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The plant of *Neomariopteris hughesii* (Zeiller) Maithy

KAMAL JEET SINGH AND SHAILA CHANDRA

Birbal Sahni Institute of Palaeobotany, 53 University Road, Lucknow 226 007, India.

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ABSTRACT

Singh KJ & Chandra S. 1999. The plant of *Neomariopteris hughesii* (Zeiller) Maithy. Palaeobotanist 48(3) : 225-238.

An attempt has been made to reconstruct the plant of *Neomariopteris hughesii* based on fifty five hand specimens collected from the Barakar Formation exposed near Brijraj Nagar Railway Station in the Ib-River Coalfield, Orissa. The limitations of this reconstruction have been realised by the authors as the main trunk of the plant and the fertile structures are not recorded from this very location, however, combined evidences put together from other sources as well suggest that this fern plant could be a small tree based on branched stems of considerable length and width rather than a usual prostrate fern habit. An up to date list of all the specimens recorded under the genus *Neomariopteris* and its six species by various workers from different localities and formations of India has also been given.

Key-words—*Neomariopteris hughesii*, Reconstruction, Pinnae, Pinnule, Rachis, India.

सारांश

निओमेरियॉप्टेरिस ह्यूगेसाइ (ज़ीलर) माइती का पौधा

कमलजीत सिंह एवं शैला चन्द्रा

उड़ीसा के ईब नदी कोयला क्षेत्र में बृजराज नगर रेलवे स्टेशन के निकट अनावरित बराकर शैलसमूह से संगृहीत 55 हस्त प्रादर्शों के आधार पर *निओमेरियॉप्टेरिस ह्यूगेसाइ* के पौधे की पुनर्रचना करने का एक प्रयत्न किया गया। इस पुनर्रचना के लिए लेखकों को अनेक अवरोधों का सामना करना पड़ा क्योंकि पौधे का मुख्य स्तम्भ तथा उर्वर संरचनाएं इस संस्थिति से अंकित नहीं की जा सकीं, परन्तु अन्य स्रोतों से प्राप्त प्रमाणों को संयुक्त करने से प्रस्तावित होता है कि इस पर्णांग का पौधा अत्यन्त लघु वृक्ष रहा होगा, जो लम्बे तथा चौड़े शाखित तनों पर अवलम्बित होगा तथा यह सामान्य प्रॉस्टेट प्रकृति का पर्णांग नहीं रहा होगा। भारत की विभिन्न संस्थितियों एवं शैल समूहों से विभिन्न लोगों द्वारा 6 प्रजातियों के अन्तर्गत *निओमेरियॉप्टेरिस* वंश के समस्त अंकित प्रादर्शों की अद्यतन सूची भी दी गई है।

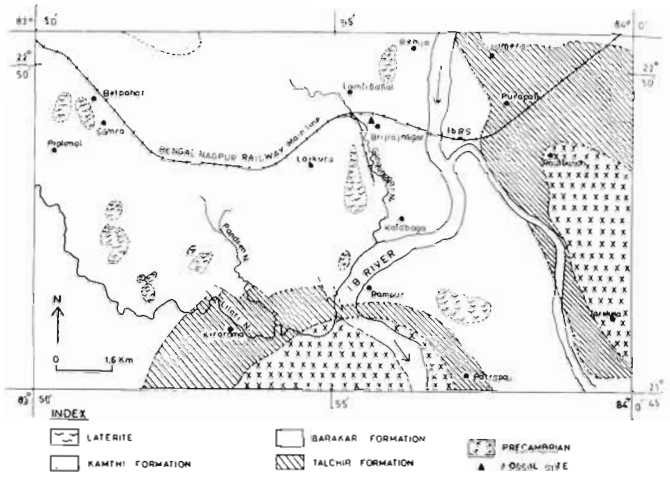
INTRODUCTION

OUR knowledge on the morphology and anatomy of filicalean group of plants from Permian of Gondwana has significantly improved during the last two decades (Gould, 1970: Maithy, 1974, 1975, 1977; Pant & Misra, 1976, 1977, 1983; Pant & Khare, 1974; Galtier & Taylor 1994). Detail studies on the morphology and the fertile parts of Permian Gondwana ferns established the differences between southern & northern forms hence placed under new generic and specific names. Of such forms *Neomariopteris* was proposed by Maithy 1974 for fern fronds having sphenopteroid venation, decurrent pinnules and winged rachis. In subsequent year (1975) he also recorded fertile pinnules, sporangium and spore types of the genus *Neomariopteris* and emended his own diagnosis. Later, Pant and Khare (1974) instituted *Damudopteris* to accommodate sphenopteroid ferns based on the same lectotype specimen of Feistmantel 1880. On the basis of pri-

ority *Damudopteris* is recognised as a junior synonym of *Neomariopteris*.

Though the fern genus *Neomariopteris* is recognized by six species viz., *N. polymorpha* (Feistm.) Maithy, *N. hughesii* (Zeiller) Maithy, *N. lobifolia* (Morris) Maithy, *N. talchirensis* Maithy, *N. khanii* Maithy and *N. barakarensis* Srivastava, no attempt has been made to reconstruct the plant for any of the species under this genus. Of the six species of this genus, *N. hughesii* is the best understood and most commonly occurring species in the Permian strata of India.

A fresh collection of impressions and casts from the Middle Permian beds in Ib-River Coalfield has enabled us to reconstruct the plant of *Neomariopteris hughesii* (Text-figures 1, 2). Observations on this species by various other workers have also been incorporated for such an attempt.



Text-figure 1—Geological map of IB River Coalfield, District Sambalpur, Orissa showing the fossil site.

PLATE-1

1. Part of stem cast of *Neomariopteris hughesii* (Zeiller) Maithy showing smooth surface. x 1.5, B.S.I.P. Specimen number 36870.
2. Broader portion of stem cast showing longitudinal striations and also two branches coming out of the stem indicated by arrows marks. x 1, B.S.I.P. Specimen number 36871(A).
3. Another stem specimen of *N. hughesii* with a distinct branch of equal width shown by arrow. x 1, B.S.I.P. Specimen number 36872.
4. Widest stem cast specimen in the collection with longitudinal striations on the surface. x 1, B.S.I.P. Specimen number 37364.

PLATE-2

1. Stem cast specimen of *Neomariopteris hughesii* with longitudinal striations on the surface. x 1, B.S.I.P. Specimen number 37365.
2. Three pinnae with less lobed pinnules having sphenopteroid venation, appears to be from the terminal portion of the branch. x 1.5, B.S.I.P. Specimen number 37366.
3. Another cast of the stem portion of the plant of considerable length. x 1, B.S.I.P. Specimen number 37367.
4. Pinnules showing distinct serrate margins and distinct sphenopteroid venation. x 2, B.S.I.P. Specimen number 37368(A).

