ON THE OCCURRENCE OF *PACHYPTERIS* IN THE JABALPUR SERIES OF INDIA

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ABSTRACT

Pachypteris indica (Oldham & Morris) n. comb. and *P. holdenii* sp. nov. are described here from the Jabalpur Series of India. The two species differ from each other in their stomatal distribution and in the nature of the subsidiary cells.

INTRODUCTION

THE genus *Retinosporitis* was instituted by Holden (1915) on the basis of cuticular studies made on two specimens — one of which was previously mentioned and figured by Oldham and Morris (1863, PL. 33, FIG. 5) as *Taxodites* (?) *indicus* and the other was described by Feistmantel (1876, p. 57, PL. 9, FIGS. 6, 6a) as "*Palissya*, like the species from the Rajmahal group." The former specimen was collected from Sehora, Sher river and the latter from Trambau in Kutch. These two leaves, belonging to *Retinosporitis indica*, were supposed to be related to *Retinospora* — like seedling leaves of *Thuya* and *Juniperus*. The cuticle of *R. indica* was further studied by Sahni (1928) and he felt that Holden's choice of the generic name was not quite justified. Florin (1940) re-examined the cuticular structure of *R. indica* and he compared it, along with the general habit of the leaves, with that of the living genus *Acmophyle pancheri* belonging to Podocarpaceae. All these authors (Feistmantel, Holden, Sahni and Florin) described the leaves of *R. indica* as simple linear leaves. Except Feistmantel they also described the leaves as without clearly marked midrib.

In March, 1957 one of us (Bose) visited the type locality in Sehora, Sher river. From there a large number of specimens looking like *R. indica* were collected. Among them two specimens were clearly found to be bipinnate leaves (PL. 2, FIGS. 10 & 12). When cuticular preparations were made out of them, they were found to resemble the cuticle of *R. indica*. So the distinctly bipinnate leaves with cuticle like *R. indica* created doubt as to the exact nature of *R. indica*. Therefore, the other specimens collected along with them were also examined and they were found to be detached pinnae.

In 1960-61 fresh collections were made from Trambau in Kutch. The leaves collected were very fragmentary but they too were found to be pinnate (PL. 1, FIGS. 3-5). When examined under a binocular, some of the pinnae (? pinnules) showed a distinct midrib. All these facts raised a doubt regarding the exact nature of *R. indica*. When the figured specimens of Holden (PL. 1, FIG. 1 and PL. 2, FIG. 13) were examined, they too were found to be compound leaves and not simple linear leaves as was mentioned earlier. Also the cuticular preparations made out of the specimens from Sehora (PL. 2, FIG. 13) and Trambau (PL. 1, FIG. 1) showed that the two leaves had different cuticular structure. While the specimen from Sehora had numerous irregularly scattered stomata all over the entire lower surface the specimen from Trambau had fewer stomata and they were sparsely scattered avoiding the mid rib. So it was found that the Sehora and Trambau specimens belonged to two different species.

A fragmentary specimen (PL. 2, FIG. 14) collected from Bansa, South Rewa Gondwana basin (by Dr. Sukh Dev) was sent to Professor T. M. Harris, the University of Reading in 1962. After examining the cuticle of that specimen he suggested that the leaf belonged to the genus *Pachypteris*. In December, 1964, when he visited the Palaeobotany Institute in Lucknow, we had the opportunity of showing him all our previous collections from Sehora and Trambau and the slides of the cuticular preparations made out of Holden's original specimens. He again confirmed that all

the specimens belonged to the genus *Pachypteris* and that there were only two species in the entire collection. So the present paper describes two species of *Pachypteris* — one based on Holden's original specimen from Sehora and on the new specimens from Sehora, Trambau and Bansa and the other on the original specimen from Trambau and one new specimen from the same locality. The former species is described as *Pachypteris indica* (Oldham & Morris) and the latter as *P. holdenii* sp. nov. While *P. indica* is known from all the three localities, *P. holdenii* is known only from Trambau and there too it is rather rare.

The following specimens also belong to the genus *Pachypteris* but in the absence of cuticle it is difficult to place them under a definite species.

1963 *Taxodites* (?) *indicus* Oldham & Morris, Pl. 33, Fig. 6.
1876 *Palissya bhoojoorensis* Feistmantel, p. 56, Pl. 9, Figs. 4, 5.
Palissya, resembling *Taxites laxus* Phillips: Feistmantel p. 57, Pl. 12, Figs. 8, 9.
1877b *Palissya indica* (Feistm.) Oldham: Feistmantel, p. 22, Pl. 8, Fig. 7.
1877c *Palissya indica* (Oldham: Feistmantel, p. 15, Pl. 10, Figs. 2, 3.
1879 *Palissya indica* O. & M.: Feistmantel, p. 27, Pl. 12, Figs. 1, 8, Pl. 15, Fig. 15.
1920 *Retinosporites indica* Feist.: Seward & Sahni, p. 36, Pl. 6, Fig. 66.
1928 *Retinosporites indica* (O. & M.): Sahni p. 16, Pl. 1, Fig. 18.

