

STUDIES ON THE FOSSIL FLORA OF THE JABALPUR SERIES FROM THE SOUTH REWA GONDWANA BASIN — 1. *CYCADOPTERIS*, *NIPANIOPHYLLUM* AND *GINKGOITES*

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ABSTRACT

Cycadopteris brauniana Zigno and four new species of the genus (*C. pulcherrima*, *C. auriculata*, *C. indica* and *C. majus*), a new species of *Nipaniophyllum* (*N. hirsutum*) and another of *Ginkgoites* (*G. feistmantelii*) form the subject of the present paper. All the species of *Cycadopteris* have been distinguished from one another on the basis of their cuticular structure. *N. hirsutum* is characterized by having a large number of trichome bases on both the upper and lower surfaces and by having on the lower side cells with straight or slightly undulated walls. *G. feistmantelii* is different from the other known species of *Ginkgoites* as it has only a slight notch near the apex and is not lobed. It has also very few veins.

INTRODUCTION

IN the South Rewa Gondwana basin the outcrops of the Upper Gondwana rocks, which are rich in plant fossils, are mainly exposed at and near Chandia and Bansa. The majority of the specimens here described were collected in a carbonaceous shale, cropping out at three different places in the Machrar river; the first about half a mile N.E. (Marwar Ghat), the second about the same distance N.N.W. and the third about a quarter of a mile N.N.W. of Bansa. A few specimens of *Cycadopteris* and *Ginkgoites* were also collected near Patparha and Barwar (only *Ginkgoites*) about two and a half miles S.E. of Chandia.

DESCRIPTION

? CORYSTOSPERMALES

Genus *Cycadopteris* Zigno

Cycadopteris pulcherrima n. sp.

Pl. 1, Figs. 3, 6; Pl. 2, Figs. 12, 13; Text-figs. 1E-G, 2A-D, 4C

Diagnosis: *Fronde* — Frond bipinnate, about 9 cm. long and 2.4 cm. broad. Rachis 3 mm. wide, upper surface with longitudinal and transverse striations. Pinnae 2.4-4.5 cm. long and 1.1-3 cm. broad. Pinnules

7×4 mm., closely set, oval with rounded apex and truncate base, posterior margin slightly decurrent. Margin thickened but not revolute, lower margin slightly overlapping the pinnule below. Secondary veins passing obliquely into a thick midrib which does not reach the apex. Pinnae rachis a little more than 1 mm. wide.

Cuticle: *Rachis* — Epidermal cells similar on both the sides, mostly polygonal or rectangular. Lateral and end-walls straight and thick. Surface uneven or with a few striations, mostly with a thinly cutinized slit-like area near the centre, generally situated in the longitudinal direction. Stomata very few, distant but present on both the sides, irregularly scattered, mostly longitudinally orientated. Subsidiary cells 5-7, mostly 5 or 6. Trichomes absent.

Lamina — Upper cuticle thicker than the lower. Stomata present only on the lower side. Cells of the upper side irregularly packed. Lateral and end-walls thick, rounded and more thickened near the corners. Surface smooth, a few with longitudinal striations or with numerous minute pits. Near the base and running about one-third of the entire length of the pinnule a few cells of the midrib visible. Midrib cells more or less serially arranged.

Except near the thickened margin lower side thinner than the upper. Stomata mostly in interveinal bands, only a few occurring along the midrib and the secondary veins. Stomata never present along with the thickened marginal cells which occupy an area of about 1 mm. in width all along the entire margin. Marginal cells irregularly packed and similar to those of the upper side. Cells between the veins and the stomata also irregularly packed and polygonal. Lateral and end-walls thinner than the marginal cells. Surface smooth or like those of the marginal cells, pits rare. Cells of the midrib serially arranged, rectangular or polygonal. Lateral and end-walls thick and almost straight, very rarely at places inner walls

protruded. Surface with one or two longitudinal striations or with numerous minute pits. Cells of the secondary veins like those of the midrib but less regularly arranged and with smaller dimensions. Stomata closely packed between the veins and irregularly orientated. Subsidiary cells mostly touching the subsidiary cells of the adjacent stomata, but very rarely two stomata sharing a common subsidiary cell between them. Subsidiary cells mostly 5 or 6, very rarely 4 or 7, less thinly cutinized than the ordinary epidermal cells, mostly with a narrow slit near the centre. Guard cells thinly cutinized and sunken. Opening slit-like, rhomboidal or oval. Trichomes absent.

Locality — Marwar Ghat about half a mile N.E. of Bansa and about a quarter of a mile N.N.W. of Bansa.

Collection — Holotype No. 30245 and paratype Nos. 30128 and 30026 of the Birbal Sahni Institute of Palaeobotany Museum.

Comparison — The pinnules of *C. pulcherrima* resemble most the pinnules of *C. anglica* Gothan (1914), formerly described by Seward (1904) as *Thinnfeldia rhomboidalis* Ett., in having only a thickened margin instead of a revolute edge as is common in most of the species of *Cycadopteris*. However, it differs from *C. anglica* in lacking papillae on the lower side. In *C. anglica* the lower cuticle is much thinner than the upper, but in *C. pulcherrima* the lower cuticle is not so thin.

Cycadopteris brauniana Zigno

Pl. 1, Figs. 1, 2, 4, 5, 7; Pl. 2, Figs. 10, 11;
Text-figs. 1D, 3C, E-F, 4A

Description: Frond — Detached pinnae, about 3.5-5.8 cm. long and 1-1.8 cm. broad, imparipinnate. Rachis with longitudinal striations, about 0.5-2 mm. thick. Pinnules closely set, 0.4-1 cm. long and 0.25-0.6 cm. broad, typically 0.7 × 0.3 cm., broadly oval with rounded apex and truncate base, posterior margin about 1 mm. broad. Midrib broad, forming a turned-under flange, generally not reaching the apex. Secondary veins not clear, arising at an acute angle, rarely bifurcating.