PLATE 3

1. Stem cast of *Neomariopteris hughesii* shown still embedded in the sediment. x 1 B.S.I.P. Specimen number 37368(B).

2-5. Pinnae with pinnules showing serrate margins and sphenopteroid venation in various specimens. 2-x1.5; 3-5-x 2,. B.S.I.P. Specimen numbers from 2-5 - 37369, 36871(B), 37370 and 37371 respectively.

PLATE 4

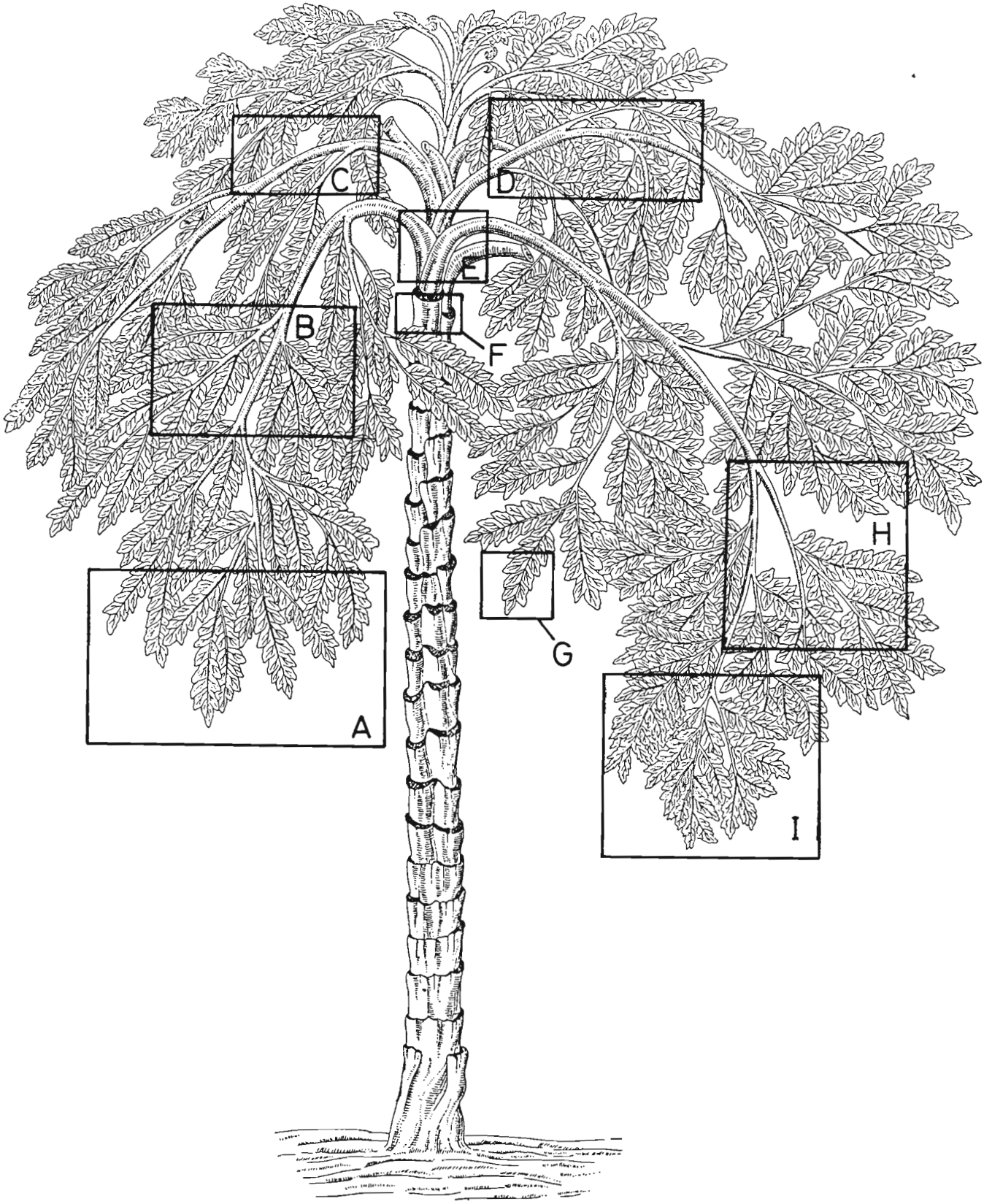
1 & 2. Cast of rachis of the plant of *Neomariopteris hughesii* with three branches shown by arrows. Longitudinal striations on the rachis are distinctly seen. x 1, & x 2 respectively. B.S.I.P. Specimen number 37372 (Both the figures showing the same specimen).

PLATE 5

1. Secondary and tertiary branching of rachis of *Neomariopteris hughesii* , branches indicated by arrows. Pinnae with pinnules showing distinct sphenopteroid venation. x 1.5, B.S.I.P. Specimen number 37375.
2. Terminal portion of frond with sub-opposite branching. x 1.5, B.S.I.P. Specimen number 37376.
3. Pinna with serrate pinnules showing distinct sphenopteroid venation. x 2, B.S.I.P. Specimen number 37377.

PLATE 6

1. The specimen of *Neomariopteris hughesii* showing two branches attached alternately on the rachis with pinnae, serrate pinnules with distinct sphenopteroid venation. x 1.5, B.S.I.P. Specimen number 37378.
2. Two pinnae attached on the rachis, appears to be from the apical portion of the frond, rachis and venation are preserved in the form of cast, laminar portion of pinnules are preserved as impression. x 2, B.S.I.P. Specimen number 37379.
3. Pinnae shown attached to rachis alternately. x1.5, B.S.I.P. specimen number 37380.
4. Another specimen of *Neomariopteris hughesii* showing branching pattern of pinnae and rachis attachment. Pinnules are preserved as impression and their venation as cast. x 1.5, B.S.I.P. Specimen number 37381.



