

On the genera *Pantophyllum*, *Euryphyllum* & *Kawizophyllum* from Karanpura and Bokaro coalfields, India

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ABSTRACT

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The paper contains description of a new species of *Pantophyllum* (*P. gidiensis* sp. nov.) and further investigations made on a species of *Euryphyllum* (*E. whittianum*). The cuticle of *Euryphyllum whittianum* is a new contribution. Besides, paper also includes two species of genus *Kawizophyllum* viz. *K. dunpathriensis* sp. nov. and *K. barakarensis* sp. nov. *Kawizophyllum* is a characteristic fossil of Dunpathri Member of the Mamal Formation in Kashmir but now found in South Karanpura Coalfield constitute only record from the peninsula.

Key-words— *Pantophyllum*, *Euryphyllum*, *Kawizophyllum dunpathriensis*, Karanpura, Bokaro, India.

भारत के करनपुरा एवं बोकारो कोयला क्षेत्रों से प्राप्त पन्तोफिल्लम, यूरीफिल्लम एवं काविजोफिल्लम वंशों के बारे में

शिवमोहन सिंह

सारांश

प्रस्तुत शोध पत्र में पन्तोफिल्लम (पी. गिडिएन्सिस नव प्रजाति) की एक नई प्रजाति तथा यूरीफिल्लम (ई. हिटिएनियम) की एक प्रजाति के बारे में किये गये अनुसन्धानों का वर्णन किया गया है. यूरीफिल्लम हिटिएनम के उपचर्म एक नई उपलब्धि हैं. इसके अतिरिक्त इस शोध पत्र में काविजोफिल्लम वंश की दो प्रजातियों के. दुनपथरिएन्सिस एवं के. बराकरेन्सिस नवप्रजातियों का भी अध्ययन किया गया है. काविजोफिल्लम, जो कश्मीर में मैमल शैलसमूह के दुनपथरी सदस्य का अभिलाक्षणिक पादपाश्म है, दक्षिणी करनपुरा कोयला क्षेत्र से प्राप्त हुआ है तथा यह प्रायद्वीप से प्राप्त एक मात्र अभिलेख है .

संकेत शब्द— पन्तोफिल्लम, यूरीफिल्लम, काविजोफिल्लम दुनपथरिएन्सिस, करनपुरा, बोकारो, भारत.

INTRODUCTION

PANTOPHYLLUM, *Euryphyllum* and *Kawizophyllum* are exclusively gondwanan leaf form-genera. Among these *Pantophyllum* and *Euryphyllum* are reported from numerous Gondwana basins in strata ranging from Upper Carboniferous to Upper Permian (Rosler, 1978; Archangelsky *et al.*, 1980; Archangelsky & Cuneo, 1984; Archangelsky & Azcuy 1985), while *Kawizophyllum* is a characteristic fossil of Dunpathri Member of Mamal Formation in Kashmir (Kapoor, 1979). *Pantophyllum* (= *Noeggerathiopsis*) appears to have reached peak abundance during the Late Carboniferous and Early Permian (Lecle & Maithy, 1964; Archangelsky *et al.*, 1987). The name *Pantophyllum* was instituted by Rigby (1984) and adopted by Bajpai (1992) as a generic name *Pantophyllum* Rigby for all *Noeggerathiopsis spatulata*-type leaves.

The latter genus was instituted by Feistmantel (1879) on the basis of a specimen showing a single large woody stem with round leaf scars and two leaves, which although not attached to the stem, were lying in a position that showed an apparent relationship. The leaves are asymmetrical, ovate, spatulate in shape, have asymmetrical rounded apex, gradually contracted base, median sub-parallel veins and arched, dichotomising lateral veins.

Arber (1905) considered that the venation characters, i.e., arching of lateral veins, of these leaves are not sharp enough for distinguishing them from that of *Noeggerathiopsis*. He, therefore, merged this genus under *Noeggerathiopsis*. However, Seward and Sahni (1920), Maithy (1965), Plumstead (1975), Pant (1982) and Srivastava (1992) consider *Euryphyllum* to be a distinct genus. According to these authors the leaves of *Noeggerathiopsis* do not possess arching lateral veins, leaves of the genus *Euryphyllum* are asymmetrical while those of *Noeggerathiopsis* are symmetrical.

Feistmantel (1879) regarded *Euryphyllum* as being related to conifers; but recognised a possible relationship with *Noeggerathiopsis*. The leaves are similar to those of *N. hislopii*, but differ in their more spatulate and slightly asymmetrical lamina and in more divergent and numerous forked veins.

Kapoor (1979), in his reappraisal of Gondwana of Kashmir Valley, illustrated several hand specimens, one of which (Kapoor, 1979, pl. 170, fig. 2) was casually named as *Kawizophyllum dunpathriensis* gen. *et* sp. nov.; neither a

description nor a diagnosis was provided. As such under the articles of International Code of Botanical Nomenclature, the name is invalid. On a re-examination of Kapoor's collection, from the lower 3 metres of the grey shale exposed near the junction of Hodsar Nar and Kawiz Nar, ½ km east the Mamal Village (34°01' north latitude: 75°18' east longitude), several more specimens were found resembling the one figured by him. In a recent collection, from the shales associated with the Naditoli Seam mined in the Sirka Colliery, South Karanpura Coalfield, Bihar, another bunch of similar specimens, but with a carbonified crust were recovered. On the account of characters displayed by all such specimens it is opined that the genus *Kawizophyllum* merits the rank as an independent taxon, and the genus is validated by providing a diagnosis and a type species, in the present communication.