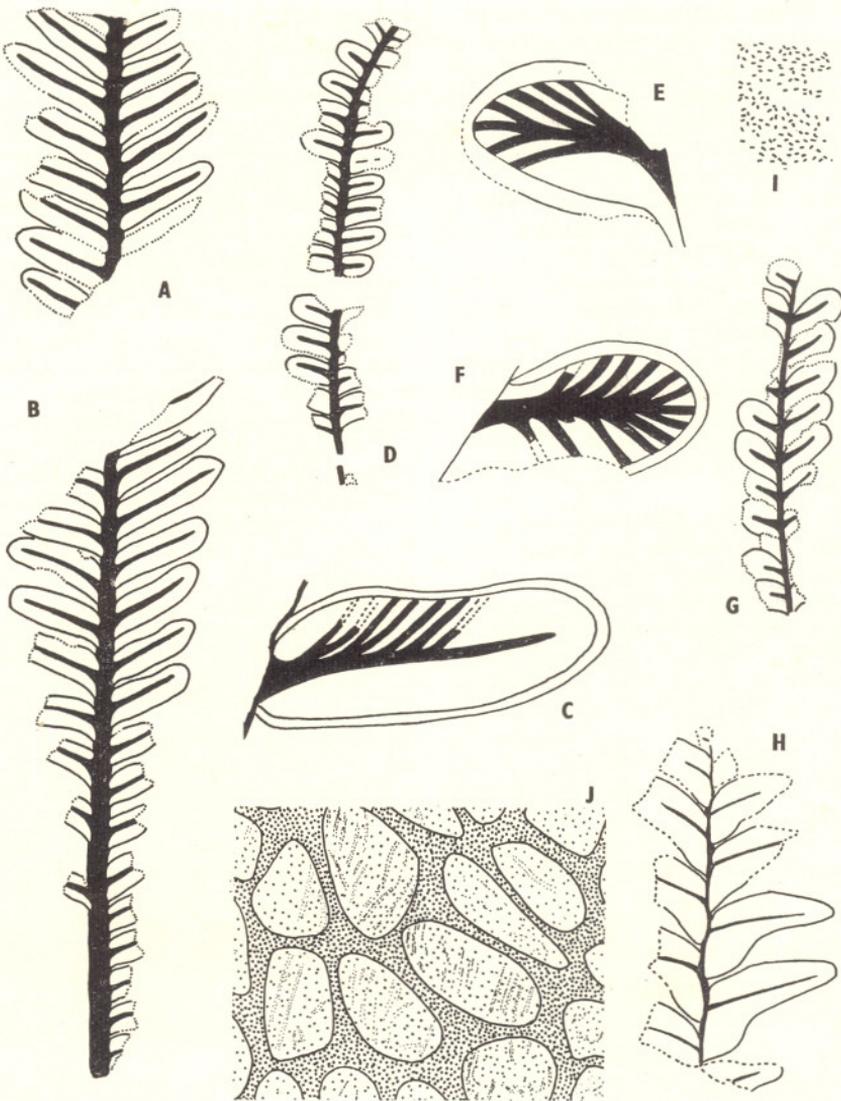
Cuticle: Rachis — Stomata absent on both the surfaces. Epidermal cells on both the upper and lower sides rectangular or polygonal, serially arranged. Lateral and end-walls thickened, surface-wall mottled or with numerous minute pits.

Lamina — Upper cuticle much thicker than the lower. Stomata present only on the lower side. Ordinary epidermal cells on the upper side irregularly arranged, mostly polygonal with rounded corners sometimes oval or circular. Walls thick and straight. Surface finely striated or with many small pits, a few with longitudinal slits. Cells of the midrib recognizable near the base only, mostly rectangular or polygonal, more or less serially arranged. The lower cuticle shows a broad region of the midrib, cells of which rectangular or polygonal and serially arranged. Walls thick and straight, surface mottled, a few papillate. Cells of the secondary veins smaller and with less thinner walls, serially arranged. Cells between the stomata irregularly packed, walls less thick, surface smooth or mottled or with pits, many with oval or circular knob-like papillae. Papillae also present on some of the cells of the secondary veins. Marginal cells like those of the upper surface. Stomata closely packed and irregularly orientated, between the veins. Also common along the secondary veins but rare along the midrib. Subsidiary cells of adjacent stomata mostly touching each other sometimes two stomata having one or two common subsidiary cells. Subsidiary cells mostly 6, sometimes 5, rarely 7, more cutinized than the ordinary epidermal cells. Stomatal pit polygonal. Guard cells thinly cutinized, sunken, aperture narrowly elliptical.

Locality — Marwar Ghat about half a mile N.E. of Bansa and about one half and a quarter of a mile N.N.W. of Bansa.

Collection — Nos. 30309, 30249 and 30601 of the Birbal Sahni Institute of Palaeobotany Museum.

Comparison — The detached pinnae here described resemble both in external features as well as in the cuticular structure the leaves of *C. brauniana* Zigno described by Hirmer (1924). But so far in our specimens we have failed to observe the turned-under flange over the secondary veins. The cuticle of *C. brauniana* resembles very much the cuticle of *C. pulcherrima*. Both of them have similar type of epidermal cells on the upper as well as lower surface and in both the distribution and orientation of stomata is similar. Also when examined from the upper side, in external form, they are very difficult to distinguish from each other. But *C. brauniana* can readily be separated from the latter in the presence of papillae on the lower



TEXT-FIG. 1 — A-B, *Cycadopteris majus* n. sp. No. 30862. $\times 1$. C, *C. majus*, a pinnule magnified, showing venation. No. 30862. $\times 4$. D, *C. brauniana* Zigno. No. 30601. $\times 1$. E-G, *C. pulcherrima* n. sp. E, a single pinnule magnified. No. 30245. $\times 4$. F, another pinnule magnified. No. 30128. $\times 4$. G, No. 30128. $\times 1$. H-J, *C. auriculata* n. sp. H, No. 30570. $\times 1$. I, lower cuticle, showing distribution of the stomata. Sl. No. 30260/1. $\times 15$. J, cells of the upper cuticle. Sl. No. 30570/2. $\times 250$.

surface. *C. pulcherrima* does not have papillae on any of the surfaces. While the margin in *C. brauniana* is revolute, *C. pulcherrima* has only a thickened margin. In *C. pulcherrima* a few stomata are also present on the rachis while no stoma has so far been observed on the rachis of *C. brauniana*. The subsidiary cells in *C. brauniana* are mostly

6, whereas, in *C. pulcherrima* they are either 5 or 6.

