

SOME GYMNOSPERMIC REMAINS FROM THE TRIASSIC OF NIDPUR, SIDHI DISTRICT, MADHYA PRADESH

SHYAM C. SRIVASTAVA

Birbal Sahni Institute of Palaeobotany, Lucknow

ABSTRACT

Five species of *Glossopteris* (*G. cf. G. linearis*, *G. nidpurensis*, *G. sp. A*, *G. sp. B* and *G. sp. C*), *Rhabdotaenia* sp., *Taeniopteris glandulata* sp. nov., *Noeggerathiopsis* sp. and *Conites* sp. are described here in this paper. Out of these, *Glossopteris nidpurensis*, *G. sp. A*, *G. sp. B*, *Rhabdotaenia* sp., *Taeniopteris glandulata* and fragmentary conifer shoots are mainly based on their cuticular characters and remaining ones have been described on their external morphology.

INTRODUCTION

A LARGE number of plant fossils, preserved in the form of incrustations, in black carbonaceous shale or in a dark ash colour shale were collected by Dr. M. N. Bose and myself from Nidpur (24° 7' : 81° 54'), Gopad river valley, Sidhi District, Madhya Pradesh during the years 1964-67. At Nidpur, the plant beds are full of species of *Dicroidium* but along with them a few species of *Glossopteris*, *Rhabdotaenia*, *Taeniopteris*, *Noeggerathiopsis*, *Conites* and fragmentary conifer shoots were also collected. Out of these, on the basis of cuticular structure, seven species of *Glossopteris*, one species each of *Rhabdotaenia*, *Taeniopteris*, *Noeggerathiopsis*, *Conites* have been identified. Among the species of *Glossopteris*, *G. senii* and *G. papillosa* have already been described by me (Srivastava, 1969).

DESCRIPTION

GLOSSOPTERIDALES

Genus — *Glossopteris* Sternberg 1825

In the Triassic of India, the occurrence of *Glossopteris* Sternberg (1825) is known since 1881 when Feistmantel first reported *G. indica* Schimper (1869) and *G. communis* Feistmantel (1876) from the Panchet Stage of Raniganj and Ramkola coalfields. Recently, Saksena (1952 and 1962) and Lele (1962) have added two more species from Karkati, Kamtadand, Parsora and

other adjacent localities in the South Rewa Gondwana basin. The species reported by them are *G. browniana* Brongniart (1828) and *G. angustifolia* Brongniart (1828). Apart from these species according to Rao and Shah (1960), *G. stricta*, *G. ampla* are also present in the Maleri Stage of Adilabad District. Recently, from the Triassic of Nidpur, Srivastava (1969) has described two new species of *Glossopteris* viz. *G. senii* and *G. papillosa*. Besides these already known species of *Glossopteris*, four more species and one *Glossopteris cf. G. linearis* are described here from Nidpur. Except one species and *Glossopteris cf. G. linearis*, all the new species are based on cuticular structure.

Glossopteris cf. G. linearis McCoy

Pl. 4, Fig. 5

Leaf simple, linear lanceolate, measuring 8.9 cm. in length and 2 cm. in breadth; base tapering gradually, apex obtuse, margin entire. Midrib distinct, width about 2-3 mm., longitudinally finely striated, base with fine tubercles. Secondary veins arising at an acute angle forming an arch all over lamina. Meshes broad, polygonal near midrib and elongate narrower towards margin.

Collection — No. 33973.

Locality — Nidpur, Sidhi District, M.P., India.

Age — Lower Triassic

Remarks — The present description is based on a single and nearly complete specimen but with a slightly broken base.

COMPARISON

The present specimen resembles most in its characteristic linear shape, size range and venation pattern with *G. linearis* McCoy described by Feistmantel (1890, p. 126; Pl. 16, Figs. 1-2) from Australia and by

Maheshwari (1965) from Raniganj, India. Indian specimen of *G. linearis* (MAHESHWARI, 1965) differs slightly in having petiole but since the present specimen is broken in its basal region, this petiolate condition has not been marked. Also in present specimen, secondary veins from the point of emergence upto margin run throughout lamina forming an arch while in *G. linearis*, veins become little straight after a gentle arch. From *G. browniana* Brongniart, the present species differs in having narrow linear form of lamina. In the narrow form of lamina, the present specimen comes closer to *G. angustifolia* Brongniart but the latter differs in the presence of more oblique veins and acute apex. *G. papillosa* Srivastava (1969) shows similarity from the present specimen in the presence of fine tubercles in the basal portion of midrib.

Glossopteris nidpurensis sp. nov.

Pl. 1, Figs. 1-3; Pl. 2, Figs. 1-2; Text-figs. 1A-D

Diagnosis — Leaves fairly large, available length 10-18 cm., breadth 7-8 cm.; nature of base and apex not known. Midrib very distinct, 5-7 mm. wide, longitudinally striated. Secondary veins arising at an acute angle just after emergence, curving upwards and then running at right angles, dichotomizing and anastomosing frequently to form short and broad meshes near midrib, slightly narrower and longer over remaining surface.

Cuticle on both surfaces about 2.5 μ thick, upper and lower surfaces not distinguishable; amphistomatic. Cells along veins serially arranged, rectangular, much longer than broad. Cell wall 7-15 μ thick, straight, broken by pits or slightly undulated, surface unspecialized. Cells within meshes smaller in size, rectangular or polygonal. Cell walls like vein cells, cell surface smooth or slightly thickened at places. Stomata few, sparse, mostly longitudinally orientated. Subsidiary cells 5-7, mostly 7, unspecialized but inner wall highly cutinized forming elliptic rhomboidal opening. Guard cells not preserved.

Holotype — No. 33909.

Locality — Nidpur, Sidhi District, M.P., India.

Age — Lower Triassic.

Remarks — The above description is based on two specimens. All of them are

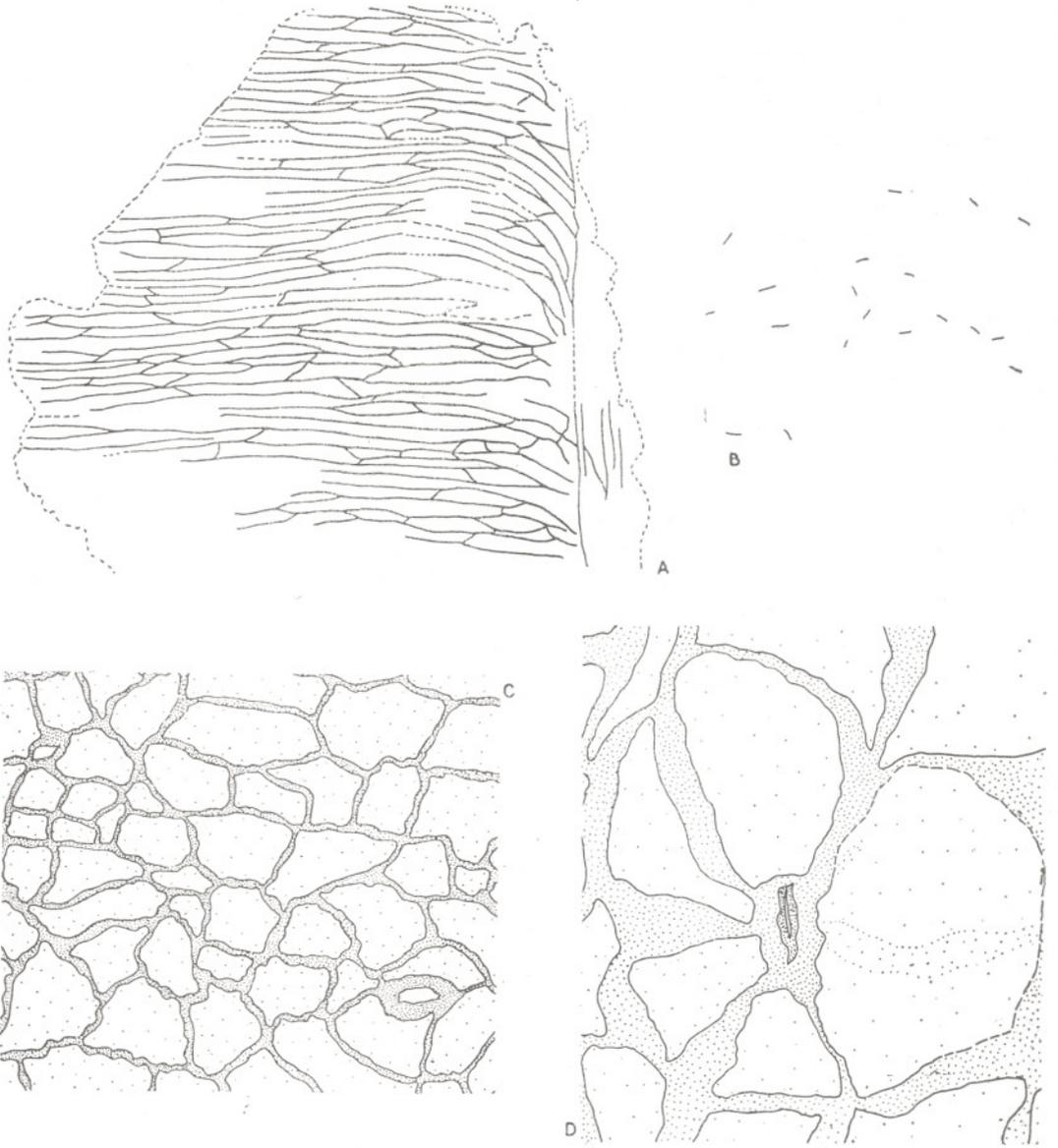
incomplete both at base and apex. The leaves seem to be fairly large, perhaps measuring upto 30-35 cm. in length and 14-18 cm. in breadth.