GEOLOGY

The Karanpura Coalfields, situated between the Hazaribagh and Ranchi plateau, lie between 85°28' - 84°46' east longitude and 23°38' - 23°50' north latitude. The total area of the coalfield is about 1400 sq. km of which 190 sq. km lies in the southern part of the coalfield which is separated by a narrow bridge of Archaean rocks from the northern part. The northern and southern fields, however, are connected by a narrow corridor comprising Talchir rocks. The northern and southern fields initially were named as Hoharo and Tungi fields, respectively by Williams and Ball. The area was extensively mapped by Jowett (1925). Officers of the Geological Survey of India have remapped/resurveyed the area and have revised its geology (Mchta *et al.*, 1967; Raja Rao, 1987). The present collection was made from Sirka and Gidi Collieries of South Karanpura, Sarubera Colliery of West Bokaro Coalfield and Rikba plant bed of North Karanpura Coalfields. The assemblage mostly comprises other plant fossils viz., *Gangamopteris* spp., *Glossopteris* spp., seeds & fructifications.

MATERIAL AND METHODS

The specimens of the genera *Pantophyllum*, *Euryphyllum* and *Kawizophyllum* were collected from the shales associated with different coal seams spread within the Karanpura and West Bokaro coalfields. The specimens are preserved mostly as impressions, sometimes as compressions with preserved cuticles. The shales are grey and carbonaceous. The specimens

PLATE I

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| <p>1,2 <i>Euryphyllum whittianum</i> Feistmantel 1879. Specimen nos. BSIP 38434, 38435. Barakar Formation, Sarubera Colliery, West Bokaro Coalfield, Bihar. x nat size</p> <p>3 <i>Euryphyllum whittianum</i>. Specimen no. BSIP 38436. Barakar Formation, Gidi A Colliery, South Karanpura Coalfield, Bihar. x nat. size.</p> <p>4,5 Stomatiferous cuticle of <i>Euryphyllum whittianum</i> showing stomata ar-</p> | <p>ranged in linear rows. Specimen no. BSIP 38436. x 200.</p> <p>6 Stomatiferous cuticle of <i>Euryphyllum whittianum</i>, Specimen no. BSIP 38436. x 100.</p> <p>7 Cuticle of the stomatiferous surface of <i>Euryphyllum whittianum</i>, note papillae of the subsidiary cells overhanging the stomatal pore. Specimen no. BSIP 38436. x 400.</p> |
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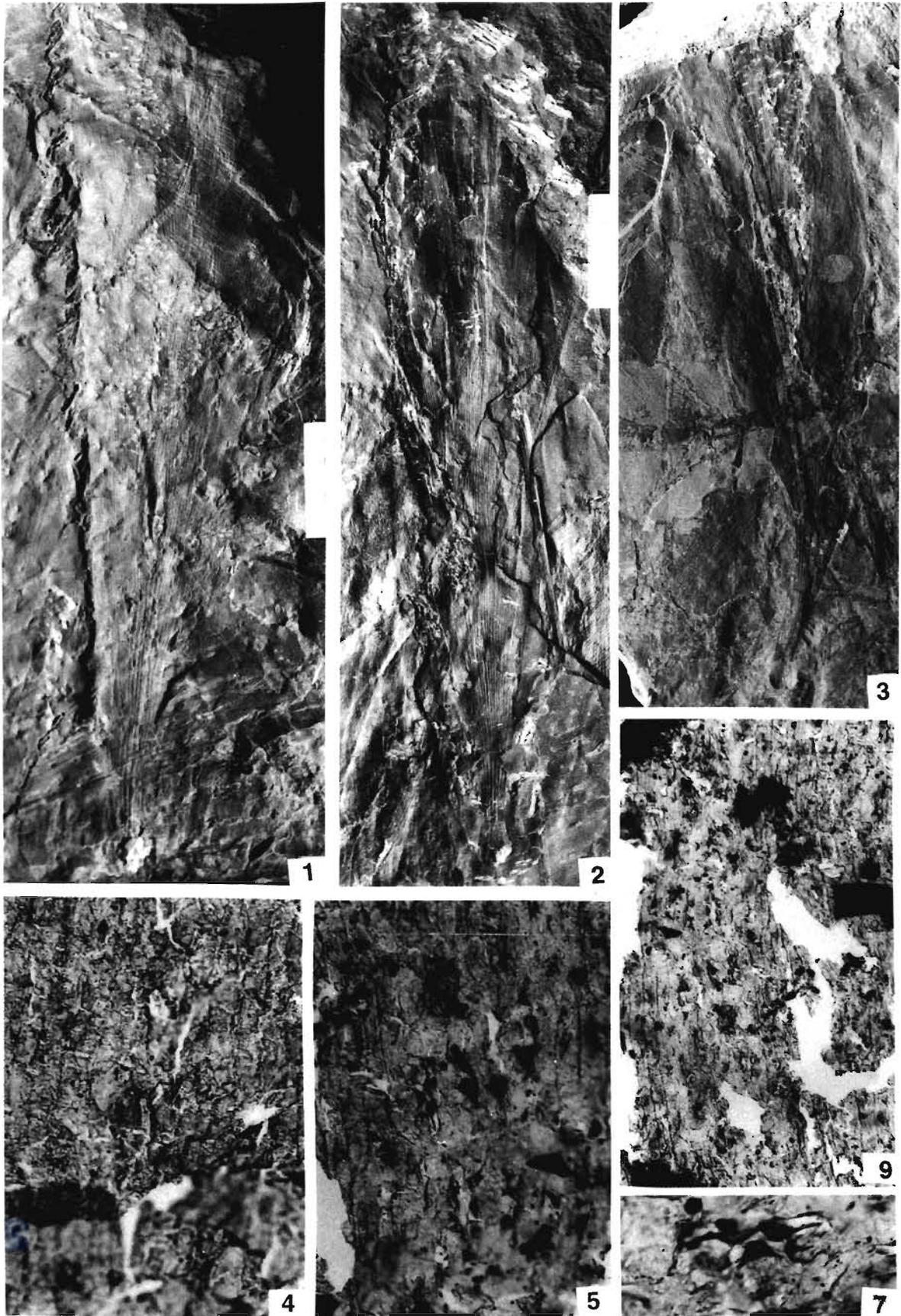