Cycadopteris auriculata n. sp.

Pl. 2, Fig. 14; Text-figs. 1 H-J, 3B, 4D

Diagnosis: Frond — Detached pinnae 4.5 cm. long and 3.2 cm. wide. Rachis straight

about 1 mm. broad. Pinnules closely set and touching each other, attached to the rachis by their entire base, anterior part of the base almost straight, posterior markedly auriculate, apex slightly rounded. Edges revolute, turned-under margin about 1 mm. wide. Midrib prominent, evanescent near the tip. Secondary veins obscure.

Cuticle: Rachis — Cells of the upper and lower side similar, mostly rectangular or polygonal. Walls thick and straight. Surface with numerous pits. Stomata absent. Trichomes absent.

Lamina — Stomata present only on the lower surface which has much thinner cuticle. Cells of the upper surface large polygonal with corners rounded or oval, irregularly packed. Lateral and end-walls thick and straight, near the corners more thickened. Surface either smooth or a few with numerous minute pits. Lower cuticle much thinner than the upper. Stomata irregularly orientated and closely packed in interveinal bands. Mostly touching each other, but rarely two adjacent stomata sharing a common subsidiary cell. Subsidiary cells 6-7, mostly 6, more cutinized than the ordinary epidermal cells. Stomatal pit large and oval or polygonal. Guard cells not preserved. Ordinary epidermal cells polygonal. Walls thick and straight. Surface smooth, devoid of papillae.

Locality — About a quarter of a mile N.N.W. of Bansa.

Collection — Holotype No. 30570 of the Birbal Sahni Institute of Palaeobotany Museum.

Comparison — The lower cuticle of *C. auriculata* resembles the lower cuticle of *C. brauniana*. In both the number of subsidiary cells is 6 and they are more cutinized than the ordinary epidermal cells. But the former differs from the latter in many ways; such as in *C. auriculata* the posterior margin of the pinnules is auriculate while in *C. brauniana* it is decurrent. The cells of the upper cuticle in *C. auriculata* are larger than those of *C. brauniana* and also while *C. auriculata* is devoid of papillae on its lower surface, *C. brauniana* has numerous papillae all over the lower surface. *C. auriculata* is different from *C. anglica* because the pinnules in the former are auriculate and the cells on the surface are without any papillae; the pinnules in *C. anglica* are not auriculate and most of the cells on the lower side are papillate. In the absence of papillae on the lower surface *C. auriculata* comes nearest to *C. pulcherrima*.

But the subsidiary cells in the two differ from each other. In *C. auriculata* they are more cutinized than the ordinary epidermal cells but in *C. pulcherrima* the subsidiary cells are less thinly cutinized and they are often with a median slit. Moreover, while in *C. pulcherrima* the pinnules have only thickened margins, in *C. auriculata* they are revolute. From *C. jurensis* Schimper described by Salfeld (1907) and Hirmer (1924), *C. auriculata* can readily be distinguished by the shape of the pinnules alone. In *C. jurensis* the pinnules are not auriculate and they have turned-under flange over the midrib and the secondary veins. No such turned-under flange over the midrib or the secondary veins is present in the pinnules of *C. auriculata*.

Cycadopteris indica n. sp.

Pl. 1, Fig. 9; Text-figs. 2E, 3A, 4B

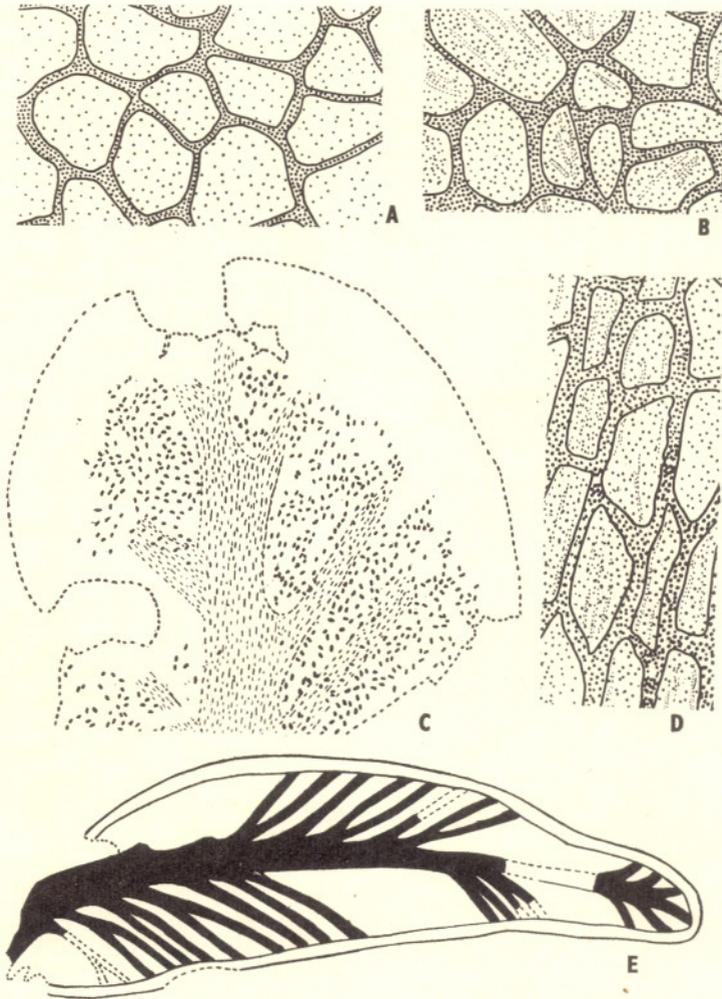
Diagnosis: Frond — Pinnae 5.2-7.7 cm. long and 3-4 cm. broad. Rachis about 2-3 mm. wide, with longitudinal striations. Pinnules ovate to lanceolate, margin revolute, turned-under margin about 1 mm. wide; apex rounded or a few slightly acute, lower margin decurrent on the rachis, upper margin contracted. Pinnules 1.5-2.8 cm. long and 4-7 cm. broad, typically the basal pinnules almost touching each other and occasionally separated near the apex. Arising at an angle of about 60°. The midrib distinct, fading away near the tip, without any turned-under flange. Lateral veins faintly marked, simple or forked.

