

STUDIES ON THE FOSSIL FLORA OF NIPANIA, RAJMAHAL SERIES, INDIA — BENNETTITALES

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INTRODUCTION

NIPANIA as a fossiliferous locality is now well known for the silicified and rich plant remains of the Charophyta (VISHNU-MITRE, 1952), Lycopodiales (SRIVASTAVA, 1946), Pteridophyta (RAO, 1948), Pentoxyleae (SAHNI, 1932b, 1948; RAO, 1943a; SRIVASTAVA, 1946; VISHNU-MITRE, 1953), Coniferales (RAO, 1943b, 1946, 1949; VISHNU-MITRE, 1956) and the sporae dispersae (RAO, 1943c; VISHNU-MITRE, 1954, 1955).

Nipania* is a small village close to Dumurchir near Amrapara, District Dumka, in the Santal Pargana of the Bihar State. The description of the locality and the nature of the fossiliferous deposits have already been dealt with in detail by Professor Sahni (1948, pp. 47, 48).

Sahni & Rao in 1933 first reported the occurrence of some bennettitalean remains at Nipania, viz. *Williamsonia* sp. cf. *W. sewardiana*, *Ptilophyllum* and *Taeniopteris spatulata* (SAHNI & RAO, 1933, p. 192). Later in 1948 Rao reported the occurrence of silicified *Ptilophyllum cutchense* at Nipania. During a visit to the locality in April 1953, I collected two impressions of *Ptilophyllum* cf. *cutchense* from stray pieces of blocks of hard creamy white rock found at the foot of the hillock about half a mile east of the Dumurchir Dak Bungalow.

The impressions of the plant remains which I collected from Nipania include *Ptilophyllum* cf. *cutchense*, *Thinnfeldia indica* Fst., *T. odontopteroides* Bgt., *Dicksonia* (*Sphenopteris*) *bindrabunensis* Fst., *Clathropteris* sp., *Cladophlebis denticulata* Bgt., *Taeniopteris spatulata* McCl., *Brachyphyllum mamillare* Bgt., *Pagiophyllum* sp. cf. *P. divaricatum* Bunb., *P.* sp. cf. *P. peregrinum* L. & H., *Elatocladus conferta* O. & M., *E. jabalpurensis* Fst. and *E.* sp. cf. *Retinosporites indica* Holden.

Pollen grains belonging to Bennettitales are also known from Nipania (RAO, 1943c, p. 91; VISHNU-MITRE, 1954, p. 126).

*In earlier publications the locality Nipania has been described to be in the District Amrapara.

The silicified bennettitalean remains recently discovered from Nipania include (1) fragments of fronds, isolated sections of rachises and pinnae or of both of *Ptilophyllum* and (2) remains of leaf-bases or bracts and stems resembling those of *Bucklandia*. Many of these plant remains were found embedded in the chert and were discovered in sections of the rock pieces. Some of them were also seen exposed on the chert pieces by accidental breaking or weathering.

Methods — The epidermal characters of the pinnae were studied either from the surface under reflected light or the surface was ground thin till the epidermal characters became clear. Cross-sections of the rachis and pinnae *in situ* were prepared to study the anatomical details. Duco transfers were tried of leaf-surfaces which showed depressions probably representing the stomata. The two *Bucklandia* stems were incidentally obtained, and cut in oblique longitudinal sections, the cutting wheel having passed through the woody region. The fragmentary detached leaf-bases or bracts were found isolated in other sections of the chert. A serial study made of some of these bracts showed that they were not more than 2-3 mm. in length.

DESCRIPTION

1. Genus *Ptilophyllum* Morris

(i) *P.* cf. *cutchense* Morris

(Pl. 1, Figs. 1-3)

The species is represented by a single specimen about 7.5 cm. long, a fragment probably from the middle region of a frond lying obliquely in the chert. A part of it exposed on the surface of the block (PL. 1, FIG. 1) showed four to five complete to incomplete pinnae on one side of the rachis, the rest of the rachis was found embedded obliquely in the block. In between the veins and alternating with them there were noted bands of depressions probably representing the depressions of the sunken stomata. Each band

usually two, sometimes three, depressions thick (PL. 1, FIG. 2). These depressions were found to be 70-90 per mm. Hair scars not observed. Four to five rows of poorly preserved epidermal cells are noted on a vein (PL. 1, FIG. 3).