PLATE 1

were collected from Barakar Formation. The method used for present study included cleaning and sorting of specimens, study of surface topography, cuticular preparations, maceration and photography. The specimens used in the present study have been kept in the repository of Birbal Sahni Institute of Palaeobotany, Lucknow.

For preparation of cuticles a few drops of cellulose acetate solution (cellulose flakes + acetone) were placed over small patches of midrib and laminar regions of the leaves chosen for study with the help of a thin glass rod or a needle. The cellulose peel when dry, was lifted with the help of a needle and a pair of tweezers and oxidised in concentrated HNO₃ in petridishes. When the crust turned brown, it was washed several times with water so as to completely remove the acid. The washed crust was then cleared with 5% KOH solution to separate the upper and lower cuticles. The cuticle was then washed with water and mounted in Canada Balsam with polyvinyl alcohol.

SYSTEMATICS

GYMNOSPERMS

Genus—*PANTOPHYLLUM* Rigby, 1984

Species—*PANTOPHYLLUM GIDIENSIS* sp. nov.

Pl. 1·1-5, Pl. 3·1, 2

Specimen nos.—BSIP 38437, 38438, 38439, 38440, 38441.

Locality—Rikba Plant Bed, North Karanpura Coalfield; Gidi-A Colliery, South Karanpura Coalfield.

Horizon—Talchir and Barakar formations.

Holotype—BSIP specimen no. 38437, shales associated with Argada Seam, Barakar Formation, Early Permian; Gidi-A Colliery, South Karanpura Coalfield, Bihar.

Description—Simple leaf.

Shape—spathulate (Pl. 1·1-5).

Size—length 5-16·5 cm, width 3·5-4·2 cm.

Apex—probably broad obtuse.

Base—narrow, tapering.

Margin—entire.

Venation—Veins strong, about 4 veins enter the base, frequently dichotomise, veins in the middle almost subparallel, those near the margins slightly arched, generally pass on straight towards the broadly rounded apex. vein frequency 9-20 per cm in different regions of the lamina (Pl. 3·1, 2).

Cuticle—Carbonified crust present, but did not yield cuticle.

Comparison—In overall shape the specimens resemble most *Pantophyllum indica* Maithy; the latter, however, has relatively coarser venation.

Diagnosis—Leaves simple, spatulate in shape, with broadly rounded apex and narrow tapering base, and entire margin; about 4 veins enter the base, dichotomise but do not anastomose, about 20 per cm in the broadest part of the lamina [Cuticle not known].

Genus—*EURYPHYLLUM* Feistmantel 1879

Species—*EURYPHYLLUM WHITTIANUM* Feistmantel 1879

Pl. 2·1-7, Pl. 3·3

Specimen nos.—BSIP 38434, 38435, 38436.

Locality—Sarubera Colliery, West Bokaro Coalfield, Gidi-A Colliery, South Karanpura Coalfield.

Horizon—Barakar Formation.

Description—Simple leaf (Pl. 2·1-7).

Size—length 11-15 cm, width 3-4 cm.

Apex—probably rounded or acute.

Base—narrow tapering.

Margin—entire.

Venation—Veins strong, about 4 veins emerging from the base, veins in the median region subparallel, those on either side of median region arching towards the margins, frequently dichotomising but never anastomosing, reaching a frequency of 30-35 veins per cm at the apex (Pl. 3·3, 4).

Cuticle—Cuticle of both the surfaces has been recovered. The cuticle is amphistomatic. However, on one of the surfaces, the stomata are extremely rare, the cells are long rectangular and arranged end-to-end. On the other surface, the stomata are distributed in longitudinal rows between the veins and are mostly oriented longitudinally. The subsidiary

PLATE 2

1-3 *Pantophyllum gidiensis* sp. nov., Specimen nos. BSIP 38437, 38438, 38439, Barakar Formation, Gidi-A Colliery, South Karanpura Coalfield, Bihar. x nat. size.

4-5 *Pantophyllum gidiensis* sp. nov., Specimen nos. BSIP 38440, 38441, Talchir Formation, Chano-Rikba Basin, North Karanpura Coalfield, Bihar. x nat. size.