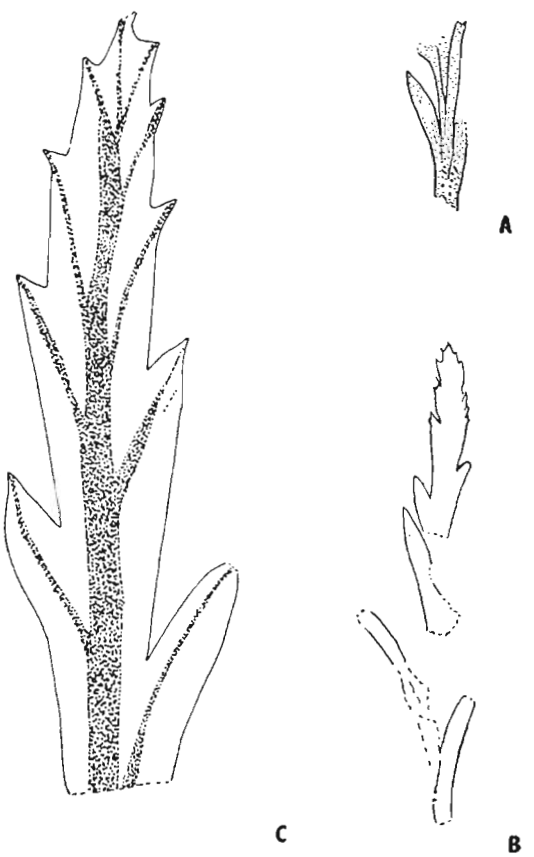
DESCRIPTION

Pachypteris indica (Oldham & Morris) comb. nov.

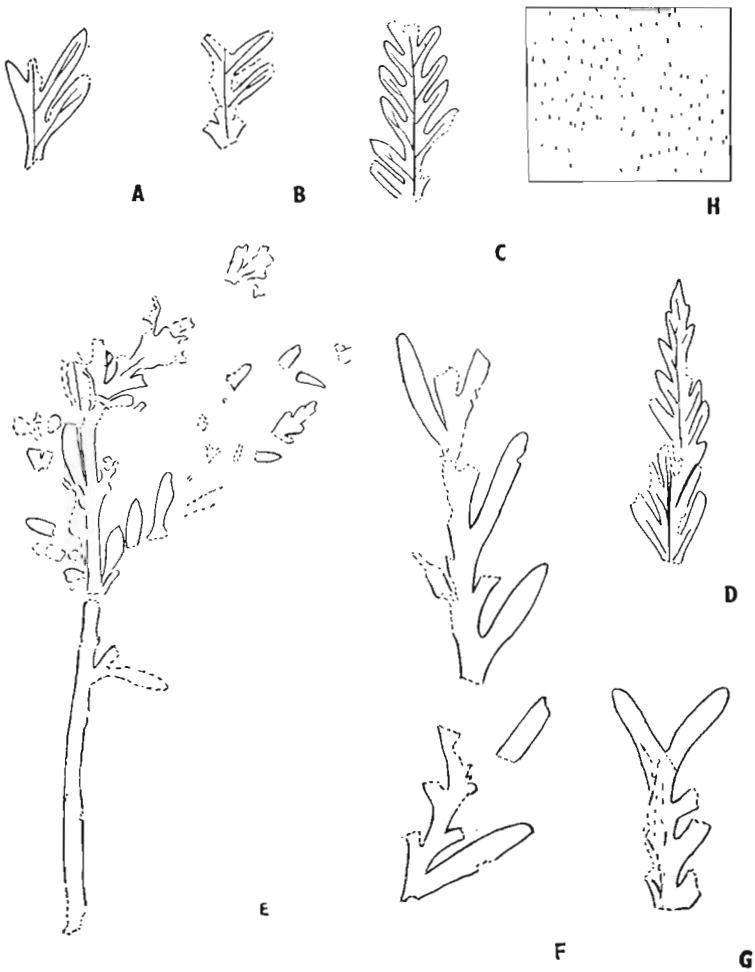
(Pl. 1, Figs. 3-5, 7, Pl. 2, Figs. 10-14 and Pl. 3, Figs. 15-16, 19-20; Text-figs. 1 A-C, 2 A-H, 3 A-C, 4 A-D and 5 A)

1863 *Taxodites* ? *indicus* Oldham & Morris, Pl. 33, Fig. 5.
1877c *Palissya indica* Oldham: Feistmantel, p. 15, Pl. 8, Figs. 1-5.
1915 *Retinosporitis indica* Holden, p. 219, Pl. 11, Figs. 1, 4, 9, 11.
1928 *Retinosporites indica* (O. & M.): Sahni, p. 16.
1940 *Retinosporites indica*: Florin, p. 64.

