Metaphyte and Metazoan fossils from Precambrian sediments of India : a critique

Mukund Sharma, Manoj Shukla & B. S. Venkatachala

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Evidences of multicellular life from the Indian Precambrian sediments have been reviewed. Their nature, morphology, biogenecity and syngenecity are evaluated in the light of associated evidences. The published records have been grouped under 13 categories, viz., Archaeocyatha, *Chuaria-Tawuia* group, frondoid forms, Hyolithoides, *Longfengshania*, medusoids, metaphytic algae, *Sekwia excentrica*, shelly forms, spiral forms, trace fossils, trilobitoid and eurypteroid and enigmatic group. Contrary to the world wide records of multicellular organisms only at the Terminal-Precambrian (≅ 600 Ma), some of the Indian reports are 1,000-2,500 Ma old. This older antiquity needs proper explanation. In the present review after reassessment, all the records have been classed as true fossil, non-fossil and dubiofossil. In few cases, it has not been possible to comment upon the structure reported due to non-availability of specimen and poor photographic reproduction in print, such records have been grouped separately without any comments.

In several cases synaeresis and mud cracks have been described as trace fossils. Sedimentary structures have also been described as *Sekwia, Longfengshania, Cyclomedusa,* Archaeocyatha, Dasycladaceae algae, *Epiphyton*, lamellibranchs and such other forms Some records though of undoubted biogenic nature, viz., *Katnia singhi* and *Vindhyavasinia misrai* and Ajaicicyatha (from Krol sediments) need reassessment concerning their taxonomic affinity.

The oldest authentic biogenic structures in this review are considered to be about 1,000 Ma old. These records of metaphytes and metazoans—*Ramapuraea vindhyanensis*, vendotaenid forms, trace fossils, megascopic spiral algal forms and *Chuaria-Tawuia* assemblage, are mostly from the base of Kaimur and top of Semri groups. Trace fossils from Bhander Limestone of Vindhyan Supergroup; a metaphytic alga *Renalcis* from the Calc-Zone of Pithoragarh, and frondoid forms, trace fossils as well as small shelly fauna from the Krol-Tal sequence belonging to younger sediments of probable Vendian-Tommotion age are authentic records.

The multicellular plants and animals undoubtedly proliferated during the Vendian, but there are a few authentic exceptional records of multicellular life prior to 600 Ma from India. Similar earlier records are also known from China and Canada. These records are important in understanding the antiquity of multicellular life.

Key-words—Metaphyte, Metazoans, Morphology, Biogenecity, Syngenecity, Precambrian, India.

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सारांश

भारत के कैम्ब्रिय-पूर्व अवसादों से मेटाफ़ाइटी एवं मेटाजीवी जीवाश्म—एक समालोचना

मुकुन्द शर्मा, मनोज शुक्ला एवं बेंगलूर श्रीनिवासा वेंकटाचाला

भारतीय कैम्ब्रिय-पूर्व अवसादों से बहुकोशिकीय जीवन के प्रमाणों की समालोचना की गई है। सहयुक्त प्रमाणों के आधार पर इनकी प्रकृति, आकारिकी, जीवजनिकता तथा सहजनिता का मूल्यांकन किया गया है। सभी प्रकाशित अभिलेखों को 13 समूहों में विभाजित किया गया है ये आर्कियोस्यँथा, **चुआरिया-तवुइया** समूह, फ्रॉन्डॉयडी प्ररूप, ह्योलिथॉयड, **लौंगफेंगशानिया**, मेडुसॉयड, मेटाफाइटी शैवाल, **सेकविया एक्सेन्ट्रिका**, शैल-प्ररूप, कुन्तलाकार प्ररूप, ट्रेस जीवाश्म, ट्राइलोबिटॉयड एवं यूरिप्टेरॉयड तथा रहस्यात्मक समूह हैं। विश्वभर से बहुकोशिकीय जीवाश्मों के अभिलेखों (लगभग 600 एम-ए०) के विपरीत कुछ भारतीय अभिलेख 1,000-2,500 एम-ए० पुराने हैं। इन आँकड़ों की यथार्थता हेतु समुचित पुष्टी की आवश्यकता है। कुछ में प्रादर्श उपलब्ध

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न होने के कारण तथा अच्छे छायाचित्र न प्राप्त होने से कुछ भी टिप्पणी करना सम्भव नहीं है। इस प्रकार के अभिलेखों को अलग कर दिया गया है।

कुछ प्ररूपों में दलदली दरार आदि को ट्रेस जीवाश्म के रूप में वर्णित किया गया है। अवसादी संरचनाओं को **सेकविया लौंगफ़ेंगशानिया, साइक्लोमेडुसा**, आर्क्योसियॅथा, डेसीक्लेडेसी शैवाल, **एपिफ़ाइटन**, लेमॅलिब्रैंक तथा अन्य सदृश प्ररूपों के रूप में वर्णित किया गया है। कुछ अभिलेखों जैसे **कटनिआ सिंघाई** एवं **विन्ध्यवासनिआ मिसराई** तथा ऍजेसियथा की वर्गिकर्णिक स्थिति विचारणीय है।

इस शोध-पत्र में प्राचीनतम् स्पष्ट जीवजनित संरचनायें लगभग 100 एम-ए० आयु की मानी गई हैं। मेटाफ़ाइटियों एवं मेटाजीवियों के **वै** अभिलेख—**रामापुरिया विन्ध्यानेन्सिस**, वेन्डोटीनिड प्ररूप, ट्रेस जीवाश्म, शैवालीय प्ररूप एवं **चुआरिया-तवुइया** समुच्चय अधिकतर कैमूर के आधारी भाग तथा सेमरी समूह के ऊपरी भाग से हैं। विन्ध्य महासमूह के भन्डेर चूनापत्थर से ट्रेस जीवाश्म; पिथौरागढ़ के चूनामंडल से **रेनालसिस** शैवाल तथा क्रोल ताल से फ़ान्डॉयडी प्ररूप, ट्रेस जीवाश्म व छोटे शैल वाले जीव जो सम्भवतः वेन्डियन-टोमोटियन आयु के हैं, प्राप्त अभिलेख हैं।

वेन्डियन काल में निस्संदेह बहुकोशिकीय जन्तुओं एवं पौधों का विकास हुआ। परन्तु भारत से 600 एम-ए० से पहले बहुकोशिकीय जीवन के कुछ अपवाद-अभिलेख भी हैं। चीन एवं कनाडा से भी इसी प्रकार के अभिलेख विदित हैं। बहुकोशिकीय जीवन की यथार्थता समझने हेतु ये अभिलेख अत्यन्त महत्वपूर्ण हैं।

THE advent of multicellular life was a landmark transition achieved in the course of evolution. As a result, there was considerable change in the morphologies ultimately leading to the advent of skeletogenous organisms. Evidences available from the palaeontological records suggest a phase where in major transition occurred during the Terminal Precambrian System. These evidences of fossil metaphytes and metazoans help us to understand their advent, proliferation and also about the organismal experimentations and advancing organisations in the course of their evolution. It is, therefore, necessary to critically evaluate fossil records from Precambrian sedimentary successions and to put them in a proper taxonomic order. It is also necessary, to look into the reproduciblity of these records. It is pertinent to assess the records with reference to the age of the host rock and the palaeoecological conditions under which the organisms lived *vis-a-vis* deposition of sediments. Consideration of fossil records without such assessment may lead to incorrect inference on the antiquity and distribution of metaphytes and metazoans.

The present review, discussess the biogenecity, syngenecity and affinity of macrofossil records from Precambrian sediments of India published up to 1990. New information is added in the form of observations. The fossil records are classified as true fossil (definitely biogenic); dubiofossil (probably biogenic but whose nature is still not certain), and non-fossil (definitely non-biogenic). In few cases it has not been possible to categorise the records into any of the above three categories due to non-availability of specimens or insufficient evidences, hence, no comments have been offered. True phyletic position of most of the Precambrian fossils are not yet confidently established or known; they have, thus, been grouped here into the following 13 categories for easy reference based on their morphologies.

1. Archaeocyatha
2. *Chuaria-Tawuia* group
3. Frondoid forms
4. Hyolithoides
5. *Longfengshania*
6. Medusoids
7. Metaphytic algae
8. *Sekwia excentrica*
9. Shelly forms
10. Spiral forms
11. Trace fossils
12. Trilobitoid and Eurypteroid
13. Enigmatic forms

Additional remarks are also provided to highlight salient features that may aid proper assessment of the records. Attempts have been made to study most of the original specimens. In cases where the original specimens could not be studied, comments are based on the descriptions and illustrations provided by the authors in their publications. Records of multicellular life from Krol belt of Himalaya, which have already been reviewed by Singh (1981) published up to 1980, have not been re-reviewed. Each citation of a record includes the original name of the fossil, author's name, year of publication, illustration, figure number, repository when known (as given in the publication) and description. It is followed by remarks on the specimen incorporating our observations and critical comments based on the restudy of the specimen and supplimenting it with fresh photodocumentation. Line diagrams are added to substantiate our views in cases of those specimens which could not be located. The results of our study are tabulated (Table 1) summarising the present status of Precambrian metaphyte and metazoan records from India.

ARCHAEOCYATHA

Members of the group Archaeocyatha are considered inhabitants of coastal Cambrian shallow

Table 1—Present status of metazoan and metaphytic records of India

FORM (GENERIC OR SPECIFIC NAME)	STRATIGRAPHIC LOCALITY	REFERENCE
DUBIO FOSSILS		
Ajacicyathus	Topmost part of Krol E	Singh & Rai, 1983
Archaeocyatha & *Korgaicyatha*	Topmost part of Krol E	Tewari 1988, 1990
Beltanella sp. cf. *B. gilesi*	Upper part of Krol Formation	Mathur & Shanker, 1990
Beltanelliformis sp. cf. *B. brunsae*	Upper part of the Krol Formation	Mathur & Shanker, 1989
Bhanrerichnus damohensis	Maihar Quartzite Formation	Mathur & Verma, 1983
Brachiopod shell	Kajrahat Limestone Formation	Prakash, 1966
Dasycladaceae algae	Limestone of Cuddaph Supergroup	Rao, 1943
Drag markings, Lonzenge-shaped bodies, Mud volcanoes like structures	Bhander Group	Chakrabarti, 1990.
Epiphyton	Upper part of Krol Formation	Singh & Rai, 1983
Hyolithes rohitaswei	Rohtas Limestone Formation	Rode, 1949
Jelly fish	Nimbahera Limestone Formation	Sisodiya, 1982
Misracyathus vindhyanus	Rohtas Limestone Formation	Misra, 1949
Organic plates	Different stages of Dharwar, Bhima & Kaladgi	Venkatachala & Rawat, 1972, 1973; Viswanathiah *et al.*, 1975, 1976, 1977
cf. *Podolithus* sp.	Suket Shale Member	Shukla & Sharma, 1990
Renalcis	Upper part of Krol Formation	Singh & Rai, 1983
Sajania	Calc-zone of Pithoragarh	Shukla, 1984
Sonjiwashman basuhariensis	Basuhari Sandstone Formation	Mathur, 1982
Trace fossils	Dodguni Formation, Dharwar Supergroup	Shivarudrappa, 1981
FOSSILS		
Aulichnites	Lower Tal Formation	Banerjee & Narain, 1976
Burrow	Rohtas Limestone Formation	Misra & Awasthi, 1962
Burrows	Bhander Limestone Formation	Chakrabarti, 1990
Burrows	Morwan Sandstone Formation	Sisodiya & Jain, 1984
Chuaria circularis, Tasmanites ?kaljoi	Gangurthi shale, Bhima Supergroup	Suresh & Raju, 1983
Chuaria minima, Tawuia dalensis	Rohtas Limestone Formation	Maithy & Babu, 1983
Chuaria, Tawuia & *Tasmanites*	Suket Shales Member	Maithy, 1968
Obruchevella	Lower Tal Formation	Ahluwalia, 1979, 1985, 1988
Gordia sp. cf. *G. marina*	Upper part of Krol Formation	Mathur & Shanker, 1989
Katnia singhi	Rohtas Limestone Formation	Tandon & Kumar, 1977
Medusinites sp. cf. *M. asteroides*	Upper part of Krol Formation	Mathur & Shanker, 1990
Pteridinium	Upper part of Krol Formation	Mathur & Shanker, 1989 Shanker & Mathur, 1991
Ramapuraea vindhyanensis	Suket Shale Member	Maithy & Shukla, 1984 Shukla *et al.*, 1989 Shukla & Sharma, 1990
Renalcis	Calc-zone of Pithoragarh	Shukla, 1984
Small Shelly Fauna	Lower Tal Formation	Singh & Shukla, 1981 Azmi & Pancholi, 1983 Bhatt *et al.*, 1985
Small Shelly Fauna	Upper Krol & Lower Tal Formation	Bhatt & Mathur, 1990
Small Shelly Fauna	Lower Tal Formation	Brasier & Singh, 1987 Kumar *et al.*, 1987
Small Shelly Fauna	Upper Krol Formation	Das *et al.*, 1987
Spiroichnus beerii	Rohtas Limestone Formation	Beer, 1919 Mathur, 1983
Tawuia	Suket shales	Maithy & Shukla, 1984
Trace fossils/Pseudo Fucoids	Shirbu Shale Formation	Vredenburg, 1908 Mathur, 1983
Tirasiana	Upper part of Krol Formation	Mathur & Shanker, 1990
Trace fossils	Morwan Sandstone Formation	Shukla & Sharma, 1990
Trace fossils	Bhander Limestone Formation	Verma & Prasad, 1968 Das, 1987
Tyrasotaenia	Suket Shale Formation	Shukla & Sharma, 1990
Vindhyavasnia misrai	Rohtas Limestone Formation	Tandon & Kumar, 1977

Contd.

Table 1—Contd.

NON-FOSSILS		
Ajaicicyathus tandoni	Hinoti Limestone Formation	Maithy & Gupta, 1981
Allatheca	Suket shales member	Maithy & Shukla, 1984
Annelid traces	Rohtas Limestone Formation	Maithy *et al.*, 1986
Beltanelloides	Rohtas Limestone Formation	Maithy, 1990
Burrows	Bhander Limestone Formation	Sarkar, 1974
Coleolella billingsi	Suket shales member	Maithy & Shukla, 1984
Cyclomedusa davidi	Dholpur shales Formation	Maithy, 1990
Epiphyton	Calc-zone of Pithoragarh	Shukla, 1984
Foraminifera & Gastropoda	Krol "D" upper Krol Formation	Kumar, 1979
Frondoid Form	Rohtas Limestone Formation	Maithy, 1990
Fusiform structures	Sullavai Sandstone Formation	Bose, 1977
Vendotaenid remains	Ghurma shale Formation Rohtas Limestone Formation	Maithy, 1990
Vendotaenia & *Krolotaenia gnilovaskayi*	Lower Krol Formation	Tewari, 1988 Tewari, 1989
Ichnogenus type "A" & "B"	Ghurma Shale Formation	Maithy & Babu, 1988
Ichnofossil	Gulcheru Quartzite Formation	Mukherjee *et al.*, 1987
Krishnanid Forms	Rohtas Limestone Formation	Maithy, 1990
Lamellibranchs, etc.	G. R. Formation, Dharwar	Iyengar, 1905 Sambe Gowda *et al.*, 1978
Longfengsahnia chopanensis	Rohtas Limestone Formation	Maithy & Babu, 1988
Longfengsahnia stipitata	Rohtas Limestone Formation	Maithy & Babu, 1988
Muniaichnus	Glauconitic Sandstone Formation	Kumar, 1978
Puratanichnus bijawarensis	Amronia Quartzite Formation	Mathur & Chattri, 1986
Rohtasia tandonii	Rohtas Limestone Formation	Singh & Chandra, 1987 Maithy, 1990
Sekwia excentrica	Rohtas Limestone Formation	Maithy & Babu, 1988
Sekwia excentrica	Rohtas Limestone Formation	Maithy *et al.*, 1986
Skolithos	Glauconitic Sandstone Formation	Saxena, 1980
Tubocyathus vindhyanensis	Nagod Limestone Formation	Maithy & Gupta, 1981
Vendotaenia	Rohtas Limestone Formation	Maithy & Babu, 1988 Maithy, 1990
Worm track	Rohtas Limestone Formation	Misra & Awasthi, 1962
No Comments		
Asteriradiatus karauliensis	Karauli Quartzite Formation	Mathur, 1982
Chordoichnua latouchei	Red Sandstone of Marwar Group	La Touche, 1902 Mathur, 1983
Dasycladaceae algae	Dogra slates	Rao & Mohan, 1953
Misraea	Porcellanite Formation	Maithy & Babu, 1986
Ostracoda	Upper Krol Formation	Das *et al.*, 1990
Trace fossils	Bhander Limestone Formation	Das *et al.*, 1987
Trilobitid & Eurypterid Forms	Ganurgarh shales & Nagod Limestone Formation	Dubey, 1982

sea. They could have lived in large numbers on calcareous bottoms forming 'gardens' of sessile benthos, but do not form reefs (Moore, 1955). This extinct phylum appeared near the base of Cambrian, spread rapidly by the middle part of the Early Cambrian and probably became extinct early in the Middle Cambrian and as such is considered an index fossil group for the Early Cambrian in carbonate facies (Rigby & Gangloff, 1987).

***Misracyathus vindhyanus* Vologdin 1959**

Text-figure 29

Repository—Not mentioned. Misra, 1949, fig. 2. Misra (1949) reported 'a verticillate alga with a slender jointed stalk terminated by a globular head' from the carbonaceous limestone of upper most Rohtas Stage (Murli Hill Limestone Formation) at Banjari quarries and related it with dasycladaceaeous alga. Vologdin (1959, *in* Balakrishnan, 1974) did not agree with the algal affinity but designated it as a very early form of the phyla Archaeocyatha, and erected a monospecific new genus *Misracyathus vindhyanus* Vologdin.

Remarks—Archaeocyathids are generally found in association with stromatolite building organisms in the shallow water environments of Cambrian sea. Rohtas Limestone Formation, Rohtas, from which these records have been made was deposited in

subtidal to intertidal environment. Records of algal activity are not known from this formation. The age of these sediments on correlation has been considered ~ 1,100 Ma (Shukla & Sharma, 1990). Therefore, the chance of finding archaeocyathids in this horizon are remote. Zhuravlev (1986) also contradicted Vologdin's (1959) opinion of associating the fossil recovered by Misra (1949) with archaeocyathids and expressed the view that this specimen may be some other microfossil or oolite. Therefore, the specimen reported by Misra (1949) is neither alga nor archaeocyatha. But in the absence of original specimen the specimen can only be referred to a biogenic structure and classified as a 'dubiofossil'.

***Ajacicyathus tandoni* Maithy & Gupta 1981**

Pl. 1, figs 4, 5

***Tubocyathus vindhyanensis* Maithy & Gupta 1981**

Pl. 1, figs 1-3

Repository—Birbal Sahni Institute of Palaeobotany, Lucknow; Slide nos. 5950, 5951; Maithy & Gupta, 1981, figs 1-7.

Maithy and Gupta (1981) described *Ajacicyathus tandoni* from Hinaoti Limestone Formation of Semri Group and *Tubocyathus vindhyanensis* from Nagod Limestone Formation of Bhander Group of Vindhyan Supergroup exposed in central India; the former formation is dated ~ 1,100 Ma, while later about 800 Ma.

Remarks—The formations containing these fossils have many well developed oolitic beds (Sarkar, 1973; Singh, 1976; Chanda & Sarkar, 1977; Kumar, 1978a). The petrographic sections containing the taxa under review are also dominantly oolitic. A re-examination of slide nos. 5950 and 5951 reveal that few selected grains of ooids have been described by Maithy and Gupta (1981) as archaeocyathids because of their apparent similarity. The specimens exhibit only the cross section of ooids with inorganic mineral grain in the centre. The specimens attributed to the two taxa under review are similar and do not show any major difference in size. They also lack the diagnostic features of *Ajacicyathus* and *Tubocyathus*. Archaeocyatha are known from the shallow coastal zones rather than in high energy environment of the oolite formation. The genus *Ajacicyathus* is known from Early Cambrian of North America, Europe, Asia and Australia (Rigby & Gangloff, 1987), while genus *Tubocyathus* is known from Middle Cambrian of Asia (Raaben, 1981). Their record in 800-1,100 Ma old sediments needs a rethinking. Zhuravlev (1986) and Debrenne *et al.* (1990) have already suggested these records to be either microfossils or oolites. Our observations support their oolitic nature. Therefore, these two specimens are 'non-fossils'.

***Archaeocyatha* sp.**

Text-figures 52, 53, 58, 59, 60, 61

Repository—Geology Department, Lucknow University, Lucknow; Specimen and slide nos. not known; Singh & Rai, 1983, pl. 1, figs 2-7; pl. 2, fig. 12; Singh & Rai, 1984, figs 1-6.

Singh and Rai (1983) described archaeocyatha in a polished slab collected from the top most part of the Krol E of Mussoorie hill, Dehradun, as 'cups of 1 to 2 cm in diameter and almost 3 to 4 cm in length. The wall (both outer and inner) are highly porous, the central cavity is filled with dessepiments. This form compares with *Ajacicyathus*. There are other forms, some of them discoidal, other appear to be broken and roled pieces often in poor state of preservation.' It is again described as a separate report by Singh and Rai (1984).

Remarks—The figured specimen (as informed by Dr V. Rai) presently is on loan to Prof. Antonio Perejon, Spain for detailed study. Therefore, our comments are limited to the observations made by other workers. Zhuravlev (1986), Brasier and Singh (1987), Cowie and Brasier (1989) doubted the affinity of the specimen under review with archaeocyathids. Brasier and Singh (1987) further

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PLATE 1

(Scale in figs 1, 4, 6, 7 & 8, 1 div. = 1 cm, and in fig. 2 = 5 mm, fig. 3 = 1 mm and fig. 5 = 1.5 mm)

1-3. *Tubocyathus vindhyanensis* sp. nov. of Maithy & Gupta 1981. 1. Shows general view of the slide containing *T. vindhyanensis* showing the oolitic nature of the thin section; 2. shows the close up of the oolite; and 3. shows the closer view of some of the oolites, Slide no. BSIP-5951.