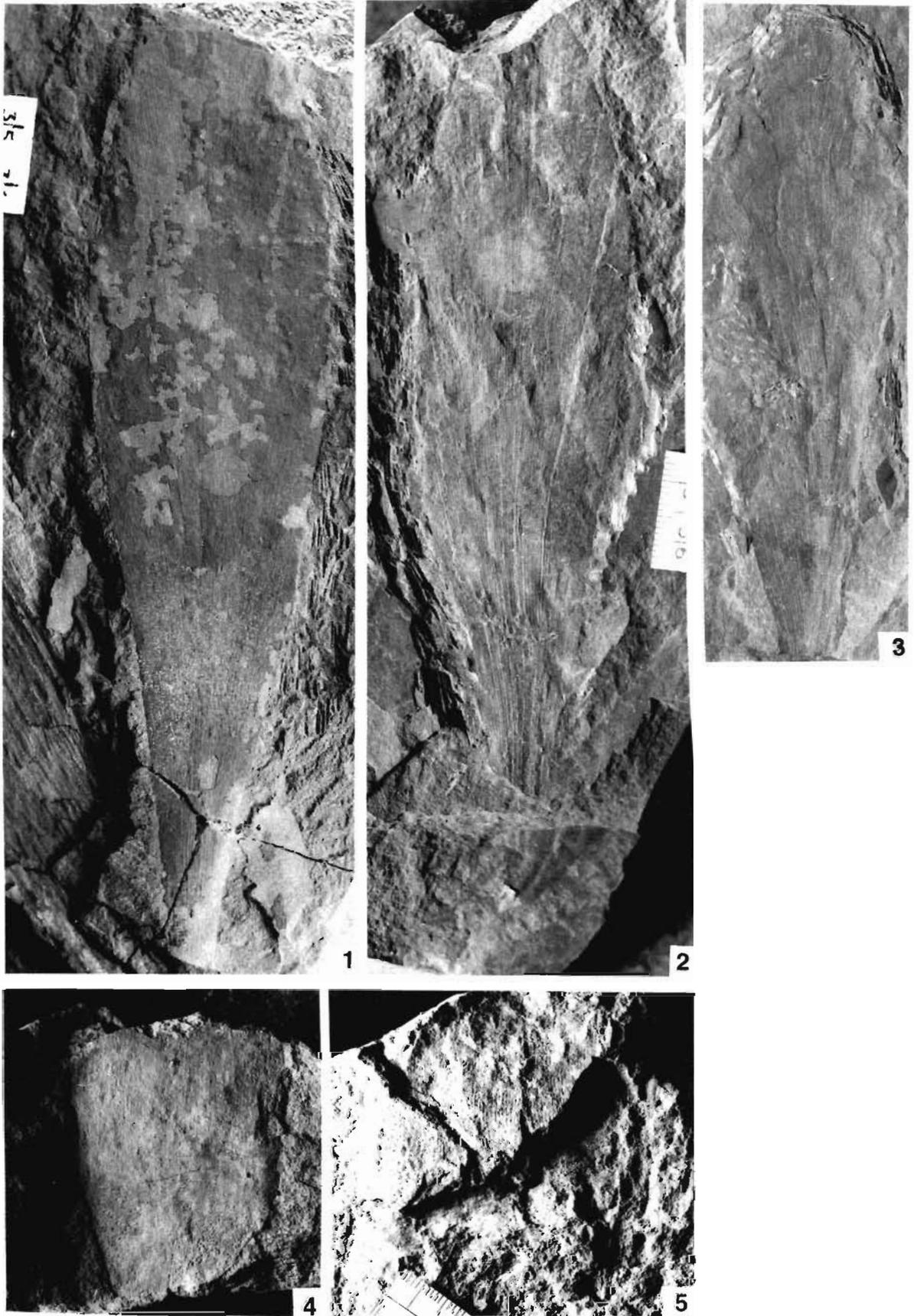


PLATE 2

cells are 4-6 in number, each having a single papilla which overhangs the stomatal pore; the guard cells are sunken.

Remarks and Comparison—In external morphology of the present studied specimens resemble those of *Euryphyllum whittianum* figured by Feistmantel (1879) and Maithy (1965). *E. obovatum* Maithy 1970 is not comparable as it is ovate in shape. *E. maithyi* Chandra & Singh 1996 is closer to *E. obovatum* and may be conspecific with it. In the former species, the density of the stomata is reported to be similar on both the upper and lower surfaces, whereas in our specimens, the stomata are rather sparse on one of the surfaces.

Diagnosis—(after Arber, 1905, cuticular information from present study):

Leaves ovate-spathulate, obtuse at apex, gradually contracted at base, asymmetrical, veins strong, radiating from the base at a very acute angle, with frequent dichotomy, those of the median portion of the leaf sub-parallel, those in the lateral portions arched towards the margins. Epidermis amphistomatic, stomatal density comparatively low on upper surface, stomata distributed in linear rows in between the veins, subsidiary cells papillate, papillae overhanging the stomatal pit, guard cells sunken.

Genus—KAWIZOPHYLLUM Kapoor 1979

Generic Diagnosis—Simple leaf, ellipsoidal in shape, base sessile, apex obtuse, lamina coriaceous, generally folded along median region, several veins enter the base, dichotomise a few times, median veins take a subparallel course towards the apex, other veins on both sides of median region arch gracefully towards the respective margins.

