

NEW LEAF COMPRESSIONS FROM THE TRIASSIC OF NIDPUR, INDIA

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ABSTRACT

Two new leaf taxa, viz. *Marhwaseaphyllum* and *Rewaphyllum*, based upon their distinctive foliar morphology, have been erected. Both genera are represented in the Nidpur Triassic flora by one species each; *M. hastatum* and *R. nidpurensis*. Further, all those leaves identical to the genus *Rewaphyllum* which were placed under *Dicroidium* sp. from Upper Triassic of Argentina by ARCHANGELSKY (1968) have been described here under a new specific assignment *R. argentinicum*. Moreover, for the leaves from Lower Triassic of Australia, earlier considered as cf. *Odontopteris dubiae*, by BURGESS (1935), a new combination *R. dubae*, has been suggested upon the circumstantial evidence.

It is concluded that the genus *Rewaphyllum* fairly occurs throughout the Triassic of Gondwanaland and has led better to understand the relationship of fossil flora of Nidpur with other Triassic floras.

INTRODUCTION

Foliar remains are widespread in the Triassic outcrop at Nidpur. The known fossil leaf-taxa are : *Glossopteris*, *Rhabdotaenia*, *Lepidopteris*, *Dicroidium*, *Taeniopteris* and *Gopadia* (SRIVASTAVA 1969, 1971, 1974, 1976; BOSE & SRIVASTAVA 1971, 1972). The genus *Dicroidium* is a major component of this flora. Here, the observations carried out upon the leaves lend a distinctive aspect to the morphology of these plant forms and warrant a new generic name for these plant organs. They have been attributed to two new genera, viz., *Marhwaseaphyllum* and *Rewaphyllum*.

Marhwaseaphyllum gen. nov.

Diagnosis—Leaf pinnate, pinnae opposite, spear-shaped, base contracted, terminally reduced to form hastate extremity, margin incised, occasionally indentate or wavy, midrib distinct, giving rise to forked veins, diverging towards pinna-margin.

Cuticle as a whole thin, leaf hypostomatic (recognised by being thicker on one side) ; thicker surface non-stomatiferous, marked distinctly, cells polygonal or rounded having lateral- and by vein cells and interveinal cells, end-walls variously thickened, surface uneven; thinner side bearing stomata in interveinal region, cells polygonal or elongated, lateral and end-walls thin, finely undulated or straight, surface uneven or smooth, stomata longitudinally or obliquely orientated, subsidiary cells 5 or 6, generally flush with fusiform stomatal pit ; guard-cells with lenticular or elliptical aperture.

Type Species—*Marhwaseaphyllum hastatum* gen. et sp. nov.

Marhwaseaphyllum hastatum sp. nov.

Pl. 1, Figs. 1-7; Text-fig. 1A-I

Diagnosis—Pinnate leaf, rachis stout, pinnae arranged in opposite direction, closely set, overlapping each other on basisopic side, base contracted, terminally reduced to form hastate extremity, spear-shaped, margin lobed or incised, occasionally



Text-fig. 1. A. *Marhwaseaphyllum hastatum* gen. et sp. nov.) General aspect of Holotype No. 35500. $\times 2$. B. A few pinnae of Holotype magnified to show the venation and lobate margin $\times 4$. C. Both surfaces attached to primary rachis, showing distinctly non-stomatic and stomatic side. $\times 250$. Slide no. 6962/35500. D. Epidermal cells along primary rachis. $\times 250$. Slide No. 6965/35500. E. Epidermal cells of non-stomatic side showing unevenly thickened anticlinal walls. $\times 250$. Slide no 6968/35500. F. A few irregularly orientated stomata. $\times 250$. Slide no. 6967/35500. G, H, I. Each stoma showing varied stomatal pit and degree of cutinization $\times 250$. Slide Nos. 6962/35500, 6966/35500, & 6962/35500, respectively.

indentate or notched at times in basal region wavy or repand, midrib prominent becoming evanescent towards apical portion, veins originating from midrib and giving rise to forked secondary veins, diverging extremities terminating at pinna-margin.