4, 5. *Ajacicyathus tandoni* sp. nov. of Maithy and Gupta, 1981. 4. Shows general view of thin section containing *A. tandoni*. Close observation shows the presence of numerous oolites in thin section, some of them have been enlarged and shown in fig. 5, Slide no. BSIP-5950.

6-8. *Pteridinium* of Mathur & Shanker 1989 and Shanker & Mathur, 1991. 6. Due to fragmentary nature of figure it is considered non-fossil; 7. considered dubiofossil; 8. shows characteristics of *Pteridinium*, viz., primary furrow, secondary furrow and median axis, hence considered true fossil, Specimen nos. GSI-20283, 20285 and 20286.

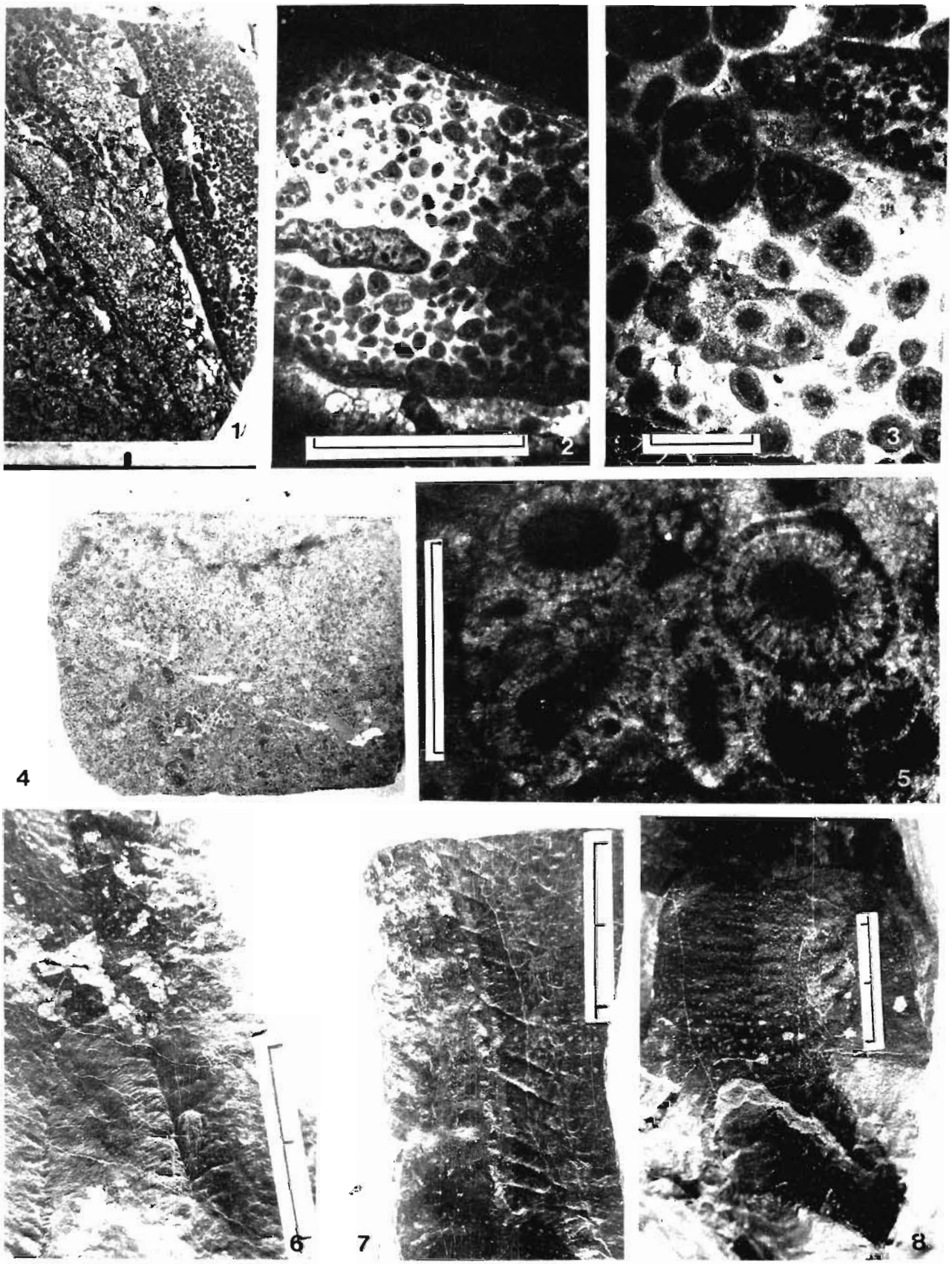

PLATE 1

commented that the specimens of Singh and Rai (1983, pl. 1) resemble thrombolitic fabric. Material containing similar structures from the same horizon (shown to Brasier & Singh by P. Kalia) exhibits a complex fenestral and fissure filling texture. Debrenne *et al.* (1990) after restudy of topotype similar material further comment that 'Critical examination of the original description shows that on the weathered surfaces, the authors considered the light material as a porous skeleton, while on polished surfaces the dark material is proposed as the intervallar skeleton. This is inconsistent with our observations; the light material is highly recrystallized (calcite and dolomite) while the dark material is interpreted as detrital filling displaying cryptalgal fabric, in columnar like structures'. Kumar (1989) made a thorough search of the horizon in Mussoorie area but could not locate such specimens.

We also consider that the features of the specimens are apparently biogenic and may be compared with thrombolite; and classified under the category of 'dubiofossil'.

Archaeocyatha and *Korgaicyatha* Tewari 1988

Text-figure 64

Repository—Not mentioned. Tewari, 1988; Tewari, 1989, pl. 7, fig b.

Tewari (1988, 1989) reported the presence of *Archaeocyatha* and *Korgaicyatha* without any description in Krol E and neither mentioned the locality nor repository.

Remarks—The illustrated figure lacks diagnostic features to justify the assignment. The comments offered on the specimens figured by Singh and Rai (1983, 1984) are also applicable here. This record is also considered as 'dubiofossil'.

CHUARIA, TAWUIA AND ALLIED FORMS

Chuaria, Tawuia and allied forms are found as carbonaceous compression, impression and sometimes as mineralised cast. They have invariably been reported from 1,000-600 Ma old sediments. There are many records of *Chuaria* and *Tawuia* from Suket Shale of Rampura, district Mandsaur. Maithy and Shukla (1984b) have already reviewed these records. However, here we confine to those reports published after 1984 or which could not be incorporated in the earlier review of Maithy and Shukla (1984b) and those specimens which are available in the repository of Birbal Sahni Institute of Palaeobotany, Lucknow. *Chuaria, Tawuia* and allied forms are now considered to be eukaryotic algae, such forms were attributed earlier to brachiopods (*Fermoria, Protobollela*, etc.).

Tasmanites Newton

Repository—Birbal Sahni Institute of Palaeobotany, Lucknow; Slide no. 2804; Maithy, 1968, pl. 1, fig. 6.

Suket shales from Rampura have yielded *Tasmanites* with other microfossils, viz.,

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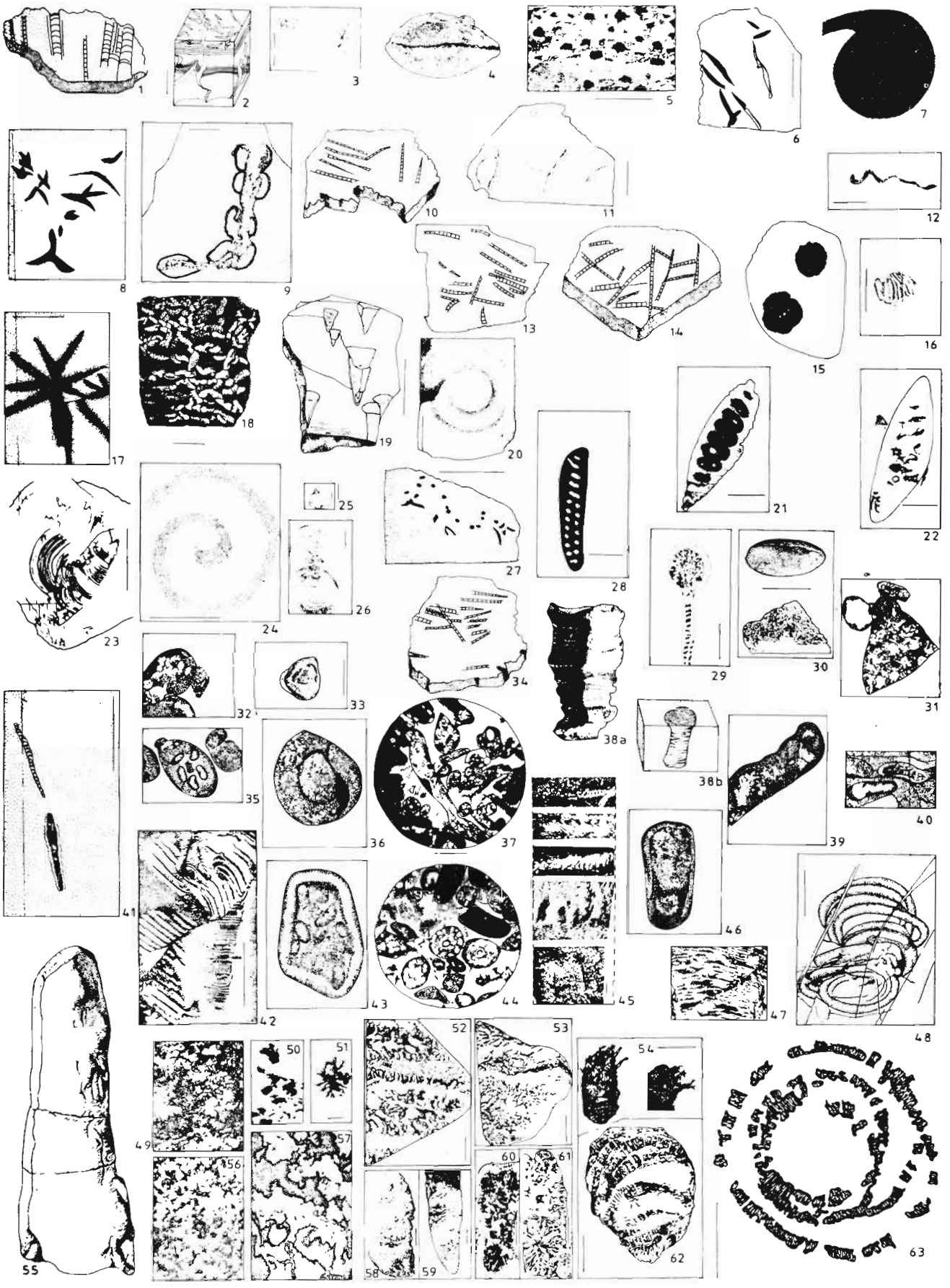
Text-figure 1—Figures **1, 10, 13, 14, 34**: Ichnofossils (Das *et al.*, 1987, pl. 1, figs 1-3; pl. 2, figs 1-2), Scale is same as in fig. 1 = 2 cm. **2.** Burrows (Sarkar, 1974, fig. 4D), Scale = 1.5 cm. **3.** Jelly fish (Sisodiya, 1982, fig. 1). Scale = 2 cm. **4, 5.** Ostracoda (Das *et al.*, 1990; pl. 1, fig. 1b & 2c), Scale = 100 μm. **6.** Work track (Misra & Awasthi, 1962, fig. 15), Scale = 5 cm. **7, 15.** *Chuaria circularis* (Suresh & Raju, 1983, figs 2.1 & 2.2), Scale = 1.5 mm. **8.** Trace fossil (Saxena, 1980, fig. 1), Scale = 7 cm. **9.** *Bhanrerichnus damohensis* (Mathur & Verma, 1983, fig. 1), Scale = 2 cm. **11.** *Sonjiwashmam basubariensis* (Mathur, 1982, fig. 2b), Scale = 2 cm. **12.** *Muniaichnus* (Kumar, 1978b, pl. 2, fig. 1), Scale = 29 cm. **16.** Shell-like form (Prakash, 1966, fig. 1), Scale = 4 cm. **17.** *Asteriradiatus karauliensis* (Mathur, 1982, fig. 2A), Scale = 2 cm. **18.** Fusiform structure (Bose, 1977, fig. 1), Scale = 4 cm. **19.** *Hyolithes rohitaswei* (Rode, 1946, fig. 1), Scale = 4 cm. **20.** *'Rohtasia tandonii'* (Maithy, 1990, pl. 1, fig. 7), Scale = 5 cm. **21, 22, 28.** Foraminifera and Porifera. *Archaediscus, Pachypholia (?), Palaeobigenerina* (Ahluwalia, 1979, 1a, 1b, 1c), Scale = 350 μm. **23.** Ichnofossil (?) (Shivarudrappa, 1981, pl. 1, fig. 2), Scale = 10 cm. **24.** Spiral impression, *Spiroichnus beerii* (Beer, 1919, pl. 30, fig. 1; Mathur, 1983, pl. 2, fig. 1), Scale = 0.5 mm. **25.** *Medusinites* (Maithy, 1990, pl. 2, fig. 9), Scale = 1 cm. **26.** *Cyclomedusa* (Maithy, 1990, pl. 2, fig. 8), Scale = 1 cm. **27.** Trace fossil (Sisodiya & Jain, 1984, pl. 1, fig. 1), Scale = 10 cm. **29.** Dasycladaceae/*Misracyathus vindhyanus* (Misra, 1949, fig. 2), Scale = 600 μm. **30.** "Lamellibranchs, etc." (Gowda *et al.*, 1978; pl. 2, figs b, d), Scale = 7.5 cm. **31.** *Paraboultonia* foraminifera (Kumar, 1979, pl. 2, fig. 5). **32.** *Diplotermina* foraminifera (Kumar, 1979, pl. 2, fig. 3). **33, 38a, 38b.** Conical structures (Misra & Awasthi, 1962, fig. 7, 8, 9), Scale = 1 cm (for fig. 33 = 2 cm). **35.** Umblical view of *Tetrataxis*-foraminifera (Kumar, 1979, pl. 2, fig. 4). **36.** *Gourisina* foraminifera (Kumar, 1979, pl. 1, fig. 3). **37, 44.** Dasycladaceae algae (Rao, 1943, fig. 1; Rao, 1949, fig. 1), Scale = 0.5 mm. **39.** *Novella* foraminifera (Kumar, 1979, pl. 1, fig. 1). **40.** *Nodosaria*-foraminifera (Kumar, 1979, pl. 1, fig. 2). **41.** *Puratanichnus bijawarensis* (Mathur & Chattri, 1986, pl. 1, fig. 1), Scale = 5 cm. **42.** Frondoid form (Maithy, 1990, pl. 2, fig. 7), Scale = 4 cm. **43.** *Tetrataxis* foraminifera (Kumar, 1979, pl. 1, fig. 5). **45.** Dasycladaceae algae (Rao & Mohan, 1954, figs 2-5), Scale = 1,000 μm. **46.** *Lunucanmina perforata* foraminifera (Kular, 1979, pl. 2, fig. 1). **47.** Vendotaenid form (Maithy, 1990, pl. 2, fig. 1), Scale is same as in fig. **42. 48, 62, 63.** *Katnia singhi* (Conway-Morris, 1989, fig. 2b; Tandon & Kumar, 1977, fig. 1), Scale is same as in fig. 48 = 10 mm. **49.** *Sajania* (Shukla, 1984, pl. 1, fig. 5). **50, 51.** *Epiphyton* (Shukla, 1984, pl. 1, figs 3, 4), Scale = 3,000 μm. **52, 53, 58, 59-61.** Different view of Archaeocyatha (Singh & Rai, 1984, pl. 1, figs 1-6), Scale = 1 cm. **54.** *Vindhyavasinia misrai* (Tandon & Kumar, 1977, fig. 3), Scale = 0.5 mm. **55.** *Chordoichnus latouchei* (Vredenburg, 1908, pl. 34, Mathur, 1983, pl. 1), Scale = 6 cm. **56, 57.** *Renalcis* (Shukla, 1984, pl. 1, fig. 1 & 2). Scale = 3000 μm.



Text-figure 1

Leiosphaeridia sp., *Protoleiosphaeridium* sp., *Retisphaeridium vindhyanensis* Maithy and *Gloeocapsamorpha* sp. *Tasmanites* is described as circular vesicles ranging from 500-1,000 μm in size having numerous puncta and pores that appear as shallow depressions (Maithy, 1968).

Remarks—The authors are in agreement with Maithy (1968) that the morphological features of *Tasmanites* are closely comparable to the morphological features of macerated specimens of *Chuaria* at least in some cases. The biological affinity of *Tasmanites* has been discussed in detail by Wall (1962) who related them to Parsinophyceae. The present specimen is a 'true macrofossil' comparable with *Tasmanites*/*Chuaria*.

***Chuaria* Walcott**

Text figures 7, 15

Repository—Not mentioned. Gowda *et al.* 1979; Gowda, 1980; Suresh & Godwa, 1981, pl. 1, fig. 2; Suresh & Sunder Raju, 1983, fig. 2.

Chuaria circularis, Tasmanites kaljoi, ? and allied forms (acritarchs) have been described from Gangurthi shales of Bhima Basin from the Gangurthi locality in Gulbarga District, Karnataka (Gowda *et al.*, 1979; Gowda, 1980, Suresh & Gowda, 1981; Suresh & Sunder Raju, 1983). *Chuaria* are discoidal and elliptical in shape and occur both as compression and impression. They are also found in the macerated residue. They are considered as marine phytoplankton of algal origin (comparable to *Volvox*) (Suresh & Sunder Raju, 1983).

Remarks—We could not examine the described specimens, still our study of the material from this area, supports the occurrence of *Chuaria* from the Late Proterozoic sediments and confirm the validity of the identification of *Chuaria circularis* and *Tasmanites kaljoi*?. They are considered as 'true macrofossils'.

***Tawuia* Hofmann**

Pl. 8, fig. 1

Repository—Birbal Sahni Institute of Palaeobotany, Lucknow; Specimen no. 25277; Maithy & Shukla, 1984a, pl. 1, fig. 4; Shukla & Sharma, 1990, pl. 1, fig. 6.

A compression of *Tawuia dalensis* Hofmann has been reported from Mandsaur, Suket Shale of Semri Group in Madhya Pradesh. It is 0.83 cm in length 0.2 cm in width, rod-like in shape, straight or curved with smooth surface and rounded end (Maithy & Shukla, 1984a; Shukla & Sharma, 1990).

Remarks—The specimen described by Maithy and Shukla (1984a, pl. 1, fig. 4) and Shukla and Sharma (1990, pl. 1, fig. 6) is comparatively much smaller than the holotype of *Tawuia dalensis* (1-8.5 mm wide and several centimeters long). As per description of Hofmann (1979, in Hofmann & Aitken, 1979) and Hofmann (1985), the holotype is a carbonaceous compression or impression of straight and curved, roundly terminated, tomaculate (sausage-shaped) structure. Hence, the form reported by Maithy and Shukla (1984a) and Shukla and Sharma (1990) is comparable with *Tawuia*. It can not be attributed to *T. dalensis* Hofmann 1979. The specimen reported by Maithy and Shukla (1984a) is a 'true macrofossil'.

***Chuaria* Walcott and *Tawuia* Hofman**

Pl. 3, figs 6, 7

Repository—Birbal Sahni Institute of Palaeobotany, Lucknow; Specimen no. 36105; Maithy & Babu, 1988, pl. 1, figs 1-6.

Maithy and Babu (1988) described *Tawuia dalensis* as a platyspermic sausage-shaped carbonised compression on 'grey coloured limestone' with rounded ends, measuring 5-10 mm in length and 2.5 mm breadth with smooth surface. The specimens of *Chuaria minima* were described as platyspermic carbonised circular to oval disc measuring 2-4 mm on 'black coloured limestone'. According to them some specimens have small central area indicating possible opening. Discs have smooth surface and show fine puncta.

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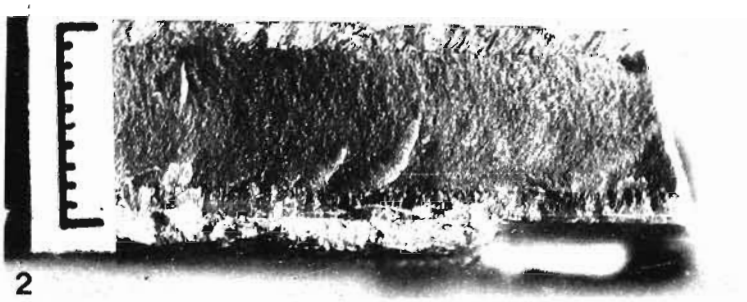
PLATE 2

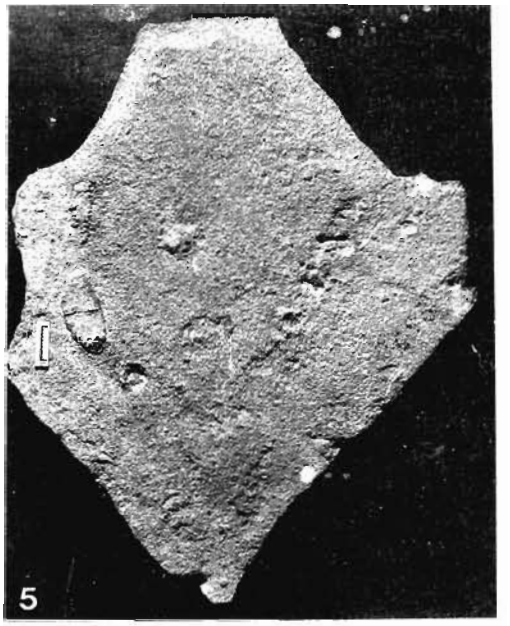
(Scale in all figures, 1 div. = 1 mm)

1. *'Longfengsahnia chopanensis'* of Maithy & Babu 1988, note the yellow silty material as grey coloured in photograph', Specimen no. BSIP-36111.
2. Side view of the specimen shown in fig. 1. Note the presence of thin vener of fibrous calcite on either side of the slab marked with arrow.
3. *'Longfengsahnia chopanensis'* of Maithy & Babu 1988, Holotype. Note the weathering feature of the clast, attached on the bedding plane of a limestone, Specimen no. BSIP-36112.