COMPARISON

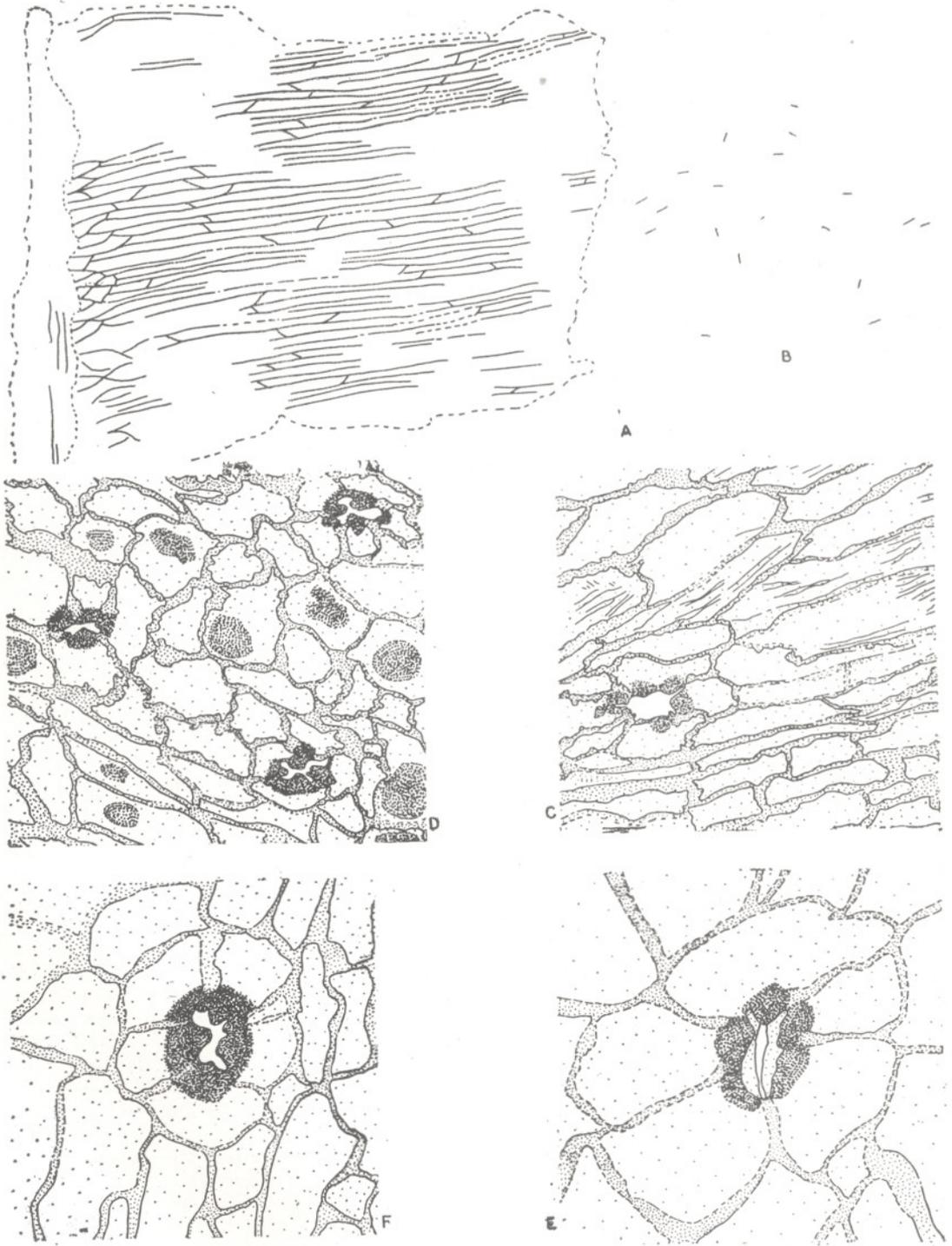
Glossopteris nidpurensis in size and shape resembles the larger specimens of *G. damudica* Feistmantel (1881, PL. 30, FIG. 1, PL. 31, FIG. 2) but the latter species has slightly narrower midrib and much broader meshes than the former. Moreover, the cuticle of *G. damudica*, as described by Srivastava (1957) differs from the present species in having only on one surface sparsely distributed stomata and in having nonpapillate subsidiary cells. Also in *G. damudica* the ordinary cells have smooth surface wall. In *G. nidpurensis* stomata are mostly longitudinally orientated and are present on both the surfaces and also the surface wall of the cells is mostly thickened.

G. nidpurensis differs from *G. browniana* Brongniart (1828), *G. communis* Feistmantel (1876), *G. longicaulis* Feistmantel (1880) and *G. cf. G. divergens* Feistmantel (1881) in general form, in the breadth of the lamina, in the angle of emergence of veins and in the nature of meshes. They resemble the present species in having stomata on both the surfaces but in other details of the cuticular structure *G. nidpurensis* differs markedly from all of them. Because, according to Srivastava (1957), in *G. browniana* stomatal distribution is irregular and also the subsidiary cells are differentiated into polar and lateral subsidiary cells; in *G. communis* stomata are irregularly distributed and orientated, the ordinary cells are non-papillate but subsidiary cells are papillate; in *G. longicaulis* stomata are distributed in linear order and the cells are non-papillate and also in *G. cf. G. divergens* stomata are irregularly distributed and the inner wall of subsidiary cells is not cutinized.

Amongst the Australian species, *G. taeniopteroides* Feistmantel (1878 and 1890) to some extent, is comparable to *G. nidpurensis* in its general form and in the angle of emergence of secondary veins but the former can be distinguished from the latter in having much narrower lamina and midrib and also by the presence of narrow elongate meshes of almost equal breadth throughout the lamina. The cuticle of *G. taeniopteroides* described from Raniganj coalfield



TEXT-FIG. 1 — *Glossopteris nidpurensis* sp. nov.— A, showing venation; holotype No. 33909. $\times 1$. B, cuticle, showing distribution of stomata; Slide No. 33910-1. $\times 40$. C, cuticle showing stomata and epidermal cells; Slide No. 33910-1. $\times 250$. D, a single stoma; Slide No. 33909-1. $\times 500$.



TEXT-FIG. 2 — *Glossopteris* sp. A — A, showing venation; No. 33914. $\times 2$. B, thicker surface, showing distribution of stomata; Slide No. 33914-3. $\times 40$. C, thinner surface, showing a stoma and epidermal cells; Slide No. 33914-1. $\times 250$. D, thicker surface, showing a few stomata and epidermal cells; Slide no. 33914-3. $\times 250$. E, a stoma from thinner surface; Slide No. 33914-1. $\times 500$. F, a single stoma from the thicker surface; Slide No. 33914-4. $\times 500$.

by Srivastava (1957) differs from the present species in having longitudinally distributed stomata only on one surface and also in having non-papillate cells. However, Maheshwari (1965) has raised the doubt whether Srivastava's specimen really belongs to the Australian species, *G. taeniopteroides*. *G. nidpurensis* is not comparable to any of the so far described species of *Glossopteris* from Africa by Zeiller (1896), Seward and Leslie (1908), Dutoit (1927), Walton (1929), Plumstead (1958), Pant (1958), Thomas (1958) and Höeg and Bose (1960).

Similarly, it is not possible to compare *G. nidpurensis* with any of the species of *Glossopteris* described from South America by Dolianiti (1948 & 1953) and Archangelsky (1957-58), from Falkland island by Halle (1912) and from Antarctica by Plumstead (1962).

Glossopteris sp. A

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

Frond size and shape not known, available length 10 cm., breadth exceeding 8 cm., substance of lamina thin. Midrib distinct, width about 4 mm., longitudinally striated. Secondary veins emerging at right angles from midrib, nearer midrib forming broad, short and oval meshes, over the remaining surface meshes long and narrow, cross-connections present almost over the entire surface.

Cuticle of unequal thickness, amphistomatic, one side slightly thicker than the other. Thinner side with rectangular or elongated cells, measuring $15 \mu \times 7.5 \mu$; lateral- and end-walls more or less straight, surface-wall mottled. Thicker side 2.5μ thick, cells polygonal or rectangular, measuring $39.1 \mu \times 16.2 \mu$. Lateral- and end-walls straight, surface slightly thickened or papillate, papillae circular, solid. Stomata on both surfaces confined irregularly between meshes, scattered, orientation not regular, majority longitudinally placed. Subsidiary cells mostly 5, rarely 4 or 6, forming a ring, inner surface papillate, papillae solid, pyramidal or deltoid in shape, overhanging stomatal pit. Guard cells mostly not preserved, thinly cutinized. Encircling cells not distinct.

Collection — No. 33914.