Cuticle extremely thin, recognised by non-stomatiferous and stomatiferous surfaces, hypostomatic, thicker side devoid of stomata, cells over the veins usually rectangular, end-walls straight, surface smooth; cells in interveinal region generally polygonal more often rounded having corners thickened like those of collenchymatous elements, lateral-and end-walls variously thickened giving beaded-like appearance, surface usually uneven, sometimes smooth, occasionally bearing hollow papillae, broken by pits, rarely laminated.

Thinner side bearing stomata in inter-veinal region, cells along the veins distinctly marked, cells in between veins polygonal or elongated, lateral-and end-walls finely undulated or straight, surface smooth or uneven bearing at places fine laminations or crescent-shaped or rounded hollow papillae, at times emergence of minute projections from lateral- and end-walls marked, usually stomata sparsely distributed sometimes lying side by side, longitudinally or obliquely orientated, subsidiary cells 5-6 in number, a few showing feebly developed papillae, not differentiated from ordinary epidermal cells, occasionally distinct, generally flush with fusiform stomatal pit, guard-cells apparent, aperture lenticular or elliptical at times with wide opening.

Rachis-cuticle—Cells rectangular or elongated polygonal, lateral- and end-walls straight, at places, end-walls oblique, surface smooth, sometimes thickenings present along the side of cell-walls; stomata longitudinally placed surrounded by irregular 5 subsidiary cells.

Holotype—No. 35500 of Birbal Sahni Institute of Palaeobotany, Lucknow.

Locality—Near Nidpur, Gopad River Valley, Sidhi District, Madhya Pradesh, India.

Age—Triassic.

Comparison and Discussion

The general form and the epidermal structure of the leaf of *Marhwaseaphyllum* resemble in certain respects to that of some leaves of pteridosperm complex, e. g. *Thinnfeldia* Ettingshausen, *Scytophyllum* Bornemann, *Lepidopteris* Schimper and *Dicroidium* Gothan. With these Mesozoic leaf genera when a detailed comparison of *Marhwaseaphyllum* is made that shows that *Thinnfeldia* can be distinguished by having a neat collar of small even-sized subsidiary cells whereas *Lepidopteris* is distinctly different by its blister-like swellings on the rachises and also in bearing radially symmetrical and papillae-overhanging stomata. Further, *Dicroidium* sharply contrasts from *Marhwaseaphyllum* in being an amphistomatic leaf. Besides, *Pachypteris* and *Scytophyllum* are radically different from the later in possessing papillae or cutinized lappets over stomatal pit. However, *Pachypteris* also differs in having slightly specialized and rather irregular subsidiary cells showing surface markings from ordinary epidermal cells. Apart from these, megascopically *Marhwaseaphyllum* presents a close agreement with *Thinnfeldia hastata* Douglas 1969 from Liassic of Australia, in its spear-shaped pinna, but the later is readily distinguishable by having deeply incised pinna in basal part and in the presence of trichomes on both the surfaces.

Rewaphyllum gen. nov.

Diagnosis—Bipinnate leaf, pinnae elongate-lanceolate, pinnately lobed, arranged

opposite-subopposite, laterally inserted, base decurrent, basispic margin contiguous, margin lobate, uneven or sinuous; pinnules ovate or orbicular, at times longer than wider, attached by whole base, at times partly united by adjacent pinnules, microscopically margin finely undulated, apex obtuse or rounded, venation consisting of one decurrent vein running upto apex; leaf amphistomatic, epidermal cells polygonal tending to be rectangular or elongated, lateral and end-walls uneven or straight, surface mottled or smooth, sometimes bearing single rounded papillae, stomata irregularly distributed, usually longitudinally oriented, rarely irregular, subsidiary cells 5-7, irregularly placed, occasionally subcircular, more often surface smooth or papillate, stomatal pit rectangular or oval, stomata devoid of papillae or papillae overhanging stomatal pit, guard-cells sunken, aperture slit-like or elliptic.

Type Species—*Rewaphyllum nidpurensis* gen. et sp. nov.

Rewaphyllum nidpurensis sp. nov.