Text-figure 2— Reconstruction Model Boxes A - I indicate the portions of fossil specimens in different photo plates and is the basis for the reconstruction. **A.** Pl. 3, fig. 4 **F.** Pl. 1, fig. 4 **B.** Pl. 5, fig. 1 **G.** Pl. 2, figs 2,4 **C.** Pl. 1, figs 2,3 **H.** Pl. 6, fig. 4 **D.** Pl. 4, figs 1,2 **I.** Pl. 6, figs 1-3 **E.** Pl. 2, figs 1,3

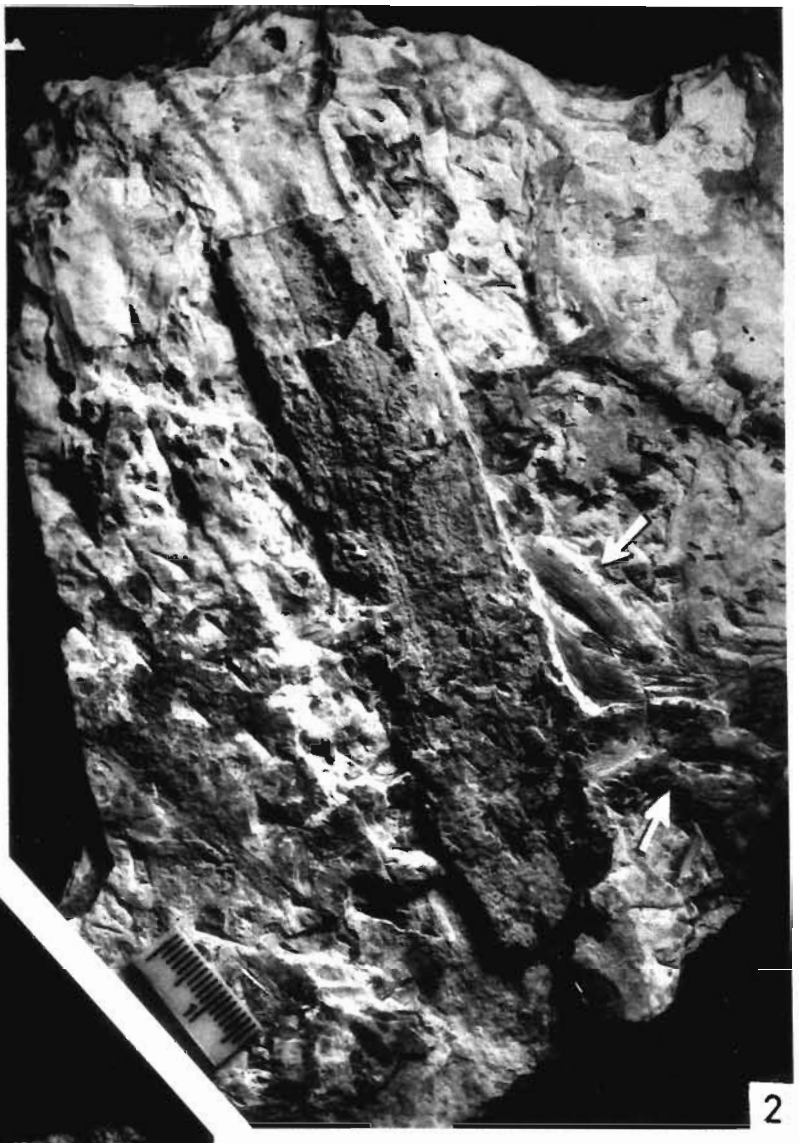
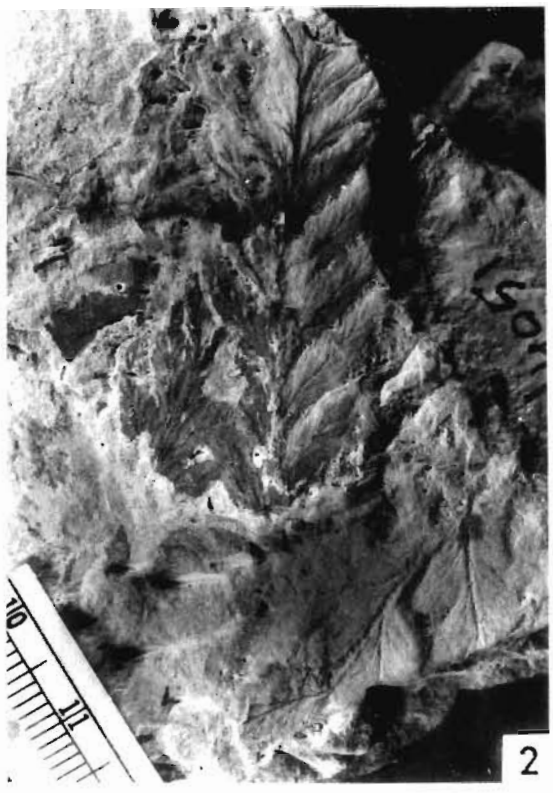