Remarks—In the overall morphography, the leaves placed under the genus *Kawizophyllum* show a marked resemblance to those of the genera *Pantophyllum* and *Euryphyllum*, more so with the latter in arching of the veins. However, in the folded nature of the lamina, *Kawizophyllum* stands apart from all the other known taxa. The irregular distribution and orientation of the stomata on the leaf also differentiates this genus from the cordaitalean leaf genera.

In general appearance the specimens closely resemble leaves of the cordaitalean group of plants; however, the data from the cuticular studies does not support such an affinity. In the absence of data about the fertile organs, a more closer affinity cannot be assigned.

Species—KAWIZOPHYLLUM DUNPATHRIENSIS sp. nov.

Pl. 5-3-6, Pl. 6-1, 2, 4

Specimen nos.—BSIP-38443-B, 38446, 38447, 38449

PLATE 4

See Page No. 38

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|---------|--|-----|--|
| 1, 2 | <i>Kawizophyllum barakarensis</i> sp. nov., Specimen no. BSIP 38442, 38443-A, Barakar Formation, shales associated with Naditoli Seam, Sirka Colliery, South Karanpura Coalfield, Bihar. x nat. size. | 4 | <i>Kawizophyllum barakarensis</i> sp. nov., a part of the nonstomatiferous cuticle showing details of the circular area which probably is the result of some sort of infection, Specimen no. BSIP 38442 x 200. |
| 3, 6, 9 | Nonstomatiferous cuticle of <i>Kawizophyllum barakarensis</i> sp. nov., showing cells over the veins and in the intercostal areas, Fig. 6 shows a circular area which probably is the result of some sort of infection, Specimen no. BSIP 38442 x 100. | 5 | <i>Kawizophyllum barakarensis</i> sp. nov., cells of the nonstomatiferous surface showing one papilla each, Specimen no. BSIP 38442, x 200. |
| | | 7-8 | Stomatiferous cuticle of <i>Kawizophyllum barakarensis</i> sp. nov., the stomata are better seen in figure 8, Specimen no. BSIP 38442, x 200. |

PLATE 5

See Page No. 39

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|----------|---|---|--|
| 1, 2, 7, | 38445, 38449, 38450, 38451 Barakar Formation, Naditoli Seam, Sirka Colliery, South Karanpura Coalfield, Bihar. x nat. size. | 8 | Cuticle of <i>Kawizophyllum barakarensis</i> sp. nov., showing possibility of infection over the cuticle, Specimen no. BSIP 38442 x 200. |
| 9, 10 | <i>Kawizophyllum barakarensis</i> sp. nov., Specimen nos. BSIP 38444, | | |
| 3-6 | <i>Kawizophyllum dunpathriensis</i> sp. nov., Specimen nos. BSIP 38446, 38447, 38443-B, 38448, Barakar Formation, Naditoli Seam, Sirka Colliery, South Karanpura Coalfield, Bihar. x nat. size. | | |

PLATE 6

See Page No. 40

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|---------|---|---|--|
| 1 | <i>Kawizophyllum dunpathriensis</i> sp. nov., Specimen no. BSIP 38447, Sirka Colliery, South Karanpura Coalfield. | 4 | 38445, 38443-A, 38442, Sirka Colliery, South Karanpura Coalfield |
| 2 | <i>Kawizophyllum dunpathriensis</i> sp. nov., Specimen no. BSIP 38448, Sirka Colliery, South Karanpura Coalfield. | 4 | <i>Kawizophyllum dunpathriensis</i> sp. nov., Sirka Colliery, South Karanpura Coalfield. |
| 3, 6, 8 | <i>Kawizophyllum barakarensis</i> sp. nov., Specimen nos. BSIP 38444, | 5 | <i>Kawizophyllum barakarensis</i> sp. nov., Specimen no. BSIP 38449, Sirka Colliery, South Karanpura Coalfield |

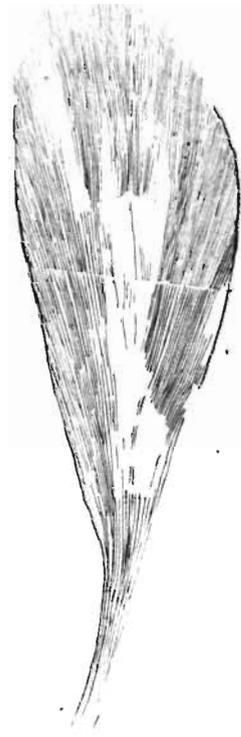
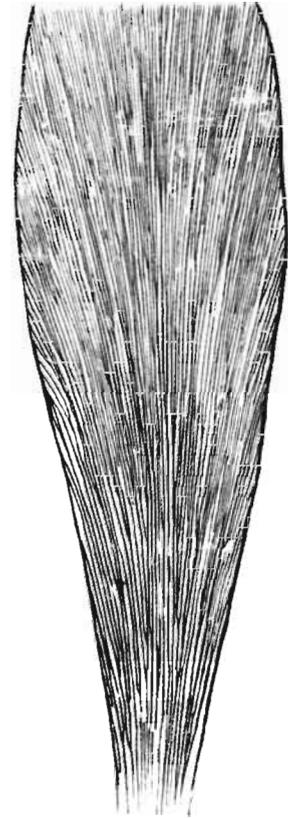
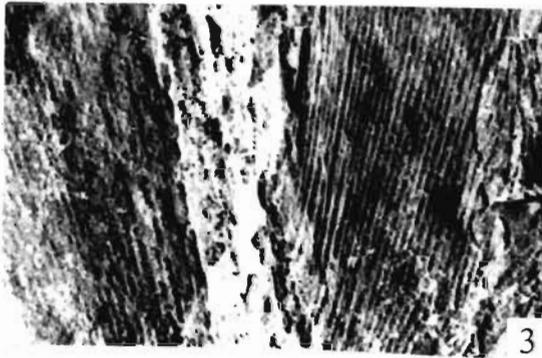


PLATE 3

1-2 *Pantophyllum gidiensis* sp. nov., Specimen no. BSIP 38438, South Karanpura Coalfield.