Pl. 2, Figs. 1-6; Text-figs 2A-I

Diagnosis—Bipinnate leaf, rachis marked by irregular minute tubercles, pinnae rachis conspicuously grooved, pinnae elongate and narrow, lobed and pinnate, opposite to sub-opposite in arrangement, laterally inserted, 3-4 mm apart, base decurrent, margin lobate or slightly undulated, acroscopic margin constricted, basispic margin contiguous, in general pinna-lobation irregular, towards distal portion incision incomplete, near apex pinnae-margin entire or very slightly uneven, in basal region pinnules well-marked, basalmost pinnule largely borne directly on rachis, usually pinnules ovate or orbicular, attached by whole base, mostly separate, at times partly united with adjacent pinnules at base, margin microscopically undulated or rounded, venation not discernible.

Cuticle about 1 μ m thick, distinguished by two surfaces (one of the two slightly thicker), amphistomatic, on thinner side stomata fewer, towards apical region slightly more in number, epidermal cells rectangular-polygonal, lateral-and end-walls straight or bearing minute projections along the margin, surface mottled, cells over the veins marked by rectangular cells having lateral and end-walls thickened, at places unusual thickening looking like a fold of semilunar shape, midvein cells considerably much thickened giving a beaded appearance, generally surface-wall superficially bearing irregular pits on both sides, sometimes around the pits thickened, outline distinct, at times appearing somewhat star-shaped representing possibly a trichome-base, trichome unicellular, commonly emerging from the side-walls, frequently occurring on thinner side, stomata irregularly distributed, usually longitudinally oriented, infrequently irregular, subsidiary cells 5-6 in number, usually 5, wedge-shaped or irregular in shape, occasionally sub-circular, more often surface smooth or mottled, stomatal pit rectangular or oval, rarely dumb-bell-shaped, inner-wall or subsidiary cells cutinized, papillae overhanging or projecting over pit, sometimes papillae feebly developed or only bulging towards pit, at times giving a thickened rim around pit, guard-cells deeply sunken, aperture elliptic or slit-like, sometimes slightly thickened near opening.

Rachis-Cuticle—Primary and secondary rachises identical in their epidermis, epidermal cells elongated rectangular, having thickened lateral walls, end-walls occasionally oblique, surface smooth or hairy, more often irregular pitting or hair bases frequent, at places longitudinal cutin ridges present, stomata scattered, longitudinally oriented, stomatal apparatus similar to that of leaf.



Text-fig. 2. *Rewaphyllum nidpurensis* gen. et sp. nov., A. Bipinnate leaf Holotype No. 35501. B. Primary rachis-cells elongated rectangular having at places unusually thickened anticlinal walls; stoma longitudinally placed; along both the sides of rachis, lamina surface showing irregularly distributed and orientated stomata. $\times 100$. Slide No. 6887/35501. C. Secondary-rachis-cells rectangular or polygonal having anticlinal walls unevenly thickened or occasionally broken with pits; periclinal walls showing frequent presence of numerous (unicellular) trichomes $\times 150$. Slide no. 6961/35501. D, E. Each stoma showing degree of cutinization and papillae overhanging pit, at times completely concealing aperture. $\times 150$ & $\times 250$ respectively. Slide Nos. 6886/35501 & 6889/35501. F-G. Stomata devoid of papillae, at places papilla feebly developed or cutinized bulging projecting towards pit. $\times 150$. Slide No. 6885/35501. H. Epidermal cells showing emergence of trichomes. $\times 150$. Slide No. 6889/35501. I. Primary rachis cells traversed by rounded depressions representing trichome bases. $\times 250$. Slide No. 6960/35501.

Holotype—No. 35501 of Birbal Sahni Institute of Palaeobotany, Lucknow.

Locality—Near Nidpur, Gopad River Valley, Sidhi District, Madhya Pradesh, India.

Age—Triassic.

