — The fertile organs of *W. reticulata* are not yet found from the South Rewa basin. Therefore, the systematic position of this fern is not discussed here. On this topic one may refer to Alvin (1968).

Comparison and Discussion — The pinnules in my specimens are mostly narrower and falcate with an obtuse apex. Some are however almost parallel-sided and straight. Venation is formed of a loose reticulum. The specimens having pinnules with parallel sides, as mentioned above, resemble the English Wealden specimens, where the pinnules are typically short, massive, parallel-sided and with broadly rounded apex. Venation in the English specimens is very variable from a loose to a compact reti-

culum. The Indian and the English specimens also agree in the characters of the upper epidermis. In both the anticlinal walls of the upper epidermis are thick and strongly looped. The French Wealden specimens also possess a similar upper epidermis. The lower epidermis in the Indian and the French specimens is not known.

The lower epidermis was first described by Florin (1919) in the Belgian specimen. I macerated certain English specimens and found that the stomatal structure is essentially the same as in Florin's. The English specimens are well preserved and gave more details of the lower epidermis (TEXT-FIG. 4A-C). Recently Reymanowna (1965) figured similar epidermal structure in her specimens from Poland (*see* Synonyms).

In the past some species of the genus *Weichselia* had been created on small differences. While others found it difficult to differentiate them specifically. Edwards (1933) gives the fullest reasons. My views for uniting them all is that while there is indeed a great range, the specimens intergrade in form and venation. The finding that there is agreement in epidermis also fully supports this conclusion.

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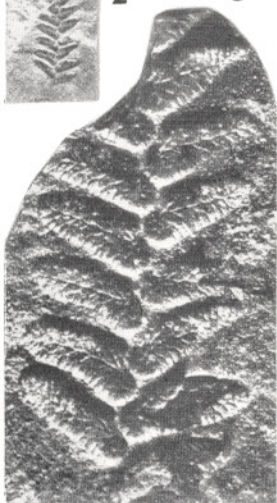
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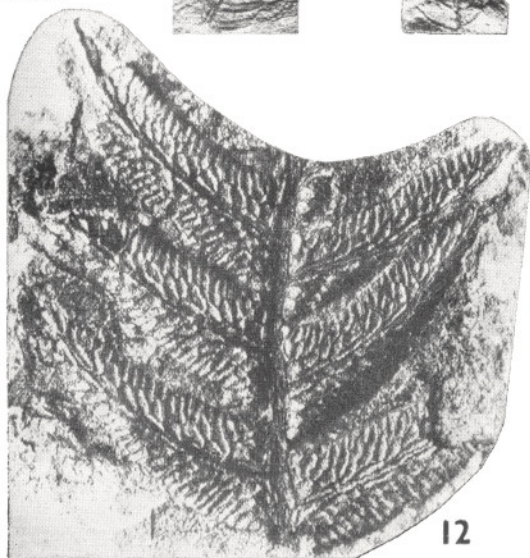
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EXPLANATION OF PLATE

PLATE 1

1. *Gleichenia nordenskiöldii* Heer. No. 30769, × 1. Patparha.
2. *G. nordenskiöldii*. No. 31693, × 1. Bansa (Loc. B).
3. Above specimen magnified, showing venation and the asymmetrical base of pinnules. × 5.
4. *G. nordenskiöldii*. No. 31691, × 1. Bansa (Loc. A, Specimen consumed).
5. Above specimen magnified, showing asymmetrical base of pinnules. × 5.
6. *Phlebopteris polyodioides* Brongniart. No. 30869, × 1. Patparha.
7. *P. polyodioides*. No. 30318, × 1. Bansa (Loc. B).
8. *P. polyodioides*. No. 31154, × 1. Patparha.
9. A portion of the specimen shown in Fig. 7 magnified, showing venation. × 5.
10. *Weichselia reticulata* (Stokes & Webb) Ward. No. 31680, × 1. Bansa (Loc. A).
11. *W. reticulata*. No. 31689, × 1. Bansa (Loc. A).
12. *W. reticulata*, venation. No. 30226, × 5. Bansa (Loc. C).
13. *W. reticulata*. No. 30654, × 3. Bansa (Loc. A).
14. *W. reticulata*. No. 31682, × 1. Bansa (Loc. A).
15. *W. reticulata*. No. 30230, × 1. Bansa (Loc. C).