Diagnosis — Leaf bipinnate, form and size of whole leaf unknown, largest available leaf measuring 11·3×9·5 cm. Rachis towards base 2-3 mm. wide, showing a median longitudinal groove. Pinnae alternate or sub-opposite, arising at an angle of 35°-45° over most of leaf, slightly less towards apex; 3·5-7 cm. long and 1-1·2 cm. broad, decreasing towards apex. Pinnae rachis 1-1·5 mm. or less in width, showing a median goove. Pinnules coriaceous, closely set, mostly distinct, sometimes touching each other but very rarely overlapping, apical pinnules sometimes fused with each other (pinnatifid), arising at an angle of 20°-40°, mostly about 40° near middle and less than 30° towards apex. Pinnules linear or laceolate, typically 10-13 mm. in length, 1-2 mm. in breadth; margin mostly entire, rarely in some microscopically serrated near the apex. Basiscopic margin distinctly decurrent, apex acute or obtuse. Veins concealed, sometimes midrib leaving an impression on lower side, in some midrib



TEXT-FIG. 1 — *Pachypteris indica* (Oldham & Morris) — A, no. 32103, × 2, B, no. 32102. × 2. C, no. 32102, showing venation, × 7.



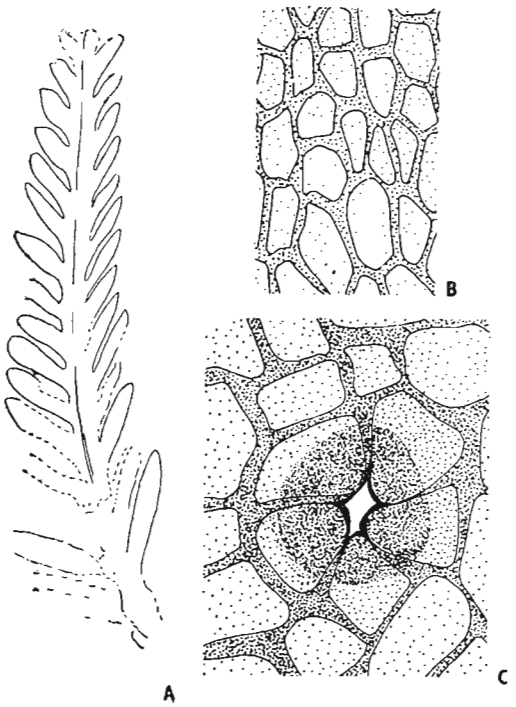
TEXT-FIG. 2 — *Pacypteris indica* (Oldham & Morris) — A-D, showing venation, nos. 28770-D, 28770-C, 28770-E and 28700-F. × 2. E-G, nos. 28765, 28781 and 32121. × 2. H, sl. no. 4909-3, showing distribution of stomata, × 20.

clearly visible (under transmitted light), reaching almost upto apex. Lateral veins arising at a small angle, never reaching margin.

Cells of main rachis similar on both sides, mostly rectangular, sometimes ± rhomboidal. Cell walls fairly thick, sometimes at places slightly wavy. Surface wall fairly thick, sometimes at places slightly wavy. Surface wall unspecialized, in some cells highly cutinized, broadly oval or circular areas visible (? papillae or hair bases). Stomata few.

Cells of pinna rachis rectangular or polygonal on upper side. On lower, rectangular or ± rhomboidal. Cell walls straight or slightly wavy at places, surface smooth without papillae or hair bases. Stomata present on both sides, very few or absent on upper side.

Pinnules with stomata only on lower side, very rarely 1-3 or more also present on upper side nearer base. Cuticle on both sides thick, about 6-8 μ. Upper cuticle showing irregularly arranged cells, mostly polygonal, sometimes rectangular; but rarely in some near midrib, extending from base to about half the length or less, cells tending to be somewhat serially arranged. Cell walls straight or slightly wavy at places, fairly thick and prominent. Surface wall smooth and unspecialized.