PLATE 1



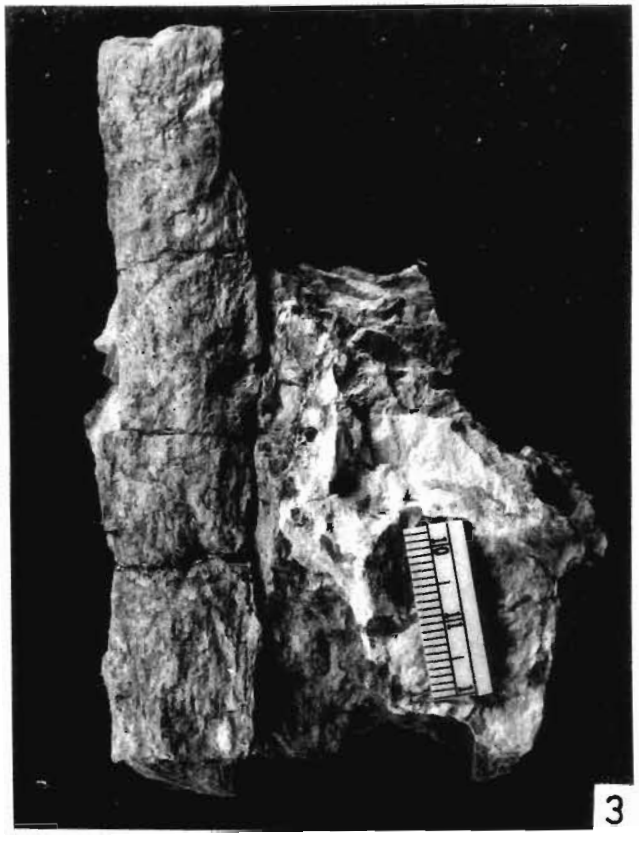


PLATE 2

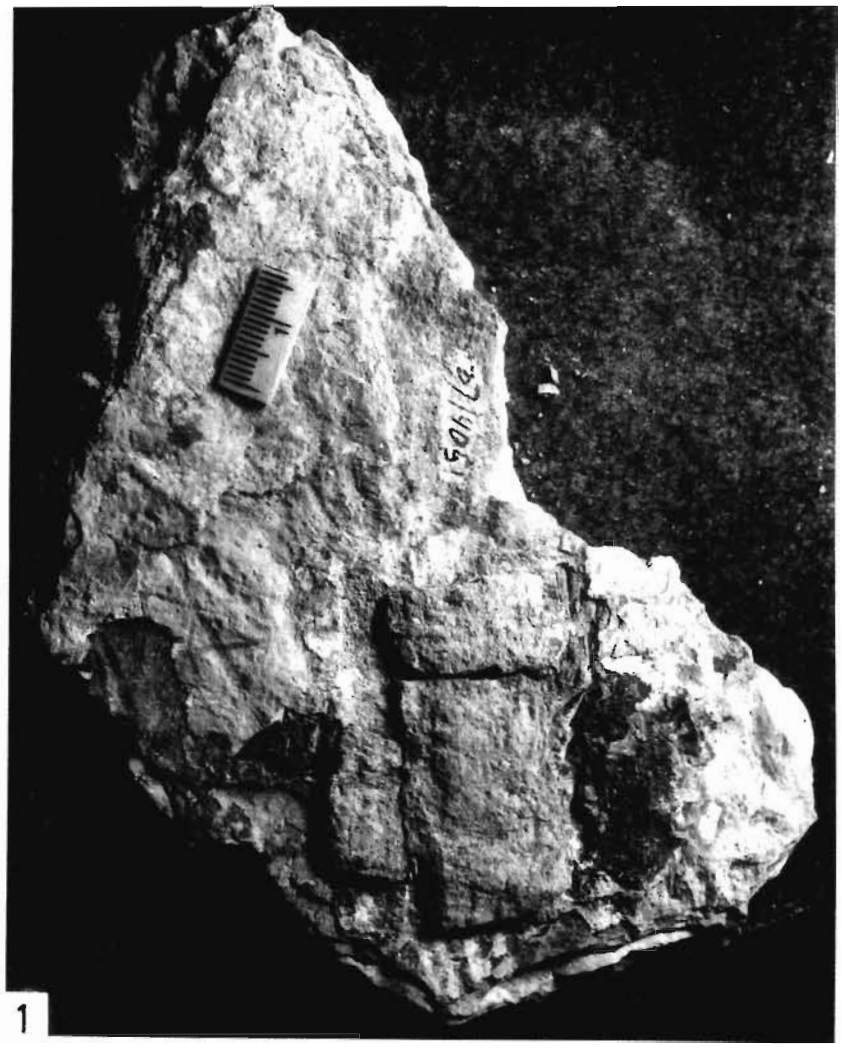


PLATE 3

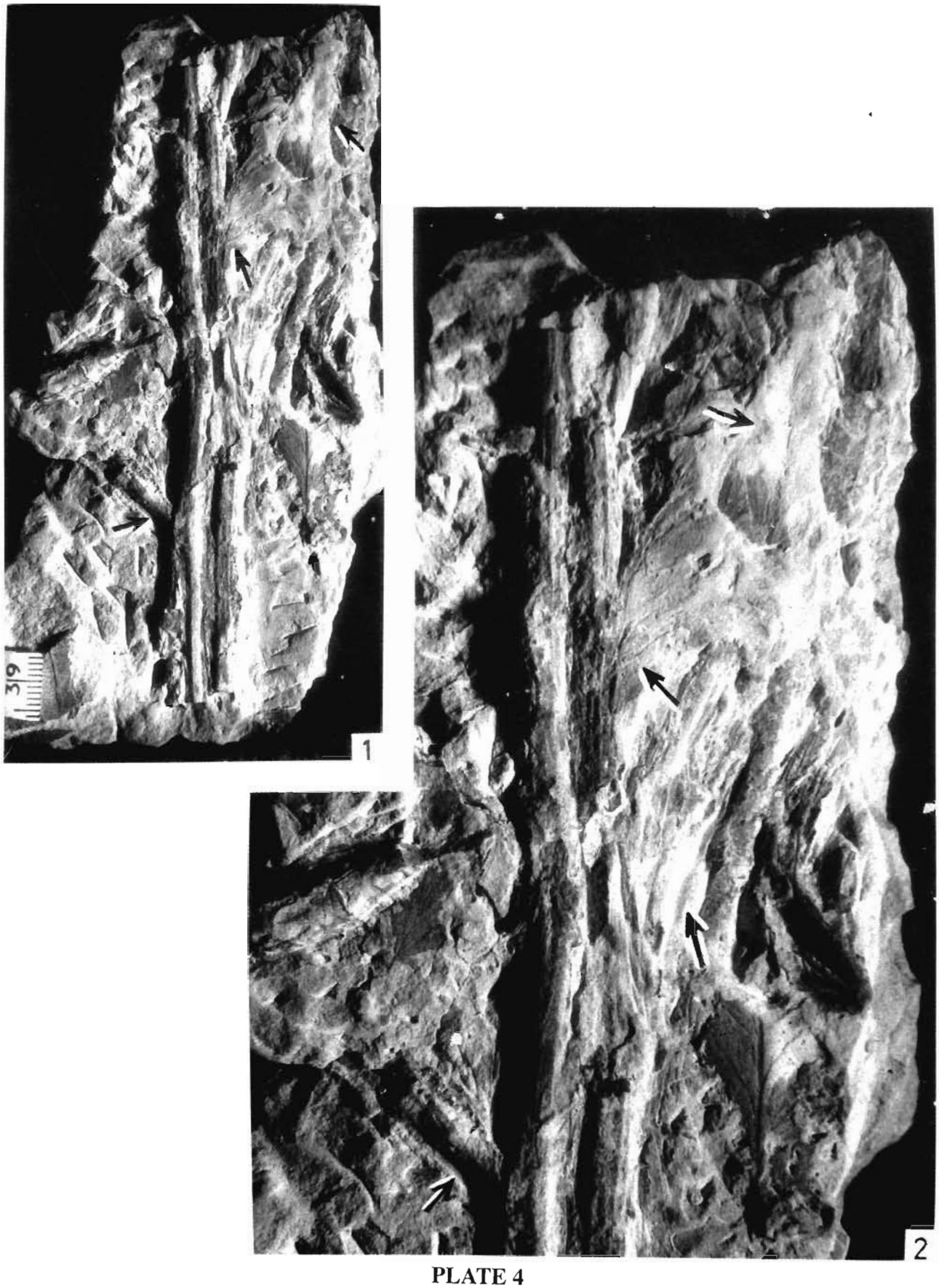


PLATE 4

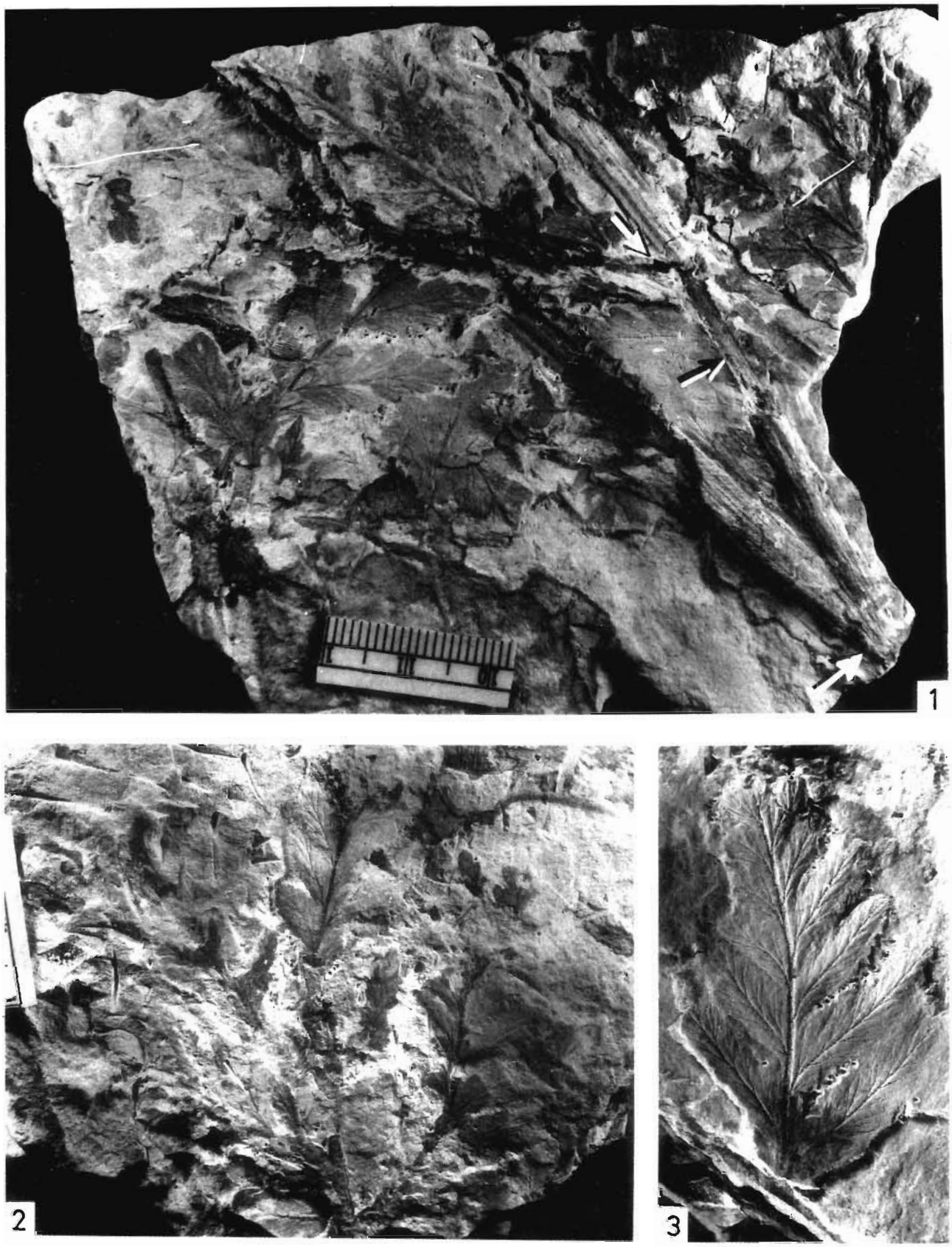


PLATE 5

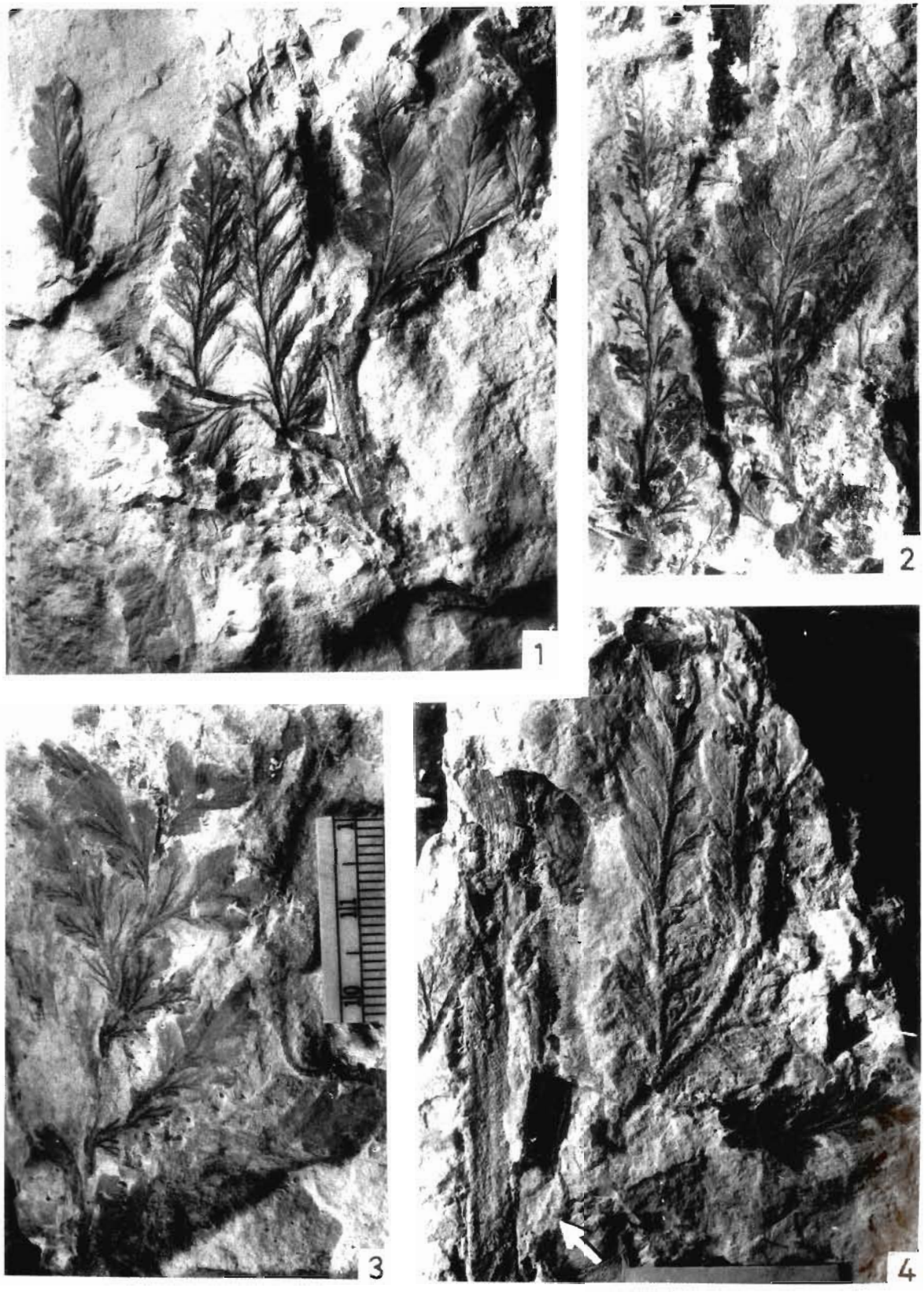


PLATE 6

MATERIAL AND LOCALITY

The fern specimens were collected from the surface outcrop of the Barakar beds exposed in the Ganga Nagar *Nala* Section near Brijraj Nagar Railway Station in the Ib-River Coalfield, District Sambalpur, Orissa (Text figure 1). The total length and width of the collected site is about 3 x 1 m. The 55 specimens of fern pinnae and pinnules are preserved as impressions on pinkish yellow, fine to coarse grained shales and the stems and petioles of the fronds as cast. Anatomical studies of these stems and petioles could not be made as the internal structures are not preserved. All the fern pinnules are sterile and no fertile structures are seen preserved. Just a few meters from this fern fossil site, vertically