Cuticle: Rachis — Cells similar on both the sides. Rectangular, polygonal or rhomboidal, more or less serially arranged. Lateral and end-walls distinct and straight. Surface smooth. Stomata absent.

Lamina — Cuticle thin, lower cuticle dissolves in the acid. Cells of the upper surface polygonal and irregularly packed. Lateral and end-walls thick and almost straight. Surface smooth and thinly cutinized. Marginal cells more thickly cutinized and also polygonal in shape. Cells of the midrib serially arranged, rectangular or a few polygonal, with very thick lateral and end-walls. Stomata absent on the upper surface.

Locality — A quarter of a mile N.N.W. of Bansa and Patparha.

Collection — Holotype No. 30672 and paratype No. 28588 of the Birbal Sahni Institute of Palaeobotany Museum.



TEXT-FIG. 2 — A-D, *Cycadopteris pulcherrima* n. sp. A, cells of the upper cuticle. Sl. No. 30128/1. $\times 250$. B, cells of the lower cuticle, showing the marginal cells. Sl. No. 30128/1. $\times 250$. C, lower cuticle, showing the distribution of the stomata. Sl. No. 30128/1. $\times 15$. D, lower cuticle, showing the cells of the midrib. Sl. No. 30128/1. $\times 250$. E, *C. indica* n. sp. a pinnule magnified, showing the venation. No. 30672. $\times 4$.

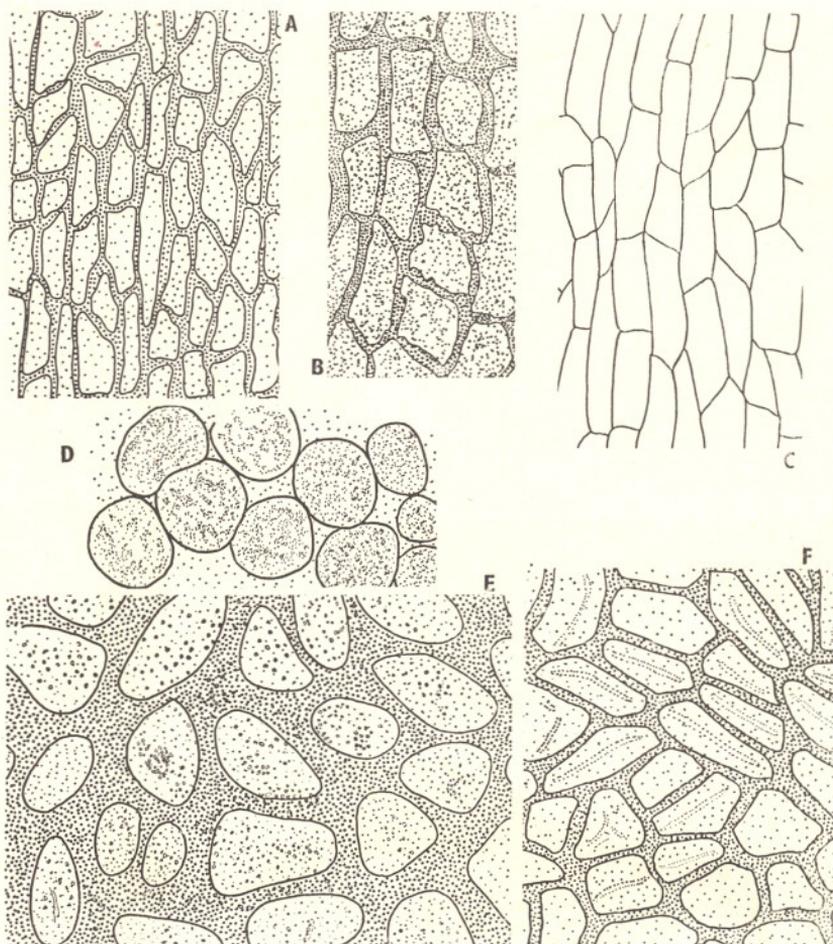
Comparison — Like *Cycadopteris* sp. described by Bose (1957), the lower cuticle of *C. indica* is very thin and dissolves away in acid. But the pinnules in *C. indica* are larger and also differ in being ovate or lanceolate. In *Cycadopteris* sp. the pinnules are obovate. The upper epidermal cells in *C. indica* are also different from the cells of *Cycadopteris* sp. In *C. indica* they are polygonal with thinly cutinized surface wall. In *Cycadopteris* sp. the cells are polygonal, oval or circular and the surface wall here is mostly with a median slit and sometimes the central

region is not even preserved. *C. indica* differs from *C. pulcherrima*, *C. brauniana* and *C. auriculata* in having a very thin lower cuticle. Moreover, its upper cuticle is not so thick, the cells of which differ from those of the others in having less cutinized and smooth surface walls.

Cycadopteris majus n. sp.

Pl. 1, Fig. 8; Text-figs. 1A-C, 3D

Diagnosis — Detached pinnae, about 16.5-18.5 cm. long and 2.5-3 cm. broad. Pin-



TEXT-FIG. 3 — A, *Cycadopteris indica* n. sp., showing cells on the lower side of the rachis. Sl. No. 30672/2. $\times 250$. B, *C. auriculata* n. sp., showing cells on the lower side of the rachis. Sl. No. 30570/1. $\times 250$. C, *C. brauniana* Zigno, showing cells on the lower side of the rachis. Sl. No. 30309/1. $\times 250$. D, *C. majus* n. sp.? thickened hypodermal cells. Sl. No. 30237/1. $\times 250$. E-F, *C. brauniana* Zigno. E, showing cells of the upper cuticle. Sl. No. 30449/1. $\times 250$. F, showing cells of the upper cuticle. Sl. No. 30132/1. $\times 250$.