In its external morphology, the specimen compares those of *P. cutchense* Morris. In the anatomy of the pinnae and the rachis the specimen further resembles *P. cutchense* (BANCROFT, 1913, p. 75). In this respect it also resembles *P. amarjolense* (BOSE, 1953b). In the distribution of the stomata the specimen compares *P. cf. cutchense* McCl. sp. (SAHNI & RAO, loc. cit., p. 191) and *P. cutchense* Morris (JACOB & JACOB, 1954). The presence or absence of papillae and the nature of the epidermal cells as known in *P. cutchense* both in the stomatiferous and the non-stomatiferous bands is not made out because of the extremely poor preservation of the epidermal characters in the specimen.

(ii) *Ptilophyllum nipanica* sp. nov.

(Pl. 1, Figs. 4-7; Text-figs. 1-5)

A fragment of a frond about 5-6 mm. long and 8-10 mm. broad with the pinnae overlapping each other, disposed in two rows, falcate with pointed apex and with upper and lower round corners at the proximal region (PL. 1, FIG. 4; TEXT-FIG. 1). The lateral veins very few, 3-5 in number and occasionally dichotomizing.

The upper epidermis, devoid of stomata, is made up of very much sinuous, squarish cells with large loops (TEXT-FIG. 2). The epidermal cells are comparatively thinner except at the region of the loops.

The lower epidermis is made up of very much sinuous, squarish to rectangular thick-walled cells. The epidermal cells along the periphery and on the apex — the regions devoid of the stomata are rectangular (TEXT-FIG. 3) while in the rest of the region more or less squarish cells are noted. In some epidermal cells faint hollow cavities are noted which might represent the papillae (TEXT-FIG. 4).

The stomata, $38-51 \times 35-45 \mu$ (including the subsidiary cells), are scattered on the entire lower surface of a pinna leaving a little non-stomatiferous region along the margin and at the apex of the pinna. The non-stomatiferous bands are not recognized on this stomatiferous surface (PL. 1, FIGS.

5, 6). The stomata are evenly placed to contiguous, irregularly arranged, transverse to oblique in orientation which in low magnification appear to be disposed in short files.

The two subsidiary cells extend beyond the guard cells and each bears a papilla (PL. 1, FIG. 7; TEXT-FIGS. 4, 5). The apex of the papilla is round and free from that of the other. The aperture of the guard cells is not hidden by the papillae.

The crescent-shaped thickenings of the guard cells are not very strongly developed. Some sort of thickenings are also noted on the inner walls of the guard cells (PL. 1, FIG. 7; TEXT-FIGS. 4, 5).

Comparison — In the absence of the non-stomatiferous bands in the stomatiferous region of the pinnae, *P. nipanica* resembles *P. sp.* known from Cloughten Wyke beds of Yorkshire (SEWARD & SAHNI, 1920, pp. 22-24) and *P. oldhami* known from the Umia beds of Cutch (JACOB & JACOB, 1954). From *P. oldhami* our specimen differs in the presence of papillae on the subsidiary cells and the falciform apex. In general morphology the specimen approaches *P. cutchense* and *P. amarjolense* but differs widely from these species in the epidermal characters.