4, 7 *'Longfengsahnia stipitata'* of Maithy & Babu 1988. General view of the slab having specimen. Note the nature of the intraformational conglomerate with clast. One such clast shown in fig. 7 is considered as *L. stiptata* by Maithy & Babu, Specimen no. BSIP-36110.

5, 6. *'Longfengsahnia stipitata'* of Maithy & Babu 1988. General view of the slab containing specimen marked with arrow. Note the intraformational conglomeratic nature of slab with several clasts on it. One such clast has been enlarged and shown in fig. 6 and is considered as *L. stiptata* by Maithy & Babu, Specimen no. BSIP-36109.





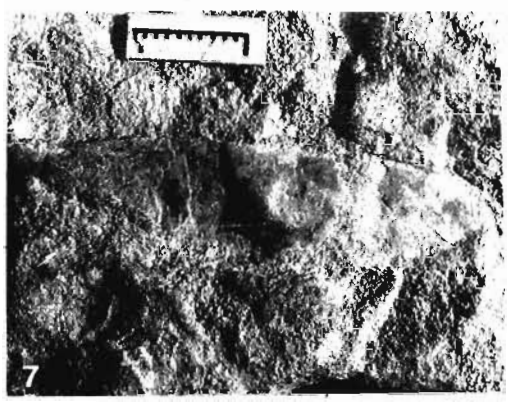


PLATE 2

Remarks—*Chuaria* and *Tawuia* present on the 'same grey coloured limestone'. They are aligned in one direction suggesting possible drift from the place of growth in the open sea to the tidal zone along the current direction. These discoid specimens show wide ranging morphology from circular, ovoidal to oblong to slender long specimens. They are impressions and do not show any trace of carbon on the specimen (carbonaceous crust present on the surface have been removed for the study-pers. communication—Maithy, 1992).

Restudy shows presence of 22, long slender specimens (attributed to *Tawuia dalensis* Maithy & Babu 1988) on the rock surface. They measure 4-11 mm in length and 1-2.5 mm in breadth. Maithy and Babu (1988, pl. 1, figs 3-6) reported bulbous structures, with a fluffy nature and sickle shaped, on the fossils in a SEM study. These doubtful artifacts may have been formed during preparation of the material for study. Close observation of the specimen under optical microscope reveals the presence of annulation on some parts of *T. dalensis*. The fragmentary and incomplete preservation of annulation on different regions suggests that they were probably annulated organisms. The presence of annulation on the body could indicate movement through peristalsis. On this basis a metazoan affinity could be attributed for these specimens. *T. dalensis* sensu Hofmann, 1979 in all probability is of algal origin and can not be a metazoan. However, the specimens described by Maithy and Babu, 1988, pl. 1, figs 1-6 show characters attributable to metazoa. Thus the specimens under review cannot be identified as *T. dalensis*. There are reports of fossils of soft bodied animals predating the Ediacara fauna from the Late Precambrian rocks of Huai River China (Junyuan, 1988). The specimens described from China are better preserved and show several characters in developed stage which are also noticed on the fossils attributed to *T. dalensis* by Maithy and Babu (1988).

The specimens of *Tawuia* under review are 'true macrofossils' though their taxonomic assignment need reassessment in the light of above comments.

Further, *Chuaria minima* present on the same rock surface has a wide range of shape, from circular, ovoid to oblong. They are found as impressions on the bedding surface. In all, 128 specimens of *Chuaria* are present on the limestone slab. Their diameter varies from 1.5 to 3 mm (x = 2.2; N = 30). The central opening as reported by Maithy and Babu (1988) could not be observed in the specimens. The size parameter and morphological details suggest that these specimens are 'true macrofossils'.

FRONDOID FORMS

Pteridinium

Pl. 1, figs 6, 7, 8; Pl. 3, fig. 3

Repository—Geological Survey of India, Calcutta; Specimen nos. 20283, 20285, 20286 and 20287; Mathur & Shanker, 1989, pl. 1, figs 2, 4, 5, 6; Shanker & Mathur, 1991, pl. 1, figs 1-4; pl. 2, fig. 4.

Mathur and Shanker (1989) described bilaterally symmetrical frond like body with median axis giving rise to primary and secondary furrows from the upper part of Krol Formation exposed in the southern limb of Nainital syncline. On the basis of fresh collection made from the same locality, organic nature of the *Pteridinium* was questioned by Misra (1990, pp. 114-115), Bhatt and Mathur (1990b, pp. 115-117) and Azmi and Tewari (1991). According to these authors the primary and secondary furrows are either concentrated patterns formed due to folding on the fold axis, or represent ripple marks. Shanker & Mathur (1991) redescribed this form and considered it authentic.

Remarks—Re-examination of the specimens of Mathur and Shanker (1989) and also fresh collection available with them shows the presence of *Pteridinium* like structure both in the depressed as well as on the elevated zone of rock surface. Thus, structures described by Mathur and Shanker (1989) are not merely compressional features concentrated

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PLATE 3

(Scale in figs 1, 2 & 3, 1 div. = 1 cm; fig. 4 = 2 cm; fig. 5 = 2 mm and
6 & 7, 1 div. = 1 mm)

1, 4. Frondoid form of Maithy, 1990, which is present on thin vener of clacite; 1. shows general view of slab containing Frondoid form; and 4. shows the close up of fig. 1, Specimen no. BSIP-36226.

2. Frondoid form of Maithy, 1990, which is present on thin vener of clacite, Specimen no. BSIP-35959.

3. *Pteridinium* of Mathur & Shanker, 1989. Note the fragmentary nature of the specimen of *Pteridinium*, Specimen no. GSI-20287.

5. *'Rohtasia tandonii'* of Maithy, 1990, the specimen is product of weathering and is present on shale, Specimen no. BSIP-35960.

6, 7. *Chuaria* and *Tawuia* of Maithy & Babu, 1988. 6. Shows general view of the specimen showing rounded *Chuaria* and elongated *Tawuia*; 7 close up of fig. 6, elongated specimens have annulations, specimen no. BSIP-36105.

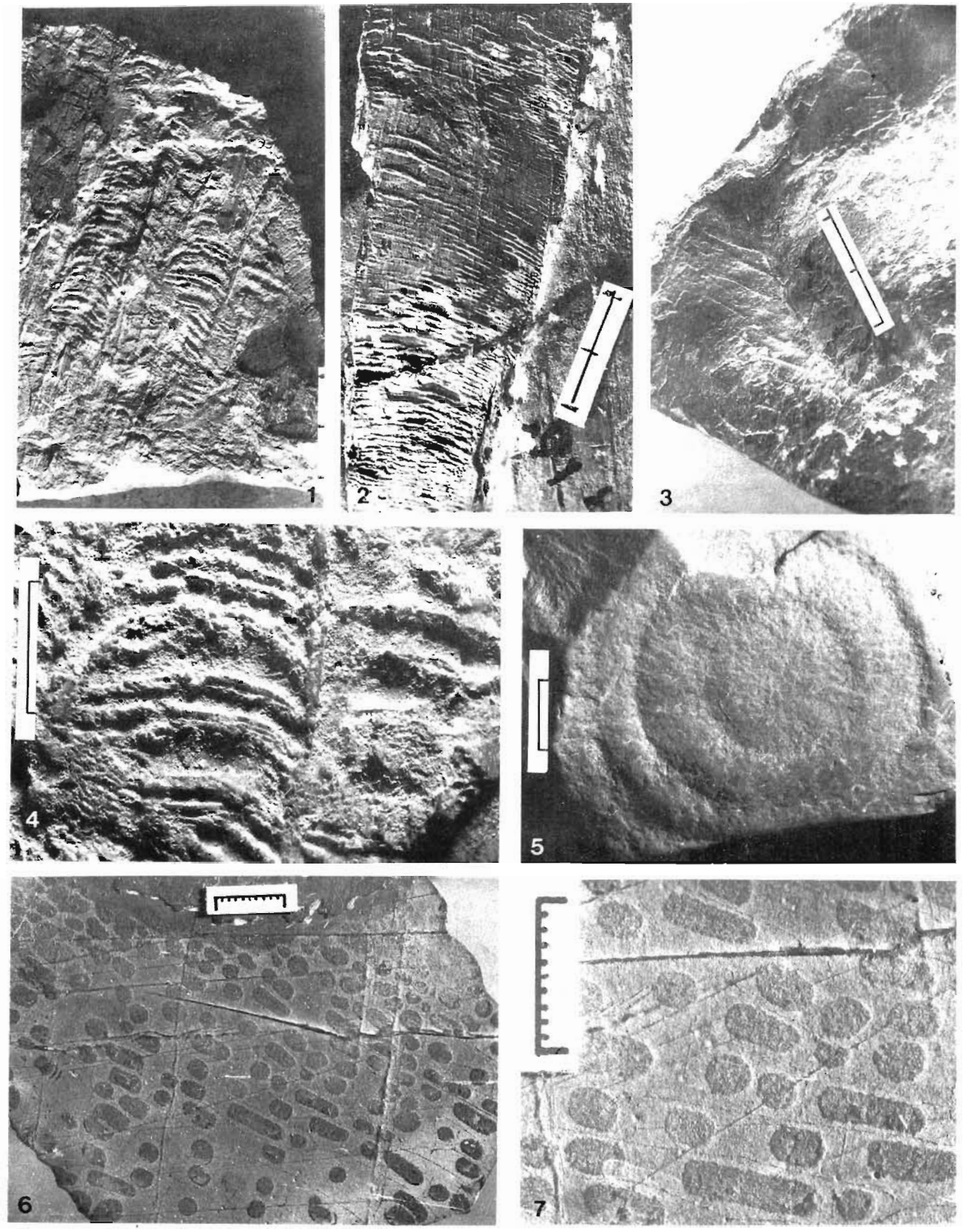

PLATE 3

on fold axis. The fossil has also been interpreted as a sedimentary structure resembling a ripple mark. A ripple-marked surface should show a flat surface and other surface should show crests and depressions signifying wave action. The specimen observed in the collection of Mathur and Shanker do not show this feature and hence possibilities of these structures being ripple marks can be ruled out. Field studies carried out by us indicate the presence of folded/ripple marked structures, along side with the fossils. In our opinion the sedimentary structures are distinctly different from the forms identified as frondoid form by Mathur and Shanker (1989, pl. 1, fig. 5). Since, nearly all the diagnostic features of frondoid form, viz., primary furrow, secondary furrow and median axis are clearly observable in this form it is considered here as a true representative of metazoan affinity. Late Professor Glaessner (corresp. to editor Jour. GSI) and Professor Narbonne (pers. comm. to G. Kumar) have also expressed a similar view. It is difficult to comment on the specimens described on pl. 1, figs 2, 4, 6 of Mathur and Shanker, (1989) due to their fragmentary nature, though, Prof. Narbonne (pers. comm. to G. Kumar) has opined that figs 4 and 6 look more similar to *Charniodiscus*.

Hence, we consider the form described by Mathur and Shanker (1989, pl. 1, fig. 5) as 'true fossil' while those in (Mathur & Shanker, 1989, figs 4, 6) may be considered as 'dubiofossil'. The form described in figure 2 may be considered 'non-fossil' since it does not show any diagnostic features, besides apparently similar structures of inorganic origin are also present in the same locality.

Frondoid forms

Pl. 3, figs 1, 2, 4.

Repository—Birbal Sahni Institute of Palaeobotany, Lucknow; Specimen no. 36226, number for fig. 7 not mentioned; Maithy, 1990, pl. 2, figs 6, 7.

Maithy (1990) described frondoid forms having an overall morphology similar to petalonamid form —*Pteridinium* from the Rohtas Limestone Formation of Vindhyan Supergroup. He further expressed an opinion that these forms may not be related to coelenterates due to the absence of autozooids and scyphozooids and he favoured an algal affinity for these structures. He also compared them with members of Rhodophyceae and Chlorophyceae (*Caulerpa*).

Remarks—The structures described in plate 2, figure 6 of Maithy (1990) are present on a thin vener of fibrous secondary calcite spread throughout the limestone slab and biogenecity of any structure present on such surfaces is doubtful. The specimen illustrated by Maithy (1990, pl. 2, fig. 7) is not available for observation; however, the illustration shows morphological features similar to those in the specimen figured on plate 2, figure 6 (Maithy, 1990). This specimen is from the same locality. It is, therefore, most likely that this specimen also is present on similar thin vener of fibrous calcite which covers the limestone surface. Hence, we consider the frondoid remains (Maithy, 1990; pl. 2, figs. 6, 7) as 'non-fossils'.

HYOLITHIDS

Hyolithes robitaswei Rode

Text-figure 19

Repository—Not mentioned; Rode, 1946, fig. 1.

Rode (1946) noticed symmetrical, conical straight shells with numerous striae on the surface of a slab collected from talus, possibly representing the top zone of Rohtas Stage (Rohtas Formation, now referred to as Murli Hill Limestone Formation), Semri Series (Semri Group) 4.5 km west of Ramdhera in Rohtas District, Bihar. He considered them to be *Hyolithes robitaswei*.

Remarks—No details of repository are available. Photographic illustrations are also absent. The line diagram and description of the fossil are complimentary. Such a form has neither been recorded by later workers nor Hyolithids are known from the Precambrian sediments. Therefore, this record is classed under the category 'dubiofossils'.

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PLATE 4

(Scale in figs 1, 2, 3, 1 div. = 1 cm; 4 & 5 = 1 mm & 6, 7 & 8 = 5 mm)

1-3. Vendotaenid form of Maithy, 1990. 1, 2 Show criss cross pattern of mineral vein like feature present on either side of the rock piece, vein marked with arrow has been considered as vendotaenid remain; and 3. shows enlarged view of the vein, Specimen no. BSIP-35958.

4, 5. *Sekwia excentrica* of Maithy & Babu 1988. 4. Shows general view of weathered limestone bedding plane, having ovoidal clast This clast has been enlarged in fig. 5, it has no diagnostic characters to be assigned to *Sekwia excentrica*, Specimen no. BSIP-36106.

6, 7 Crinoidal holdfast-like structure Shukla & Sharma 1990, Specimen no. BSIP-25222/273.

8. *Tyrasotaenia* of Shukla & Sharma, 1990 showing flat brown films on the slab without any reproductive organs, Specimen no. BSIP-25211/273.

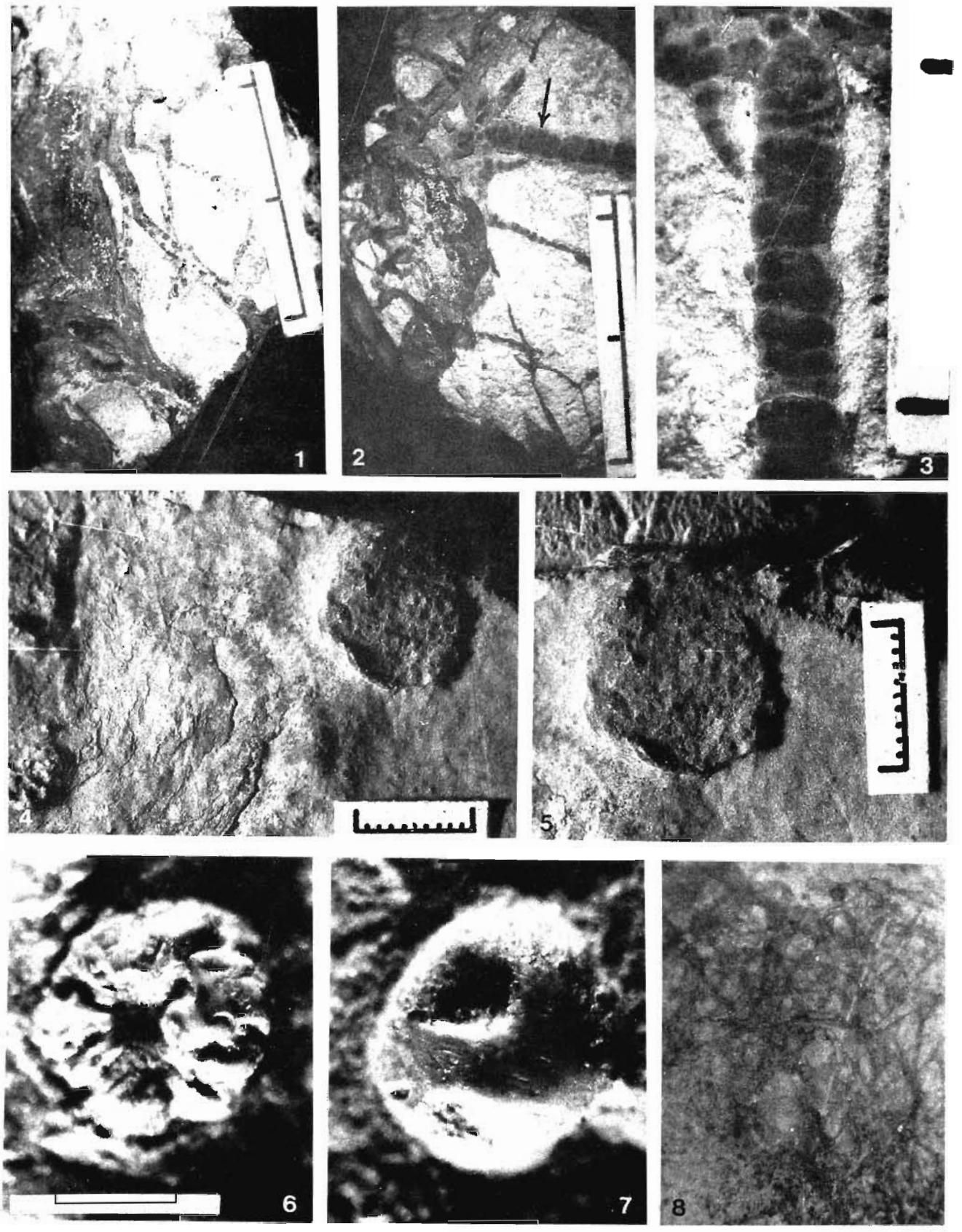

PLATE 4

LONGFENGSHANIA

Du and Tian (1985) described *Longfengshania* as a foliate structure with a stalk-like parastem and occasional rhizome at the base. The presence of parastem is a diagnostic feature. It not only supports the foliate structure and connects it with rhizome, but also exposes it towards sunlight for photosynthesis in water. The size of both the parastem as well as the foliate structure depends on the ecological realm. Many forms exhibit surface ornamentation such as marginal rings of variable width, ring veins and inner ring veins. Some of them appear to exhibit 'organic differentiation' similar to that of higher plants.

***Longfengsahnia (Longfengshania) stipitata* Maithy & Babu**

Pl. 2 figs 4-7

Repository—Birbal Sahni Institute of Palaeobotany, Lucknow; Specimen no. 35919; Maithy & Babu, 1988, pl. 2, figs 2, 3; Specimen nos. 36109, 36110; Maithy, 1990, pl. 2, fig. 4.

Maithy and Babu (1988, pl. 2, figs 2, 3) described '*Longfengsahnia stipitata*' from Ghurma Shale Formation of Kaimur Group, Vindhyan Supergroup, as an elongate oval impression measuring 8-40 mm long and 4-12 mm wide with the broadest region at 1/3 length from apex; basal end with stalk like structures which are ± 0.5 mm wide and ± 2 mm long and rounded distal end with smooth surface.

Remarks—Longfengsahnia (Longfengshania) stipitata (Maithy & Babu, 1988, pl. 2, fig. 2) is present on a fine grained sandstone having clastic fragments on its upper surface (specimen no. BSIP 36110 instead of BSIP 36109 as mentioned by Maithy & Babu, 1988). The slab is a part of intraformational conglomerate, wherein thin/tabular pieces of shale are embedded in a sandy matrix. Such flat pebble conglomerates are usually known in the formation composed of alternating shale and sandstone bands and the shale pieces attached on the surface may be a product of subaqueous fragmentation perhaps "pull aparts" produced by turbidity flow (Pettijohn, 1957, p. 277). Thus, it is quite apparent that the structure described by Maithy and Babu (1988, pl. 2, fig. 2) is an inorganic clast. The other similar specimen having *L. stipitata* reported and photodocumented by Maithy and Babu (1988, pl. 2, fig. 3) is also a fine grained sandstone. The reported structure and its counterpart both are deposited under the specimen number BSIP-36109 instead 36110 as mentioned in their publication. Both cast and mould of '*L. stipitata*' reported and photodocumented by Maithy and Babu (1988, pl. 2, fig. 3) is also a fine grained sandstone. The reported structure and its counterpart both are deposited under the specimen number BSIP-36109 instead 36110 as mentioned in their publication. Both cast and mould of '*L. stipitata*' are present on a thin vener of shale. Besides, there are several other fragmentary clasts present on the surface of the bedding plane. The structure is an oblong clast rimmed by black material and is also part of an intraformational conglomerate. Thus, the specimens described by Maithy and Babu (1988, pl. 2, figs 2, 3) are part of an intraformational conglomerate and hence the structures are 'non-fossils'.

In a subsequent publication Maithy (1990, pl. 2, fig. 4) has reported a Krishnanid remain (specimen no. BSIP 35919). It is infact the same specimen which was earlier considered as '*Longfengsahnia stipitata*' (Maithy & Babu, 1988, pl. 2, fig. 2 BSIP specimen no. 36110). The author has apparently reassessed the taxonomic status of this structure, though without referring to his previous report (Maithy & Babu, 1988). On the specimen no. BSIP 35919 we found Krishnanid remains reported by Maithy, 1990, in pl. 2, fig. 3 rather than the form reported by him in the same paper (Pl. 2, fig. 4). Further, the difference in the spelling of the original holotype *Longfengshania* to *Longfengsahnia* in two successive publications (Maithy & Babu, 1988; Maithy, 1990) is apparently due to oversight and therefore these specimens are to be considered Dyslexotype—a specimen whose name is mis-spelt on the museum label; in the present case it has also been published twice.