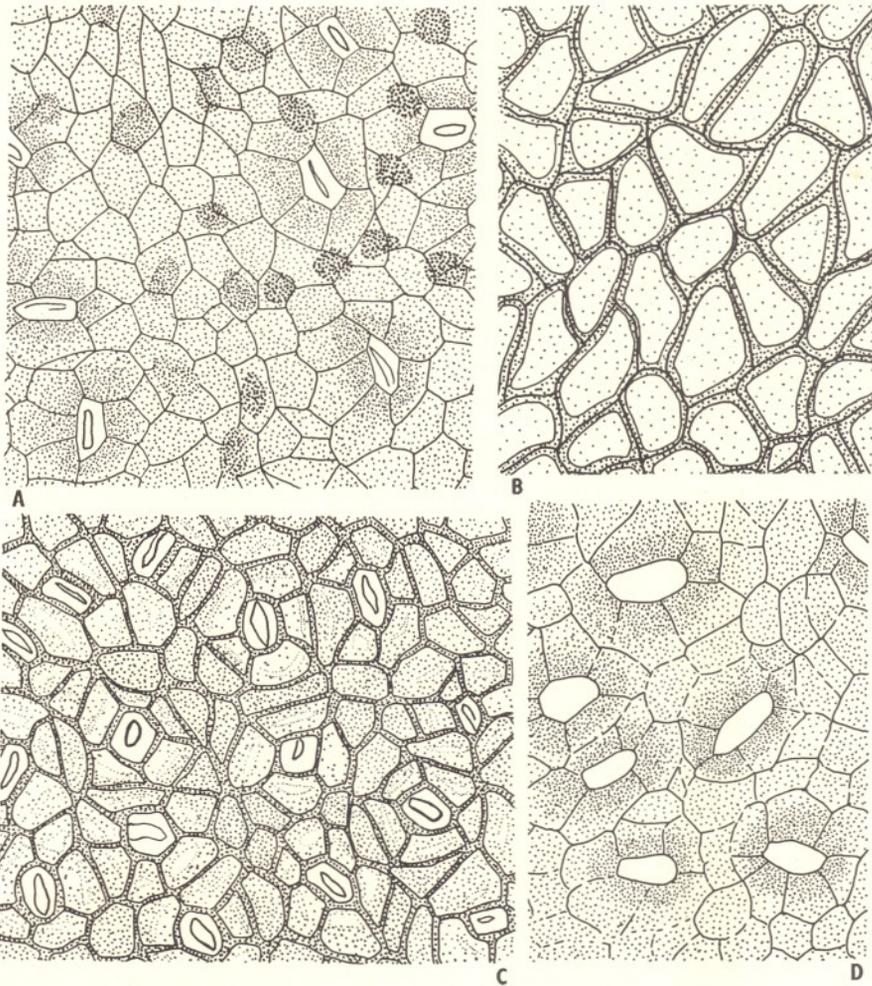
nules distant or closely set, elongate oval, apex rounded, attached by entire base, margin revolute. Pinnules typically about 1.7×0.5 cm.; with a very thick and prominent midrib, forming a groove, usually evanescent near the tip; secondary veins arise at an acute angle and very rarely divide only once. Rachis thick 2-2.5 mm. wide, longitudinally striated. Substance of lamina thin.

Cuticle thin, dissolves in the acid, leaving a few circular thick-walled cells of the hypodermis (?).

Locality — A quarter of a mile N.N.W. of Bansa and Patparha.

Collection — Holotype No. 30231 and paratype No. 30862 of the Birbal Sahni Institute of Palaeobotany Museum.

Comparison — In general shape of the pinnae and the pinnules *C. majus* resembles somewhat the pinnae and the pinnules of *C. brauniana* Zigno described by Hirmer (1924) and Antevs (1915) and *C. zeilleri* Antevs (1915). But the cuticle in *C. majus* is extremely thin and in this respect it differs from all the species of *Cycadopteris* described so far.



TEXT-FIG. 4 — A, *Cycadopteris brauniana* Zigno, lower cuticle. Sl. No. 30309A/3. $\times 250$. B, *C. indica* n. sp., upper cuticle. Sl. No. 30672/1. $\times 250$. C, *C. pulcherrima* n. sp., lower cuticle. Sl. No. 30128/1. $\times 250$. D, *C. auriculata* n. sp., lower cuticle. Sl. No. 30260/1. $\times 250$.

Discussion — All the new species of *Cycadopteris* described here have mainly been created on the basis of their cuticular structure. Some of the species can even be distinguished from each other by the mere shape of their pinnules. The two species, *C. pulcherrima* and *C. auriculata* do not have the usual papillae on the lower surface. In this respect they come much closer to the genus *Thinnfeldia* Ett. But they differ from *Thinnfeldia* in having pinnules with thickened or revolute margin. Moreover, in *Thinnfeldia* the stomata on the lower surface are not so crowded as in *C. pulcherrima* and *C. auri-*

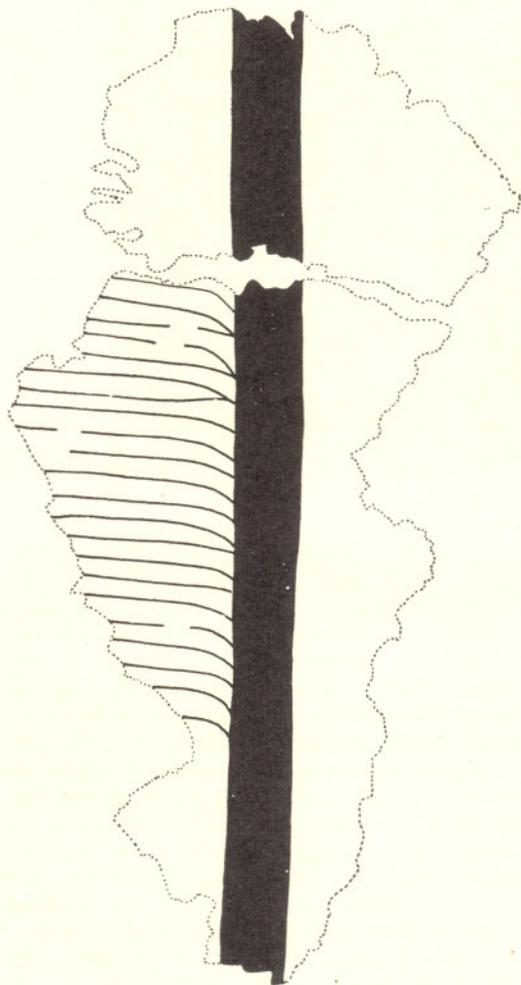
culata. Except for the absence of the papillae on the lower cuticle, the cuticles of *C. pulcherrima* and *C. auriculata* are very similar to *C. brauniana*. From *Dicroidium* Gothan another genus, commonly found in the Indian Mesozoic, all the species of *Cycadopteris* can readily be distinguished by their pinnules alone. In *Dicroidium* the pinnules do not have a revolute margin also they are amphistomatic. In *Cycadopteris* the stomata are confined only to the lower side. While the stomata in *Cycadopteris* are very crowded, in *Dicroidium* they are scattered.