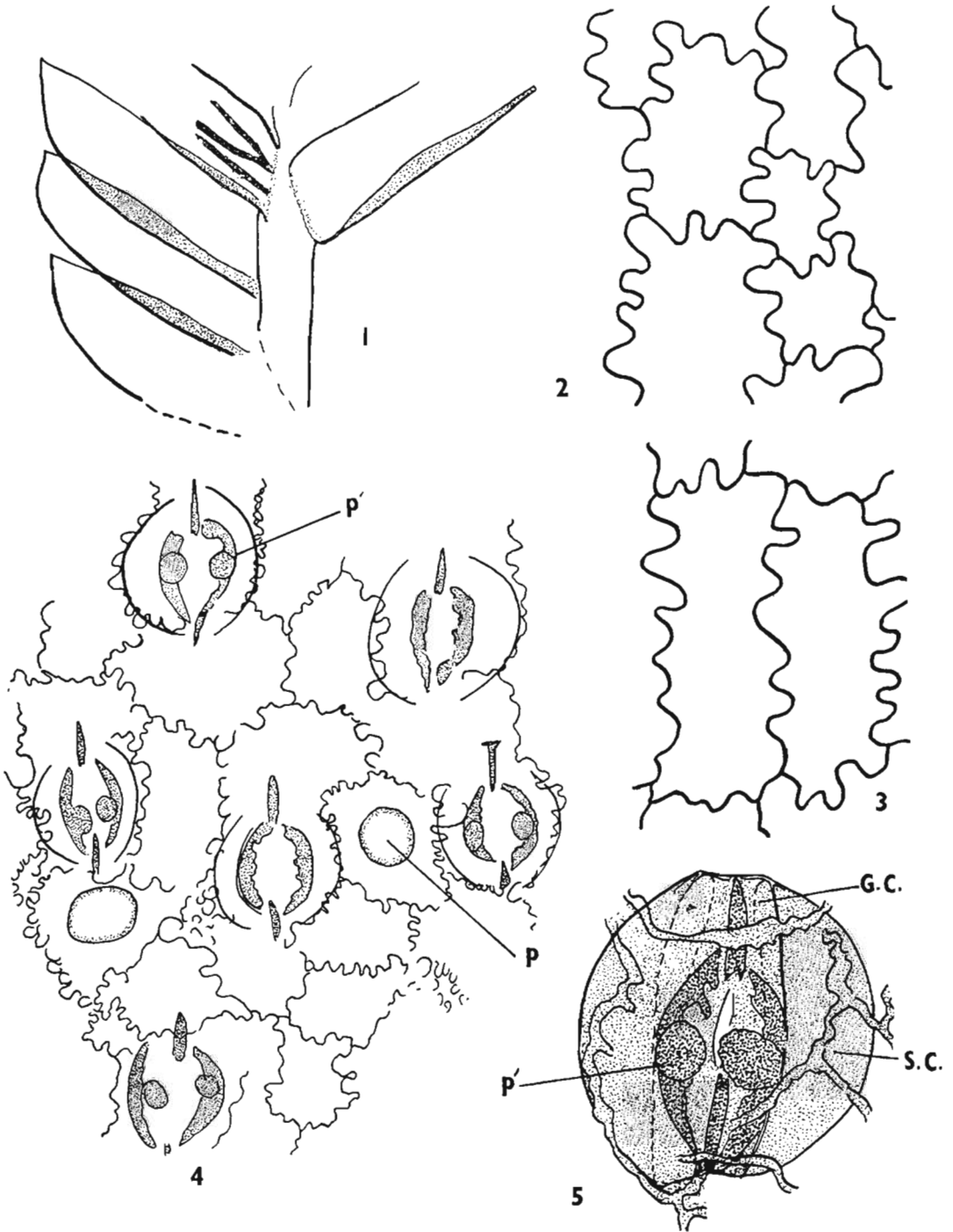
Isolated rachises and pinnae

(Pl. 1, Figs. 8, 9)

There are several isolated rachises found in the microscopic sections of the chert. These fragments of the rachises are not more than a few millimetres in length. In some the pinnae are attached with the rachis in section. The isolated pinnae have similar anatomy as those *in situ*.

A rachis (PL. 1, FIG. 8), about 1-2 mm. in diameter and ovoid in cross-section, is made up of round to oval parenchymatous cells with frequent intercellular spaces amidst them. The vascular bundles, 25-30 in number, are arranged in a double series in the form of 'U'. The xylem in bundles of both the series points inwards. The tracheids bear scalariform pitting. Phloem is not preserved.

A pinna in cross-section (PL. 1, FIG. 9) shows the upper epidermis made up of rectangular cells followed by a single layer of more or less isodiametric hypodermal cells. The single-layered palisade tissue consists of broad cubicular cells. Mesophyll is loose and spongy. Vascular bundles, 3-4 in number, possess scalariform tracheids.



TEXT-FIGS. 1-5 — *Ptilophyllum nipanica* sp. nov. 1, the type specimen. $\times 9.5$. 2, epidermal cells from the upper surface of the leaf. $\times 560$. 3, epidermal cells from the marginal non-stomatiferous area. $\times 560$. 4, a part of the stomatiferous epidermis showing the stomata, the papillae and the thickenings of the guard cells. $\times 560$. P = a papilla on the epidermal cell, P' = a papilla overhanging a guard cell. 5, a stomatal apparatus shown enlarged. $\times 1000$. S.C. = subsidiary cell. G.C. = guard cell. P' = a papilla overhanging a guard cell.