Locality — Nidpur, Sidhi district, M.P., India.

Age — Lower Triassic.

Remarks — The above description is based on a single incomplete specimen having neither base nor apex and it is only a portion of a frond on one side of the midrib. From the available length and breadth it seems that the leaf was of fairly large size. Although the cuticle is very distinct from all the other species of *Glossopteris* from Nidpur yet in the absence of better preserved specimens, at present, I have preferred to describe this as *Glossopteris* sp. only.

COMPARISON

In its general form of lamina and angle of emergence of veins, *Glossopteris* sp. A resembles very much *G. nidpurensis*. On the basis of cuticular structure, *G. sp. A* can easily be distinguished from *G. nidpurensis* by its irregular distribution of stomata, mottled or papillate cell surface and in the presence of papillate subsidiary cells which are overhanging the stomatal pit.

In the nature of venation, *G. sp. A* appreciably differs from *G. browniana* Brongniart (1828), *G. communis* Feistmantel (1876), *G. longicaulis* Feistmantel (1880) and *G. cf. G. divergens* Feistmantel (1881) because in all the latter species, the veins while arising from the midrib are forming an arch and the meshes formed are of varying form and size. The cuticle of *G. browniana* as described by Srivastava (1957) resembles *G. sp. A* in the presence of stomata on both the surfaces but the former differs in having cells with smooth surface-wall and non-papillate subsidiary cells. The cuticle of *G. communis* as described by Srivastava (1957), too, is amphistomatic. Here, like *G. sp. A*, the subsidiary cells are papillate but the papillae are not overhanging the stomatal pit. In *G. longicaulis* the stomata are distributed on both the surfaces but the subsidiary cells are non-papillate. Srivastava (1957) described the cuticle of *G. cf. G. divergens*. According to his description, the stomata are present on both the surfaces. So, in this character, the present species may be compared with *G. cf. G. divergens*. But, unlike the former, the latter species has non-papillate cells and also the subsidiary cells are devoid of finger like projections.

G. sp. A is comparable to some extent with *G. taeniopteroides* Feistmantel (1878 and 1890) described from Australia, in its emergence of secondary veins at right angles from the midrib but the latter differs from the former species in having less broader lamina and midrib. Also in *G. taeniopteroides* the meshes towards the margin, are oblong, narrower and obliquely acute and are slightly narrower and smaller in size on the remaining surface. The cuticle of *G. taeniopteroides* as described by Srivastava (1957) differs from *G. sp. A* in its hypostomatic nature and also in having longitudinally distributed stomata and non-papillate cells. In external form, *G. sp. A* is quite distinct from all the so far known African species. But on the basis of cuticular structure it comes somewhat closer to *G. fibrosa* Pant (1958) and *G. hispida* Pant (1958) as in all these species the subsidiary cells are papillate which are overhanging the stomatal pit. But the latter two species, apart from their differences in external characters,

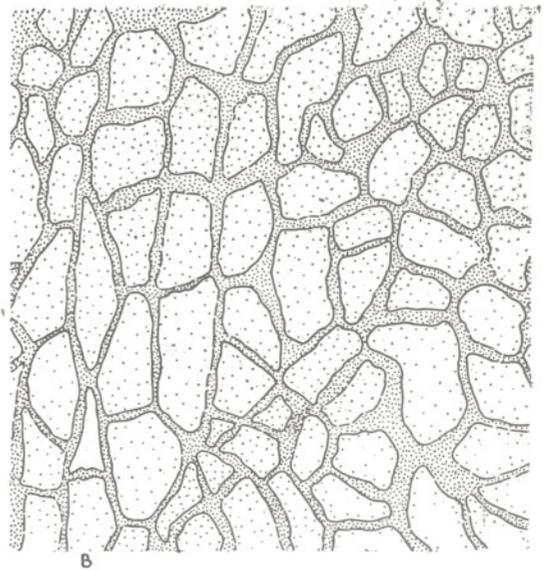
also differ in having stomata only on one side.

Glossopteris sp. B

Pl. 2, Figs. 6-7; Pl. 3, Fig. 4; Text-figs. 3A-B

Leaf size and shape not known, about 3.6 cm. long and 1.4 cm. broad. Margin entire. Midrib distinct, 4 mm. wide, longitudinally striated. Secondary veins arising at wide angle and curving upwards, frequently dichotomizing and anastomosing, forming short and broad meshes near midrib, slightly narrower and longer over remaining surface.

Cuticle on one surface much thinner than the other. Details of cell structure not visible on thinner surface. Cells along veins on thicker surface serially arranged, rectangular; lateral- and end-walls straight, surface-wall smooth. Cells between veins polygonal, irregularly arranged; lateral- and end-walls straight, surface-wall smooth.



TEXT-FIG. 3 — *Glossopteris sp. B* — A, showing venation; No. 33911. $\times 6$. B, cuticle showing epidermal cells; Slide No. 33911-1. $\times 500$.

Collection — No. 33911.

Locality — Nidpur, Sidhi District, M.P., India.

Age — Lower Triassic.

Remarks — The above description is based on a single incomplete specimen without base or apex.

COMPARISON

Glossopteris sp. B. is comparable to *G. angustifolia* Brongniart (1828) in its linear form but the latter species differs from the former in having veins which are emerging at an acute angle and also in having narrower meshes. *G. taenioides* Feistmantel (1882) and *G. balmei* Rigby (1966) from Australia differ from *G. sp. B* in having veins which are arising at an angle and also in having narrower form of lamina with narrow, small meshes. *G. senii* Srivastava (1969) resembles *G. sp. B* by the presence of broader meshes but differs in having much narrower lamina. As the cuticle of *G. sp. B* is incompletely known, further comparison with *G. senii* is not possible. However, the epidermal cells of *G. sp. B* are polygonal or rectangular with thick and straight cell walls unlike *G. senii* where they are little smaller, polygonal with straight or slightly wavy walls.

Glossopteris sp. C

Pl. 3, Figs. 5-6; Pl. 4, Figs. 1-4; Text-fig. 4

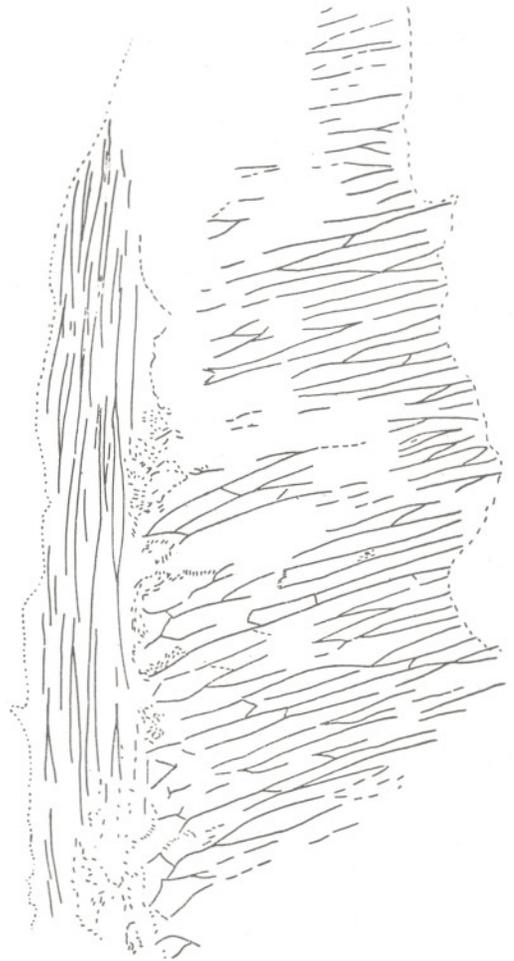
Leaf incomplete, available length 3.7-17 cm., breadth 2.7-5 cm., broadly lanceolate, base not preserved, apex obtuse or rounded. Midrib prominent 3-4 mm. in width, longitudinally striated. Secondary veins over major part of lamina emerging at an angle of about 70°-80°, just after emergence forming an arch and then running almost at right angle. Near the apex veins arising at an acute angle and not running at right angle to the midrib.

Collection — No. 33912.

Locality — Nidpur, Sidhi District, M.P., India.

Age — Lower Triassic.

Remarks — The above description is based on 15 specimens. In all of them there is a carbonized crust preserved but from none of them it was possible to make cuticular preparations.



TEXT-FIG. 4 — *Glossopteris* sp. C — showing venation, No. 33986. × 4.

COMPARISON

The present specimens of *Glossopteris* sp. resemble most *G. damudica* Feistmantel described by Maheshwari (1965) from Bansloi valley. They resemble each other in the breadth of lamina and in venation pattern. The specimens of *G. damudica*, as described by Feistmantel (1881), shows a great variation in size and shape. His specimen with broadest lamina (FEISTMANTEL 1881, PL. 30A, FIG. 1) is more than twice the breadth of the present species. Also the meshes, near midrib in *G. sp. C* are not so broad. Feistmantel's specimen of *G. damudica* figured in pl. 25A fig. 4 (*loc. cit.*) has somewhat the same vena-

tion pattern as the specimen of *G. sp. C* figured here in Pl. 3, fig. 6 which like the former too, comes from the apical region. The other specimens of *G. damudica* figured by Feistmantel (*loc. cit.* PL. 31A, FIGS. 1-3 & PL. 40A, FIG. 6) resemble the present specimens of *G. sp. C* in lamina width and in venation pattern. But all specimens of Feistmantel have broader meshes. *G. damudica* as figured by Srivastava (1957, PL. 6, FIG. 37) resembles very much the larger specimens of *G. sp. C*, in external form and venation pattern. Further comparison is not possible because the cuticular structure of the present species is not known.