PENTOXYLEAE

Genus *Nipaniophyllum* Sahni*Nipaniophyllum hirsutum* n. sp.

Pl. 3, Figs. 16-21; Text-figs. 5, 6A-D

The generic name *Nipaniophyllum* was instituted by Sahni (1948) for a petrified species of *Taeniopteris*, previously described by Rao (1943) as *Taeniopteris spatulata* McCl. Sahni while describing the new genus even changed the specific name and christened Rao's specimens as *N. raoi*. Rao had discovered the stomata of *N. raoi* to be of Bennettitalean type. But recently Vishnu-Mittre (1957) has shown the stomata of



TEXT-FIG. 5 — *Nipaniophyllum hirsutum* n. sp., showing the venation. No. 30156. $\times 5$.

N. raoi to be non-Bennettitalean, i.e. he found them to be uniformly haplocheilic in the genus. The stomata in our specimens are also haplocheilic and resemble Vishnu-Mittre's specimens.

Diagnosis — Length, breadth and the shape of the leaf not known. Substance of lamina thick, with a fairly broad midrib, measuring about 2 mm. Lateral veins very prominent, about 0.5 mm. apart, arising almost at right angles to the midrib, dichotomizing near the origin or a little further out.

Cuticle moderately thick, upper being thicker than the lower. Stomata only on the lower surface. Trichome bases present on both the surfaces.

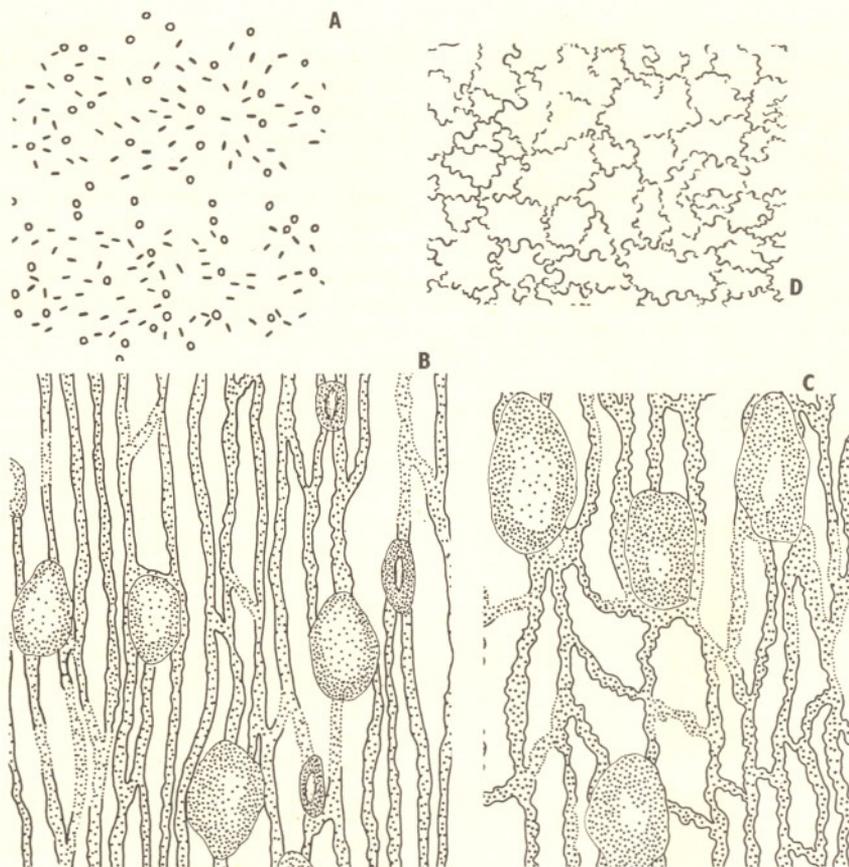
Cells of the upper cuticle variously shaped, mostly polygonal, a few rectangular or squarish; lateral and end-walls sinuous. Surface cells mostly flat, a few showing trichome bases. Cells along the midrib arranged in series, mostly rectangular or elongated rectangular, sometimes polygonal with sinuous walls. Surface full of large trichome bases. Cells along the secondary veins scarcely distinguishable.

The lower cuticle divided into two zones, the cells along the veins without stomata, while those between them with stomata. Stomata also placed on the midrib. The width of the stomatal regions much more than the vein regions. The cells between the veins polygonal, lateral and end-walls fairly thick, straight or slightly undulated, but not sinuous. Cells along the midrib thick-walled, elongated rectangular, usually with oblique walls. The cells along the lateral veins not well preserved. Trichome bases frequent along the veins and over the entire lower surface, mostly big and oval, about $60-85 \times 25-38 \mu$. Thickly cutinized.

The stomata irregularly scattered along the grooves between the veins, longitudinally placed along the midrib and absent on the lateral veins. Stomata close to each other, sometimes two stomata even sharing a common subsidiary cell. Subsidiary cells 5-6, walls slightly wavy, around the oval stomatal pit thickly cutinized, surface unspecialized. Guard cells sunken, mostly not preserved, thinly cutinized.

Locality — Near Marwar Ghat (Machrar river), Bansa, Madhya Pradesh.

Collection — Holotype, No. 30156 and paratype No. 30157 of the Birbal Sahni Institute of Palaeobotany, Lucknow.