and diagonally preserved *in-situ Vertebraria* axes are also collected. These are the only two fossil forms recorded and collected from this Middle Permian locality. All the fern specimens are deposited at the Museum of the Birbal Sahni Institute of Palaeobotany, Lucknow.

SYSTEMATICS

Order—FILICALES

Family—DAMUDOPTERIDACEAE Pant & Khare

Genus—NEOMARIOPTERIS (Feistmantel) Maithy

NEOMARIOPTERIS HUGHESII (Zeiller) Maithy

(Pl. 1, figs 1-4; Pl. 2, figs 1-4; Pl. 3, figs 1-5; Pl. 4, figs 1-2; Pl. 5, figs 1-3; Pl. 6, figs 1-4; Text-figs 1, 2, 3 & Table-1)

Of the 55 hand specimens, 12 are casts of stems and petioles and the other specimens are impression of pinnae and pinnule fronds. Some of the specimens are tripinnate and bipinnate fronds. The longest stem is 12 cm and length of other stems vary between 3.8 to 11.5 cm. The widest stem cast is 3.2 cm (Pl. 1, fig. 4) and the width of other stems vary between 1.3 cm to 2.8 cm (Pl. 4, fig. 1; Pl. 1, figs 1, 2, 3; Pl. 2, figs. 1, 3). The maximum preserved thickness of these casts of the stems or petioles is 8 mm. The surface of all the preserved stem casts show longitudinal striations (Pl. 2, fig. 1; Pl. 5, fig. 1), in some of the stems the surface is rough (Pl. 1, figs 1-4; Pl. 2, fig. 3; Pl. 3, fig. 1). The rachis width is between 1 - 2.5 mm with a narrow wing. The secondary branches are arranged alternately (Pl. 6, figs 1 & 3; Pl. 5, fig. 1) and sometimes sub-oppositely (Pl. 5, fig. 2) on the primary stems. The pinnae are generally linear in shape measuring 2 -3.9 cm in length, becoming smaller towards apex side of the plant. The pinnules in general have serrate margins and show typical sphenopteroid venation as mentioned by Maithy (1974). Details of epidermal features of the pinnae and fertile structures including sporangia and their spores have been investigated by earlier authors (Pant & Khare, 1974; Maithy, 1974, 1975) and are incorporated in our studies. The details are not discussed here to avoid repetition.