Among the species of *Glossopteris* described from Nidpur, *G. sp. C* resembles somewhat *G. nidpurensis* and *G. sp. A* in venation pattern. But, both the latter species differ in having much broader lamina and narrower elongated meshes.

Genus — *Rhabdotaenia* Pant 1958

Leaves resembling *Rhabdotaenia* Pant (1958), in external form, have been reported by Bhattacharya (1963) as *Taeniopteris danaeoides* (Royle) Arber (1905) from Deobar, Auranga coalfield and by Vimal and Singh (1968) as *Macrotaeniopteris danaeoides* (Royle) Feistmantel (1881) from Karkati, South Rewa Gondwana basin. Now from Nidpur quite a few specimens resembling *Rhabdotaenia fibrosa* Pant and Verma (1963), both in external form and cuticular structure, have been collected. Unfortunately, all the specimens are very fragmentary and most of them are detached pieces of lamina on one side of midrib alone. Because of their fragmentary nature they are, at present, described here as *Rhabdotaenia* sp.

Rhabdotaenia sp.

Pl. 5, Figs. 1-8; Text-figs. 5A-E

Leaves fragmentary, size and shape as a whole not known. Lamina entire or segmented (perhaps during preservation, lamina got segmented), substance of lamina moderately thick, largest available specimen measuring 6.2 cm. in length and 3.5 cm. in breadth. Margin mostly not preserved, when present entire. Midrib quite prominent, about 2 mm. wide, longitudinally striated. Secondary veins arising at an

angle and just after emergence arching outwards almost immediately, then running somewhat at right angles to midrib. Veins forked or unforked at the point of emergence, in latter part of lamina dichotomizing rarely and mostly running parallel to each other. In between secondary veins interstitial fibres present, sometimes crossing each other in oblique direction.

Stomata confined only on one surface. Stomatic surface slightly thicker than the non-stomatic surface. Epidermal cells of non-stomatic side, along veins, rectangular or polygonal about twice as long as broad, lateral- and end-walls thick, straight, rarely slightly wavy at places, surface-wall mostly mottled, sometimes slightly thickened but not having definite papillae. Cells between veins smaller in size than along veins mostly polygonal. Cell walls similar to that along veins. Cells of stomatic side similar to that of non-stomatic side. Stomata sparse, irregularly distributed, mostly longitudinally orientated. Subsidiary cells 5-7, mostly 6, unspecialized, inner wall highly cutinized forming rhomboidal or dumbbell-shaped opening. Guard cells sunken, thinly cutinized. Encircling cells rarely present.

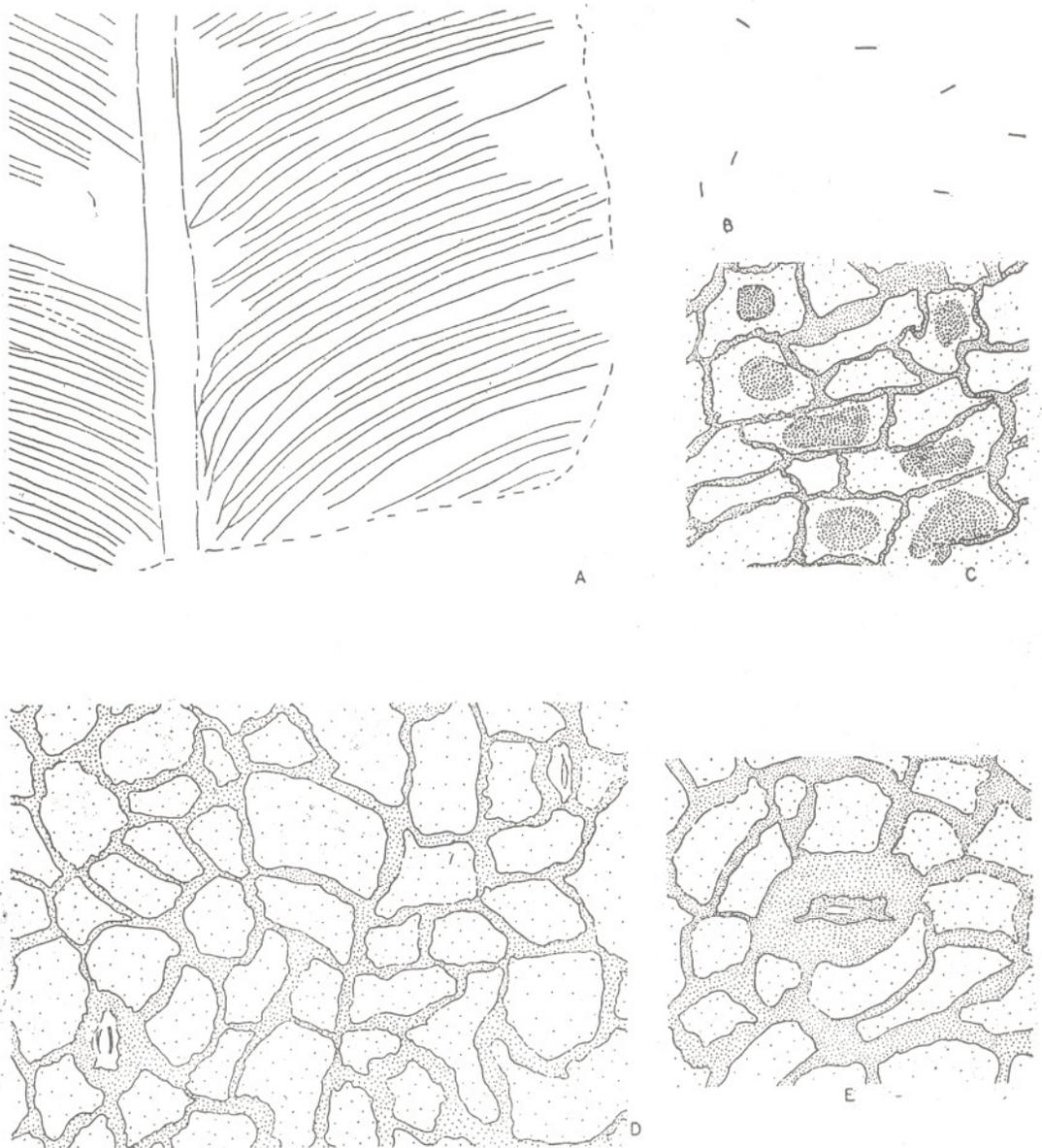
Collection — No. 33920.

Locality — Nidpur, Sidhi District, M.P., India.

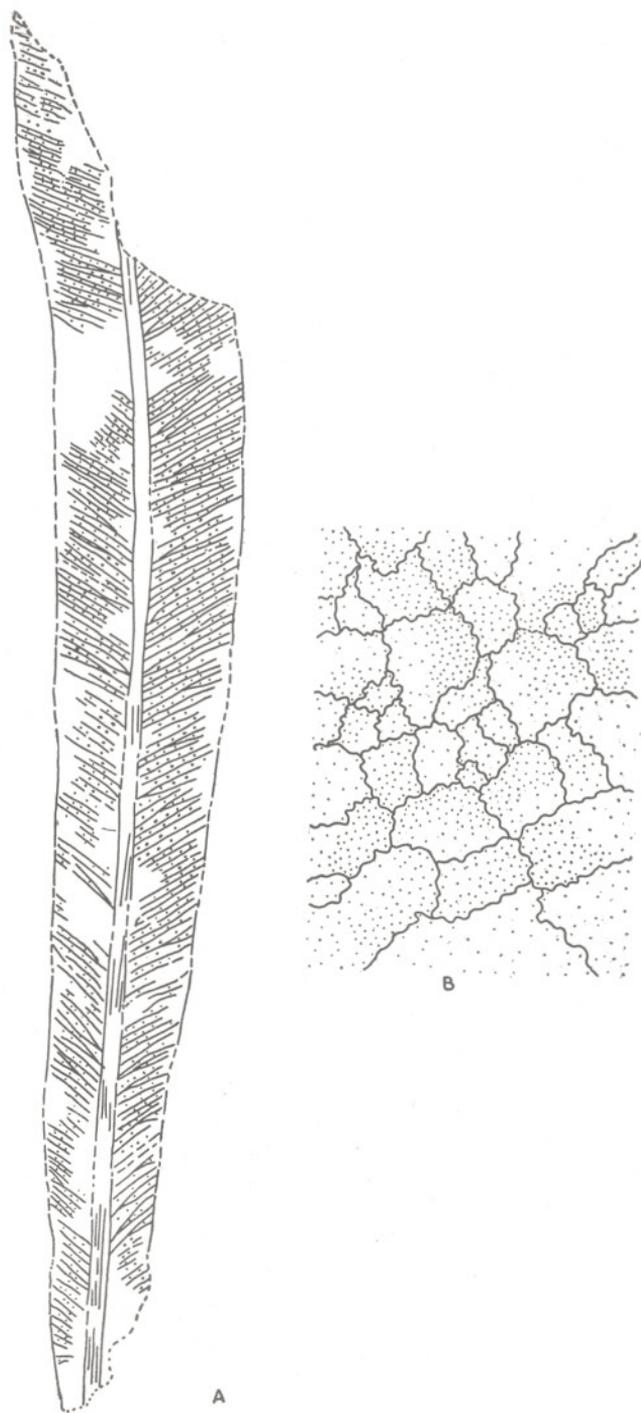
Age — Lower Triassic.