TEXT-FIG. 3 — *Pachypteris indica* (Odlham & Morris) — A, no. 28766/A. × 2. B, sl. no. 28781-1, a few cells of the upper side, × 250. C, sl. no. 4909-3, a stoma, × 500.

Lower cuticle showing cells like those of upper. Stomata irregularly scattered over entire surface from decurrent base to apex, longitudinally orientated, some slightly oblique. Guard cells sunken, thinly cutinized. Subsidiary cells 5-8, majority with 6, rarely 8, of unequal size. Sometimes subsidiary cells of adjacent stomata touching each other. Inner wall of subsidiary cells more cutizined, forming in most a sort of papilla projecting over edges of stomatal pit and covering most of it. Encircling cells may or may not be discernible, unspecialized, of unequal size.

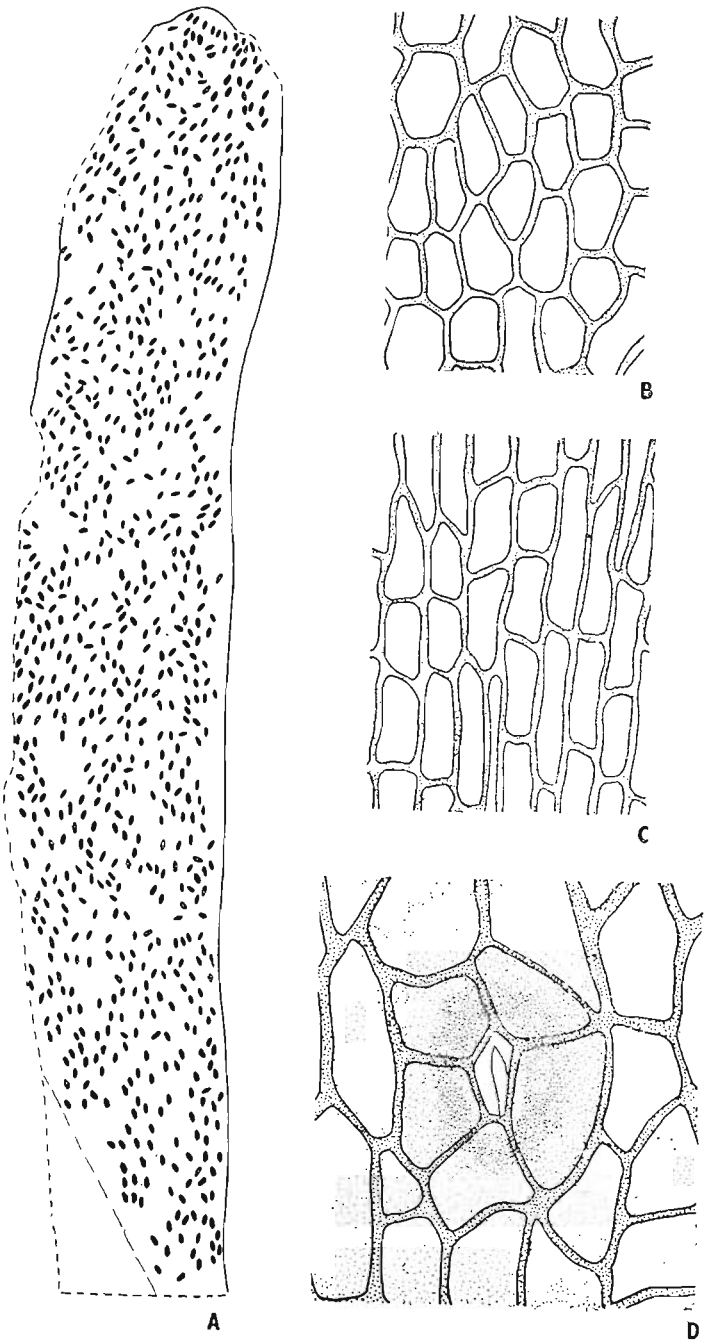
Holotype — No. 4909, Geological Survey of India, Calcutta.

Occurrence — Sehora, Sher river; Bansa, South Rewa Gondwana basin and Trambau, Kutch.

Age and Horizon — Lower Cretaceous; Jabalpur and Umia stages of the Jabalpur Series.