3-4 *Euryphyllum whitmanum*, Feistmantel 1879, Specimen no BSIP 38436, Gidi A Colliery, South Karanpura Coalfield

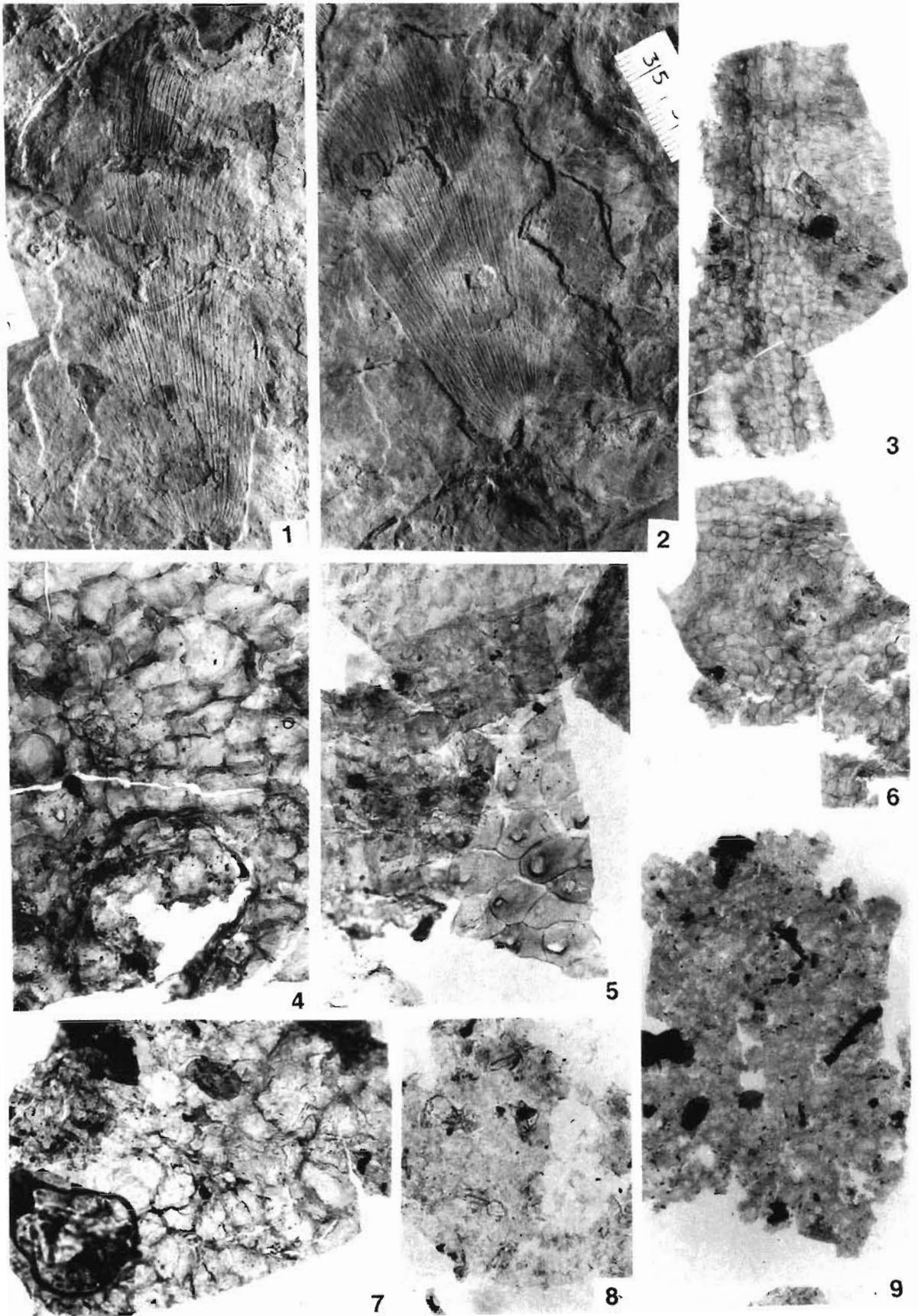


PLATE 4

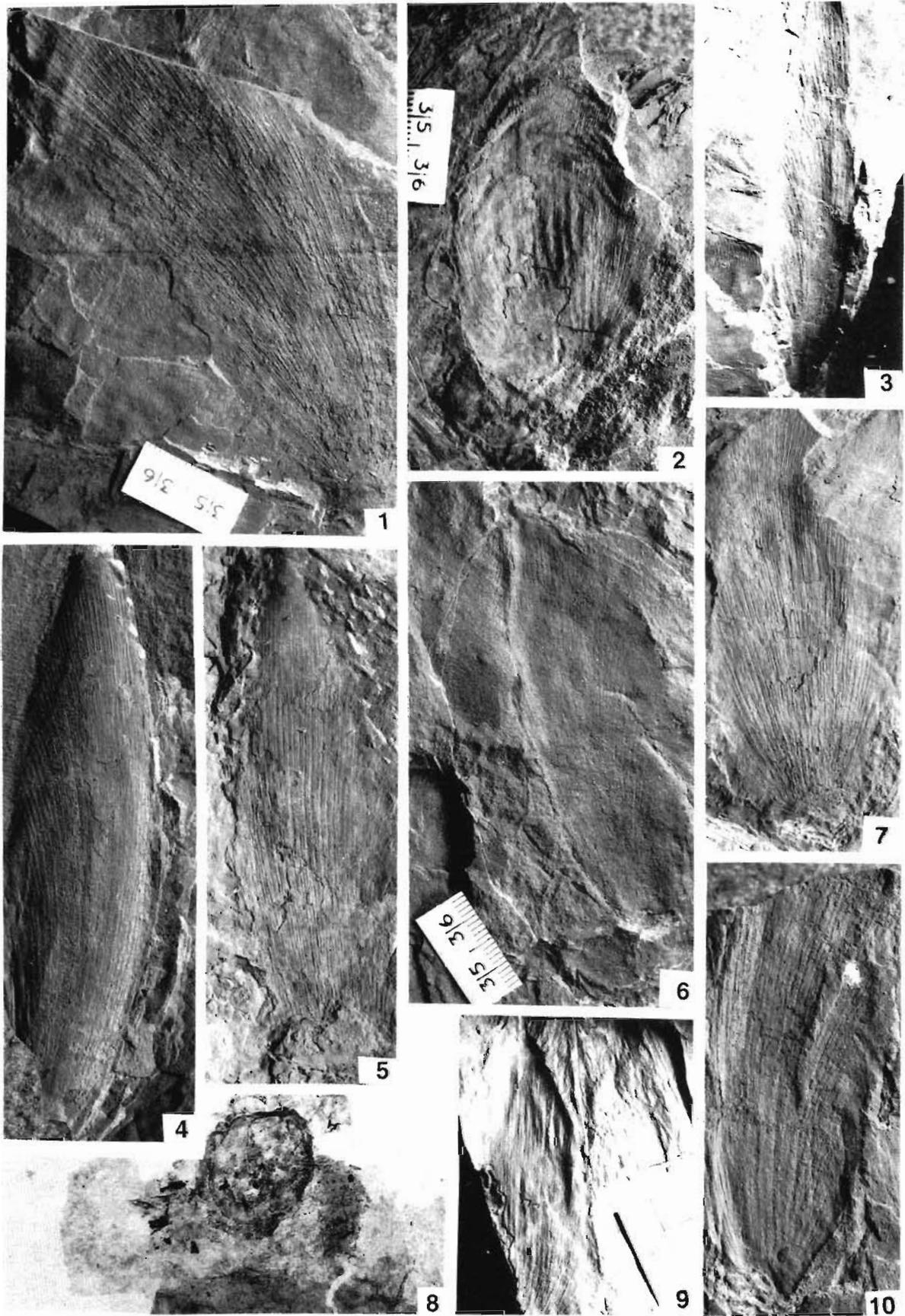