***Longfengsahnia (Longfengshania) chopanensis* Maithy & Babu 1988**

Pl. 2, figs 1-3

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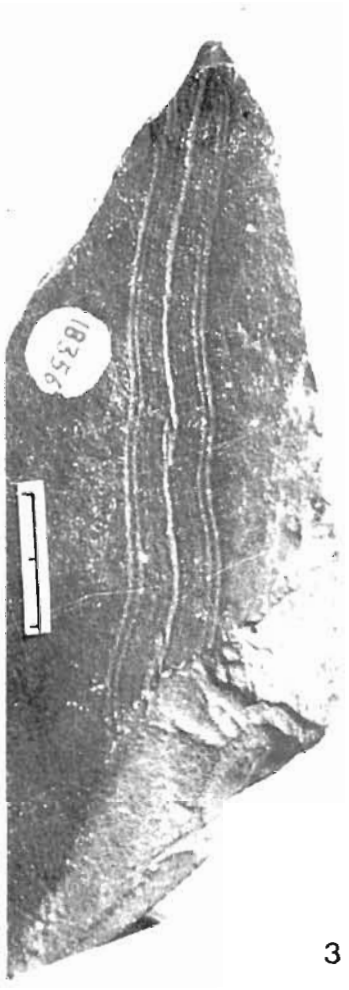
PLATE 5

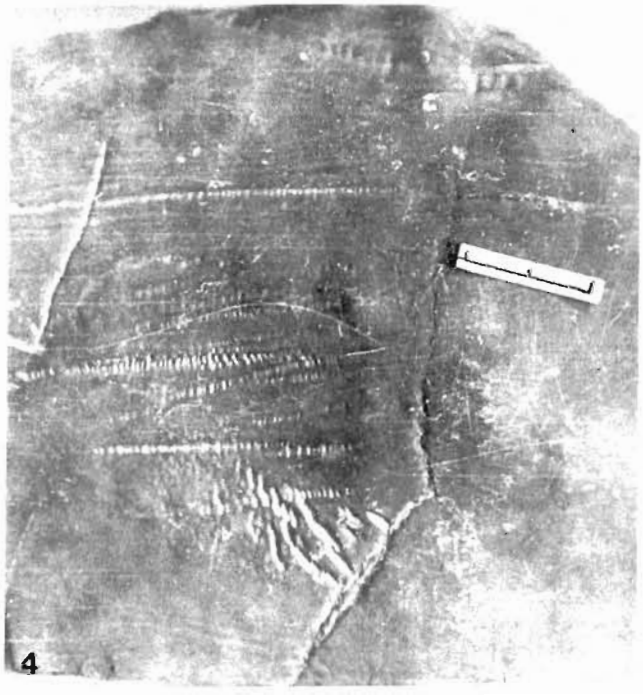
(Scale in fig. 2 = 1 cm and in others 1 div. = 1 cm)

1, 2. *Tasmanadia dassi* of Verma & Prasad, 1968. 1. Shows general view of the specimen having movement traces; and fig. 2 shows a enlarged but not parallel pair of movement trace of probable arthropod, Specimen no. GSI-18357

3. *Rouaulita rewanensis* of Verma & Prasad, 1968 showing a drag mark formed by movement of an animal, Specimen no. GSI-18356.

4, 5. *Bostrichophyton bankuiyanensis* of Verma & Prasad, 1968. 4. Shows the distribution of ichnofossils, and fig. 5 shows the details of ichnofossils, Specimen no. GSI-18355.





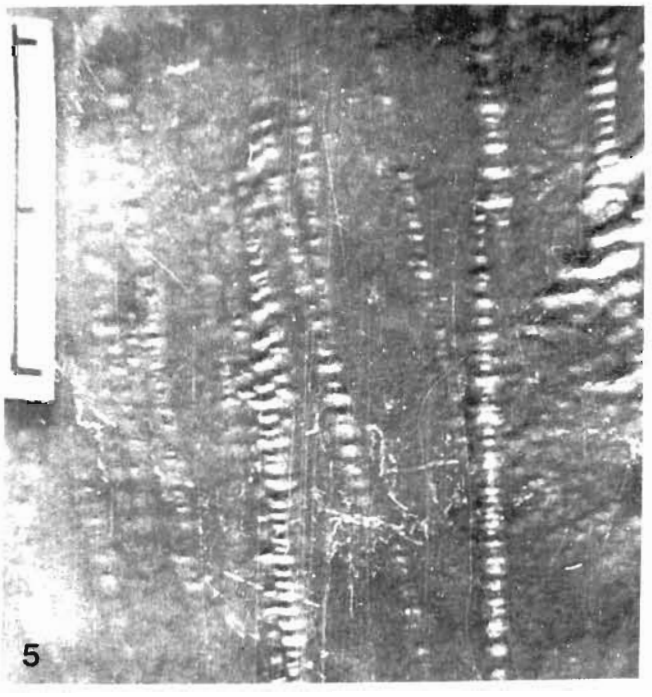


PLATE 5

Repository—Birbal Sahni Institute of Palaeobotany, Lucknow; Specimen nos. 36111, 36112; Maithy & Babu, 1988, pl. 2, figs 4, 5.

The specimens reported by Maithy and Babu (1988, pl. 2) from Rohtas Limestone Formation of Semri Group, Vindhyan Supergroup, exhibit pear-shaped external mould on the limestone surface. Nearly fifty specimens (4-50 mm long and 3-30 mm broad) having rounded apical end and tapering basal end with circular scar, measuring 2-3 mm in diameter are present in an area of 6 × 5 cm. Semicircular thickenings with cross connections extend from one margin to another on the surface. The small polygonal or trapezoidal areas gradually reduce in size from apical to basal end.

Remarks—The specimen reported by Maithy and Babu, (1988, pl. 2, fig. 4) is having small millimetric, pear shaped structures filled with yellow shaly material noted on one side of a millimeter thick fibrous calcite vener which is present on either side of the 7 mm thick limestone specimen. Such pear-shaped structures are common on the fibrous calcite found over bedding plane in the limestone quarries of Rohtas area (Pl. 9, figs 7, 8). The calcite vener is of secondary origin. Therefore, syngenecity of these structures, present on secondary surface is doubtful. Another 35 × 25 mm ovoid structure has been reported by Maithy and Babu (1988, pl. 2, fig. 5) as *L. chopanensis* on grey coloured limestone. This structure, made up of weathered calcareous shale, is impregnated with calcite and has uneven wrinkled and fractured surface indicating its incomplete or broken nature. Such ovoidal structures are commonly formed due to weathering or solutional activity at limestone and shale contact. Hence, these specimens reported by Maithy and Babu (1988, pl. 2, figs 4, 5) are considered as 'non-fossils'.

MEDUSOID FORMS

Jelly fish

Text-figure 3

Repository—Not mentioned; Sisodiya, 1982, fig. 1.

Sisodiya (1982, fig. 1) reported fossil impression of Jelly fish from Nimbahera Limestone Formation of Semri Group, Vindhyan Supergroup exposed in Mandsaur District, Madhya Pradesh. The described structures are semicircular and rectangular with maximum diameter of ≅ 12 mm with central depression representing mouth part.

Remarks—The description provided by the author is insufficient to diagnose the fossil, the photographs also are not clear for evaluation. It is thus not possible to assess the biogenicity and taxonomic status of these forms. Its affinity with jelly fish is also not valid and is considered here as 'dubiofossil' pending availability of fresh data.

Ramapuraea vindhyanensis

Pl. 10, fig. 3

Repository—Birbal Sahni Institute of Palaeobotany, Lucknow; Specimen no 27341; Maithy & Shukla, 1984a, pl. 1, figs 1-3; Shukla *et al.*, 1989; pl. 1, figs 3, 4; Shukla & Sharma, 1990, pl. 2, fig. 2; Maithy, 1990, pl. 1, fig. 6.

Ramapuraea vindhyanensis has been reported from the Suket Shale, Semri Group, Vindhyan Supergroup. This specimen is variously described as carbonised impression of medusoid affinity (Maithy & Shukla, 1984), Jelly fish comparable to *Cyclomedusa* Sprigg (Shukla *et al.*, 1989) and 'Chuarid remains' by Maithy (1990). Maithy (1990) considered them allied to *Chuaria* and doubted their coelenterate affinity. However, Shukla and Sharma (1990) on restudy considered it a medusoid remain though of older antiquity (Shukla *et al.*, 1991).

Remarks—Re-examination of the specimen further supports the views of Maithy and Shukla (1984), Shukla *et al.* (1989, 1991), Shukla and Sharma (1990). These carbonised impressions on black shales show a central part-mouth, radiating structure in the middle part considered as the

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PLATE 6

(Scale in fig. 1, 2, 3, 1 div. = 0.5 mm & fig. 5 = 5 mm and figs. 4, 6, 7 & 8 1 div. = 1 cm)

1, 3. *Robtasia tandoni* Singh & Chandra 1987. 1, 2, 3. Show three different specimens of *R. tandoni* note their encrustative nature on shale. These mineralic encrustation have been considered as medusae cast, Specimen nos. LUTS-306, 307 and 308.

4, 5. A general view of rock slab (collected from Suket Shale Member from Mandsaur) having structure similar to that of *R. tandoni*, a specimen marked with arrow has been enlarged in fig. 5 which shows mineralic incrustation nature, Specimen no. BSIP-36793.

6. Krishnanid forms—Small petiolate structure present on thin vener of fibrous calcite on limestone, Specimen no. BSIP-35919.

7. Star-shaped radiating structures on a sandstone slab. These are typical synaresis cracks from LaTouche's collection available at GSI, Calcutta bearing temporary number K-1/963.

8. *Beltanelloides* Maithy 1990. The deposited specimen bears the circular bodies which are algal balls made up of thin stratiform algal layer. The specimen does not bear any feature similar to that reported by Maithy, 1990, pl. 1, fig. 4, Specimen no. BSIP-35956.

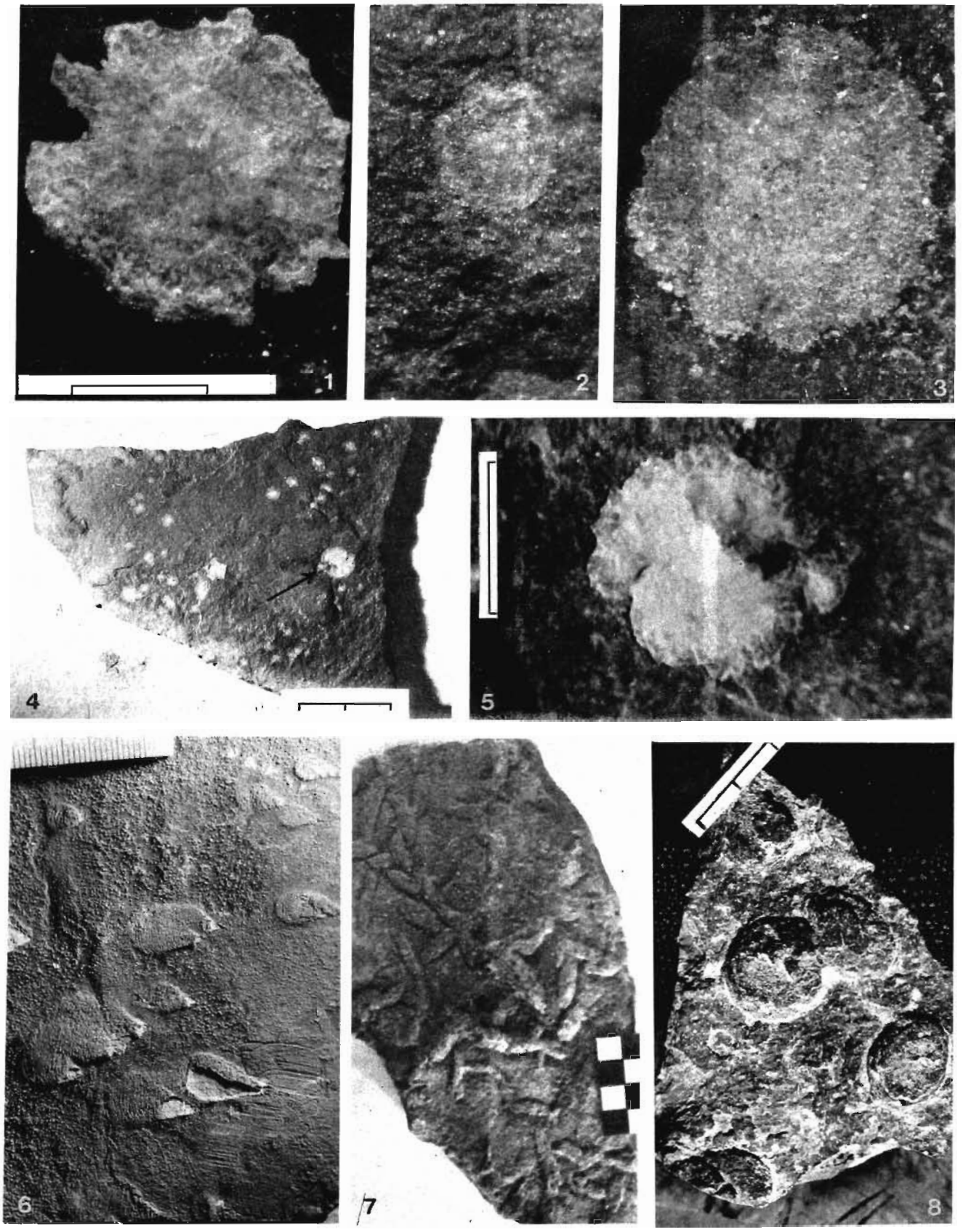

PLATE 6

umbrella and an outer flange. The compactly packed globular structure in the central part of *R. vindhyanensis*, which prompted Maithy (1990) to consider it as a cyst, is a preservational feature formed due to uneven surface of shale. We do not agree with Maithy (1990) in grouping forms of different affinities such as *Robtasia 'tandonii'*, *Ramapuraea vindhyanensis* and *Chuaria* in a single basket of 'chuarid remains' of planktonic origin. *R. vindhyanensis* is considered 'true fossils' of medusoid like form which formed part of the vast and varied planktonic biota in Pre-Ediacaran sea.

Table 2—Trace Element Analysis of Murli Pahar calcareous shale having similar structure

Element	Concentration [(PPM (μg/ml)]	Element	Concentration [(PPM (μg/ml)]
Sc	11.45	Co	8.40
Zn	142.01	Sr	67.99
Nb	10.92	La	7.03
Nd	4.59	Gd	1.08
Ho	0.17	Yb	1.33
Ta	0.74	Ni	33.57
V	102.04	Y	11.61
Ga	17.69	Ce	12.03
In	—	Tb	0.14
Sm	0.99	Lu	0.14
Er	0.72	Cu	—
Cr	110.90	Zr	107.57
Rb	231.17	Pr	1.21
Ba	216.50	Dy	1.21
Eu	0.11	Hf	2.26
Tm	0.17		

(ICP-MS-analysis by V. Balram, NGRI, Hyderabad.

Robtasia tandoni

Pl. 3, fig. 5; Pl. 6, figs 1-5

Repository—Geology Department, Lucknow University, Lucknow; Specimen nos. LUTS-306, 307-309; Singh & Chandra, 1987, pl. 1, figs 1-6. Birbal Sahni Institute of Palaeobotany, Lucknow; Specimen no. 35960; Maithy, 1990, pl. 1, fig. 7.

Singh and Chandra (1987) described *Robtasia tandoni* from Rohtas Limestone Formation of Murli Pahar, as cast of medusoid which are nearly flat, small, circular in shape, thin and white in colour. Maithy (1990) doubted their medusoid affinity due to the small size and absence of recognisable feature of coelenterates and grouped them under 'Chuarid remains', considering them allied to *Chuaria*. Maithy (1990, pl. 1, fig. 7, specimen no. BSIP 35960) also recorded *R. 'tandonii'* from the same locality and horizon.

Remarks—The specimens described by Singh and Chandra (1987) are of extremely small size (0.52-1.26 mm) and are present on black coloured shale as a paper thin mineralic encrustation. They do not leave any mark when detached from the surface, thus, negating that they are casts. The black-shale contain high percentage of carbonaceous matter and sulphides alongwith trace elements, viz., Vanadium, Nickel, Copper, etc. (see analysis of a sample of black calcareous shale from Murli Pahar, Table 2, 3). The structures reported by Singh and Chandra (1987, pl. 1, figs 1-6) are the result of oxidation of sulphides present in the sediment producing a swelling and disintegrating of the rock on exposure. In such cases a white efflorescence of melanterite or iron sulphate is left as a product covering the surface (see Pettijohn, 1957, p. 363). EDAX analysis of similar specimens collected from Suket shales indicates that the specimens are made up of high amount of Barium and Sulphur (see, Table 4). The reported effervescence produced on treatment of the cast with HCl (see Singh & Chandra, 1987) may be due to minute amount of calcareous matter present. The specimens described by Singh and Chandra (1987) are 'non-fossil'.

Maithy (1990, pl. 1, fig. 7) also recorded *R. 'tandonii'* from the same locality and horizon. Re-examination reveals clear circular markings on the bedding plane. No top and bottom of the specimen is mentioned, hence it is difficult to determine whether it is a cast or mould. Many similar features were observed by us, in the same locality which are present both on the top and bottom of the bedding surface as well as on the fractured planes. Their occurrence on the fractured surfaces indicate its

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PLATE 7

(Scale in figs 1-5, 1 div. = 1 mm and scale in fig. 6 is same for 6, 7, 8 = 2 mm)

1-3. *Sekwia excentrica* Maithy *et al.* 1986. 1. Shows general distribution of specimens on the vener of calcite on Limestone; 2. shows those specimens which were considered by Maithy *et al.* as *S. excentrica*; and 3. shows the side view of the same specimen exhibiting the presence of fibrous clacite on either side of the slab, Specimen no. BSIP-35857

4, 5. *Sekwia excentrica* Maithy & Babu 1988. 4. Shows general view of the limestone piece having oblong nodular structure which do not have any striation or excentric groove or wrinkles on the margin to assign it to *Sekwia excentrica*, Specimen no. BSIP-36108.

6-8. *Misraea*, a new body fossil described by Maithy & Babu, 1986. Note that the characters described by Maithy and Babu like inwardly curved body margin with an inner concave hollow depression are not observable. Specimen nos BSIP-35820, 35821 and 35823.

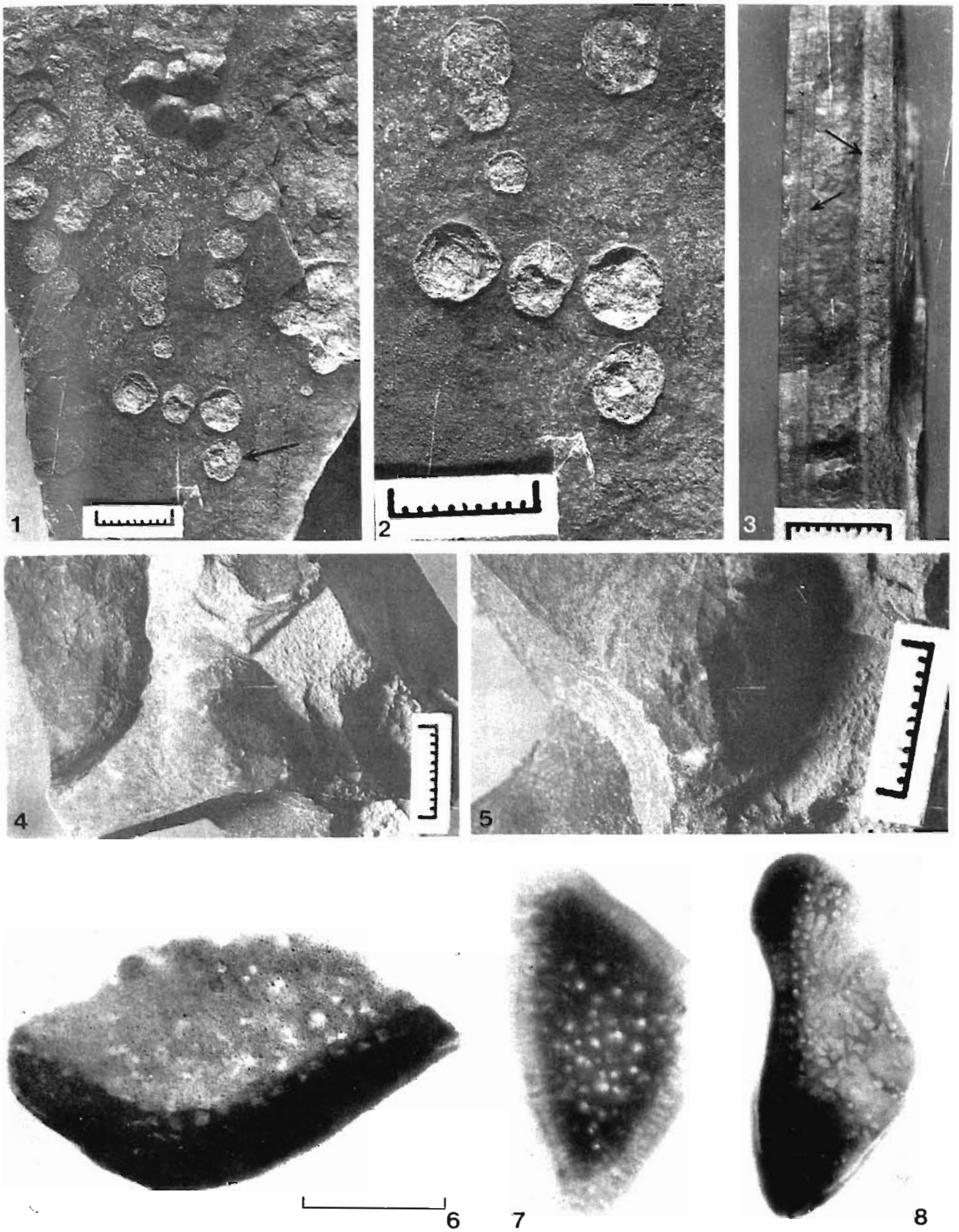


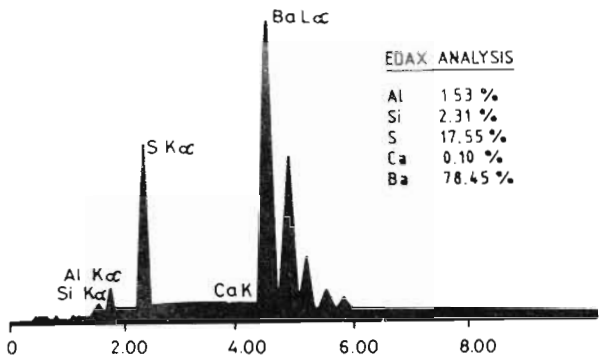
PLATE 7

Table 3—Chemical composition of the calcareous shale of Murli Pahar (XRF data) (in per cent)

SiO_2	—	62.95
TiO_2	—	0.59
Al_2O_3	—	14.90
Fe_2O_3	—	4.72
CaO	—	4.45
MgO	—	6.28
Na_2O	—	BDL
K_2O	—	5.05
MnO		0.024
P_2O_5	—	0.12

BDL—Below Detection Lable.
Analysed by P. K. Govil, NGRI, Hyderabad.