Comparison and Discussion

The investigation of leaf genus *Rewaphyllum nidpurensis* has led to a better understanding of the relation between Triassic flora of Nidpur and that of Argentina and Australia because it is very interesting to find that the specimens described as *Dicroidium* sp. by ARCHANGELSKY (1968) from Middle-Upper Triassic (Ischigualasto Formation), San Juan, Argentina, are practically identical barring a few minor characters, to that of *R. nidpurensis*, as evidenced by morphography and cuticular features. Further the leaves described under *Dicroidium* sp. by ARCHANGELSKY (1968) in its gross characters like general shape of pinnae, pinnae lobation, pinnules structure, their disposition, amphistomatic nature, nature of cell-walls, stomatal distribution and orientation, presence of hair, position and number of subsidiary cells and stomatal pit with or without overhanging papillae, merit largely its identity with that of *Rewaphyllum*. However, *R. nidpurensis* differs from the former in less constant characters like thickness of cuticle and in having generally papillate surface-wall of lamina and rachis. On account of this structural unanimity it is herewith proposed that the Argentinian leaves belong to the leaf genus *Rewaphyllum* under a new specific assignation, i. e. *R. argentinicum*. Besides there are some leaves (specimen V. 20871 from Upper Triassic of Argentina, FRENGUELLI (1937) which have been considered by TOWNROW (1957) as to be abnormal specimen of *D. odontopteroides* because their epidermis also demonstrates papillae overhanging stomatal pit associated with stomata devoid of papillae, a notable feature of *R. nidpurensis*. This is further noteworthy that TOWNROW (1957, p. 37, 3B, 4H, 5D, 6M) while figured the specimen and the legends of their epidermal structure, has pointed out it to be a comparable form of (cf.) *Odontopteris dubiae* described by BURGESS (1935) from Narra-been stage of Hawkesbury Sandstone, Australia. Seemingly, these forms are also structurally identical with that of *Rewaphyllum* except for the hairy character of rachis and the leaf. Conclusively, the features which could be made out from the text-figures are suggestive of a new combination i. e. *Rewaphyllum dubiae* comb. nov. However, its systematic description is not being given here until the original description and the figures are checked. Upon this circumstantial evidence only, in the Gondwanaland range of the genus *Rewaphyllum* could be determined from Lower Triassic-Upper Triassic with its representation fairly well in the Triassic of Argentina. Apart from these forms, *Rewaphyllum nidpurensis* in shape of pinnae also resembles *D. superbum* (Shirley) Townrow (1957) from Australia, but the epidermis of the former shows some differences mainly in the stomatal apparatus that is no papillae overhanging stomatal pit are known in the latter. Normally such papillae occur all over the surfaces of *Lepidopteris* leaf but for other reasons like presence of blisters or lumps over the rachis, pinnae being not alike in shape and having in general, radially symmetrical stomata, the leaf *Rewaphyllum* can sharply be distinguished from the former. However, in *Rewaphyllum*, stomatal apparatus often tends to be oval. Additionally, in its general disposition, shape and lobation of pinnae, *R. nidpurensis* comes closer to *Pachypteris austrepapillosa* Douglas (1969) from L. Cretaceous of Australia, *P. crassa* (Halle) Townrow (1965) from Rhaeto-Liassic of Tasmania but the latter forms are quite different by predomi-

nantly having stomata on one surface. However, in bearing papillae overhanging stomatal pit, *R. nidpurensis* demonstrates similarity with that of *P. crassa*, but from the former, *P. austropapillosa* can be distinguished by having high frequency of subsidiary cells and a very thick rim around the pit associated with a thinner flange concealing much of pit. Further, *R. nidpurensis* may also be compared in its phenotypic appearance with that of *Pachypteris* cf. *austropapillosa* described by FLINT AND GOULD (1975) from the Upper Triassic of Red Cliff Coal Measures, N. S. W. Australia. Since these leafy forms lack epidermal details, at this juncture, it could be only said that there is greater possibility for these Red Cliff leaves to belong to the genus *Rewaphyllum* than those of *P. austropapillosa* because the former, as the records reveal, is frequent only in the Triassic of Gondwana countries.