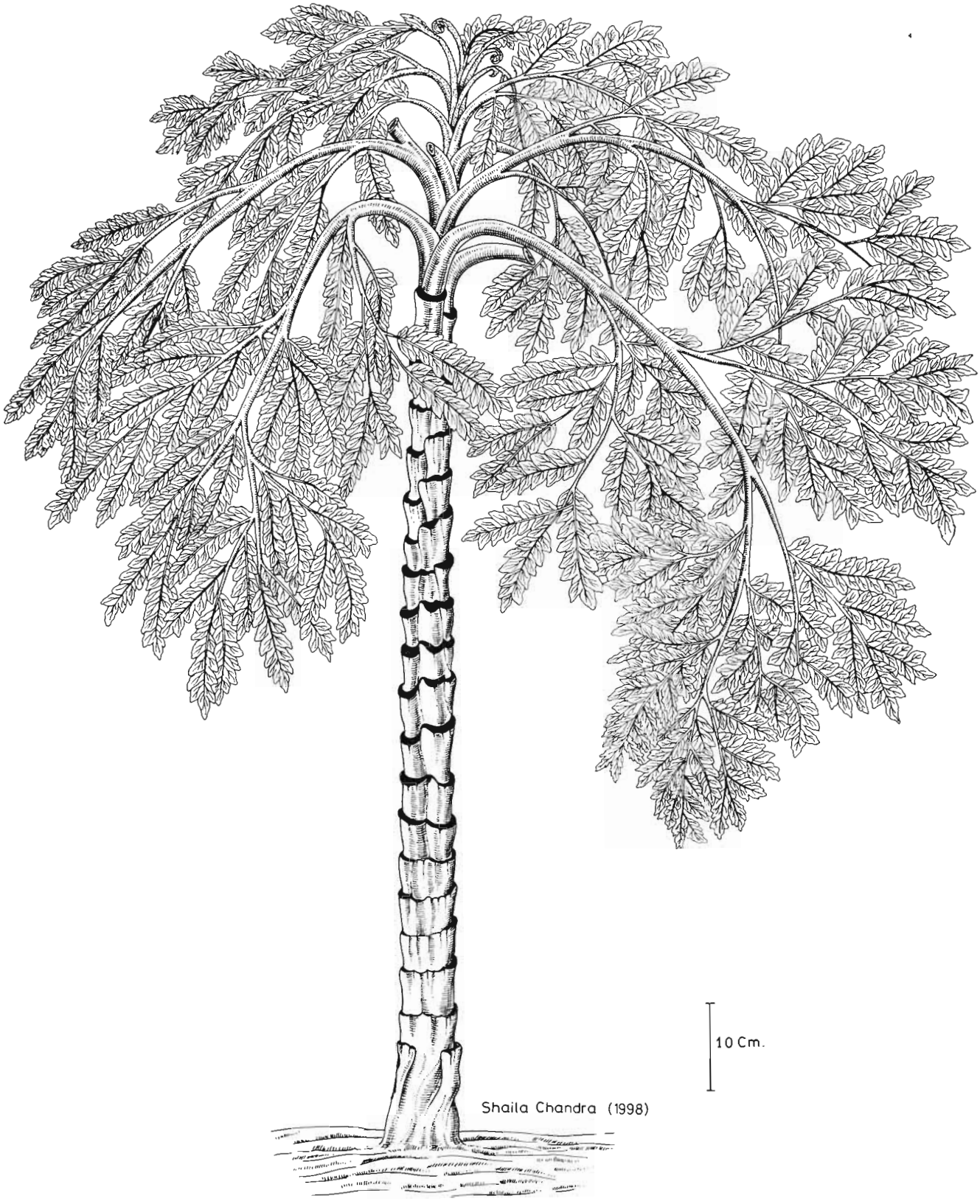
RECONSTRUCTION

As evidenced by the repeatedly branching stems of considerable length and width of common occurrence in the sediments, the plant of *Neomariopteris hughesii* must have had an upright self supporting habit with elongate tapering stem and closely adpressed relatively large petioles with stout rachises bearing vegetative pinnae. The reconstruction drawing of the plant is marked to indicate fossil evidences as shown by the photographs (Text figure 2). The reconstruction (Text-figure 3) is based mainly on the large size of branched stems, occurrence of several pinnae on the rachis and large size of pinnae and pinnules. The ferns with usual prostrate habit do not possess branched stems. The main stem part or the trunk of this plant is missing. The authors have collected several fern specimens from various Permian formations of Indian Gondwana during last several years but have never come across such branched stems in any of the fern species nor has been recorded by any other author (see Table 1).

The consistently occurring fern parts at Ganga Nagar *Nala* Section suggest that the plants of *Neomariopteris hughesii* were growing together as a "fern glen" during moist, humid and warm temperate climate of Barakar time period suitable for fern growth, although the pinkish yellow colour of the sediments suggests adverse conditions of dry climate. Similar conditions of red buff coloured shales also show luxuriant plant growth during Late Permian at Handapa in Talchir Coalfield in Angul District of Orissa. Colour of the sediment, therefore, need not in every case indicate the climatic conditions. Abundance and the luxuriant plant growth certainly proves to be more reliable climate indicator. Absence of any other plant type, except for pieces of fragments of *Glossopteris* leaves from these beds, can not be explained. The only other possible explanation could be that this particular fern plant got preserved at the same place where they were growing and there was no chance for other plants to grow at the same site because of the thick vegetation of fern plants. Similar such conditions of *in-situ* preservation are also reported for *Vertebraria* axes preserved a few meters away from *Neomariopteris hughesii* fossil site.

The absence of attached or obviously associated reproductive structures among the vegetative pinnae suggest that this plant may have reproduced primarily by vegetative means under favourable conditions of Barakar swamps as many modern ferns do and produce spores only when conditions were poor and unfavourable.

It is considered, on the basis of large size and greater number of fern plant specimens, that ferns were also important and dominant constituent of Barakar coal forming flora along with *Glossopteris* species, at least it is so in Ib-River Coalfield. *Skaaripteris minuta* Galtier and Taylor 1994 from Permian of Antarctica is considered as a sub aquatic scram-



Text-figure 3—Reconstruction of the plant of *Neomariopteris hughesii* (Zeiller) Maithy.

Table 1—Distribution of various species of *Neomariopteris* (*Sphenopteris*) in Lower Gondwana of India