Table 4—Graph shows the Edax analysis of the structure similar to *Robtasia tandoni* Singh & Chandra 1987 from shales. It shows the high percentage of Barium and sulphur which represent the evaporite of Barium



secondary origin. Such feature are commonly formed in shales due to weathering and hence the object described as *Robtasia 'tandonii'* by Maithy (1990) is a 'non-fossil'.

***Tirasiana* sp.**

Pl. 9, figs 2, 4

Repository—Geological Survey of India, Calcutta; Specimen nos. 20308, 20309; Mathur & Shanker, 1990, pl. 1, figs 1, 2.

Mathur and Shanker (1990) described two specimens of *Tirasiana* as impressions along the bedding plane. One of them is preserved as concave epirelief and the other as convex hyporelief with a diameter of 7-9 mm and relief of 1-1.5 mm which have tripartite organisation. Small central tubercle and circular groove separate the inner narrow disc from the broader outer one which sometimes has indistinct radial markings.

Remarks—Azmi and Tiwari (1991, p. 5) believe that these structures may be biogenic in nature though they did not find typical characteristic features of *Tirasiana* in specimens described by Mathur and Shanker (1990). They found these structures more comparable with *Protoniobia* Sprigg which was later considered as concretion by Cloud (1968). Poor photodocumentation of *Tirasiana* (Mathur & Shanker, 1990, pl. 1, figs 1, 2) has probably created a doubt about the biogenicity of the fossil (see Azmi & Tewari, 1991). Re-examination supports their biogenic origin but due to the absence of diagnostic characters it is not possible to assign the fossil with certainty to *Tirasiana*. The metazoan assemblage including *Tirasiana* from the upper part of Krol Formation is mostly biogenic. More finds are needed to support their correlation with 'Ediacaran' assemblage. The structure reported as *Tirasiana* are considered 'true fossil'.

***Medusinites* sp. cf. *M. asteroides* Sprigg**

Pl. 9, fig. 1

Repository—Geological Survey of India, Calcutta; Specimen no. 20310; Mathur & Shanker, 1990, pl. 1, fig. 3.

It is a lone specimen recorded by Mathur and Shanker (1990) as an impression preserved along the bedding plane. It is subcircular, with convex hyporelief, composed of smooth central disc which is separated from the broad, smooth outer ring by a subcircular groove; the disc is half the diameter of the whole structure, outer diameter of specimen is 8 mm and the disc diameter 4 mm, relief nearly 1 mm; outer ring shows faintly preserved radial grooves.

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PLATE 8

(Scale in all the figures 1 div. = 1 mm, except 3 & 4 which are = 200 μm)

1. *Tawuia dalensis* Maithy & Shukla 1984. Note the smaller size of the specimen, Specimen no. BSIP-25277.
2. *Sekwia excentrica* of Maithy & Babu, 1988, pl. 1, fig. 8—note the oblong structure on the weathered limestone surface; also note the absence of diagnostic characters of *S. excentrica*, Specimen no. BSIP-36107
3. 4. *Allatheca* of Maithy & Shukla, 1984. Note rounded nature and smaller size of the grains, Slide no. BSIP-8001.
5, 7. Trace fossil 'A' & 'B' of Maithy & Babu, 1988 & Vendotaenid remains of Maithy, 1990; note the branching pattern, angle of bifurcation and size making them a closer candidate of *Manchuriophycus* Endo which was later considered as shrinkage cracks. 5. Considered as vendotaenid remain by Maithy, 1990, Specimen no. BSIP-36113.
6, 8. Annelid traces of Maithy *et al.*, 1986, note the cris-cross branching pattern typical of Sun crack, Specimen no. BSIP-35858.

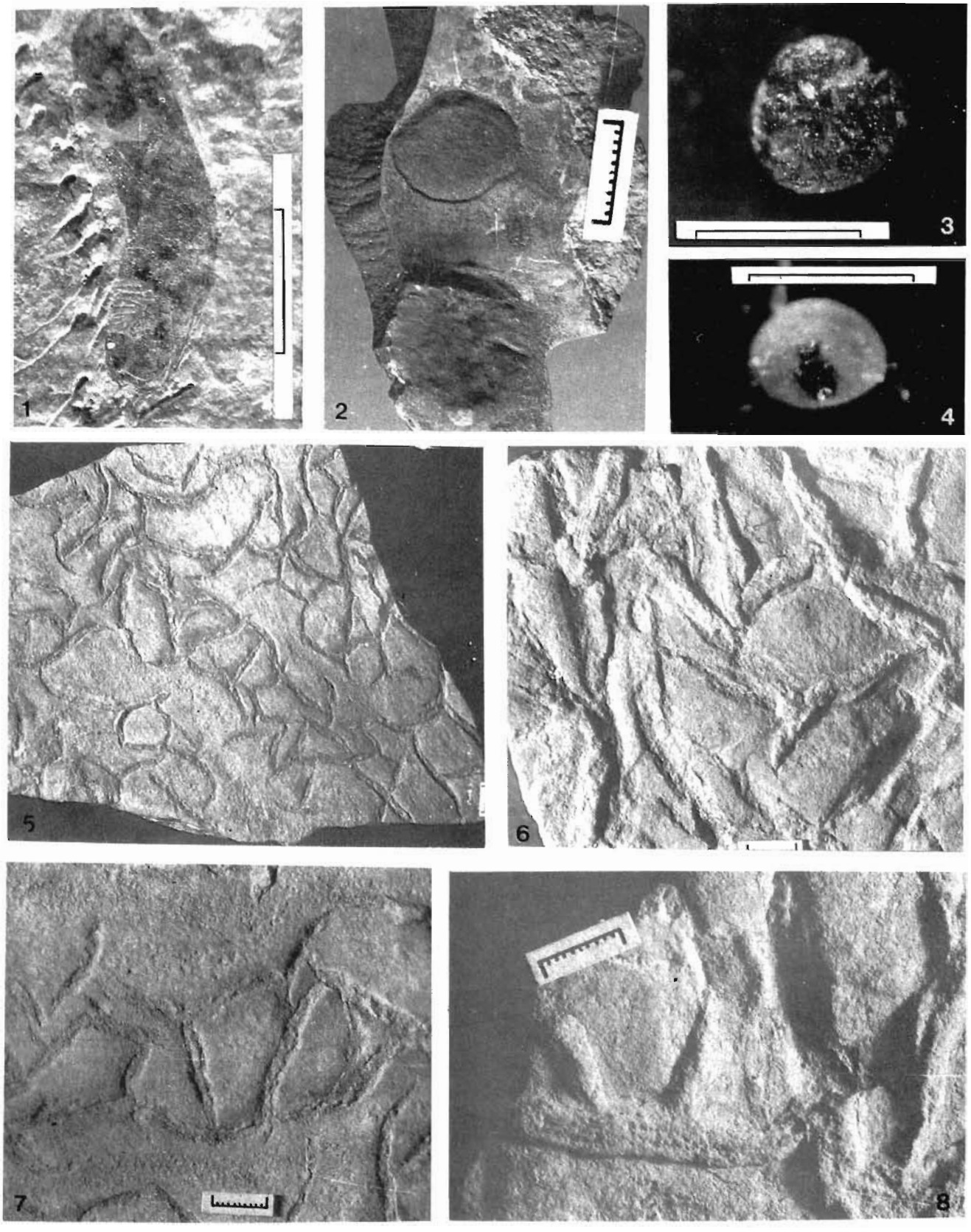
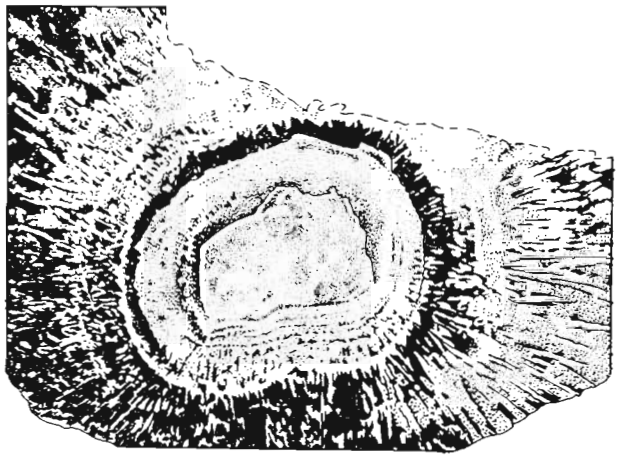


PLATE 8



Text-figure 64—*Korgaicyatha* (Tewari, 1989, pl. 7, fig. b), Scale is not given in original text.

Remarks—Azmi and Tewari (1991) assessed the specimens on the basis of published photograph and opined that the specimen does not reveal annual furrow or groove separating the central disc. They also felt that in the absence of radial furrows on the outer ring and concentric markings on the central disc which are characteristic features of *M. asteroides*, this fossil is of doubtful origin.

Re-examination of the specimen allows us to consider that the figured specimen no. GSI 20310 is a 'true fossil' of metazoan affinity. Taxonomic reassessment is needed.

***Beltanella* sp. cf. *B. gilesi* Sprigg.**

Pl. 9, fig. 3

Repository—Geological Survey of India, Calcutta; Specimen no. 20311; Mathur & Shanker, 1990, pl. 1, fig. 4.

Mathur and Shanker (1990) reported *Beltanella* sp. as an impression, preserved along the bedding plane. It is a smooth disc with a narrow rim, 16 mm in diameter and 1.5 mm in relief and surrounded by a flange about 7 mm in width preserved in convex hyporelief. The record is from the upper part of Krol Formation in Nainital. Azmi and Tewari (1990) have doubted the identification of *Beltanella* and opined that neither it compares with the forms from South Australia, nor Wernecke Mountain, Canada (Narbonne & Hofmann, 1987). They felt that relatively small size with a central disc of about 16 mm diameter and absence of 'outer flange' precludes its assignment to *Beltanella* sprigg.

Remarks—We agree with the observations of Mathur and Shanker (1990). The biogenic nature of the genus *Beltanella* is still under debate. This form is considered as 'dubiofossil'.

***Cyclomedusa davidi* Sprigg**

***Medusinites* Glaessner & Wade**

Text-figures 25, 26

Repository—Birbal Sahni Institute of Palaeobotany, Lucknow, Specimen nos. 10256, 10258; Maithy, 1990, pl. 2, figs 8, 9.

Maithy (1990) recorded the presence of *Cyclomedusa davidi* (Maithy, 1990, pl. 2, fig. 8) and *Medusinites* Glaessner & Wade (Maithy, 1990, pl. 2, fig. 9) from Dholpur shales of Bhander Group. He did not provide detailed descriptions.

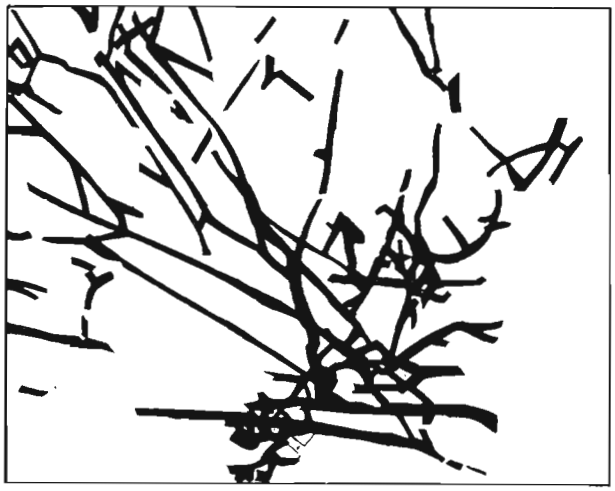
Remarks—Attempts failed to locate the specimens (nos. 10256, 10258) in the BSIP repository. On the suggestion of the author (Dr P. K. Maithy) specimen numbers 36388 to 36393 of the same locality were examined to locate the figured specimens, but again failed. However, similar structures which we consider as product of weathering are present on the rock surface of these specimens. Hence, this record is considered as 'non-fossil'.

METAPHYTIC REMAINS

Non mineralised, megascopic, ribbon-like fossils attributed to Vendotaenids, dasycladaceous algae, *Renalcis, Epiphyton* and *Sajania* are discussed. Vendotaenids are non-mineralized organic, shapeless brown films occurring profusely in the Vendian. There are few records from older sediments. Microscopic study of vendotaenid fragments separated through maceration has proved useful in ascertaining its biogenicity. Vendotaenids can be divided into two subgroups (i) ribbon-like forms occasionally bifurcating, viz., *Vendotaenia, Dvinia, Anataenia, Tyrasotaenia;* and (ii) cord-like intensely branching form *Eoholynia* Gnilovaskaya 1979. *Vendotaenia* is one of the oldest metaphytes with a thalloid structure. Gnilovaskaya (in Sokolov & Iwanowski, 1990) considers a phaeophycean affinity on the basis of general habit and nature of sporangia. Various morphological features have been described under Vendotaenid/metaphytic remains but most of these forms have been described on the surface observations only. The multicellular nature of forms reported from India, however, has mostly not been confirmed through maceration. Shukla *et al.* (1989) and Shukla and Sharma (1990) initiated the study of forms by isolation through maceration techniques.

***Krolotaenia gnilovaskayi* Tewari**

Text-figure 65



Text-figure 65—*Krolotaenia* (Tewari, 1989, pl. 4, figs a, c), Scale is not given in original text.

Repository—Not mentioned. Tewari, 1988; Tewari, 1989, pl. 4, fig. a, c.

Tewari (1988, 1989) mentioned the presence of *Krolotaenia gnilovaskayi* and *Vendotaenia* in the Lower Krol sediments and did not provide a description.

Remarks—An evaluation of illustrations provided by the author indicates similarity of these fossils with roots of extant grass preserved in the forms of impression on the bedding plane. Such impressions may form on the parting surface of shales when the grass roots penetrate into the rocks (see Frey & Pemberton, 1985; Boyd, 1975). The author has also not used the technique of maceration to prove the biogenicity of these forms. Hence, the reported specimen of *Krolotaenia gnilovaskayiv* from the Lower Krol is considered as 'non-fossil'.

Vendotaenid remains/forms

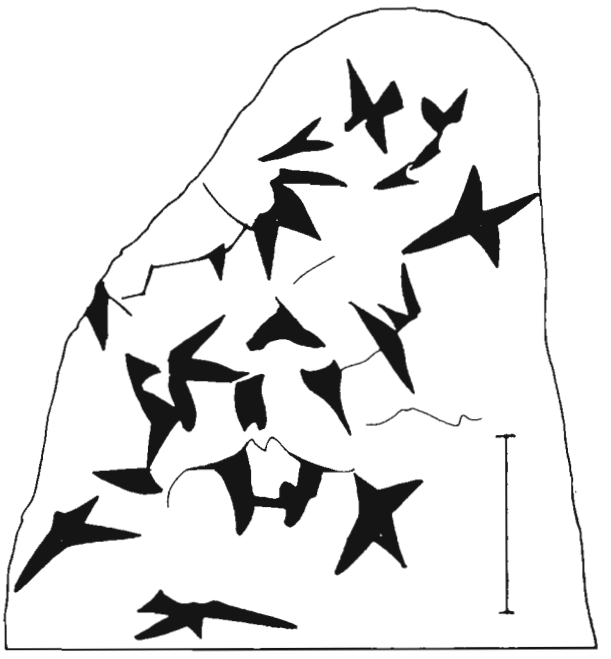
Pl. 4, figs 1-3; Pl. 8, fig. 5

Repository—Birbal Sahni Institute of Palaeobotany, Lucknow—Specimen nos. 35959, 35961; Maithy, 1990, pl. 2, figs 1, 2. Maithy, 1990, pl. 1, fig. 8; Specimen no. not known.

Maithy (1990) reported the presence of Vendotaenid remains (in pl. 1, fig. 8) from Ghurma Shale Formation of Kaimur Group and Rohtas Limestone of Semri Group, Vindhyan Supergroup without providing a description. The other 'forms' reported by Maithy (1990, in pl. 2, figs 1, 2) have been briefly described as narrow, linear structures preserved compactly parallel to one another, 30 mm in length and 3 mm in width with rounded ends and fine transverse thickenings.

Remarks—The Vendotaenid remain (Maithy, 1990; pl. 2, fig. 7) was earlier considered a trace fossil by Maithy and Babu (1988, pl. 2, fig. 7). Specimen number has not been provided for the fossil described in both the papers (Maithy & Babu, 1988, pl. 2, fig. 7; Maithy, 1990, pl. 1, fig. 8). However, the fossil is available on specimen no. 36113 in the BSIP repository. The specimen which is a 3 cm thick fine grained sandstone has wavy structures on the top of the bedding surface showing irregular or radiating pattern sometime cross cutting each other. This feature is comparable to the subaqueous shrinkage cracks or synaresis cracks, a common feature in mud layers interbedded with sandstone (Collinson & Thompson, 1982; Hofmann, 1971). These structures reported by Maithy and Babu (1988, pl. 2, fig. 7) as trace fossil and later by Maithy (1990, pl. 1, fig. 8) as Vendotaenid remain are infact synaresis cracks.

The Vendotaenid form reported by Maithy, (1990, pl. 2, fig. 1, specimen no. 35959) is recorded in the BSIP Museum as *Katania singhi*. The specimen is a thin recrystallised limestone having a thin vener of fibrous calcite with typical transverse markings which have been considered as septa of *Vendotaenia*. These features are not the primary features as considered by Maithy (1990) but are the ones developed over the secondary calcite. The third fossil described as Vendotaenid form (Maithy, 1990, pl. 2, fig. 2) is now located on specimen no 35958 and does not stand on specimen no. 35961 as indicated by Maithy (1990). While the specimen located by us is from the Lower Kaimur Sandstone of Dabua as per records of the repository, the author reports this fossil from comparatively older sediments of Rohtas Formation of Murli Pahar. It is present on a small piece of a weathered silt stone and shows mineral veins with iron oxide staining which form cris-cross patterns. The vein-like feature has been considered as *Vendotaenia* by Maithy (1990). Being the 'Type specimen', it is not possible to break the specimen to test for mineral type. These veins may be made up of any of the known sesquioxides of iron and alumina, viz., limonite, goethite, hematite/magnetite. Goethite is commonly found as reniform, botryoidal or other colloform masses with an internal concentric or radial (or both) fibrous structure. Sometime the external forms of goethite suggest an original gel state (see Pettijohn, 1957, p. 138). The fossil under discussion appears to be a product of recrystallisation of an oxide. The divisions in the vein occurring uniformly which were considered as septa, are tensional cracks during crystallisation. Further, we have no knowledge or record of *Vendotaenia* of such large



Text-figure 66—*Ichnofossil* (Mukherjee *et al.*, 1987, figs. 1, 2), Scale = 14 cm. (Scale is same for figs 49, 50, 51, 56 & 57 as in fig. 50) (Scale is same for figs 31, 32, 35, 36, 39, 40, 43, 46 as in 21, 22, 28).

dimension (30 × 3 mm). We consider these reports of Vendotaenid remains (Maithy, 1990, pl. 1, fig. 8; pl. 2, figs 1, 2) as 'non-fossil'.

Tyrasotaenia

Pl. 4, fig. 8

Repository—Birbal Sahni Institute of Palaeobotany, Lucknow, Specimen no. 25211/273; Shukla *et al.*, 1989, pl. 1, figs 5, 6; Shukla *et al.*, 1990, pl. 2, fig. 1.

Shukla *et al.* (1989) and Shukla and Sharma (1990) reported *Tyrasotaenia* as brown flattened carbonaceous film on buff coloured Suket Shale of Semri Group.

Remarks—Re-examination of specimen no. BSIP 25211/273 further supports the authors' observations (Shukla *et al.*, 1989, 1991). Maceration of associated samples yielded multicellular carbonaceous films which lack reproductive organs. It was not possible to macerate the type specimen recorded by the authors however, other similar specimens on maceration yielded organic films. These macroscopic films are considered 'true fossil' of *Tyrasotaenia*.

1. Dasycladaceae

Text-figures 37, 44

Repository—Not mentioned. Rao, 1943, fig. 1.

Rao (1943) reported a thallus of dasycladaceous algae having a central cavity with number of dark circular bodies arranged regularly along the periphery from the limestone of Cuddapah Formation.

Remarks—The photograph of the fossil published by Rao (1943, fig. 1) appears to be catagraphs or oncolites which are also known in the Upper Cuddapah (see Mandal *et al.*, 1983; pl. 1, figs 15, 16). These forms reported as multicellular dasycladaceous algae may be considered 'dubiofossil'.

2. Dasycladaceae

Text-figure 45

Repository—Not mentioned. Rao & Mohan, 1954, figs 2-5.

Rao and Mohan (1954) described a dasycladaceous algae from Dogra slates, Baramula. The fragmentary remains are considered as thallus and sporangia.

Remarks—Repository details are not provided. The illustrations are of poor quality. Hence, a proper assessment of these forms is not feasible. It is recommended that more material from the locality should be studied. For the purpose of present review it is kept under 'no comment' category.

1. *Epiphyton* Bornemann

Repository—Geology Department, Lucknow University, Lucknow, Specimen/Slide no. not known; Singh & Rai, 1983, pl. 2, figs 8-11, 13.

Singh and Rai (1983) reported the presence of *Epiphyton* from the upper part of Krol Formation in Mussoorie Hills.

Remarks—Evaluation of the illustrations of *Archaeocyatha, Renalcis* and *Epiphyton* indicates that they appear to be part of the same biotope which forms microstromatolite. Since detailed description is not available and photographs do not show all the characteristic features, these forms are considered here as 'dubiofossil'.