PLATE 5

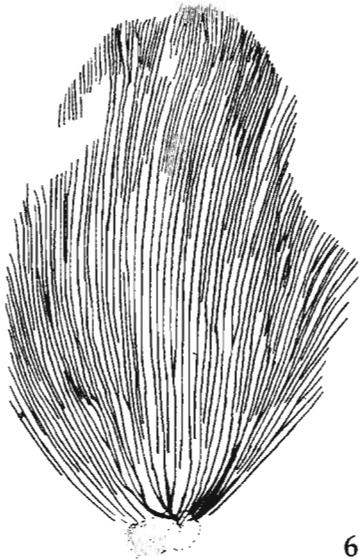
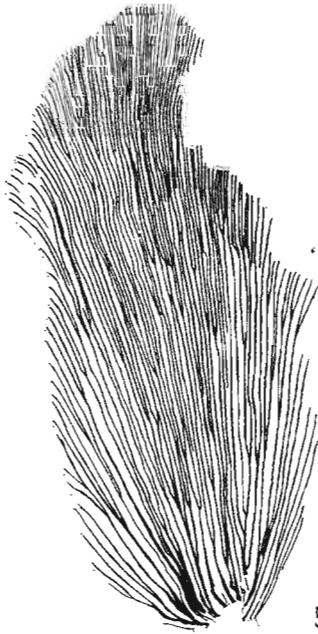
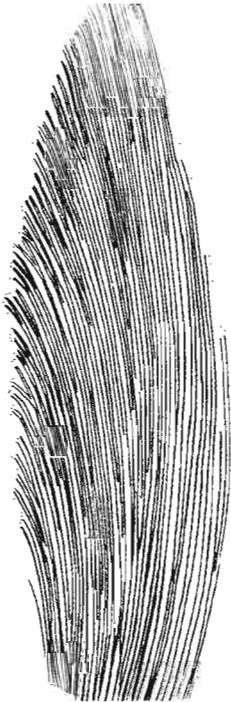
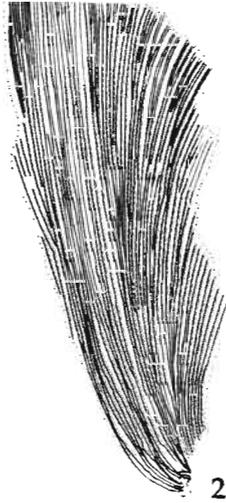
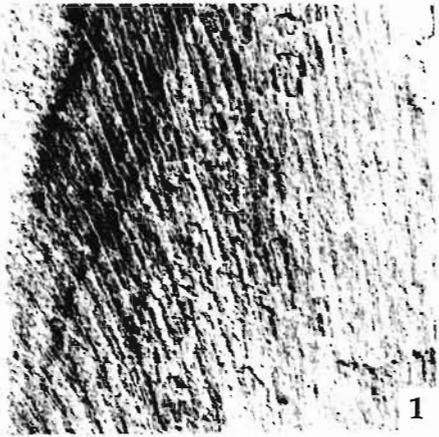