Remarks — The richest locality for *Pachypteris indica* is Sehora. Here the entire bed of about 10 cm. thickness is full of *P. indica*. From here, of the large number of specimens collected only three have been found to be bipinnate. From Bansa, so far, only one fragmentary specimen has been collected. At Trambau, *P. indica* is quite common but they are all very fragmentary. In gross-features the specimens from all the three localities resemble each other. Pinnatifid nature of the pinnules has been found only in some of the specimens from Trambau. In some of the specimens from Sehora margin has been found to be slightly thicker. It has also been found that the cuticle of all the specimens from Sehora is slightly thicker than the specimens from Bansa and Trambau. In most of the specimens the stomata are in fairly large numbers but in some of the specimens from Trambau their number is less and they are rather thinly distributed. Inner wall of subsidiary cells more cutinized forming somewhat triangular projections over the stomatal pit mostly concealing it, in most specimens from Sehora and Trambau. But in the specimen from Bansa the inner walls of subsidiary cells are not so cutinized and also the stomatal pit is more exposed.

Comparison—*Pachypteris indica* resembles most *P. lanceolata* Brongniart, described by Harris (1964) from the Jurassic of Yorkshire and by Vachrameev and Samylina (1958) from U.S.S.R., in the external character of pinnules, the general shape of the epidermal cells and in the number of subsidiary cells. *P. indica* differs from the latter species in having narrower pinnules and more sunken stomata. Also the cell surface of *P. indica* are devoid of the simple or branched thin strip which is present in *P. lanceolata*. While in the former species stomata are irregularly distributed over the entire lower surface, in the latter stomata avoid the margin and the midrib. The subsidiary cells of *P. indica* are more cutinized and the inner wall project above the pit almost concealing it. The subsidiary cells of *P. lanceolata* are not so cutinized and they show fine radiating striae. *P. papillosa* (Thomas & Bose) Harris (1964) can readily be distinguished from *P. indica* by the external character of the pinnules and the stomatal distribution. In *P. papillosa* the leaves are once pinnate and the pinnae are broader, the epidermal cells sometimes show a pipillae and also the number of subsidiary cells is commonly



TEXT-FIG. 4 — *Pachyteris indica* (Oldnam & Morris) — A, sl. no. 30588-1, showing orientation and distribution of stomata, × 40. B, sl. no. 30588-1, cells of the upper side, × 250. C, sl. no. 30588-1, cells from the upper side of rachis, × 250. D, sl. no 30588-1 a stoma, × 500. All the figures are from the specimen from Bansa, South Rewa Gondwana basin.

8. From *P. major* Reymanōwna (1963), *P. indica* can be distinguished by the shape of the pinnules and venation alone.

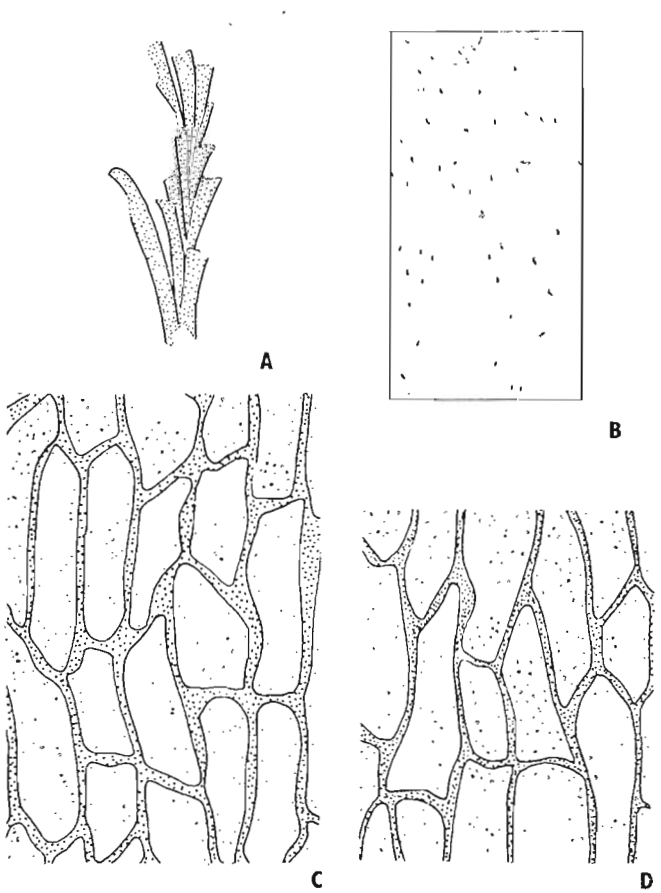
From *Thinnfeldia* and *Dicroidium*, *P. indica* can readily be distinguished by its general form and the distribution of stomata. In *Thinnfeldia*, as has been pointed out by Townrow (1957) stomata are interveinal and in *Dicroidium* they are amphistomatic. In general form of pinnules, *P. indica* may be compared with *Mesodescolea plicata* Archangelsky (1963) and *Mesosingeria coriacea* Archangelsky (*l.c.*), but the cuticular structure and the stomatal apparatus in the latter two species are quite different.