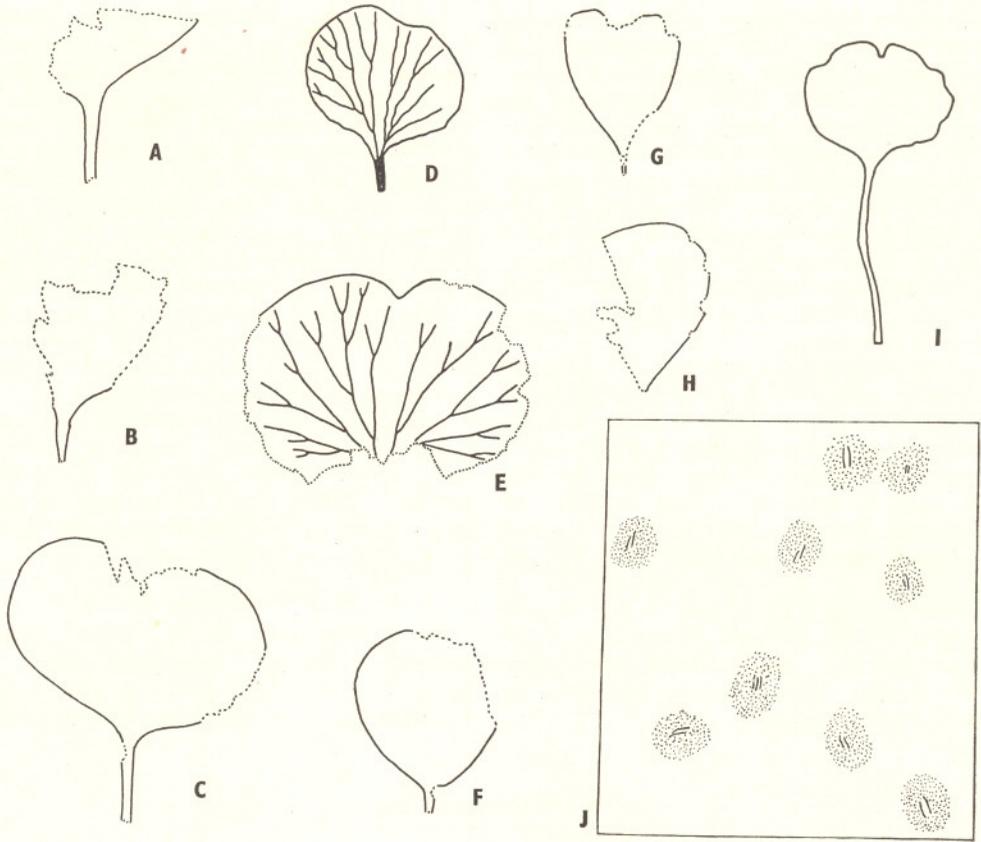


TEXT-FIG. 6 — *Nipaniophyllum hirsutum* n. sp. A, lower cuticle, showing distribution of the stomata. Sl. No. 30064/1. $\times 40$. B, lower side of midrib, showing hair-bases and stomata. Sl. No. 30156/4. $\times 250$. C, upper side of the midrib, Sl. No. 30156/4. $\times 250$. D, upper cuticle, showing cells between the lateral veins. Sl. No. 30156/3. $\times 250$.

Comparison — *Nipaniophyllum hirsutum* resembles *N. raoi* Sahni in its venation, cells of the upper surface and the midrib, in the nature of the distribution of stomata and to some extent in the number of the subsidiary cells. It, however, differs from the latter in having straight or slightly undulated cell walls on the lower surface. In *N. raoi* the cells of the lower surface have more sinuous walls than the upper while the guard cells in *N. raoi* are heavily cutinized at the polar regions, they are also thickened on the ventral, inner and outer walls, in *N. hirsutum* the guard cells are thinly cutinized and mostly not preserved. A large number of trichome bases are visible on both the surfaces of *N. hirsutum*, whereas in *N. raoi* trichome bases have so far not been noticed either by

Rao (1943) or by Vishnu-Mittre (1957). However, Rao (1943) observed in one of his preparations circular bodies on each cell or sometimes several such bodies in a cell. According to him there is a possibility of their being hair-bases or papillae. Even these circular bodies are much smaller in size than the oval trichome bases of *N. hirsutum*. Trichome bases in our specimens measure $60-85 \times 25-38 \mu$, while in *N. raoi* they are only $8.5-1.4 \mu$.

Discussion — The internal anatomy and the epidermal characters of the petrified leaves having the form and venation of *Taeniopteris* Brongniart, found at Nipania, were described in detail by Rao (1943). For these leaves Sahni (1948) instituted a new genus *Nipaniophyllum* with the diagnosis:



TEXT-FIG. 7 — *Ginkgoites feistmantelii* n. sp. A, No. 30885. B, No. 29905. C, No. 30667. D, No. 30632. E, No. 30668. F, No. 31096. G, No. 29898. H, No. 30710. I, No. 5/392. A-I, all $\times 1$. J, showing the distribution of stomata. Sl. No. 30667/1. $\times 250$.

“Petrified leaves having the form and venation of *Taeniopteris* Brongniart, combined with vascular bundles of the ‘diploxylic’ type characteristic of the modern cycads and stomata fundamentally of the Bennettitalean type with the subsidiary cells liable to subsequent transverse division.” In 1957 Vishnu-Mittre while working on a large collection of these leaves from *Nipania* found the stomatal structure of *N. raoi* to be haplocheilic and not syndetocheilic as was described earlier. He, therefore, emended the diagnosis of *Nipaniophyllum* as, “Petrified leaves with the form and venation of *Taeniopteris* Brong. Vascular bundles arranged in straight or slightly curved row, diploxylic. Stomata haplocheilic, subsidiary cells, 4-6, encircling the guard cells”.

In spite of the fact that our specimens are not petrified and as such do not show any details of the internal anatomy, we have placed them under *Nipaniophyllum* because of the close similarity in venation and epidermal structure between our specimens and *N. raoi* as described by Vishnu-Mittre.

GINKGOALES

Genus *Ginkgoites* Seward

Ginkgoites feistmantelii n. sp.