The pinnae in their internal anatomy approach those of *P. cutchense* (BANCROFT, 1913; PL. 9, FIG. 6) and *P. amarjolense* (BOSE, 1953b; PL. 28, FIGS. 25, 26). In less number of veins the specimens further approach *P. cutchense* while in this respect differ from *P. amarjolense*. The rachises have the general organization of that of *Ptilophyllum* or *Dictyozamites* (BANCROFT, 1913, pp. 74, 75; PL. 9, FIG. 7; PL. 7, FIG. 13; BOSE, loc. cit.; PL. 28, FIGS. 21-24). The pinnae differ from *P. amarjolense* in fewer number of vascular bundles. It is not possible on the basis of internal anatomy to show whether these rachises and sections of the pinnae belong to *P. cf. cutchense* or *P. nipanica*, the two species of *Ptilophyllum* that occur in the chert.

2. Genus *Bucklandia* Presl.

The stems, two in number, are obliquely cut axes. In one of them, about 7×7 mm., very little of the wood region is preserved. Wood is compact. Pitting is not made out because of the oblique nature of the section. The ramental hairs on the leaf bases are also not seen. Few empty large thick-walled cells are found scattered in the central ground tissue which is partly preserved. The leaf-bases with 5-8 vascular bundles show the typical anatomy of the *Bucklandia* leaf-bases or *Williamsonia* bracts.

The partly preserved second stem, about 12×40 mm., is represented by a tangential section showing only the leaf-bases which possess tufts of ramental hairs or scales frayed out distally. Lower parts of the bracts possess several narrow linear scales made up of single layer of cells. The leaf-bases are as described in the above stem.

Comparison — So far the anatomy of two species of *Bucklandia*, *B. indica* (SEWARD, 1917, pp. 488-490) and *B. sahnii* (BOSE, 1953a) is known from India. These two species are distinguished from one another by differences in the nature of pitting in the tracheids and the medullary rays and by the presence or the absence of the ramental hairs on the leaf-bases (BOSE, loc. cit., p. 47).

Nothing is known about the nature of the rays and the pitting in the above two stems. On the basis of the absence of hairs, the first stem might belong to *B. sahnii* Bose and the second stem to *B. indica* Seward. The second specimen also resembles the peduncles of *Williamsonia sewardiana* which Professor

Sahni (1932a) has shown to have been borne on the stems of *B. indica*.

The isolated sections of the bracts or leaf-bases are identical with those of *Bucklandia* or of *Williamsonia*.

DISCUSSION

The silicified remains of Bennettitales in the Nipania fossil flora include two species of *Ptilophyllum*, *P. cf. cutchense* Morris, *P. nipania* sp. nov. and probably two species of *Bucklandia*, *B. indica* Seward and *B. sahnii* Bose. Except the pollen grains (RAO, 1943c, VISHNU-MITRE, 1954) the other silicified remains of the fructifications of the Bennettitales are not known from Nipania.

The organic relation between *P. cutchense* and *B. indica* is known since long (SEWARD, 1917, p. 489; SAHNI, 1932a, p. 10). A relation between *B. sahnii* and *Ptilophyllum amarjolense* has been suggested by Bose (1953b, p. 610) owing to their close association and similar anatomical characters.

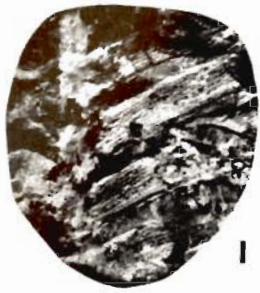
The presence or absence of the ramental hairs may not in itself constitute a very important specific character as has been made use of above. Flowers of *W. sewardiana* and the stems of *B. indica* both possess ramental hairs. On the basis of several anatomical similarities observed in the peduncle of *W. sewardiana* and the stems of *B. sahnii* Bose (1953a, p. 48) believes that "*W. sewardiana* flowers must have been borne on the stems of the type of *B. sahnii* if not on *B. sahnii* itself". Bose (loc. cit.), however, does not account for the presence or the absence of ramental hairs on the bracts of the peduncle of *W. sewardiana* which are described to be absent in *B. sahnii* (BOSE, loc. cit.).

So in the absence of other anatomical details one of the stems has with all probabilities been referred to *B. sahnii*. Whether this stem was different from the stems of *B. sahnii* which probably bore the leaves of *P. amarjolense* will only be known when more anatomical details are available of such stems.

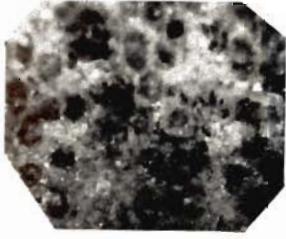
The proportion of the Bennettitales in the Nipania silicified flora is fair as compared to the representatives of Pentoxyleae and Coniferales.