***Rewaphyllum argentinicum* sp. nov.**

Dicroidium sp. Archangelsky, 1968, p. 508; pl. 97, fig. 4; Text-figs. 1C, 2C

Diagnosis—Detached pinnae, pinnae elongate-lanceolate, lobed and pinnate, pinna-rachises channelled, incised in basal region, distally showing narrow acute apex, pinnules usually longer than wider, ovate-lanceolate in shape, attached by whole base, occasionally contiguous, margin lobed or sinuous, apex obtuse or more or less bluntly pointed, venation consisting of one vein running up to apex. Cuticle evenly thick, up to 10 μ in thickness, one surface slightly thinner, amphistomatic, epidermal cells usually isodiametrical except over the veins where tending to be rectangular or elongated, lateral-and end-walls straight and thick and generally surface smooth sometimes bearing single round papillae, papillae at times hollow, towards margin papillae becoming high, usually unicellular trichomes present, stomata irregularly distributed and orientated, stomatal apparatus tending to be oval or subcircular, imperfectly dicyclic, subsidiary cells 4-7 in number not differentiated into polar and lateral cells, wedge shaped or irregular, each bearing characteristically either round or slightly elongate papilla, papillae usually overhanging mouth of pit, almost closing it, pit square or rectangular sometimes oval, guard cells sunken, slightly thickened near aperture.

Rachis-cuticle—Epidermal cells elongated forming definite longitudinal rows, surface showing presence of strongly developed papillae, longitudinal cutin ridges present.

Holotype—Slide Nos. LP 428, LP 432.

Locality—LIL 509-15 (beds 1, 3, 4 & 6), Ischigualasto Basin, San Juan Province, Argentina.

Age—Middle to late Triassic, (Ischigualasto Formation, Agua de la Pena Group, Argentina).

Comparison and Discussion

R. argentinicum when compared with *R. nidpurensis* can easily be differentiated from the latter in having a thick cuticle, irregularly oriented stomata, bearing occasionally surface-wall with varied papillae and also in higher frequency of subsidiary cells. Rachises of both the species also differ because in the former the cells are papillate whereas in the latter the rachis is smooth or unsculptured. Among other forms *D. superbum* too, resembles *R. argentinicum* in its grooved rachis, incipient lobing of pinnae, generally papillate nature of surface-wall and wedge-shaped subsidiary cells

but the later is at once distinguished because of occasional presence of protective papillae over stomatal pit and in possessing trichomes over leaf and rachis.

RELATIONSHIP

The probability that these leaves are a member of Pteridosperm Group, is largely based upon the evidence of veins being two or more times pinnate and their diverging manner, tendency of lamina of pinnae to be strongly decurrent on to the rachis, are some of the external characters in conjunction with cuticular features which emphasize the fact for *Marhwaseaphyllum* and *Rewaphyllum* to be of Pteridospermophyta.

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Addendum

Dicroidium giarensis reported recently from upper Triassic bed of Giar, M. P. (Pal, 1984 ; *Palaeobotanist*, vol. 32, p. 271) should now find a place in *Rewaphyllum* due to its close similarity with the latter.