2. *Ephiphyton* Borneman

Text-figures 50, 51

Repository—Birbal Sahni Institute of Palaeobotany, Lucknow, Slide nos. 8546, 8547; Shukla, 1984, pl. 1, figs 3, 4.

Shukla (1984) recorded calcareous algae *Epiphyton* from Calc-Zone of Pithoragarh. These are solid rod-like features, repeatedly branching at 25°-60° arranged in radial manner, length of individual rods 180-300 μm, breadth 3-5 μm at base and 6-10 μm at the point of branching and composed of black opaque microcrystalline calcite.

Remarks—Johnson (1966) has summarised the characteristics of 66 species. The fossil described by Shukla (1984) does not compare with any one of them besides the specimens under discussion did not exhibit a regular pattern of division in branching therefore it is concluded that the forms reported by Shukla (1984) are mineralic crystallite and hence are 'non-fossil'.

1. *Renalcis* Vologdin

Text-figures 56, 57

Repository—Birbal Sahni Institute of Palaeobotany, Lucknow, Slide nos. 8544, 8545; Shukla, 1984, pl. 1, figs 1, 2.

Shukla (1984) described circular to subcircular oval or even irregular calcified grey-black to brown coloured structures under *Renalcis* from the Calc-Zone of Pithoragarh. These hollow structure range from 300-400 μm in size.

Remarks—Vologdin (1932, in Sokolov & Iwanowski, 1990) described this alga as microscopic, shapeless calcareous colonies. They occur as more or less globular or elongated calcified sheaths covering either the entire colony or only the peripheral portion. The central portion of the inner hollow is diverse and filled with light calcite. *Renalcis* reported from the Calc-Zone of Pithoragarh, though morphologically similar to the ones summarised by Johnson (1966), is smaller to any known species of *Renalcis*. The specimen reported from Calc-Zone of Pithoragarh is a 'true fossil' of *Renalcis* sp.

2. *Renalcis* Vologdin

Repository—Geology Department, Lucknow University, Lucknow, Slide no. not known; Singh & Rai, 1983, pl. 2, fig. 13.

Singh and Rai (1983) reported the presence of *Renalcis* from the upper part of the Krol E of Mussoorie Hills. It is characterised by irregular thallus, consisting of calcareous shell and an inner cavity, thickness of the shell is highly variable.

Remarks—Detailed descriptions are not provided by the authors. Evaluation of the illustrations indicates that *Renalcis* recorded and illustrated here is a part of a large calcareous algal biotope (see comments under Archaeocyatha & *Epiphyton*, p. 3, 12. Similar views have also been expressed by Brasier and Singh (1987). They are considered 'dubiofossil'.

Gansser (1974) also reported calcareous algae *Renalcis* and *Oleckmia* in the Krol B unit of Nainital hills without any description and photograph. So far it has not been photodocumented from Krol B unit of Nainital. They are placed under 'dubiofossil' pending proof of the reproducibility and detailed description.

Sajania Vologdin

Text-figure 49

Repository—Birbal Sahni Institute of Palaeobotany, Lucknow, Slide no. 8548; Shukla, 1984, pl. 1, fig. 5.

Shukla (1984)reported ribbon-shaped structures from Calc-Zone of Pithoragarh which was 10-100 μm thick and branched irregularly. They are composed of opaque microcrystalline clacite.

Remarks—Re-evaluation is based on characteristics of *Sajania* given by Vologdin (1962, in Johnson, 1966). The genus is diagnosed as 'Thallus filamentous, irregularly branched. Composed of a single calcified thread which branches. Branches sometime alternate on one side than the other, but are commonly irregularly arranged. Some second order branches. Thickness of threads 100 μm or less". Comparison of thickness of thread and branching pattern show only partial similarity in diagnostic characters. Therefore we place this record under 'dubiofossil'.

SEKWIA EXCENTRICA

1. *Sekwia excentrica* Hofmann

Pl. 7, figs 1-3

Repository—Birbal Sahni Institute of Palaeobotany, Lucknow, Specimen no. 35857; Maithy *et al.*, 1986, fig. 1; Maithy, 1990; pl. 1, figs 4, 5.

Maithy *et al.* (1986) described *Sekwia excentrica* from Rohtas Formation. No reasoning is put forward to assign the fossil to *Sekwia*. The report also does not mention the repository and specimen number. In a subsequent paper a specimen with almost similar features has been described (Maithy, 1990, pl. 1, figs 4, 5) as *Sekwia excentrica*, grouped in the category of 'Chuarid remains' and compared with encystment structures of *Nucellosphaeridium* Timofeev. This specimen (Maithy, 1990, pl. 1, fig. 4) bears the repository no. BSIP 35857.

Remarks—The grey coloured limestone sample bearing the fossils has circular markings on its one surface, which has been considered as *Sekwia excentrica* by Maithy *et al.* (1986, fig. 1) and Maithy (1990, pl. 1, fig. 4). These structures are present on a thin vener of fibrous calcite, which is secondary in origin and therefore any feature on it can not be considered syngenetic to the rock. We, however, could not observe any globular structures in the centre as mentioned by Maithy (1990, pl. 1, fig. 5, p. 24) to consider the fossil as an encystment structure

or *Nucellosphaeridium*. These records (Maithy *et al.*, 1986, fig. 1; Maithy, 1990, pl. 1, fig. 4, are considered 'non-fossil'.

2. *Sekwia excentrica* Hofmann

Pl. 4, figs 4, 5; Pl. 7, figs 4, 5; Pl. 8, fig. 2

Repository—Birbal Sahni Institute of Palaeobotany, Lucknow, Specimen nos. 36106, 36107, 36108; Maithy & Babu, pl. 1, figs 7, 8; pl. 2, fig. 1.

Maithy and Babu (1988) reported circular to subcircular impressions of *S. excentrica* on a bedding plane of Rohtas Limestone Formation. They are 10-35 mm in diameter with distinct groove on margin and a small central area, on raised central portion without any radial striations.

Remarks—The diagnostic features of *Sekwia excentrica* are millimetric to centimetric sized discoidal impressions with annular groove and strongly eccentric coarse wrinkles whose centre of curvature lies near or beyond the margin of impressions (see Hofmann, 1981). The form described by Maithy and Babu (1988, pl. 1, fig. 7; specimen no. 36106) as *Sekwia excentrica* is a limestone clast which has assumed an ovoidal shape on the weathered bedding plane. This ovoidal structure is 11 mm in diameter and lacks marginal groove and radial/cresentric striations. Thus, it does not have any diagnostic characters to be assigned to *S. excentrica*. The other fossil also attributed to *S. excentrica* by Maithy and Babu (1988, pl. 1, fig. 8; specimen no. 36107) is an oblong structure on the weathered and rippled surface which is depressed in the limestone matrix. This structure appears to be a compressed concretion which is covered on the margin by projected host rock, radial striations and eccentric wrinkles are also not present. Hence, it would not be proper to assign the structure to *Sekwia excentrica*. Another oblong nodular structure of 5 mm size has also been described by Maithy and Babu (1988, pl. 2, fig. 1, specimen no. 36108) as *S. excentrica*. It is set in a matrix of limestone and not on the bedding plane as reported by Maithy and Babu (1988). The striations described by them are apparently the fractured surface of the limestone. Absence of diagnostic characters such as marginal groove, eccentric coarse wrinkles, etc. do not permit assignment of this form to *Sekwia excentrica*.

Hence, the specimens described by Maithy and Babu (1988, pl. 1, figs 7, 8; pl. 2, fig. 1) as *Sekwia excentrica* are 'non-fossil'.

SHELL-LIKE FORMS

Lamellibranchs etc.

Text-figure 30

Repository—Not mentioned. Iyengar, 1905; Gowda *et al.* 1978, pl. 1, figs A-D; pl. 2, figs a-d.

Iyengar (1905) and Gowda *et al.* (1978) reported numerous globular, oval and elongated forms from the rocks of Guddadarangavanahalli Formation (G. R. Formation), Dharwar Supergroup in Karnataka, which have an outer shell quite distinct from the inner one.

Remarks—These specimens could not be re-examined. The description and illustration too, are not convincing to assign biotic affinity. It is highly improbable that Lamellibranchs had appeared at a time when even shell forming tendency had not evolved. They are therefore considered here 'non-fossil'.

Shell-like forms

Text-figure 16

Repository—Not mentioned. Prakash, 1966, fig. 1.

Prakash (1966) reported a shell-like form from shaly limestone bed within the Kajrahat Limestone of Semri Group, north of Kajrahat Village. It is reported that the form has the appearance of a broken cast of a brachiopod shell. The convex side is placed towards the top of the bedding plane. Broken concentric fragments of stromatolites occur on the same plain. The chemical test of carbonate rock of the area gives positive signature for phosphatic material.

Remarks—In the absence of repository details the fossil could not be re-examined. The quality of illustration does not permit further evaluation. It is generally believed that mineralic shells of calcitic or phosphatic nature appeared only in Tommotian with a few exception in Vendian sediments. It is possible that the shell-like structure described by Prakash (1966) are crumpled and mud curled algal mats deposited along with fragments of stromatolites. Though possibly biogenic, these structures are not brachiopods and thus considered here 'dubiofossil'

Foraminifera ? or Porifera ? or *Obruchevella*

Text-figures 21, 22, 28

Repository—Author's collection, Ahluwalia, 1979, fig. 1a-c; Ahluwalia 1985; Ahluwalia & Bhargava, 1989.

Some biogenic structures comparable to *Archaediscus, Palaeobigenerina* and indeterminate form (? *Pachyphloia*) have been reported from cherts of Durmala, about five kilometers from Masrana situated on the Mussoorie-Tehri Road by Ahluwalia (1979, 1985) and Ahluwalia and Bhargava (1989). Comments of Dr Reitlinger, Prof. Conil and

Dr Vachard have been appended in the paper (Ahluwalia, 1979) to support the identifications and suggesting the age of foraminifera bearing beds to Carboniferous-Permian (?). However, the same author (Ahluwalia, 1985, 1989) later reassessed them as algal forms comparable to *Obruchevella* and suggested Vendian-Tommotian age for these beds.

Remarks—Our study of a single slide, made available to us by Dr Ahluwalia, confirms his latter view that the forms are *Obruchevella*. The difference in their shape is only due to their being sectioned along different planes. Hence, we consider these forms as 'true fossil' of *Obruchevella*.

Foraminifera and Gastropoda

Text-figures 31, 32, 35, 36, 39, 40, 43, 46

Repository—Author's collection. Kumar, 1979, pl. 1, figs 1-4; pl. 2, fig. 5.

Kumar (1979) reported the presence of foraminifera and gastropoda from the oolitic band of Krol D stage of the type area of Krol Formation, Krol Hill near Solan, in Himachal Pradesh. The foraminifera reported include *Novella* sp., *Nodosaria* sp., *Gourisina* (?) sp., *Lunucammina perforata* (large), *Lunucammina orientalis, Tetrataxis* sp., *Paraboultonia* sp. and *Diplotremina* sp.

Remarks—Singh (1981, p. 154) in his review considered these specimens to be only coated grains, Zhang *et al.* (1983) illustrated and explained the mechanism of formation of coated grains of sparry carbonate nucleus showing patchy recrystallisation subjected to varying degrees of diagenesis. The specimens attributed to foraminifera and gastropods by Kumar (1979) agree with the illustrations given by Zhang *et al.* (1983). Hence, they are considered 'non-fossil'.

1. Small shelly fauna

Repository—Not mentioned; Singh & Shukla, 1981. Not mentioned; Azmi & Pancholi, 1983. Geological Survey of India, Calcutta; Specimen nos. 20076-20122; Bhatt *et al.*, 1985, pl. 1, figs 1-17; pl. 2, figs 1-16; pl. 3, figs 1-14. Brasier & Singh, 1987. Kumar *et al.*, 1987.

There are a number of records of small shelly fossils from Chert-Phosphorite Member of Tal Formation reported from different localities of the Garhwal Syncline. Singh and Shukla (1981), Azmi and Pancholi (1983), Bhatt *et al.* (1985), Brasier and Singh (1987) and Kumar *et al.* (1987) reported—*Maldeotia bandalica, Protohertzina anabarica, Conotheca* sp., *Ovalitheca* cf. *multisulcatus* sp., *Barbitositheca ansata, Hexangulaconularia* cf. *formosa, Coleoloides* aff. *typicalis, Hyolithellus* aff. *insolatus, H.* cf. *insiticus, H. valdimirovae, Spirellus shankari, Olivooides trisulcatus, Protohertzina sciciformis, Protohertzina unguliformis, Hyolithes stylus, Circotheca* aff. *obessa, Circotheca dahaiensis, Turcytheca* aff. *praenguis, Anabarites* sp., *Coleoloides* sp., *Allatheca concinna, Circotheca longiconica, Circotheca* sp., *Turcutheca* sp., indet aff. *T. annae, Turcutheca lubrica, Turcutheca maldeotaensis, Protohertzina* sp., indet aff. *P. robusta, Gaulondina, Tikritheca* sp., *Maikhanella* sp., *Olivooides* sp., *Coleoloides* sp., *Spirellus?* sp., *Lapworthella*, etc. On the basis of this assemblage a Tommotian to Ordovician age has been suggested.

Remarks—The report of the small shelly fauna from Chert Member of the Tal Formation is very significant. The findings have been validated (Brasier & Singh, 1987). However, certain taxonomic reassignments have been suggested (see Cowie & Brasier, 1989, p. 52). We consider these fossils as 'true fossil'.

2. Small Shelly fauna

Repository—Geological Survey of India, Calcutta, Specimen no. not known; Das *et al.*, 1987, pl. 1, figs 1-11; pl. 2, figs 1-6.

An assemblage of shelly fauna consisting of *Olovooides* sp., *Hertzina?* sp., *Lapworthella?* sp., *Cambrotubulus.* sp., *Colooloides?* sp., specimens assigned to gen. et sp. indet 1, gen. et sp. indet 2, gen. et sp. indet 3 are recorded from the basal part of the Upper Krol dolomites near Baldiyakhan and Hanumangarhi on the Jeolikote—Nainital Road section (Das *et al.*, 1987). Shelly microfauna are claimed to be present in a large number but the authors identification are only provisional.

Remarks—The fossils illustrated by Das *et al.* (1987) are 'true fossil'. They need proper identification and description. The occurrence of *Anabarites, Circotheca* and *Protohertzina* assemblage (ACP assemblage) is important to mark the Precambrian/Cambrian boundary. Here the occurrence of some fossils of the ACP assemblage is significant to trace their antiquity.

3. Small Shelly fossils

Repository—Northern Region, Geological Survey of India, Lucknow, Specimen nos. PRF/5978, 5982, 5994 A-D & 6017; Bhatt & Mathur, 1990a, fig. 3a-g.

Small shelly fossils, including *Coleoloides typicalis* Walcott, *Olivooides multisulcatus* Qian, *?Hyolithellus* sp. and *?Turcutheca* sp., were recorded from phosphatic carbonates occurring at 7 km from Nainital on the Nainital-Kaladungi Road, near the village Chorkhet. On the basis of *Olivooides multisulcatus* and *Coleoloides typicalis* Bhatt and

Mathur (1990) inferred that the topmost 77 meters of Sherwood Member of Krol Formation and the basal 73 meters of the succeeding Giwalikhet Member of Tal Formation in the Nainital Syncline represents the same time span as the Chert Phosphorite Member of Tal Formation in Mussoorie and Garhwal Syncline.

Remarks—These forms are undoubtedly biogenic hence 'true fossil' and confirm the presence of SSF in Krol E.

Ostracoda

Text-figures 4, 5

Repository—Geological Survey of India, Calcutta, Specimen nos. 20306, 20307; Das *et al.*, 1990, pl. 1, figs 1, 2.

Two tiny carapaces having strong resemblance to Ostracoda are reported from the basal part of the Upper Krol Formation exposed 1 km north of Baldiyakhan toll gate on the Jeolikote-Nainital Road section. These specimens, obtained by maceration of thinly interbedded phosphorite and limestone, display platy appearance and are associated with shelly microfauna. The two valves bear few spines; eye tubercles are absent. The authors recommend its placement under Archaeocopida though they agree that the fossils do not show diagnostic characters of this group.

Remarks—The specimens are 600 μm in length and 350 μm in breadth. Their authentication requires further study under the Scaning Electron Microscope. Though, the specimens were available at the repository, we could not take up SEM studies due to non-availability of such facilities at the Calcutta repository. Therefore we refrain from offering comment on this record.

SPIRAL FORMS

Spiroichnus beerii Mathur

Text-figure 24

Repository—Geological Survey of India, Calcutta, Specimen no. not known; Beer, 1919, pl. 30, figs 1, 2; Mathur, 1983, pl. 2, figs 1, 2.

Beer (1919) reported small spiral groove of 13 × 11 mm from Vindhyan scarp at Sardainar near Rohtas. They could be caused by the impression left on the surface of the soft mud by the caracass of a coiled worm or may represent tracks of small burrowing animal. Mathur (1983) redescribed the same specimens as spiral grooved impression on the upper surface of the soft shaly layer (concave epirelief), and its cast on the sole of overlying slab of compact and hard limestone (convex hyporelief), whose inner termination has rounded and smooth margins and the outer pointed end broken. Mathur (1983) named this specimen as *Spiroichnus beerii.*

Remarks—The specimen was not available for our study. On the basis of published photographs (Beer, 1991; Mathur, 1983) we are of the opinion that the specimen is a biogenic structure and hence 'true fossil'.

Katnia singhi

Text-figures 48, 62, 63

Repository—Author's collection, Specimen no. LUTS-35; Tandon & Kumar, 1977, fig. 1.

Tandon and Kumar (1977) reported annelid remains from the ash-grey and white siltstone, shales and thinly laminated shaly brownish limestones of Rohtas Limestone Formation, Semri Group exposed in Katni, central India.

Remarks—Similar specimens from the same locality were made available by Dr S. Kumar to Prof. Glaessner and Dr Conway Morris for examination. According to Glaessner (1987, p. 354) "another somewhat similar fossil 'worm' has been described from the Lower Vindhyan of central India (Rohtas Formation of Semri Group, estimated age 900-1,000 Ma) as *Katnia singhi* Tandon & Kumar 1977. These fossils are compressions of tightly wound clusters, about 20 mm in diameter, of worm-like transversely annulated ribbons, just under 2 mm wide. Dr Kumar has kindly presented me with two specimens, one of which I have given to Dr Simon Conway Morris (Cambridge University) for further examination. In neither specimen could I ascertain the presence of head structures claimed by Dr Kumar for this species. They resemble illustrations of fossil oscillatorian cyanobacteria but are some 20-25 times larger". A similar view was expressed by Conway Morris (1989, fig. 2B, p. 85), wherein he has considered them flattened carbonaceous ribbons or sheets perhaps representing one or more eukaryotic groups such as brown algae.

Since, the holotype was not available for study, it is an *inaccessotype specimen.* One of us (Sharma), however, could see a photograph of another specimen which looks similar to oscillatorian filament (Text-figure 63). Thus, we agree with the assessment of Glaessner (1987) and C. Morris (1989). The fossils are 'true fossil' of plant affinity.

Vindhyavasinia nisrai

Text-figure 54

Repository—Author's collection, Specimen no. LUTS-34; Tandon & Kumar, 1977, figs 2, 3.

Tandon and Kumar (1977) reported a single laterally preserved specimen belonging to class Insecta in ash grey siltstone of Katni, Rohtas Formation, Semri Group, Vindhyan Supergroup, and designated it as *Vindhyavasinia misrai* with the following description: "In lateral view body elongate, subquadrate, differentiated into head, thorax, and abdomen, length 2.75 mm, height 1.42 mm; head broadly oval, probably hypognathus, broad dorsally, narrow ventrally, eye indistinct, below the middle of the antero-lateral margin of a head very short finely segmented, antena-like structure present just below it a short, narrow downwardly curved probosis." Besides, these major organs of an insect various other organs like leg, mouth, thorax were also discussed by the authors.

Maithy (1990, p. 26) considered *V. misrai* similar to *Krishnania* Sahni & Srivastava (1954). Maithy and Shukla (1984b) had earlier considered *Krishnania* a junior synonym of *Chuaria*.

Remarks—Since, the holotype of *V. misrai* was not available for restudy, it is an *inaccessotype specimen*. One of us (Sharma) had an opportunity on an earlier occasion to see the specimen and feel convinced that the specimen illustrated in Tandon and Kumar (1977, figs 2, 3) is a specimen of *Chuaria* preserved in fragments. Thus, we agree with Maithy (1990) that the fossil is not that of an insect but of *Chuaria (Krishnania)*. It is a 'true fossil' requiring reassessment of taxonomic affinity.

TRACE FOSSILS

Chordoichnus latouchei Mathur

Text-figure 55

Repository—Geological Survey of India, Calcutta, Specimen no. not known; La Touche, 1902; Vredenburg, 1908 (emended); Mathur, 1983, pl. 1, fig. 1.

La Touche (1902) reported a structure on red sandstone collected from Marwar Group exposed in Jodhpur area, Rajasthan and assigned a non-biological origin. Later, Vredenburg (1908) suggested an organic origin. Mathur (1983) after a restudy described and designated the specimen as *Chordoichnus latouchei*. It is a relief cast on the surface of a sandstone consisting of lobate swellings with finger-like terminations. No indication is given of its origin and affinity.

Remarks—The repository records of the specimen described by La Touche (1902) at GSI,. Calcutta bear a temporary number K1/963. It is presently misplaced and could not be examined. The specimen now designated as *Chordoichnus latouchei* has been figured in Vredenburg (1908), Pascoe (1958, vol. II, p. 516) and Mathur (1983, pl. 1, fig. 1). Its origin and affinity are not known. Thus, it is difficult to confirm it's biogenic nature untill further study of the specimen and place this form under "no comments" category.

1. Trace fossils

Pl. 10, figs 6, 7

Repository—Geological Survey of India, Calcutta, Specimen no. not known; Vredenburg, 1908; Mathur, 1983, pl. 2, fig. 3.

Vredenburg (1908) described hypichnal ridges probably casts of burrow in a slab of shaly sandstone from Lilgar in Raisen District, Madhya Pradesh. Mathur (1983) expressed a similar view for this and remarked that they are trace fossils.