ACKNOWLEDGEMENT

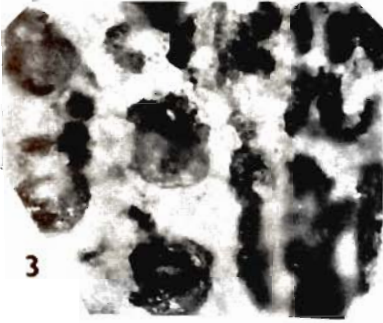
My thanks are due to Dr. K. R. Surange for his valuable suggestions.



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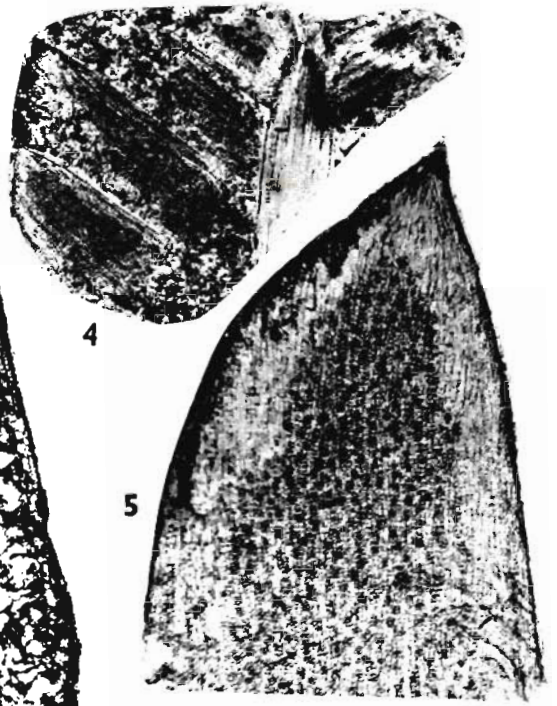
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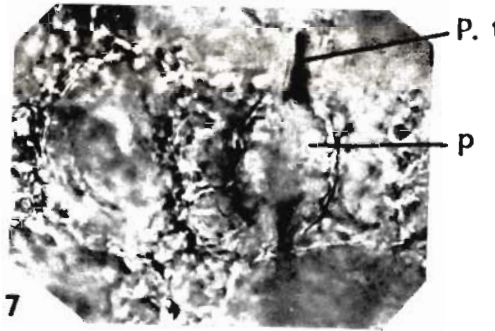


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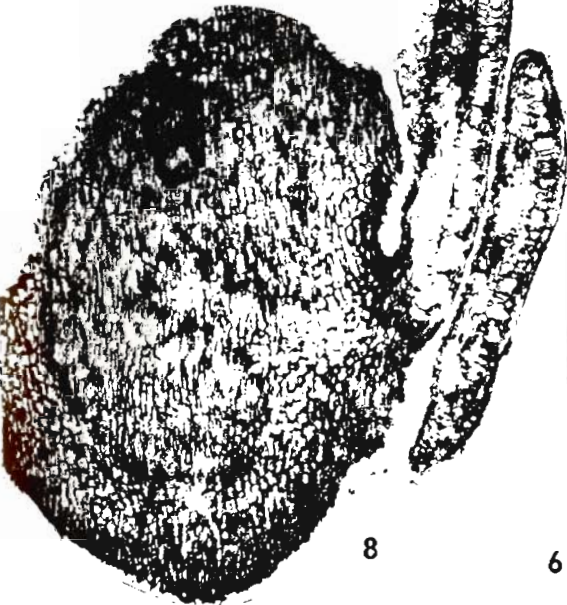


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EXPLANATION OF PLATE 1

Ptilophyllum cf. *cutchense* Morr.

1. The specimen. $\times 2$.
2. A part of the lower surface of a pinna showing the distribution of the stomata. $\times 100$.
3. A part of above enlarged to show the epidermal cells and the stomatal depressions. $\times 100$.

Ptilophyllum nipanica sp. nov.

4. The specimen. $\times 7$.

5. Lower surface of a pinna showing the distribution of the stomata. $\times 58$.

6. A part of the above enlarged showing the occurrence of stomata over a vein. $\times 200$. *v.*, vein.

7. A stomatal apparatus shown enlarged. $\times 650$.

p., a papilla on the guard cell; *p.t.*, polar thickenings.

8. An oblique cross-section of an isolated rachis showing two pinnae, one *in situ*. $\times 35$.

9. A cross-section of a pinna from above enlarged. $\times 70$.