PLATE 6

Locality—Sirka Colliery, South Karanpura Coalfield.

Horizon—Barakar Formation, shales associated with Naditoli Seam.

Holotype—BSIP specimen-38447, shales associated with Naditoli Seam, Barakar Formation, Early Permian; Sirka colliery, South Karanpura Coalfield, Bihar.

Description—Simple leaf.

Shape—ellipsoidal.

Size—length 8-11 cm, width 1.2-2.5 cm.

Apex—acute.

Base—narrow sessile.

Lamina—Coriaceous folded along the median region.

Midrib—absent, several subparallel median veins.

Venation—Several veins arise from the base, dichotomise a few times, concentration of veins 18-20 per cm cuticle absent.

Comparison—In morphograpical features, the specimens resemble those assigned to *Kawizophyllum barakarensis*; however, characters of epidermis are known for this species. Furthermore, in *K. barakarensis* the characteristic folding of the lamina is not that prominent.

Diagnosis—Simple leaf, ellipsoidal in shape, base sessile, apex obtuse, lamina coriaceous, generally folded along median region, several veins enter the base, dichotomise a few times, median veins take a subparallel course towards apex, cuticle not preserved.

Species—*KAWIZOPHYLLUM BARAKARENSIS* sp. nov.

Pl. 4-1-9, Pl. 5-1, 2, 7-10, Pl. 6-3, 5-8

Specimen nos.—BSIP 38442, 38443-A, 38444, 38445, 38446, 38448, 38449, 38450, 38451.

Locality—Sirka Colliery, South Karanpura Coalfield.

Horizon—Barakar Formation, shales associated with the Naditoli Seam.

Holotype—BSIP specimen - 38442, shales associated with Naditoli Seam, Barakar Formation, Early Permian; Sirka Colliery, South Karanpura Coalfield, Bihar.

Description—Simple leaf.

Shape—oval-spathulate.

Size—length 6.5-11 cm, width 3.6-4 cm.

Apex—obtuse.

Base—sessile, cuncate.

Margin—entire.

Lamina—coriaceous, folded along median region.

Midrib—absent, several subparallel median veins.

Venation—Several veins arise from the base, dichotomise a few times, median veins take a \pm subparallel course towards the obtuse apex, veins on either side of median region arch backwards towards the margin, concentration of the veins 14-16 per cm.

Cuticle—Only very small pieces of cuticle could be recovered. The nonstomatiferous surface is relatively much thicker and has outlines of polygonal cells. Veins are not differentiated by arrangement of cells. The stomatiferous surface is almost hyaline, no cell walls are seen. At places stomatal pore (with guard cells) could be deciphered. Some round patches and characteristic arrangement of cells therein give the possibility of some sort of infection.

Comparison—In general morphology, the specimens resemble those assigned to *Kawizophyllum dunpathriensis* described here; however, characters of the epidermis are not known for this species. Furthermore, in *K. barakarensis* the characteristic folding of the lamina is not that prominent.

Diagnosis—Leaf simple, oval-spathulate in shape, base sessile, apex obtuse, lamina coriaceous, sometimes folded along the median region, venation comprising subparallel, dichotomously branching veins. Epidermis hypostomatic, cuticle of stomatiferous surface very thin, stomata irregular in distribution and orientation.

CONCLUSIONS

From the data collected, it is evident that the fossil flora of the Barakar Formation in the North Karanpura, South Karanpura and West Bokaro coalfields predominantly comprises species of the glossopterid group of plants, particularly of those belonging to the genus *Glossopteris*. The equisetals and the ferns are extremely rare, while the sphenophylls are virtually absent. The genera *Gangamopteris*, *Euryphyllum* and *Pantophyllum* (= *Noeggerathiopsis*) are found only in the lower part of the formation. The characteristic fossils of the Karharbari flora, namely, *Botrychiopsis* (= *Gondwanidium*) and *Buriadia* are absent. On the other hand, *Kawizophyllum*, a characteristic fossil of the Dunpathri Member of the Mamal Formation in Kashmir also found in South Karanpura Coalfield is the only record from the peninsula. On the basis of a few fragmentary specimens collected by Kapoor 1979; Maheshwari, Kapoor & Bajpai (personal communication) made efforts for amendments of this taxon. The author's recent collection has two species of *Kawizophyllum* namely, *K. dunpathriensis* sp. nov. & *K. barakarensis* sp. nov. have been instituted from Barakar Formation of south Karanpura Coalfield, Bihar, here two species of the genus *Kawizophyllum* have been validated. The distribution of the taxa otherwise does

not show any appreciable change from the lower to upper part of the formation as investigated presently.

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