S.N.	Species	Author(s)	Formation	Age	Locality
1	*Neomariopteris barakarensis, Srivastava, 1978*	Srivastava, 1978.	Barakar Fm.	Middle Permian	Churulia fire clay pit, Auranga Coalfield, Bihar
2.	*Neomariopteris hughesii (Zeiller) Maithy, 1974*	Maithy, 1974.	Barakar Fm.	Middle Permian	Churulia pit, East Raniganj coalfield, West Bengal
	(Dicksonia hughesii)	Feistmantel, 1881	Raniganj Fm.	Late Permian	Jharia Coalfield, Bihar
	(D. hughesii)	Feistmantel, 1882.	Raniganj Fm.	Late Permian	Sohagpur area, Madhya Pradedsh
	(Sphenopteris hughesii)	Zeiller, 1902.	Raniganj Fm.	Late Permian	Raniganj Coalfield, West Bengal
	(S. hughesii)	Maheshwari & Prakash, 1965.	Barakar Fm.	Middle Permian	Tattitola, Bansloi Valley, Rajmahal Hills, Bihar
	(S. hughesii)	Maheshwari, 1966.	Barakar Fm.	Middle Permian	Tattitola, Bansloi Valley, Rajmahal Hills, Bihar
	(S. hughesii)	Kar, 1968.	Barren Measures	Late Permian	Katri Nala, Jharia Coalfield, Bihar
	(Sphenopteris polymorpha)	Khan, 1969.	Kamthi Fm.	Late Permian	Handapa Village, Angul District Orissa
	(S. polymorpha)	Kulkarni, 1970.	Barakar Fm.	Middle Permian	Saunda Section, South Karanpura Coalfield, Bihar
	Neomariopteris hughesii	Maithy, 1975.	Raniganj Fm.	Late Permian	Raniganj Coalfield, West Bengal
	N. hughesii	Srivastava, 1977.	Karharbari Fm.	Early Permian	Auranga Coalfied, Bihar
	N. hughesii	Chandra & Prasad, 1981	Kamthi Fm.	Late Permian	Kanhargaon Village, District Chandrapur, Madhya Pradesh
	N. hughesii	Lele, Maithy & Mandal, 1981	Raniganj Fm.	Late Permian	Searsole Colliery, Raniganj coalfield, West Bengal
	N. hughesii	Srivastava & Chandra, 1982.	Raniganj Fm.	Late Permian	Damodar Colliery, Raniganj Coalfield, West Bengal
	N. hughesii	Chandra & Rigby, 1983.	Kamthi Fm.	Late Permian	Hinjrida Ghati near Handapa Village, Angul District, Orissa
	N. hughesii	Chandra, Srivastava & Singh, 1990.	Raniganj Fm.	Late Permian	Marhwas area, Sidhi District Madhya Pradesh
	N. hughesii	Tewari, 1994	Raniganj Fm.	Late Permian	Bhatdih Colliery, Jharia Coalfield, Bihar
	N. hughesii	Srivastava & Tewari, 1996.	Barakar Fm.	Middle Permian	Tubed Area (Sukri river Section) and Sikni Open Cast Mine, Auranga Coalfield, Bihar
	N. hughesii	Tewari & Srivastava, 1996.	Barakar Fm.	Middle Permian	Kusunda area, Jharia Coalfield, Bihar
	N. hughesii	Singh & Chandra, 1996.	Barakar Fm.	Middle Permian	Gopal Prasad Village, Talchir Coalfield, Angul District, Orissa
3.	*Neomariopteris khanii Maithy, 1977*	Maithy, 1977.	Kamthi Fm.	Late Permian	Hinjrida Ghati near Handapa Village, Angul District, Orissa
	N. khanii	Chandra & Rigby, 1983.	Kamthi Fm.	Late Permian	Hinjrida Ghati near Handapa Village, Angul District, Orissa
	Neomariopteris cf. N. khanii	Prasad, Shukla & Maithy, 1987.	Dubrajpur Fm.	Late Permian	Khatngi Hills, Pachwara Coalfield, Rajmahal Hills, Bihar
4.	*Neomariopteris lobifolia (Morris) Maithy, 1974*	Maithy, 1974.	Raniganj Fm.	Late Permian	Mahavir Colliery, East Raniganj Coalfield, West Bengal
	(Sphenopteris lobifolia)	Srivastava, 1955.	Raniganj Fm.	Late Permian	Raniganj Coalfield, West Bengal
	(S. lobifolia)	Maheshwari & Prakash, 1965.	Barakar Fm.	Middle Permian	Tattitola, Bansloi Valley, Rajmahal Hills, Bihar
	Neomariopteris cf. N. lobifolia	Bose, Banerji & Maithy, 1977.	Panchet Fm.	Early Triassic	Ledho Nala near Karamdiha Village, Ramkola – Tatapani Coalfield, Sarguja District, Madhya Pradesh
	N. lobifolia	Prasad, Shukla & Maithy, 1987.	Barakar Fm.	Middle Permian	Amjhari, Bansloi River, Pachwara Coalfield, Rajmahal Hills, Bihar
5.	*Neomariopteris polymorpha* (Feistmantel) Maithy, 1974	Maithy, 1974.	Raniganj Fm.	Late Permian	Raniganj Coalfield, West Bengal
	(Sphenopteris polymorpha)	Feistmantel, 1876.	Raniganj Fm.	Late Permian	Raniganj coalfield, West Bengal
	(S. polymorpha)	Feistmantel, 1879.	Karharbari Fm.	Early Permian	Lumki Hills, Giridih Coalfield, Bihar
	(S. polymorpha)	Feistmentel, 1880.	Raniganj Fm.	Late Permian	Sitarampur, Raniganj Coalfield, West Bengal
	(S. polymorpha)	Feistmantel, 1882.	Raniganj Fm.	Late Permian	Kurabar, Karkati and Malhadu, Shadol District, Madhya Pradesh
	(S. polymorpha)	Bandyopadhya, 1959.	Barakar Fm.	Middle Permian	Palasthali, Raniganj Coalfield, West Bengal
	(S. polymorpha)	Bhattacharyya, 1959.	Raniganj Fm.	Late Permian	Jagaldaga, Palamau District, Bihar

S.N.	Species	Author(s)	Formation	Age	Locality
	(S. polymorpha)	Mehta & Anadalwar, 1960.	Barakar Fm.	Middle Permian	East of Patrapali, Ib River Coalfield, Orissa
	(S. polymorpha)	Lele, 1962.	Pali Fm.	Late Permian	Salaia, Shadol District, M.P.
	(S. polymorpha)	Saksena, 1962.	Pali Fm.	Late Permian	Karkati, Shadol District, M.P.
	(S. Polymorpha)	Bhattacharyya, 1963.	Barakar Fm.	Middle Permian	Churulia fireclay pit, Auranga Coalfield, Bihar
	(S. polymorpha)	Sen-Gupta, 1965.	Raniganj Fm.	Late Permian	East Bokaro Coalfield, Bihar
	(S. polymorpha)	Biswas, 1966.	Raniganj Fm.	Late Permian	Churulia area, Raniganj coalfield, West Bengal
	(S. polymorpha)	Maheshwari, 1966.	Barakar Fm.	Middle Permian	Tattitola, Bansloi Valley, Rajmahal Hills, Bihar.
	(S. Polymorpha)	Roy & Bhattacharyy 1967.	Barakar Fm.	Middle Permian	Ekadel, Talchir coalfield, Orissa
	(S. polymorpha)	Vimal & Singh, 1968.	Pali Fm.	Late Permian	Karkati, Shadol District, M.P.
	(S. polymorpha)	Khan, 1969.	Kamthi	Late Permian	Hinjrida Ghati near Handapa Village, Angul District Orissa
	(S. pymorpha)	Kulkarni, 1970.	Barakar Fm.	Middle Permian	Kakkari incline, South Karanpura coalfield, Bihar
	Neomariopteris polymorpha	Chitnis & Vagyani, 1979.	Kamthi Fm.	Late Permian	Satnavari Querry, Nagpur District, Maharashtra
	(Damudopteris polymorpha)	Pant & Khare, 1974.	Raniganj Fm.	Late Permian	Raniganj Coalfield, West Bengal
	N. polymorpha	Srivastava & Chandra, 1982.	Raniganj Fm.	Late Permian	Searsole Colliery, Raniganj Coalfield, West Bengal
6	*Neomariopteris talchirensis Maithy, 1974*	Maithy, 1974.	Barakar Fm.	Middle Permian	Junction of Lobjee and Sadabaha, Daltonganj Coalfield, Bihar
	(Cyathea sp. cf. *C. tchihatcheffi)*	Feistmantel, 1881.	Barakar Fm.	Middle Permian	Talchir Coalfield, Orissa
	(Sphenopteris polymorpha)	Feistmantel, 1876.	Raniganj Fm.	Late Permian	Raniganj Coalfield, West Bengal
	(S. polymorpha)	Maithy, 1969.	Karharbari Fm.	Early Permian	Daltongaj Coalfield, Bihar

bling or prostrate fern, based on petrified material.

The combined evidences lead us to believe that amongst many fern types of the Gondwana some may have a small tree habit as is envisaged for *Neomariopteris hughesii* rather than usual prostrate type. The only other fern with small tree like habit reported is *Palaeosmunda* from Late Permian of Queensland, Australia (Gould, 1970).

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