Remarks—These structures are present on the specimen no. GSI-8968 which is a fine grained maroon coloured sandstone. On one surface of this specimen, number of structures are present. Some of these structures, present in thin vener of shaly material, have been reported as trace fossils by Vredenburg (1908) and Mathur (1983). These fine linear structures of few centimeters in length are 30 in number, mostly present on the bedding plane. Some of them are alligned with cracks in the sandstone. Some of the features which are not well preserved apparently resemble the cephalon and pygidium of an ?arthropod. Some other structures are circular to ovoidal with a thin filament like tail. The composition of mineral in the trails are different from the host rock. In all probability the rock slab holds evidence of extensive biogenic activity. The forms are not identifiable. Thus, they are 'true ichnofossils' whose taxonomic position is problematic.

2. Trace fossils

Pl. 5, figs 1-5

Repository—Geological Survey of India, Calcutta, Specimen nos. 18355, 18356, 18357; Verma & Prasad, 1968, figs 1-3; Misra & Misra, 1982; Das, 1987, figs 1-3.

Verma and Prasad (1968) described trace fossils in the Bhander Limestone of the Upper Vindhyans in Bankuiyan area, Rewa District, Madhya Pradesh. Three new species of trace fossils—*Bostrichophyton bankuiyanensis, Rouaulita rewanensis* (from Repachinia Group) and *Tasmanadia dasii* (from Pascichinia Group) proposed in this paper represent movement and grazing traces of organisms. The same specimens have been again described by Das (1987, figs 1-3) without any additional information.

Similar objects have also been reported by Misra and Misra (1982).

Remarks—Linear markings occuring on a weathered limestone slab (Specimen no. GSI 18355) were identified as trace fossil —*Bostrichophyton bankuiyanensis* by Verma and Prasad (1968). In addition, the distinct linear markings, a second order of markings which are comparatively faint, are also present; unoriented cross laminations cut across these markings and are present at short intervals. These have sharp margins. Such features appear to be the crawling traces of worms and are placed in the 'true fossil' category.

A smooth bilobate trail (Specimen no. GSI-18356) is present on a black weathered limestone slab with some stylolite markings. Trail has maximum length of about 100 mm and width 15 mm and more close to be a biogenic drag made by some worm as supported by its wavy nature. There are also other trace movements (Specimen no. GSI 18357) on the weathered limestone. Significant ones are the linear traces on the smooth surface. The traces show non parallel pairs with pointed margins. They are suggestive of movements by animal in different directions as some times seen in the traces of arthropods.

Thus, even though, all the three traces are present on weathered surface and we do not know the top and bottom of these rock specimens on which the traces are present. Their morphological features suggest biogenic origin. Hence, all the three specimens are unquestionably 'true fossil'.

3. Trace fossils

Text-figure 23

Repository—Not mentioned. Shivarudrappa, 1981, pl. 1, fig. 1.

Shivarudrappa (1981) reported a few cresent-shaped structures which have been compared with *Fondinichnia*—feeding burrow from the upper bedding plane of the ripple marked quartzite near Dodguni in Karnataka. Each semicircular structure is slightly superimposed on the other and measures from 2 to 12 cm in width. The author considers that due to the absence of a central canal their comparsion with Zoophycus is not tenable, but still he considered them as trace fossil of evolved forms and consequently suggested an younger age for Dodguni chert.

Remarks—We could not examine the specimen. There are large number of stromatolites in the carbonate layers just above the quartzite in the Dodguni chert locality (Srinivasan *et al.*, 1989 and Venkatachala *et al.*, 1990) and the semicircular structures with superimposed layering described by Shivarudrappa (1981) could be parts of stromatolite. The stromatolite bearing dolomite has been silicified at places and similar structures can be observed on weathered surfaces of silicified dolomites. They are apparently broken algal mats. Besides, radiometric dates indicate that these beds are older than 2.6 billion years when even metazoa had not evolved, thus the occurrence of movement or resting traces of evolved forms cannot be explained. We consider these features as 'dubiofossil'.

4. Trace fossil

Pl. 8, figs 6, 8

Repository—Not mentioned. Maithy *et al.*, 1986, fig. 2.

Maithy *et al.* (1986) described 'trace fossil' from Murli Sandstone Formation (Kaimur Group) of Murlipahar. This is an elongated cylindrical structure measuring 5 cm in length with a central ridge and rows of deep furrows and circular on either side of the ridges. The trace fossil may be referred to as annelid traces.

Remarks—The authors have not mentioned any repository or specimen number. But this specimen

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PLATE 9

(Scale in figs 1-6, 1 div. = 1 cm & 7 = 5 cm and 8 = 1 mm)

1. *Medusinites* sp. cf. *M. asteroides* of Mathur & Shanker, 1990, note both the cast and mould of *M. asteroides* with outer ring, Specimen no. GSI-20310.
2, 4. *Tirasiana* sp. of Mathur & Shanker, 1990 note the characteristic tripartite organisation of specimens with small central tubercle, Specimen no. GSI-20308 and 20309.
3. *Beltanella* sp. cf. *B. gilesi* of Mathur & Shanker, 1990, note the smooth central disc with narrow rim preserved in convex hyporelief, Specimen no. GSI-20311.
5. *Beltanelliformis* sp. cf. *B. brunsae* of Mathur & Shanker, 1989, note the botton-shaped structure on the bedding plane with convex hyporelief, Specimen no GSI-20282.
6. *Gordia* sp. cf. *G. marina* of Mathur & Shanker, 1989. The ichnofossil is present in deepest portion of the trough of the folded specimen, note that this ichnofossil does not cross itself, Specimen no. GSI-20284.
7, 8. Commonly observable structure on the thin vener of clacite on Rohtas area. These structures are variously described as *Longfengshania chopanensis, Longfengshania stipitata* and Krishnanid forms. Infact all such features are 'non-fossil', Specimen no. BSIP-36794. Specimens marked with arrow are enlarged in fig. 8 showing characteristic feature.

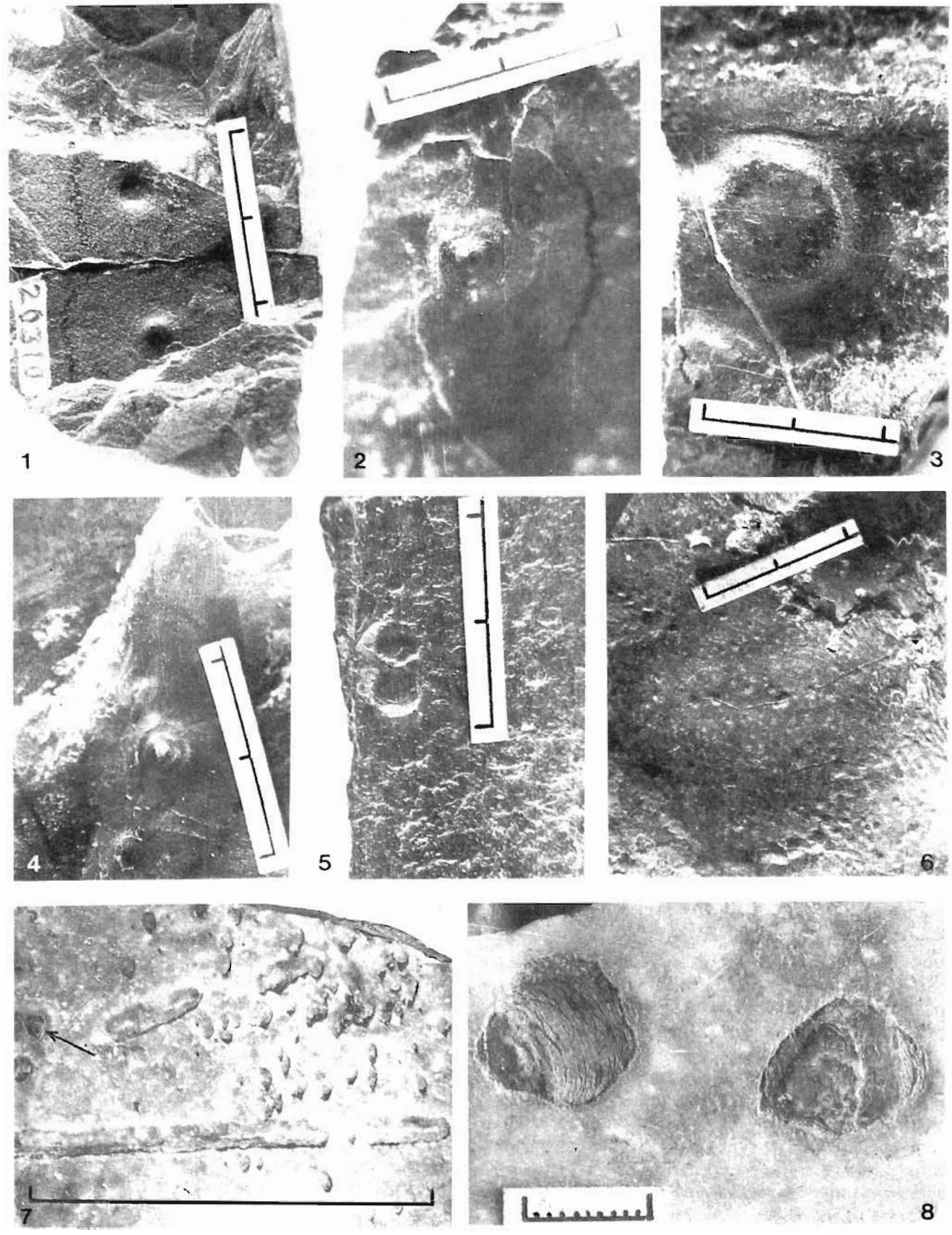


PLATE 9

was located in BSIP repository and bears specimen no. 35858. It is a yellow coloured sandstone covered by a number of linear cylindrical structures. These structures with 'V'-shaped cross section are similar to cast of Sun cracks. We consider all these structures including the one illustrated by Maithy *et al.* (1986) as 'non-fossil'.

5. Trace fossils

Text-figures 1, 10, 13, 14, 34

Repository—Not mentioned. Das *et al.*, 1987, pl. 1, figs 1-3; pl. 2, figs 1-3.

Trace fossils *Acanthichnus* Hitchcock 1858, *Bostrichophyton* Squinabol 1890, *Onisocoidichnus* Brady 1949, *Protovirgularia* M'Coy 1850 and *Tasmandia* Chapman 1920 were reported by Das *et al.* (1987; pl. 1, figs 1-3; pl. 2, figs 1-3) without any description from Bankuiyan area, Rewa District, Madhya Pradesh.

Remarks—It was not possible to re-examine the assemblage in the absence of repository details. The illustrations are not of good quality and do not show the characters mentioned in the text. True trace fossils are known from the area (see Verma & Prasad, 1968; Das, 1987). A specimen from the same area exhibiting crawling traces was made available for examination by one of the authors (Moitra). It is possible that the trace fossils illustrated by Das *et al.* (1987) are of biogenic origin.

6. Trace fossils

Pl. 10, fig. 4

Repository—Birbal Sahni Institute of Palaeobotany, Lucknow, Specimen no. 18/4031; Shukla & Sharma, 1990, pl. 2, figs 8, 9.

Shukla and Sharma (1990) described trace fossils from the contact of Suket shales and Morwan Sandstone Formation near Amarpura Ghat area on the Rampura-Gandhisagar Road. Since, the paper of Shukla and Sharma (1990) mainly dealt with the age implications of palaeobiological remains, no detailed account of trace fossil was given.

Remarks—Trace fossils (Ripichnia) are preserved in Morwan Sandstone, the lowermost part of the Kaimur Group in the area, with convex epirelief and exogenic in origin. Varied forms are reported such as meandering, straight, 'U' and 'C'-shaped tracks. Some of them have annulations. They form circular or crescent-shaped filling in the host lithology. While synaeresis cracks show a distinct 'V' shaped filling. Hence, we consider the structures described by Shukla and Sharma (1990, pl. 2, figs. 8, 9) as 'true fossil'.

1. Burrow

Text-figures 33, 38a, 38b

Repository—Not mentioned; Misra & Awasthi, 1962, figs 7, 8, 9, 10, 15

Misra and Awasthi (1962) described vertically aligned layered conical structures from Rohtas Limestone, Semri Group. These are triangular in cross section and have irregular to triangular lid. Discussing the two possible alternative origins, viz., wash out structures and organic burrow they favoured an organic burrow origin and cited the comments of Prof. F. Howell in support of their view. Prof. Howell (*In* Misra & Awasthi, 1962, p. 769) believed that they may be burrows of worms that were ancestors of Hyolithidae, some of which have triangular cross section.

Remarks—Absence of repository and specimen number permitted only evaluation based on photographs and the description available in the original paper. The conical, triangular structures are filled with coarser sediments which was later silicified (see Misra & Awasthi, 1962, p. 768, 769). It is possible that vertically oriented tubular openings were produced by burrowing of soft sediments which were later filled with coarse sediments. The causative organism is yet to be known, still it's biogenecity is beyond doubt and we consider them authentic records of worm burrow.

2. Burrow

Text-figure 2

Repository—Not mentioned. Sarkar, 1974, figs 4A-D.

Sarkar (1974, figs 4A-D) reported different types of burrows from brown and grey laminated or massive limestone of Maihar and Satna areas. The burrows are slightly raised ridges, mostly sheet-like straight to sinuous, irregular to 'V'-shaped and in some cases haphazardly oriented.

Remarks—The original specimens were not available for study. Hence, the evaluation is based on photographic illustrations. The illustrations (Sarkar, 1974, pl. 4, fig. A) and text-figure (pl. 4, fig. D) show that these burrows have spindle-shaped structure in cross section. We do not know of any animal which would form such a burrow. They appear more similar to shrinkage cracks/crack fillings. Hence, we place them in the 'non-fossil' category.

3. Burrow

Text-figure 27

Repository—Not mentioned. Sisodiya & Jain, 1984, pl. 1, figs 1, 2.

Dwelling traces (Domichnia) comparable to *Ophiomorpha* were recorded from Kaimur Sandstone exposed west of Besla in Mandsaur District, Madhya Pradesh by Sisodiya and Jain (1984, pl. 1, figs 1, 2). Burrows are up to 25 cm in length and 7 mm in diameter. These forms are supposed to have been formed by the borings of probably *Lithotrya*-type of Arthropoda, or belonging to the group of *Skolithos* (Sisodiya & Jain, 1984).

Remarks—Absence of repository details permitted evaluation only on the basis of photographs and description. The conical shape of structures proved by cross section, mineral filling of material other than the host rock, confirms the observation of Sisodiya and Jain (1984) that the structures belong to domichnia group and may have formed by animals probably belonging to the group of *Skolithos*. They are considered 'true ichnofossil'.

Burrows and bioturbations

Repository—Indian Institute of Technology, Kharagpur, Specimen nos. LBSM—99, 100, 101, 105, 107, 110, Chakrabarti, 1990, figs 3-10, 13-22.

Chakrabarti (1990) has recorded evidences of biogenic activity from the Bhander Group of rocks exposed near Maihar, central India. These signatures include burrows and bioturbations associated with long and curved scratch markings and 'bean-shaped' or 'Lozenge' shaped projections. The burrows are of Monocraterion and Diplocraterion types, the scratch markings and other features are considered as dubiotraces by Chakrabarti (1990).

Remarks—Chakrabarti (1990) studied burrows and bioturbations from the Bhander Group of rocks in petrographic thin sections, polished longitudinal sections and by radiography. This comprehensive study has helped to understand the biogenicity and syngenecity of these structures. The burrows and microburrows with large diameter are considered 'true fossils'. The affinity and biogenicity of the other structures such as drag or scratch markings, 'Lozenge' or 'bean-seed'-shaped bodies and 'mud volcano-like structures' can not be properly established and are considered 'dubiofossils'.

Worm tracks

Text-figure 6

Repository—Not mentioned. Misra & Awasthi, 1962, fig. 15.

Misra and Awasthi (1962) recorded worm tracks from Kaimur Quartzitic Sandstone of Rampura area and also in the Sirbu shales of Maihar area. Considering the poor state of preservation they are not assigned to any particular genus.

Remarks—In the absence of repository the material could not be examined. However, evaluation of figure of the object suggests more similarity with typical synaresis cracks rather than the worm tracks and burrows. Therefore, the record is considered here as 'non-fossil'.

Aulichnites

Pl. 10, figs 1, 2

Repository—Not mentioned. Banerjee & Narain, 1976, figs 3, 4a.

Two different trails occurring in positive epirelief are described as *Aulichnites* Fenton & Fenton. They occur on jointed and fractured thinly laminated sandy layers of a thickly bedded micaceous sandstone (subgreywacke of Psammite Member of Lower Tal Formation). One trail is 0.5-1 cm deep, 0.3 cm wide and 60 cm long, while the other is 3.75 cm wide, 1 cm deep and 40-75 cm long. Both these records of traces movement have been clubed into one group *Aulichnites*.

Remarks—Identification of *Aulichnites* (Banerjee & Narain, 1976, figs 3, 5) is based on field studies only, hence the specimens were not deposited in a repository. The fossils occur on jointed and fractured rock. Dr Banerjee (Pers. communication) also informed that the fragile nature of rock does not permit collection of more specimens. He kindly provided a photograph of the trail marking which is convincing and permits an evaluation of the habit, shape and size of the traces. We consider these structure as 'true trace fossil'.

Fusiform structures

Text-figure 18

Repository—Not mentioned. Bose, 1977, fig. 1.

Bose (1977, fig. 1) reported fusiform structures from Sullavai Sandstone occurring in the stream *Sudda vagu* 4 km north of Chelvai in the Warangal District, Andhra Pradesh. These are present on single bedding plane. He favoured a biogenic origin for these structures on the basis of the absence of (i) mud-crack in the vicinity of fusiform structures, (ii) pelitic layer at the bottom of the spindles, and (iii) easily separable spindles which occur as discrete bodies in the host quartzite and considered them sand filled worm burrows.

Remarks—Absence of repository details restricted us to evaluate these structures on the basis of photographic illustrations. Such structures which are common in Precambrian sedimentary sequences

are often mistaken for trace fossils. Similar structures are also frequently present in younger sediments (see Collinson & Thomson, 1982, figs 9, 8b, p. 141). La Touche (1898) also recorded such structures from Vindhyan Sandstone near Jodhpur (available in GSI repository, Calcutta bearing temporary numbers K-1/963) and reproduced here in Plate 6, figure 7. The fusiform shape of these structures in planar view indicates possibilities of their being casts of typical synaeresis cracks. These structures are made up of rounded quartz grains which explain their easy separability from the host rocks. These are nonbiogenic structures. We consider them as 'non-fossil'.

***Muniaichnus* Kumar**

Text-figure 12

Repository—Not mentioned. Kumar, 1978b, pl. 2, fig. 1.

Kumar (1978b) reported a specimen which is 16 cm long and 0.6-10 cm wide meandering structure with a broader end on one side and a tapering end on the other side under a new genus *Muniaichnus* from the glauconitic sandstone of Kheinjua Formation. He compared and considered these structures different from *Gordia* Emmons 1844 and *Cochlichnus* Hitchcock 1859.

Remarks—Evaluation of illustration of the form, in the absence of repository details, shows it's close similarity with weathered ripple mark or mud crack similar to the ones described as *Manchuriophycus* (Endo, 1933). In a personal discussion (with Sharma) Dr Kumar agreed that these structures may be the mud cracks and hence categorised as a 'non-fossil'.

***Skolithos/Westites kymorensis* Saxena**

Text-figure 8

Repository—Geology Department, Sagar University, Specimen no. GNS-V/K. 101; Saxena, 1980, fig. 1.

Saxena (1980) described a trace fossil *Westites kymorensis* of class *Repichnia* from glauconitic sandstone of Kaimur Group from the foot-hills opposite A.C.C. factory, Kymore, Madhya Pradesh. It has a maximum length of 10 cm and a diameter of 0.8 cm. These horizontal traces have 'Y'-shaped branching which sometimes intersects, forming tunnels and channels, filled with other minerals, the burrows and channels are generally thickest in the middle of each branch, or at the point of intersections, they further gradually taper. The structures occur as ridges rising in relief on the sandstone with sharp relief.

Remarks—A perusal of the description by Saxena (1980) highlights their maximum length and diameter, 'Y' shaped branching and their presence as a relief on the sandstone slab. All these features indicate characteristics of a mud crack particularly the 'Y' shaped branching which in all probability suggest a typical 120° angle made by sun cracking of loosely consolidated sand. These cracks subsequently have widened due to weathering and filled with later sediments. It is a common knowledge that such Sun cracks start widening from the junction and taper toward the edge. Thus, the shape, size and branching pattern of these structures described by Saxena (1980) indicate their origin through mud cracking and hence considered 'non-fossil'.

***Asteriradiatus karauliensis* Mathur**

Text-figure 17

Repository—Not mentioned. Mathur, 1982, fig. 2A.

Mathur (1982, fig. 2A) named a new genus of trace fossil, *Asteriradiatus karauliensis* as a star-shaped trace fossil from Karauli Quartzite, Rewa Group, Panna District, Madhya Pradesh without any description or diagnostic features.

Remarks—The specimen was not available for restudy. The photographs are also of not adequate quality for fine assessment; diagnosis or description has not been given and the illustrated specimen has been named as the holotype. The genus is thus invalid. It could be possible that the structure is formed by cracking in the loosely packed sediments and may be lenticular and radiating shrinkage crack.

PLATE 10 →

(Scale in fig. 4 = 200 μm fig. 5 = 2 cm and fig. 7 = 1 cm)

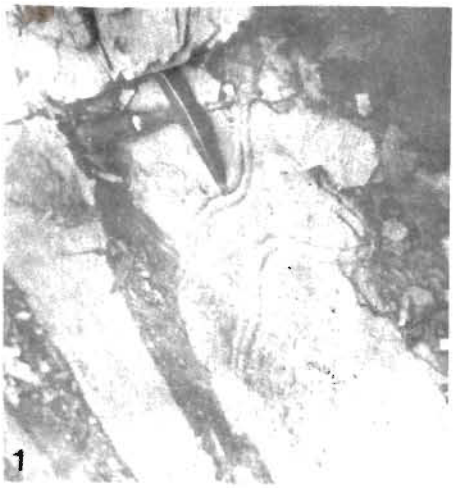
1, 2. *Aulichnites* sp. Banerjee & Narayan 1976, note the movement traces on thinly laminated sandy layers.