COMPARISON

In venation pattern *Rhabdotaenia* sp. resembles most *R. fibrosa* Pant and Verma (1963) and also like *R. fibrosa*, the present species, too, has interstitial fibres between veins. As for the cuticular structure, in both the species, the surface-wall is mottled and in both, the stomata are confined on one side only. The cuticle of *R. fibrosa*, however, differs from *R. sp.* in having cells with sinuous walls on lower surface and in having subsidiary cells which are 3-5 in number. In *R. sp.* cell wall is straight or slightly wavy at places; the subsidiary cells are 5-7 in number. In *R. danaeoides* (Royle) Pant and Verma (1963) veins are sparse and on the lower cuticle, cell wall is sinuous. The number of subsidiary cells in *R. danaeoides* is also 3-5, unlike *R. sp.* where it is 5-7. The cuticle of *R. harkinii* Pant (1958) is quite distinct from *R. sp.* because it has



TEXT-FIG. 5 — *Rhabdotaenia* sp. — A, showing venation; No. 33920. $\times 2$. B, thicker side, showing distribution of stomata, Slide No. 33923-1. $\times 40$. C, thinner side showing epidermal cells; Slide No. 33922-2. $\times 250$. D, thicker side, showing a few stomata and epidermal cells; Slide No. 33923-1. $\times 250$. E, a single stoma from thicker surface; Slide No. 33922-2. $\times 500$.



TEXT-FIG. 6 — *Taeniopteris glandulata* sp. nov.— A, showing venation and gland-like circular bodies; holotype No. 33965. $\times 2$. B, cuticle piece, showing epidermal cells with sinuous cell walls; Slide No. 33971-2. $\times 250$.

cells with sinuous walls and also some of the cells have distinct papillae. The subsidiary cells in *R. harkinii* are also papillate.

Like *R. fibrosa*, the present species resembles very much *Taeniopteris feddenii* (Feistmantel) Arber (1905) in the nature of venation and it differs in the same way as *R. fibrosa* i.e. in *T. feddenii* interstitial fibres are not visible. *R. sp.* differs from *Macrotaeniopteris danaeoides* (Royle) Feistmantel described by Vimal and Singh (1968) from Karkati in the South Rewa Gondwana basin, in having much more closely set secondary veins. Unlike *R. sp.* in *M. danaeoides* (according to Arber 1905), *M. danaeoides* of Vimal and Singh (1968) should really be known as *Taeniopteris danaeoides* (Royle) McClelland the veins are more sparse and more frequently forking, sometimes even forking more than once.

? CYCADALES

Genus — *Taeniopteris* Brongniart 1828

This genus is not so well represented in the Triassic of India. Only during the last 13 years, Lele (1955 & 1961) has reported *Taeniopteris spatulata* McClelland (1850) and *T. sp. cf. T. feddenii* (Feistmantel) Arber (1905) from Parsora and Beli, South Rewa Gondwana basin.

From Nidpur a large number of specimens of *Taeniopteris* have been collected. Most of them are fragmentary and all of them have very badly preserved cuticle. With great difficulty cuticular preparations could be made out of four specimens. But here, too, only one surface showed a few cells at places. In none of them stomata could be detected.

Taeniopteris glandulata sp. nov.

Pl. 6, Figs. 1-5; Text-figs. 6A-B

Leaves 2.1-10 cm. in length, perhaps exceeding 14 cm. in length and 0.9-2.1 cm., in breadth, linear lanceolate or spatulate, substance of lamina thin. Apex more or less obtuse, base tapering gradually. Margin entire. Midrib distinct, about 1.1-5 mm. wide, longitudinally striated. Secondary veins arising at an angle of about 55-70°, branched or unbranched. When forking, bifurcating at all levels, but rarely

forking near margin, more or less parallel to each other. Between secondary veins, 4 to 8 distinct circular, gland-like bodies about 0.5 mm. in diameter visible at intervals of 1.1-5 mm.

Cuticle of uneven thickness. Details of cell wall visible only on thicker surface. Cells between veins rectangular or polygonal, irregularly placed, cells along veins serially arranged. Lateral- and end-walls of all the cells sinuous, surface unevenly thickened. Nature of circular gland-like resin bodies not known. Details of stomata not known.

Remarks — Cuticle on one side is much thinner than the other. On the thinner side no details of cell walls or stomata are visible. On the thicker surface, too, stomata are not recognizable. The nature of the circular gland-like bodies or resin bodies is also not known.

Holotype — No. 33965.

Locality — Nidpur, Sidhi District, M.P., India.

Age — Lower Triassic.

COMPARISON

Taeniopteris glandulata differs from all the, so far, described Indian species, viz. *T. feddenii* (Feistmantel) Arber (1905), *T. spatulata* McClelland (1850) and *T. vittata* Brongniart described by Feistmantel (1876) from Kutch, in having gland-like circular resin bodies in between the secondary veins. *T. dentata* Rao and Jacob (1957) can be distinguished from the present species by the presence of dentate margin and by the absence of gland-like bodies.

T. glandulata may be compared with *Nipaniophyllum raoi* Sahni (1948) in the nature of ordinary epidermal cells. Because in both, the cell wall is sinuous. As the other details of cuticle are not known in the present species, it is not possible to compare the two further. Unlike the present species, in *N. raoi* no gland or resin bodies are present between veins.

T. glandulata in its linear lanceolate or spatulate shape, to some extent, is comparable to *T. daintreii* described by McCoy (1860) from Australia and Frenguelli (1944) from Argentina, *T. thomsoniana* Arber (1917) from New Zealand, *T. cricumensis* Dolianiti (1953) from Brazil and also to *T. arctica* from Auckland and *T. minensis* Oishi



TEXT-FIG. 7 — *Noeggerathiopsis* sp.—A, specimen No. 33974. $\times 1$. B, showing venation; No. 33974. $\times 3$.

(1932) from Japan. But all these species differ from the present species in the angle of emergence of veins and by the absence of circular resin-like bodies between veins. *T. coriacea* Sellards (1901), comes slightly closer to *T. glandulata* by the presence of oval bodies in between the secondary veins but the former can be distinguished from the latter in having notched oval bodies half immersed in the substance of lamina and also by the absence of forked veins.

In the presence of resin like bodies, *T. glandulata* may be compared with some of the species of *Nilssonia* Brongniart (1824) viz. *Nilssonia tenuinervis* (Seward) Harris (1964) in having circular resin like bodies between secondary veins. But the present species differs from *N. tenuinervis* in the presence of forked secondary veins and in having laterally attached lamina.

Incertae Sedis

Genus — *Noeggerathiopsis* Feistmantel 1879

The present collection includes three specimens of *Noeggerathiopsis* type of leaf. All these specimens are very fragmentary and from none of them it was possible to make cuticular preparations. So here they are being described as *Noeggerathiopsis* sp. Besides these specimens, from the Triassic of India, so far only *N. hislopii* Bunbury is known and that too from the Parsora Stage (see LELE, 1955 & 1961).

Noeggerathiopsis sp.

Pl. 6, Figs. 6-7; Text-figs. 7A-B

Leaves fragmentary, lanceolate or wedge-shaped, measuring 5.6-7.9 cm. in length

and 1.3-2.6 cm. in breadth at its broadest region. Base slightly contracted, 0.6-1 cm. in width. Margin entire. Veins arising from base, fine, fairly close, sub-parallel, near middle about 12-16 veins in 1 cm. width, usually dichotomizing near base but occasionally bifurcating in middle part of lamina as well.

Collection — No. 33974.

Locality — Nidpur, Sidhi District, M.P., India.

Age — Lower Triassic.