Pachypteris holdenii sp. nov.

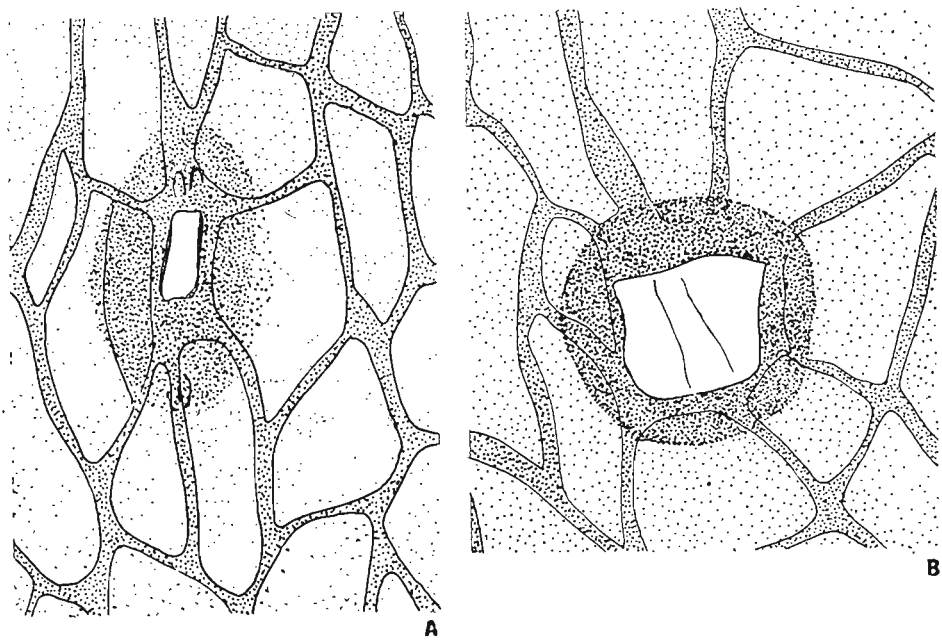
(Pl. 1, Figs. 1, 2, 8-9, Pl. 3, Figs. 17-18; Text-figs 5 B-D and 6 A-B)

1876 *Palissya*, like the species from the Rajmahal group: Feistmantel, p. 57, pl. 11, fig. 6, 6a.
1915 *Retinosporitis indica* Holden, p. 221.
1928 *Retinosporites indica* (O. & M.): Sahni, p. 16.

Diagnosis — Leaf pinnate (? bipinnate), measuring 1·7-9·3 cm. in length and 0·4-1·2 cm. in breadth. Rachis about 1-1·5 mm. thick, partially concealed by pinnae (? pinnules). Pinnae crowded, sometimes overlapping, alternate or subopposite arising



TEXT-FIG. 5 — *Pachypteris indica* (Oldham & Morris) — A, no. 32118, × 2. *Pachypteris holdenii* sp. nov.— B, sl. no. 4838-1, showing the distribution of stomata on the lower side, × 20. C, sl. no. 32115-1, a few cells of the upper side, × 250. D, sl. no. 32115-1, a few cells of the lower side, × 250.



TEXT-FIG. 6 — *Pachypteris holdenii* sp. nov.— A, sl. no. 4838-1, a stoma with six subsidiary cells, × 500. B, sl. no. 32115-1, a stoma with eight subsidiary cells, × 500.

at an angle of about 32°; linear or lanceolate, coriaceous, measuring 3-13 mm. in length and 1-1·5 mm. in breadth. Pinnae margin entire, apex acute or obtuse, basiscopic margin decurrent. Veins mostly not visible, at places midrib discernible.

Similar cells on both surfaces of rachis. Cells rectangular or elongated with oblique ends. A few stomata present on lower surface.

Cuticle of pinnae more or less of same thickness on both sides, about 5 μ. Stomata confined on lower side only. Cells of upper cuticle rectangular or somewhat polygonal, of variable size, a few more than twice the breadth, without any definite arrangement, at places tending to be serially arranged. Cell walls thick, uninterrupted by pits, at places slightly wavy. Surface wall smooth, without any hair or papillae.

Cells of lower cuticle like those of upper, near midrib at places cells more elongated and forming more or less longitudinal files. Stomata sparse, mostly longitudinally placed, a few oblique, irregularly scattered, tending to avoid mid-rib, rarely a few also present near mid-rib as well. Subsidiary cells usually 5-6, mostly 6, rarely 7 or 8, irregular in size, inner wall of subsidiary cells more cutinized, forming a ± circular, broadly oval or polygonal pit. Rim of stomatal pit raised, formed by cutinized inner wall of subsidiary cells. Encircling cells mostly present, irregular in size, unspecialized. Guard cells sunken, thinly cutinized, aperture slit-like, slightly more cutinized.