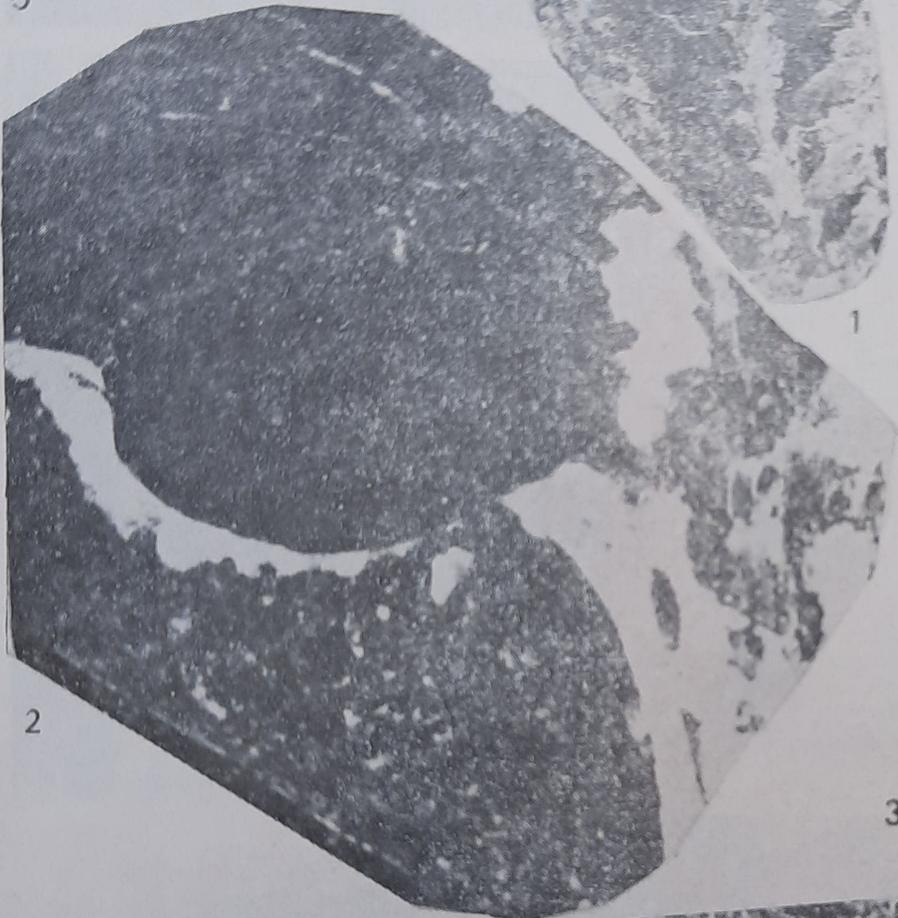
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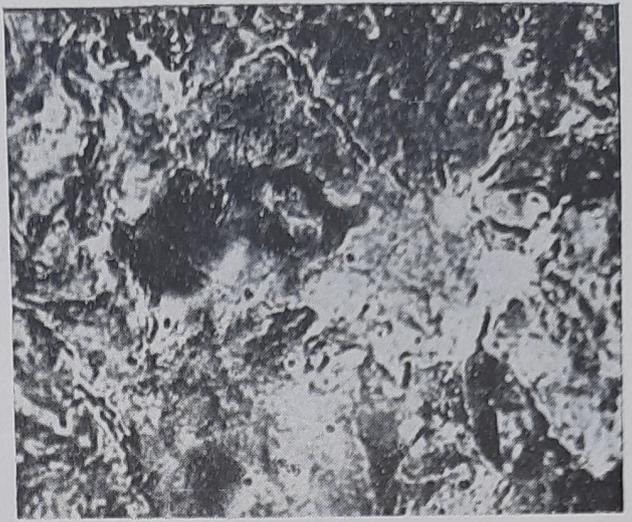
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2



EXPLANATION OF PLATES

PLATE 1.

Murhwaseaphyllum hastatum gen. et sp. nov.

1. Leaf showing pinnatifid nature of pinnac. Holotype No. 35500. \times nat.
2. Holotype enlarged to show venation of lobed pinnac. \times 8.
3. Non-stomatiferous side showing epidermal cells with rounded corners and unusually thickened anticlinal walls. Slide No. 6963/35500. \times 300.
4. Stomatiferous side showing a few variously orientated stomata along the side of midrib which is consisting of narrower, elongated rectangular cells. Slide No. 6963/35500. \times 300.
- 5 & 6. Single stoma, both showing variations in subsidiary cells and stomatal pit. \times 500. Slide Nos. 6964/35500, 6962/35500 respectively.
7. Primary rachis-epidermal cells \times 500. Slide No. 6962/35500.

PLATE 2.

Rewaphyllum nidpurensis gen. et sp. nov.

1. Bipinnate leaf showing disposition of pinnae and degree of its pinnate nature. Holotype, No. 35501. \times nat.
2. Pinna-rachis consisting of rectangular epidermal cells traversed by unicellular trichome, occasionally presence of irregular or somewhat rounded depressions frequent over the periclinal walls; along the side of pinna rachis a few epidermal cells of lamina bearing stomata visible. \times 200. Slide no. 6888/35501.
3. Primary-rachis cells with unusual thickening of anticlinal walls, at places minor folds frequent; a stoma with highly cutinized inner wall of subsidiary cells having protective papillae over stomatal pit distinct. \times 200. Slide No. 6887/35501.
4. Lamina surface showing a few stomata with papillae projecting over stomatal pit and some distinctly devoid of papillae; presence of trichomes quite common over the periclinal walls. \times 200. Slide No. 6888/35501.
5. Single stoma with papillae overhanging stomatal pit. \times 300. Slide No. 6886/35501.
6. A stomatal apparatus showing stoma devoid of papillae, subsidiary cells specialized with their inner walls cutinized. \times 300. Slide no. 6885/35501.