COMPARISON

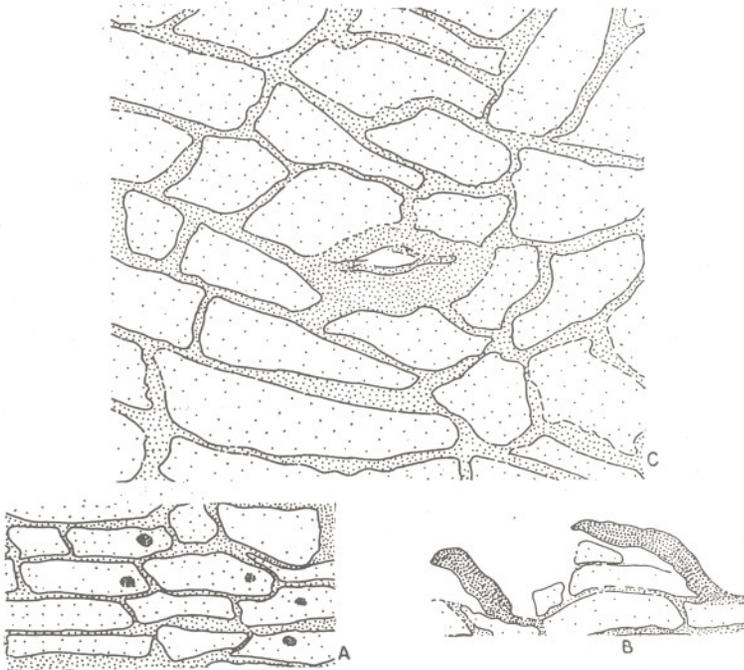
Noeggerathiopsis sp. resembles *N. gondwanensis* Lele and Maithy (1964) and *N. densinervis* Maithy (1965), in venation pattern. In all these species veins are fairly close to each other. But *N. sp.* is distinct from the latter two species in having lesser number of veins. The present species differs from the specimens of *N. hislopii* Bunbary described by Lele (1955 & 1961) from Daigaon and Parsora in having finer and closely set veins. In *N. hislopii* veins are coarser

and less divergent. The present specimens from Nidpur differs from *N. hislopii* described by Walkom (1922) from Australia and *N. sp.* Frenguelli (1944) from Argentina in having more closely set veins.

Fragmentary conifer shoots

Pl. 6, Figs. 8-12; Text-figs. 8A-C

The present collection includes three fragmentary conifer shoots. Cuticular preparations were obtained from all of them but the macerated pieces were extremely small. In none of them it was possible to distinguish the two surfaces. Most of the pieces showed only a few cells, however, in one piece a single stoma could be detected (PL. 6, FIG. 12) and in another a few long papillae were observed (PL. 6, FIG. 11). It was impossible to determine the side to which this stoma belonged and also the region to which these papillate cells belonged i.e. whether the cells were papillate near base, apex or margin. Therefore, I am, here describing these different cuticle pieces separately.



TEXT-FIG. 8 — *Fragmentary conifer shoots* — A, conifer shoot-piece of cuticle showing epidermal cells; Slide No. 33975-1. $\times 250$. B, conifer shootpiece of cuticle showing long, hollow papillae; Slide No. 33975-3. $\times 250$. C, a single stoma; Slide No. 33975-2. $\times 500$.

External features — Fragmentary leafy twig, measuring 1.5-2.2 cm. in length and about 0.3-0.5 cm. in breadth. Leaves spirally arranged, crowded, linear or needle-like; base broad, sometimes decurrent; apex acute, unforked.

Cuticle piece without stomata (PL. 6, FIG. 10) — Piece extremely fragmentary, having serially arranged rectangular or polygonal cells; lateral- and end-walls straight, surface-wall smooth.

A cuticle piece with papillate cells (PL. 6, FIG. 11) — This piece having cells similar to those described above. But along with smooth walled cells, a few cells having long, hollow papillae. Papillae measuring 82.5 μ in length and 12.5 μ in width.

A cuticle piece with a stoma (PL. 6, FIG. 12) — Cells serially arranged, rectangular or polygonal; lateral- and end-walls straight, surface-wall smooth or a few cells with a minute rounded papillae placed on one side of cells. Stomatal apparatus consisting of 5 subsidiary cells, sunken guard cells with a slit-like aperture.

Collection — No. 33975.

Locality — Nidpur, Sidhi District, M.P., India.

Age — Lower Triassic.

COMPARISON

From the above description of cuticle pieces one can only guess that the pieces having cells with smooth surface walls belonged to one surface and the piece with papillate cells and the stoma to the other. Also perhaps the piece with long papillae belonged to the stomatal side. But on the whole the cuticle of the present conifer shoots is too imperfectly known to be compared with the cuticle of any of the so far known conifers, from the Gondwanaland. In external features the present twigs resemble most some of the specimens of *Buriadia heterophylla* (Feistmantel) Seward and Sahni described by Pant and Nautiyal (1967, PL. 4, FIG. 1 & PL. 15, FIG. 4). But, unlike, the latter species none of the present specimens have bifid leaves. The cells of the presumed non-stomatic surface of the present shoots somewhat resemble the non-stomatic surface of *B. heterophylla*. In both, cells are arranged in longitudinal series and in both surface-wall is unspecialized. But the lower cuticle of *B. heterophylla* differs

from the present material in having stomatic bands and papillate subsidiary cells.

Paranocladus indica Surange and Lele (1957) differs from the present shoots in having broader leaves. As the cuticular structure of the former species is not known so further comparison is not possible. However, the cuticle of the genus *Paranocladus* Florin (1940-45) is quite distinct from the present shoots, because it has the long stomatic bands on the upper side having strongly papillate stomatal apparatus and on the lower side the stomata are slightly papillate and are occurring in scattered groups. The leaves of *Walkomiella indica* Surange & Singh (1951 and 1953) are quite distinct in being much bigger in size and also in having curved marginal hairs. Both *Brachyphyllum* Brongniart and *Pagiophyllum* Heer differ from the present shoots in having triangular or rhomboidal or hexagonal leaves (Kendall, 1947-48) and in having stomata arranged in single files which tend to converge near apex.

Genus — *Conites* Sternberg 1823

Conites sp.

Pl. 6, Figs. 13-14

The description is based on a single fragmentary carbonized specimen. When pieces of cone-scales were macerated in HNO₃, the specimen, however, did not yield any cuticular preparation. A transfer of the whole specimen was also made according to Walton's (1923) method in order to study the cone in detail. In the transfer no pollen sacs or ovules were visible in any of the cone scales.

Cone incomplete, measuring 5 cm. in length and 1.8 cm. in breadth at its broadest region, shape as a whole oval-elongate. Cone-scales spirally arranged, near base smaller in size, somewhat rhomboidal in shape, other cone-scales lanceolate or elongate-lanceolate. Cone-scales mostly keeled. Basal scale measuring 0.3-0.6 cm. in length and 0.2-0.3 cm. in breadth, other cone-scales 0.9-1 cm. in length and 0.2-0.3 cm. in breadth.

Collection — No. 33980.

Locality — Nidpur, Sidhi District, M.P., India.

Age — Lower Triassic.

COMPARISON

In size and overall structure the present specimen resembles most ?*Araucarites sydneyensis* described by Walkom (1925) from

the Narrabeen Stage of Australia. The Australian specimen, however, differs from the present specimen in having much smaller cone-scales.

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EXPLANATION OF PLATES

PLATE 1

Glossopteris nidpurensis sp. nov.

- Fig. 1 — Holotype No. 33909. $\times 1$.
 Figs. 2-3 — *G. nidpurensis*, two stomata magnified; Slide No. 33909-1. $\times 500$.

PLATE 2

- Fig. 1 — *Glossopteris nidpurensis* sp. nov. — showing venation; holotype No. 33909. $\times 3$.
 Fig. 2 — *G. nidpurensis*, showing distribution of stomata; Slide No. 33910-1. $\times 150$.
 Fig. 3 — *Glossopteris* sp. A, specimen No. 33914. $\times 1$.
 Fig. 4 — Figure 3 magnified, showing venation. $\times 2$.
 Fig. 5 — *G.* sp. A, thinner surface, showing distribution of stomata; Slide no. 33914-1. $\times 150$.
 Fig. 6 — *Glossopteris* sp. B, No. 33911. $\times 1$.
 Fig. 7 — Figure 2 magnified, showing venation. $\times 6$.

PLATE 3

- Fig. 1 — *Glossopteris* sp. A, a stoma from the thinner surface; Slide No. 33914-2. $\times 500$.
 Fig. 2 — *G.* sp. A, thicker surface, showing stomatal distribution; Slide No. 33914-3. $\times 150$.
 Fig. 3 — *G.* sp. A, two stomata from the thicker surface; Slide No. 33914-4. $\times 500$.
 Fig. 4 — *Glossopteris* sp. B, showing epidermal cells; Slide No. 33911-1. $\times 500$.
 Fig. 5-6 — *Glossopteris* sp. C, specimen Nos. 33915 (Fig. 5) and 33913 (Fig. 6). $\times 1$.

PLATE 4

- Figs. 1-3 — *Glossopteris* sp. C, specimen Nos. 33916 (Fig. 1), 33912 (Fig. 2) and 33917 (Fig. 3). $\times 1$.
 Fig. 4 — Counter part of specimen figured in Fig. 5 (Pl. 3), showing venation. $\times 2$.
 Fig. 5 — *Glossopteris* cf. *G. linearis* McCoy No. 33973. $\times 1$.

PLATE 5

Rhabdotaenia sp.

- Figs. 1-3 — Specimen Nos. 33920 (Fig. 1), 33923 (Fig. 2) and 33922 (Fig. 3). $\times 1$.
 Fig. 4 — Figure 1 magnified, showing venation. $\times 2$.
 Fig. 5 — A cuticle piece, showing fibres; slide No. 33920-1. $\times 100$.
 Fig. 6 — Thinner side, showing epidermal cells; Slide No. 33922-3. $\times 150$.
 Fig. 7 — Showing stomatal distribution; Slide No. 33923-1. $\times 150$.
 Fig. 8 — A single stoma from thicker side; Slide No. 33922-3. $\times 500$.