Holotype — No. 4838, Geological Survey of India, Calcutta.

Occurrence — Trambau, Kutch.

Age and Horizon — Lower Cretaceous; Umia Stage, Jabalpur Series.

Remarks — From the description of the cuticle it seems earlier authors (Holden, Sahni and Florin) had taken the cuticle of *Pachypteris indica* alone into consideration. They had all described the stomata as scattered all over the entire surface on lower side. From the new preparations made out of the specimen no. 4838 (PL. 1, FIG. 1) from Kutch it is quite clear that the stomata are not distributed over the entire lower surface. In the original specimen as well as in the new specimen stomata are not found along the midrib, if present, they are very rare. So under synonymy of *P.*

holdenii, except the Kutch specimen no. 4838, the description and figures of other specimens have not been included.

P. holdenii is rather rare. Except one all the new specimens recently collected belong to *P. indica*. Both the original and the new specimen are fragmentary. It is not known whether they are unipinnate or bipinnate. So here the term ' pinnae ' has been used instead of 'pinnules.'

Comparison — Pachypteris holdenii resembles most *P. indica* in gross features and as well as in the cuticular structure. The former can be distinguished from the latter by the general shape of epidermal cells, stomatal distribution and the nature of subsidiary cells. In *P. holdenii* upper cuticle shows more rectangular cells and they are more wavy than *P. indica*. In the former species stomata are absent along the midrib and they are rather thinnly distributed, whereas, in the latter stomata are irregularly distributed over the entire lower surface and they are much numerous. The inner wall of the subsidiary cells are less cutinized in *P. holdenii* than *P. indica* where they are forming a sort of papillae. But the subsidiary cells do resemble the subsidiary cells of the specimen from Bansa, where too, the inner wall of subsidiary cells is not so cutinized. But the specimen from Bansa can be distinguished from *P. holdenii* by the nature of stomatal distribution alone.

From *P. lanceolata* Brongniart, *P. papillosa* (Thomas & Bose) Harris and *P. major* Reymanōwna the present species can be distinguished in the same way as *P. indica*. But in the manner of stomatal distribution *P. holdenii* resembles more *P. lanceolata*.

ACKNOWLEDGEMENTS

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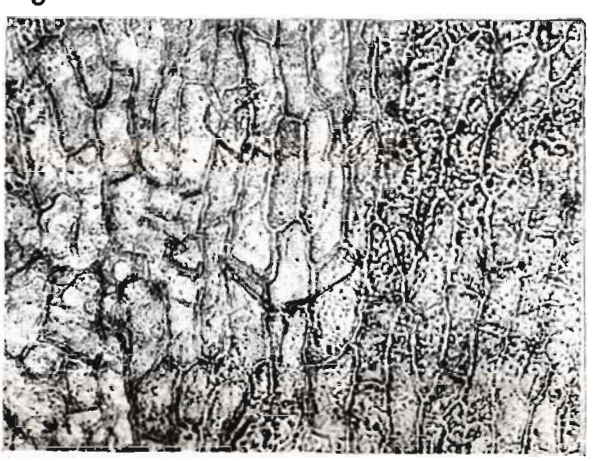