Pl. 3, Fig. 15; Text-figs. 7 A-J

1882. *Ginkgo* sp., Feistmantel; p. 49, Pl. III, Fig 1.
1882. *Araucarites cutchensis* Feistmantel; Feistmantel, p. 49, Pl. III, Fig. 14

Diagnosis — Leaf form variable. Lamina obovate, orbicular or oval; the smaller being

mostly obovate, the bigger orbicular or oval. Lamina typically about 1.8 cm. long \times 2.5 cm. broad (extreme specimens 2.7 cm. long \times 3.7 cm. broad; 2.9 cm. long \times 3.9 cm. broad; and 2.0 cm. long \times 1.6 cm. broad), almost entire, mostly with a single notch at the upper margin, lower margin prolonged to a fairly long petiole. Petiole 1.2-2.2 cm. long \times 1-1.5 mm. thick, with a single dark strand dichotomizing just below the lamina. After a short distance the two forks of the strand dichotomizing repeatedly, but forming only very few veins.

Cuticle very thin on both sides. Cell walls not visible, only at places the impressions of the more cutinized guard cells visible. Stomata seem to be irregularly distributed.

Localities — Machrar river, near Marwar Ghat and about half a mile N.N.W. of Bansa; near Barwar (S.W. of Chandia) and Patparha about two and a half miles S.E. of Chandia.

Collection — Holotype No. 5/392 of the Geological Survey of India, Calcutta.

Paratypes Nos. 30632, 30668, 30667 and 29898 of the Birbal Sahni Institute of Palaeobotany, Lucknow.

Comparison — Among the Indian species of *Ginkgoites* some of our smaller specimens, in general outline of the lamina, come nearest to *G. crassipes* (Feistmantel) Seward described by Feistmantel (1879) and Seward (1919) from the Madras Coast. But our specimens have very few veins as compared to *G. crassipes*. The obovate form of *G. feistmantelii* also resembles *G. obovata* (Nathorst) Seward described by Nathorst (1886) from the Rhaetic beds of Scania and by Harris (1935) from Scoresby Sound, East Greenland, but only in shape and not in venation. *Ginkgo integriscula* Heer (1876) resembles *G. feistmantelii* in having almost entire lamina, but the former has many more veins. *G. feistmantelii* may be compared with some of the specimens of *G. minor* Hollick (1930) from Alaska showing emarginate apex but the venation and the general form in the two are different.

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EXPLANATION OF PLATES

PLATE 1

- 1, 2. *Cycadopteris brauniana* Zigno. Nos. 30144 and 30132. \times 1.
3. *C. pulcherrima* n. sp. No. 29976. \times 1.

- 4, 5. *C. brauniana* Zigno. Nos. 30309B and 30309A. \times 1.
6. *C. pulcherrima* n. sp. No. 30245. \times 1.
7. *C. brauniana* Zigno. No. 30249. \times 1.
8. *C. majus* n. sp. No. 30237. \times 1.
9. *C. indica* n. sp. No. 30672. \times 1.

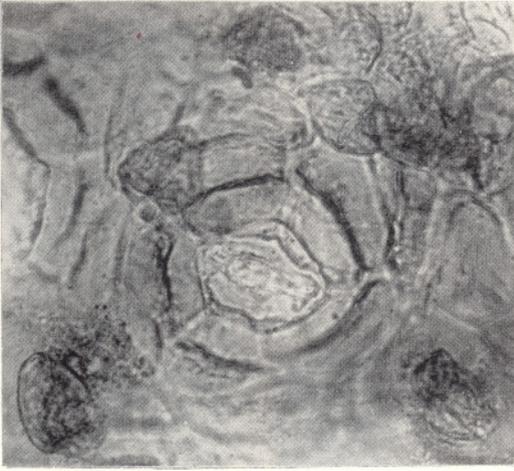
PLATE 2

10. *Cycadopteris brauniana* Zigno, showing a stoma and a few papillae. Sl. No. 30249/1. $\times 500$.
 11. *C. brauniana* Zigno, showing cells of the midrib. Sl. No. 30309A/2. $\times 250$.
 12. *C. pulcherrima* n. sp., showing stomata. Sl. No. 30128/1. $\times 500$.
 13. *C. pulcherrima* n. sp., showing a stoma and the cells on the lower side of the rachis. Sl. No. 30026/1. $\times 250$.
 14. *C. auriculata* n. sp., showing stomata. Sl. No. 30260/2. $\times 500$.

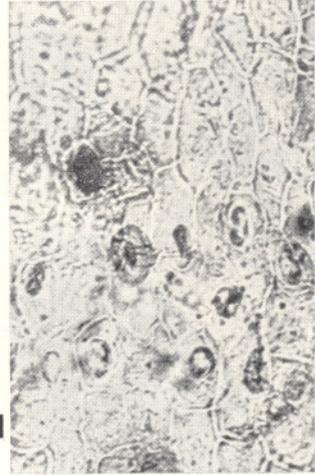
PLATE 3

15. *Ginkgoites feistmantelii* n. sp. No. 30632. $\times 1$.
 16. *Nipaniophyllum hirsutum* n. sp. No. 30156. $\times 1$.
 17. Lower cuticle of *N. hirsutum* showing the stomata and a trichome base. Sl. No. 30156/1. $\times 250$.
 18, 19. Two stomata of *N. hirsutum*. Sl. No. 30156/3. $\times 500$.
 20. Lower surface of midrib, showing the large hair-bases. Sl. No. 30156/2. $\times 250$.
 21. The specimen in figure 16, magnified. $\times 2$.



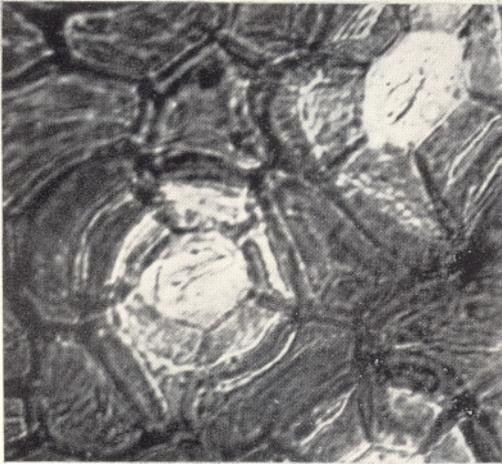


10



11

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