PLATE 6

- Fig. 1-3 — *Taeniopteris glandulata* sp. nov. — holotype No. 33965 (Fig. 1) and Nos. 33971 (Fig. 2) and 33967 (Fig. 3). $\times 1$.
 Fig. 4 — *T. glandulata* sp. nov. — showing venation and gland-like circular bodies. No. 33969. $\times 5$.
 Fig. 5 — *T. glandulata* sp. nov. — showing epidermal cells; Slide No. 33971-2. $\times 500$.

- Fig. 6 — *Noeggerathiopsis* sp., 33974. $\times 1$.
Fig. 7 — Figure 6 magnified, showing venation. $\times 3$.
Fig. 8 — Fragmentary conifer shoot, No. 33975.
Fig. 9 — Figure 8 magnified. $\times 2$.
Fig. 10 — Conifer shoot — a piece of cuticle showing epidermal cells; Slide No. 33975-1. $\times 150$.
Fig. 11 — Conifer shoot — a piece of cuticle: showing long, hollow papillae; Slide No. 33975-1. $\times 500$.
Fig. 12 — Conifer shoot — a piece of cuticle showing a stoma; Slide No. 33975-2. $\times 500$.
Fig. 13 — *Conites* sp., No. 33980. $\times 1$.
Fig. 14 — The above in figure 13, magnified. $\times 2$.

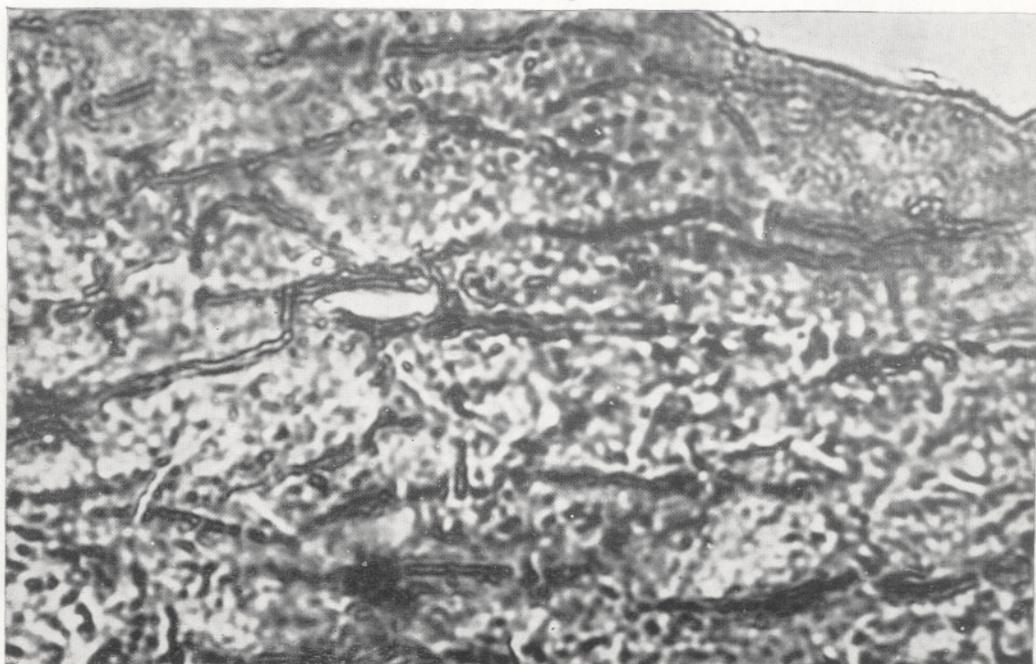


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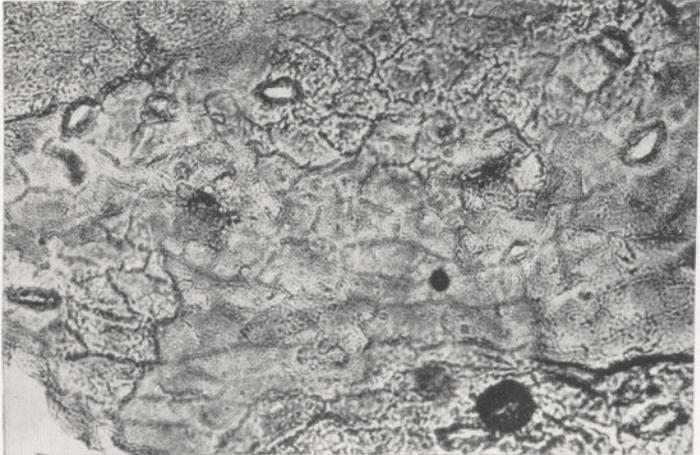