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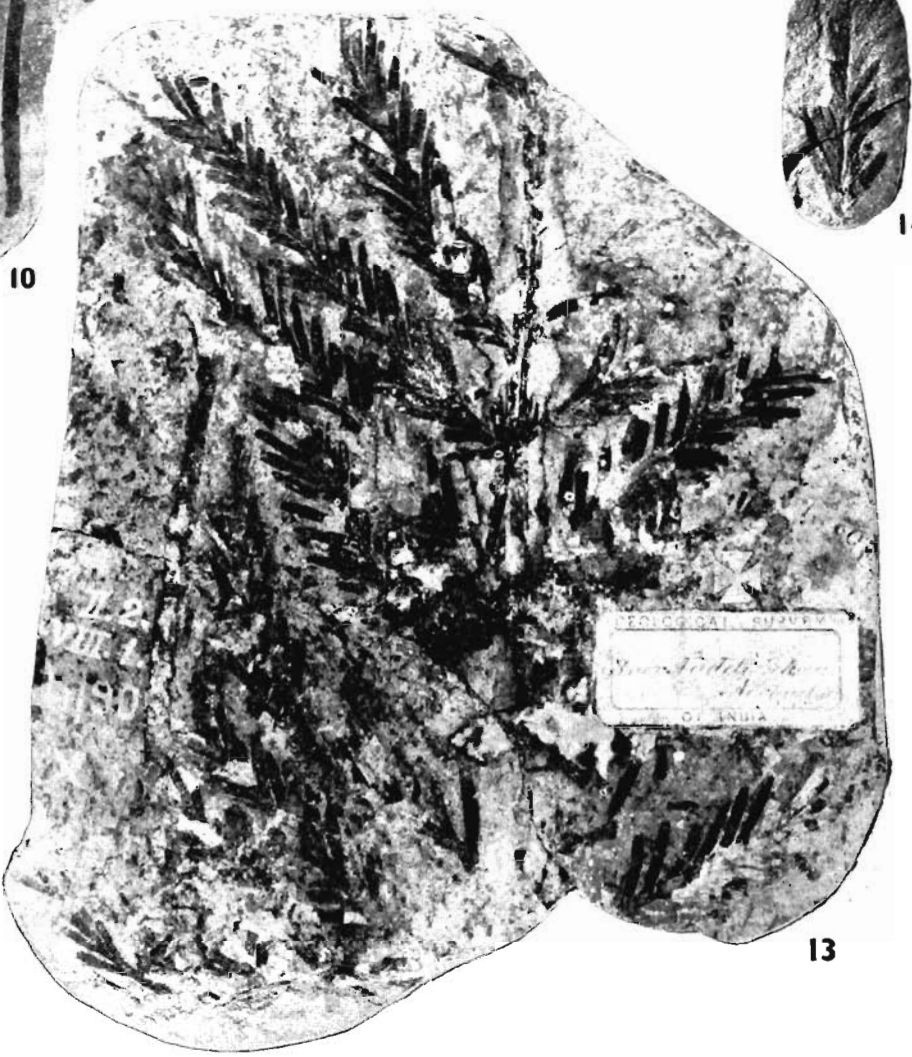

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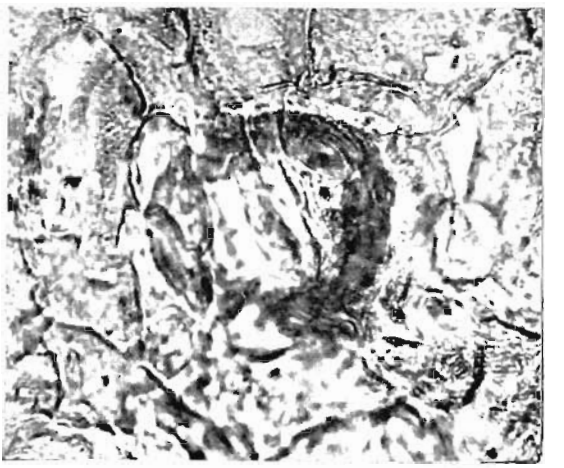

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EXPLANATION OF PLATES

PLATE 1

1. *Pachypteris holdenii* sp. n. No. 4838. From Trambau, Kutch. × 1.
2. A portion of the above magnified. × 2.
3. 5-7. *Pachypteris indica* (Oldham & Morris) n. comb. Nos. 32102, 32121, 28781 and 28766. Figs. 3 and 5 from Trambau and figs. 6 and 7 from Sehora, Sher river. × 1.
4. The apical pinnules of the specimen shown in fig. 3. × 7.
8. *P. holdenii*, showing a few cells of the upper cuticle. Sl. no. 32115-1. × 150.
9. *P. holdenii*, showing the distribution of stomata on the lower side. Sl. no. 32115-1. × 150.

PLATE 2

10-13. *P. indica*, figs. 10 and 12 clearly showing the bipinnate nature of the fronds whereas, in fig. 13 some of the pinnae seem to be attached to the main rachis. Nos. 28765, 28781, 28770 and 4909. All the specimens are from Sehora. × 1.
14. *P. indica*, the only specimen so far collected from Bansa, South Rewa Gondwana basin. No. 30588. × 1.

PLATE 3

15. *P. indica*, showing a few cells of the upper cuticle near the base. Sl. no. 28876. × 150.
16. *P indica*, lower cuticle showing the distribution of stomata. Sl. no. 4909-3. × 150.
17-18. *P. holdenii*, showing one stoma each from the holotype and a new specimen respectively. Sl. nos. 4838-1 and 32115-1 × 500.
19. *P. indica*, showing a few cells from the lower surface of the main rachis. Sl. no. 28795. × 500.
20. *P. indica*, showing a stoma. Sl. no. 4909-3. × 500.