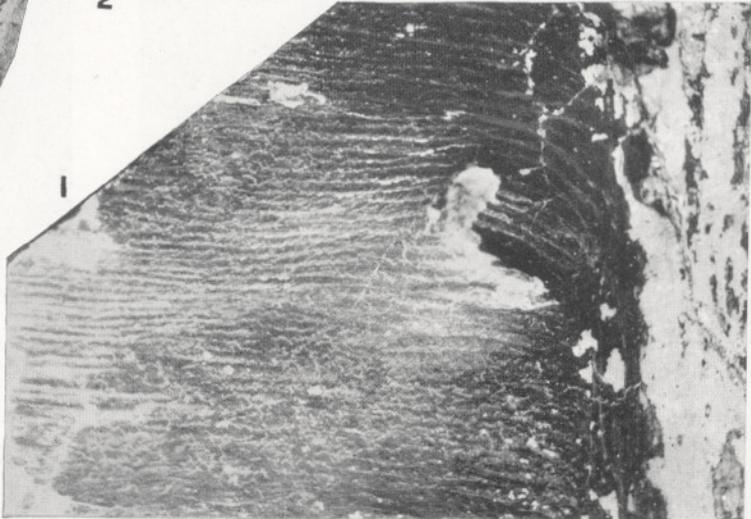
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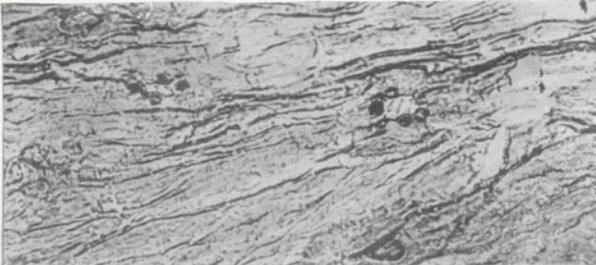
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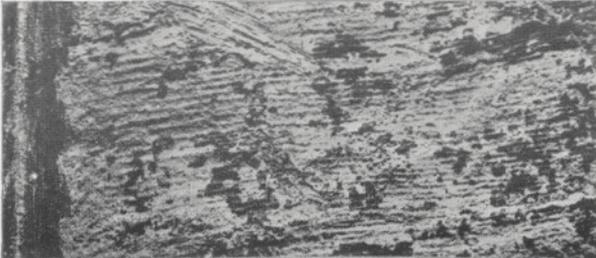
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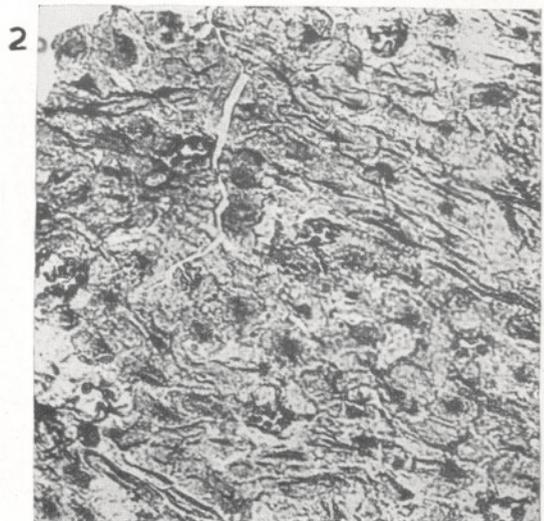
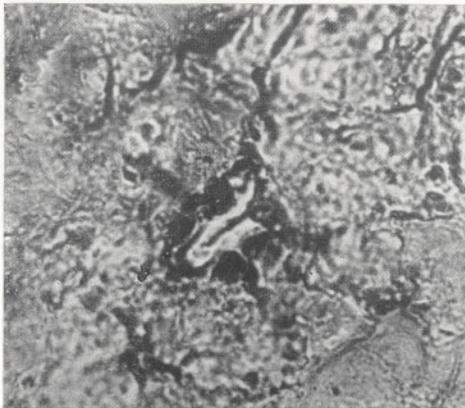
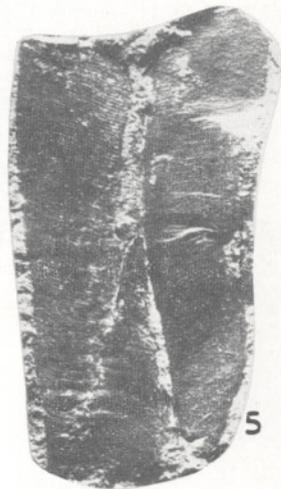
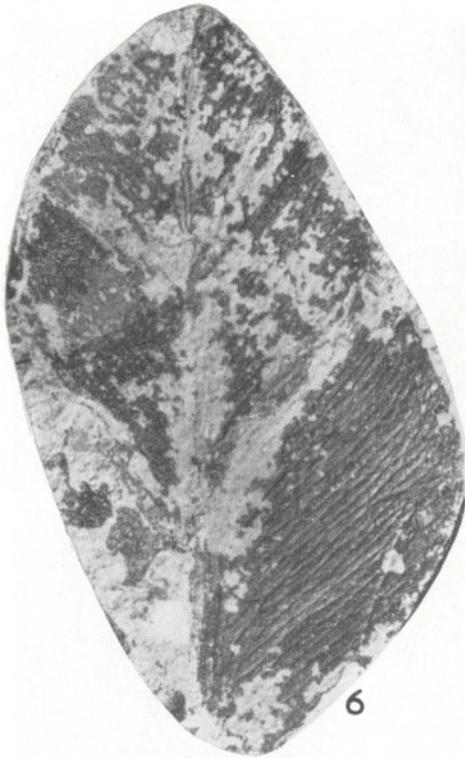
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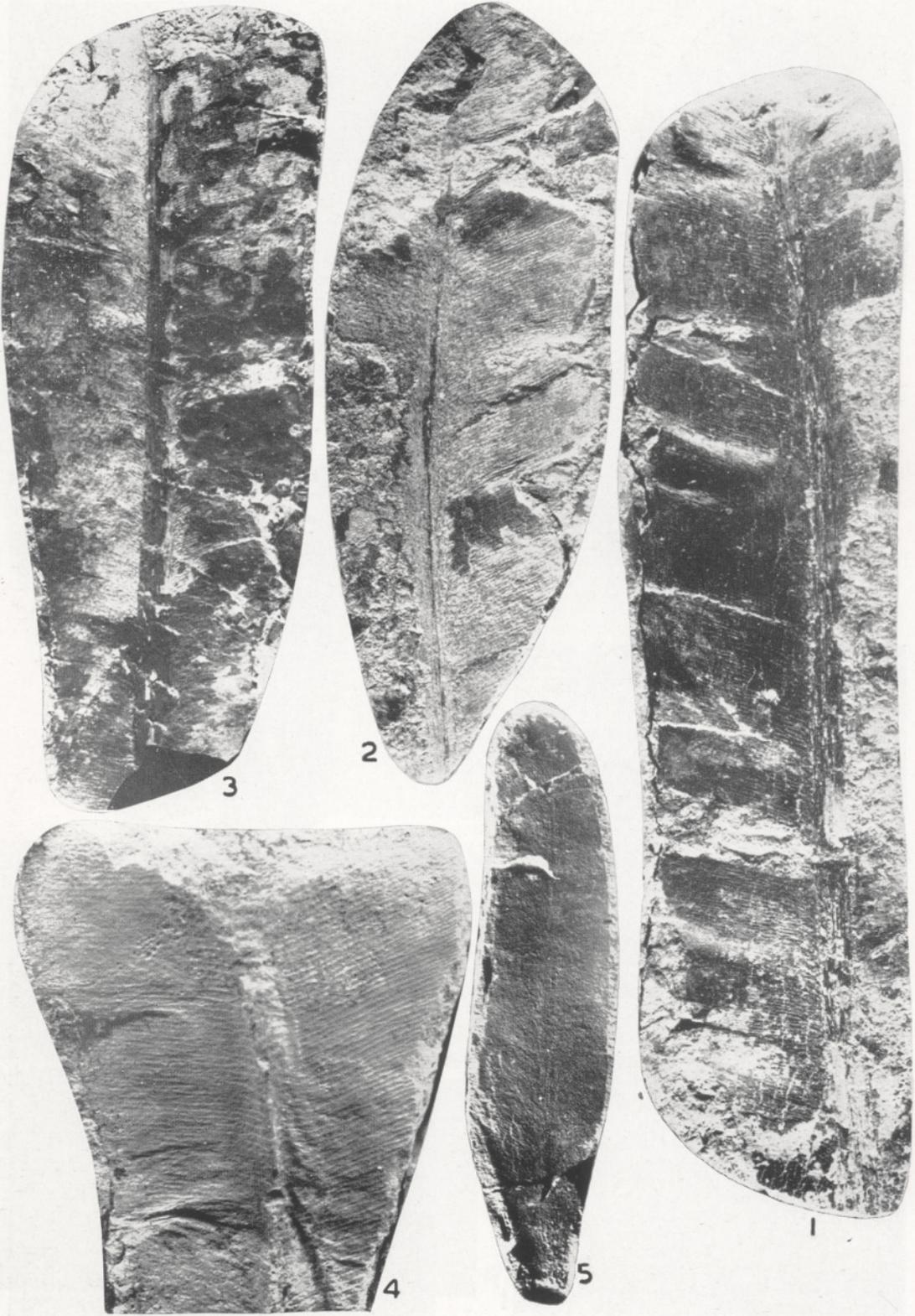


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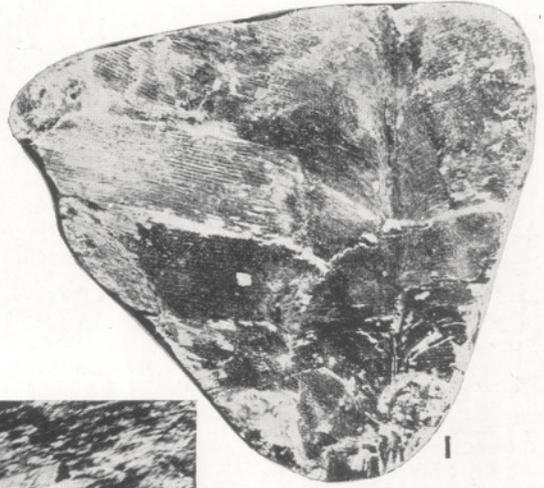
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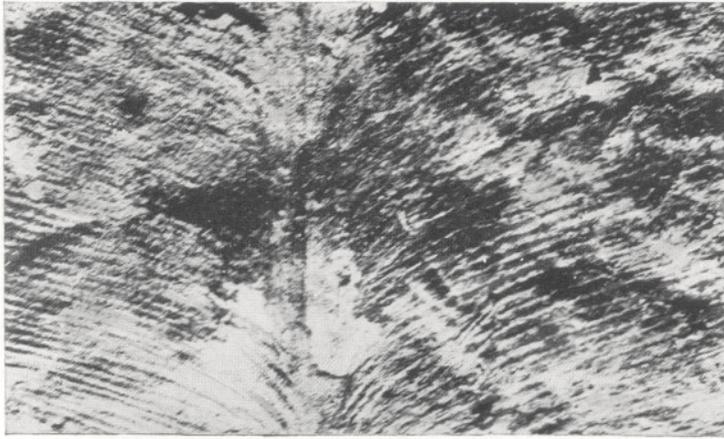




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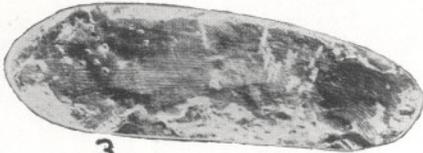
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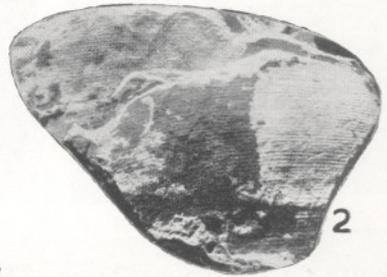
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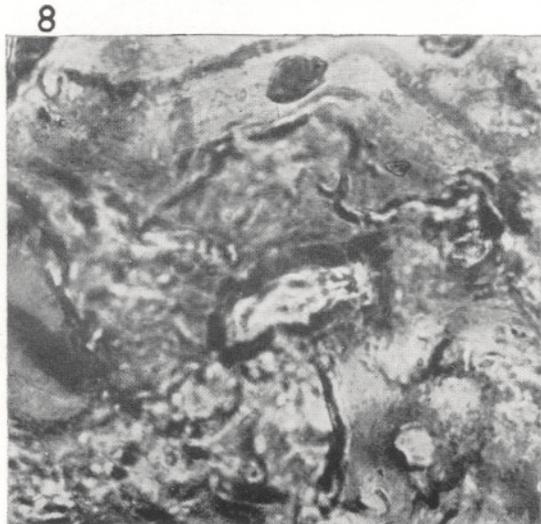
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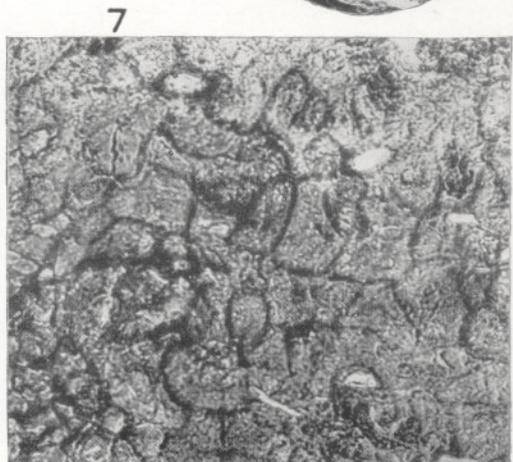
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