3. *Ramapuraea vindhyanensis* Maithy & Shukla 1984, Specimen no. BSIP-27341.

4. Trace fossil Shukla & Sharma 1990, note a meandering structure on the sandstone surface, Specimen no. BSIP-18/4031.

5. *Coleolella billingsi* Maithy & Shukla 1984a, a calcitic ring-shaped structure which is a by product of maceration and hence considered non-fossil, Specimen no. BSIP-8001.

6, 7. Trace fossils Vredenburg 1908, note the object marked with arrow in fig. 6 which is enlarged in fig. 7 giving the impression of probable arthropod, Specimen no. GSI-8968.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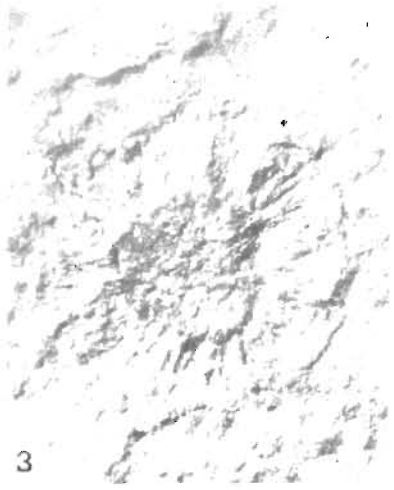
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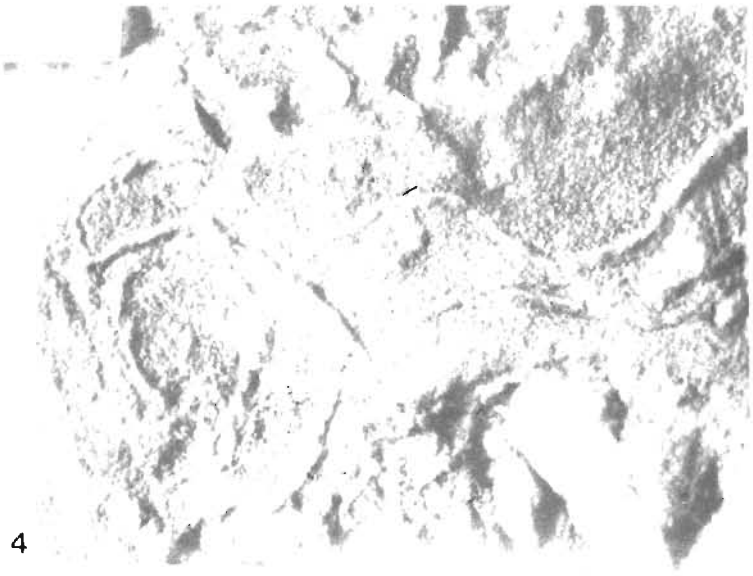
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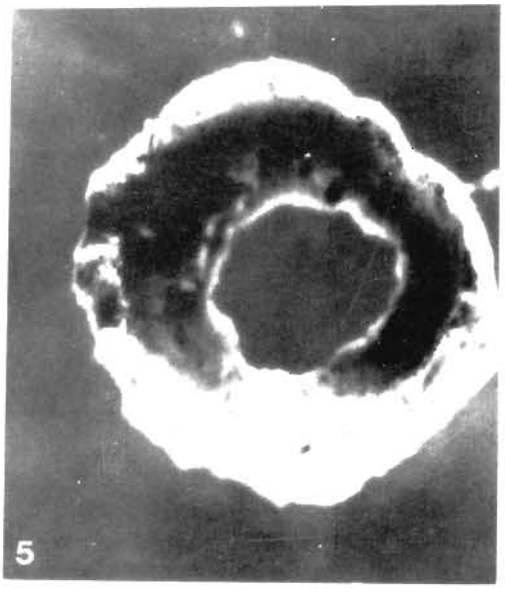
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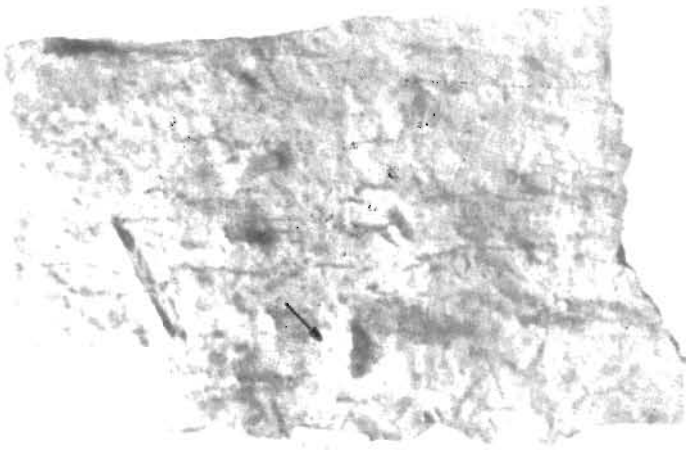
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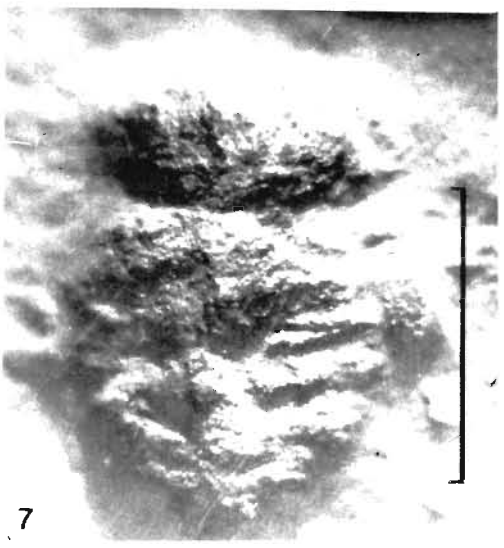
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PLATE 10

***Sonjiwashmam basuhariensis* Mathur**

Text-figure 11

Repository—Not mentioned. Mathur, 1982, fig. 2B.

Mathur (1982) named *Sonjiwashmam basuhariensis* a new genus of trace fossil from Basuhari Sandstone, Semri Group, Mirzapur District, Uttar Pradesh without any description or diagnosis.

Remarks—The genus is invalid because of the lack of diagnosis and description. Evaluation of the photograph suggests that the meandering structures with smooth margin and uniform breadth could be the movement trace or *Manchuriophycus* Endo. Therefore, the structure described by Mathur (1982, fig. 2B) is considered as 'dubiofossil'.

***Bhanrerichnus damohensis* Mathur & Verma**

Text-figure 9

Repository—Not mentioned. Mathur & Verma, 1983, fig. 1.

Mathur and Verma (1983) described an ichnofossil *Bhanrerichnus damohensis* from Maihar Quartzite Formation of Bhander Group, Vindhyan Supergroup in Damoh District, Madhya Pradesh. This form occurs on the slab of a very dusky red-purple quartz arenite which is ripple marked. This trace fossil has convex hyporelief which is reverse 'L'-shaped with four pairs of symmetrically placed lobes without any ornamentation or marking on any part of the structure. Its formation is attributed to resting and burrowing organisms of uncertain affinity.

Remarks—The form could not be re-examined due to absence of repository details. The illustration provided by the authors is also not clear. However, the complex nature of this (?) trace fossil is difficult to interpret. Its presence on rippled surface and the symmetrical nature of the lobes suggest that it is a 'problematic' fossil which can not be assigned to any known phylum, hence, considered 'dubiofossil'.

***Puratanichnus bijawarensis* Mathur**

Text-figure 41

Repository—Geology Department, Sagar University, Specimen no. not known; Mathur & Chattri, 1986, pl. 1, fig. 1A, B.

Mathur and Chattri (1986, pl. 1, fig. 1A, B) reported trails of probable annelid worms on the Amronia quartzite of the Bijawar Group (~ 2,500 Ma) Both the trails are figured (pl. 1, fig. 1A, B), one of them belong to epichnial groove while the other to hypichnial ridge. Both the trails are about 10 cm long and 5-8 mm wide. In a communication to Mathur and Chattri (1986) Prof. Seilacher commented that these structures could be inorganic sedimentary features known as *Manchuriophycus* Endo. However, Mathur and Chattri (1986) still consider them biogenic.

Remarks—Two linear ridged corrugated structures are considered as *Puratanichnus bijawarensis* by Mathur and Chattri (1986). This is one of the few reports claiming the presence of metazoan trail from such an old sedimentary rock. Metazoan records are not known prior to Neo Proterozoic. It is difficult to explain records of Metazoan activity in 2,500 Ma old sediments. In a personal discussion with us, Dr Mathur informed that the specimen was lost when it was loaned to an Indian expert for re-examination.

Evaluation of photographs suggests that the ridge on these structure appear similar to 'Tool marks' of continuous category of Collinson and Thompson (1982, p. 42). Such tool marks can be formed when any material is carried by a flow on a soft surface leaving a mark either in the form of a groove or when filled in as a groove cast. In the present context the groove casts are preserved. We thus, infer that the structure described by Mathur and Chattri (1986) are 'non-fossil'.

Ichnofossils

Text-figure 66

Repository—Not mentioned. Mukherjee *et al.*, 1987, figs 1, 2.

Mukherjee *et al.* (1987) described a wide variety of ichnofossils from the Gulcheru Quartzite of Lower Cuddapah sequence. Particularly rich ichnocoenoses have been observed in a dirty brown quartzite occuring at 120 m from the base of the unit. Casts of horizontal burrows are most common. In the branching types, the horizontal burrows are commonly petal-shaped or spindle-shaped casts with minor grooves. In the cast portion horizontal burrows are 3-10 mm wide, 1-3.9 cm long and 2-6 mm high. A few petal-shaped casts show median depression of 1 mm width. In the groove portion the horizontal burrows are 3-9 mm wide, 1.2-2.9 cm long and 1-2 mm deep. The burrow fills are made up of coarser quartzite with a coating of cherry brown ferruginous clay. In higher horizons the assemblage gets diversified to successively include vertically paired burrows.

Remarks—These structures are closely comparable with the subaqueous shrinkage cracks discussed in Collinson and Thompson (1982, p-141). Such petal shaped/fusiform/or lobed structures are common on the basal face of the sandstone beds and often confused with trace fossils. The structures are considered 'non-fossil'

Ichnogenus Type 'A' & Type 'B'

Pl. 8, figs 5, 7

Repository—Birbal Sahni Institute of Palaeobotany, Lucknow, Specimen no. 36113; Maithy & Babu, 1988, pl. 2, figs 6, 7.

Maithy and Babu (1988; pl. 2, figs 6, 7) described sinuous to meandering trails which are elongated structures with pointed ends. They are 1-2 mm wide (mainly from 1.5-2.0 mm) and up to 0.5 mm deep or raised, showing arcuately transverse annulated appearance with constrictions or septa, chiefly at 2-4 mm intervals. Occasionally a rounded circular scar is preserved in the centre of the septae.

Ichnofossil type B (Maithy & Babu, 1988; pl. 2; fig. 7) is paired structure with circular marks with a interspacing gap of 1-4 mm from one another, arranged over a length up to 10 cm in a linear fashion. The paired circular markings are less than 1 mm in dimension. Linear distance between two pairs is less than 2 mm.

Remarks—The meandering structures with negative relief (Maithy & Babu, 1988, figs 6, 7) can be observed on the three centimeter thick fine grained sandstone slab. The negative relief indicates that they are present on the upper bedding surface. The irregular or radiating patterns with trails sometimes cross cutting one another is also clearly observable. Neither the septae nor the circular scar in between the septae are noticed. These structures taper downward in the longitudinal section of the bed forming a 'V'-shape; which is a characteristic feature of mud cracking common in the mudstones interbedded with sandstone. Similar mud cracks/synaeresis cracks have been considered earlier also as trace fossils (see discussion in Cloud, 1968, p. 29; Glaessner, 1969, p. 370; Hofmann, 1971, pp. 36-39) and hence, the structure described by Maithy and Babu (1988, pl. 2, figs 6, 7) are considered synaeresis cracks and categorised as 'non-fossil'.

***Gordia* sp. cf. *G. marina* Emmons**

Pl. 9, fig. 6

Repository—Geological Survey of India, Calcutta, Specimen no. 20284; Mathur & Shanker, 1989, pl. 1, fig. 3B.

Mathur and Shanker (1989) described few impressions on the bedding plane of shales of the Krol Formation of Nainital Syncline. These are horizontal long and slender burrows with no branching. Burrows are smooth with a diameter of approximately 1 mm. The biogenicity of *Gordia* has been questioned by Azmi and Tewari (1991), who considered them to be negative impression produced by the sharp axial hinge of the folds which appear as or the "median of *Pteridinium*" on one surface and as *Gordia* on the other.

Remarks—Examination of *Gordia* reported by Mathur and Shanker (1989, pl. 1, fig. 3B) shows that it is present in the deepest part of the trough of the folded specimen. But we did not find any *Pteridinium*-like structure on it's reverse or in the counter part which was also available. Therefore, we believe that the structures reported by Mathur and Shanker (1989) are different from those that Azmi and Tewari (1991) have discussed. The burrows reported by Mathur and Shanker (1989) do not cross itself and hence cannot be referred to *Gordia*. The closest comparison could be with *Helminthopsis* or *Helmintheidichnites* (G. M. Narbonne, In Pers communication G. Kumar also agrees with this interpretation). Hence, we consider *Gordia* reported by Mathur and Shanker (1989, pl. 1, fig. 3B) as an authentic movement trace representing metazoan activity at that time but its taxonomic position needs revision. This specimen is considered 'true fossil'.

TRILOBITID AND EURYPTERID FORMS

Repository—Not mentioned. Dubey, 1982.

Dubey (1982) reported the presence of Trilobitid and Eurypterid remains from the Ganurgarh shales and Nagod Limestone located about 5 km north of Rewa. Due to absence of any description, illustration or repository details, we are only listing this record without any comment. The record should be kept pending till more details are available. For the present review we include it under 'no comment category'.

ENIGMATIC FORMS

This category includes forms whose affinity is yet not firmly established.

***Allatheca* Missarzhevsky**

Pl. 8, figs 3, 4

Repository—Birbal Sahni Institute of Palaeobotany, Lucknow, Specimen no. 8001; Maithy & Shukla, 1984a, pl. 1, figs 5-8.

Maithy and Shukla (1984a) described four specimens of circular to subcircular calcitic bodies of 200-500 μm in size from the Suket Shale Formation of Vindhyan Supergroup around Ramapura, Madhya Pradesh. Their top is raised and bottom flattened, with smooth to reticulate surface; reticulation are pronounced and raised. Maithy and

Shukla (1984a) compared the specimen with *Allatheca* sp. of Tommotian age.

Remarks—These four specimens of *Allatheca* sp. are much smaller in size than the known species of *Allatheca* which are 20-30 times larger. A restudy indicates that they are siliceous rounded grains with brown coloured garnet or calcitic material attached to them. They appear as tubercles as illustrated in fig. 5 of Maithy and Shukla (1984a) and an attached brown covering in the illustration at fig. 7 of Maithy and Shukla (1984a). Since these grains are part of the original rock they could be of varying composition either silicious or calcitic. Monotonously arranged growth lines, folds, ribs and septa in the initial part of the shell which are diagnostic features of *Allatheca* are not recognised on these specimens. Hence, we consider them as 'non-fossil'

***Coleolella billingsi* Missarzhevesky**

Pl. 10, fig. 5

Repository—Birbal Sahni Institute of Palaeobotany, Lucknow, Specimen no. 8001; Maithy & Shukla, 1984a, pl. 1, fig. 9.

Maithy and Shukla (1984a) described a specimen recovered from Suket Shale, Semri Group, Ramapura, Mandsaur, Madhya Pradesh as a ring-like calcitic fossil, measuring up to 530 μm in dimension with a $\pm$ 450 μm central hollow area and a $\pm$ 30 μm broad border, whose surface is smooth to rugose. It was compared with Tommotian record of the operculum of *Coleolella billingsi*.

Remarks—The restudy indicates that this is a fragile, calcitic ring-shaped structure which is comparable, in over all morphology, to the discoid structures with asymmetrically placed opening, which were considered as the operculum of *Coleolella billingsi* by Missarzhevesky (1981). But it has a smaller diameter (530 μm) in comparison to *Coleolella billingsi* (1.8 mm) of Missarzhevesky (1981). Maithy and Shukla (1984a) have used sodium bicarbonate as a dispersing agent to pulverize the shale. The resultant product often assumes a ring shape. The fragile nature of the specimen further supports the conclusion that the ring-like structure is inorganic in origin and has been formed through the process discussed earlier. Hence, it is considered 'non-fossil'.

Beltanelliformis* sp. cf. *B. brunsae

Pl. 9, fig. 5

Repository—Geological Survey of India, Calcutta, Specimen no. 20282; Mathur & Shanker, 1989, pl. 1, figs 1, 3A; Shanker & Mathur, 1991, pl. 2, fig. 1.

Mathur and Shanker (1989) and Shanker and Mathur (1991) described *Beltanelliformis* from Krol Formation of Nainital syncline as a button-shaped circular to semicircular structure with convex hyporelief and 1.5 to 6 mm diameter. The specimens present vary from smooth, flat disc to more strongly convex forms with faint marginal grooves. The biogenicity, and the age of beds bearing these specimens have been doubted (Misra, 1990, p. 114; Bhatt & Mathur, 1990b, p. 117; Azmi & Tewari, 1991).

Remarks—Button-shaped structures similar to those reported by Mathur and Shanker (1989) are invariably found associated with Ediacaran fossils. Their phylogeny is still not known. Re-examination indicates that these structures are present sporadically and in clusters having two size maxima. Since, both negative as well as positive reliefs are present on the same specimen they do not appear to be rain prints. These forms may be related to *Chuaria* (Misra, 1992) as their size range compares with the size maxima of *Chuaria* in Iran. At present it is difficult to conclude on it's biogenicity and phyletic position. They are considered 'dubiofossil'

***Beltanelloides* Sokolov**

Pl. 6, fig. 8

Repository—Birbal Sahni Institute of Palaeobotany, Lucknow, Specimen no. 35956; Maithy, 1990, pl. 1, fig. 3.

Maithy (1990) recorded a specimen which has fine surface thickenings with raised portion in the centre. He assigned it to "Chuarid remains" and termed it *Beltanelloides* as recommended by Sokolov (1965 *in* Maithy, 1990) for such forms. No other details like diagnostic character, horizon or site of collection are given in the text.

Remarks—The specimen no. 35956 collected form Dabua locality, Rohtas Formation, Semri Group does not have any carbonaceous structure or impression similar to that described by Maithy (1990, pl. 1, fig. 3). Similar structures have been observed on a thin vener of fibrous calcite which is of secondary origin. This structure is similar to *'Longfengsahnia'* (*Longfengshania*) reported by Maithy and Babu (1988) which has already been considered 'non-fossil' in the present review. Hence, the structure described by Maithy (1990, pl. 1, fig. 3) is considered here as 'non-fossil'.

Krishnanid forms

Pl. 2, figs 5, 6

Repository—Birbal Sahni Institute of Palaeobotany, Lucknow, Specimen nos. 36109, 36919, 36576; Maithy, 1990, pl. 2, figs 3-5.

Oval to oblong structure with single stipe or appendage, from Rohtas Limestone Formation, Semri Group, were described by Maithy (1990, pl. 2, figs 3-5) as Krishnanid forms. The body has two distinct parts. The distal structure is foliate, circular-oval or elongate oval in shape, occasionally with a distinct border on the margin. Surface of the specimen may be smooth or with thickenings. Narrow stalk like structures emerge out from the contracted point of foliate structure. When the stalk gets detached it leaves a rounded scar on the proximal end of the foliate part indicating the point of attachment.

Remarks—This form (Maithy, 1990; pl. 2, fig. 4) has already been described by Maithy and Babu (1988, pl. 2, fig. 5) as '*Longfengsahnia*' (*Longfengshania*) *chopanensis* which has been considered as a 'non-fossil' (see discussion under heading *Longfengshania chopanensis*).

It was observed on the specimen no. 35919 instead of 36109 as mentioned in the text by Maithy (1990; pl. 2, fig. 3). The rock on which the ?fossils are found is a thinly bedded carbonate and the ?fossils are present on a thin vener of recrystallised calcite. Such structures are also described by Maithy and Babu (1988; pl. 2, fig. 4) as '*Longfengsahnia*' (*Longfengshania*) *chopanensis* and considered 'non-fossil' in the present review (see discussion under *Longfengshania chopanensis* specimen no. 36111).

It is present on the specimen no. 36516 instead of specimen no. 36576 as mentioned in the paper by Maithy (1990; pl. 2, fig. 5). This specimen is presently not available in the museum, hence could not be studied. Evaluation is based on photographic illustrations only. These forms look similar to other forms reported by Maithy (1990; pl. 2, fig. 3) and Maithy and Babu (1988; pl. 2, figs 4, 5) from the same locality. These later forms have been considered 'non-fossil' in the present review. Hence, the objects described by Maithy (1990; pl. 2, figs 3-5) as Krishnanid forms are considered as 'non-fossil'.

cf. *Podolithus* sp.

Pl. 4, figs 6, 7

Repository—Birbal Sahni Institute of Palaeobotany, Lucknow, Specimen no. 25222/273; Shukla & Sharma, 1990, pl. 2, figs 3-7.

Shukla and Sharma (1990) described two types of holdfast like structures from the buff coloured Suket shales of Semri Group. The specimen illustrated in Plate 4, figure 6 is compared with *Podolithus* sp. This fossil is characterised by a lobed appearance (or conical volcano shape) and is up to 2 mm large, the concave scar is interpreted as stem attachment point. The other type of holdfast (Pl. 4, fig. 7) is nearly flat with clearly demarcated central area and lobed outer margins. This form is compared to similar holdfast described as "Type 3" of Palmer and Palmer (1977).

Remarks—The characters observed by Shukla and Sharma (1990) are present in the specimens. The well organised morphology and close similarity with known holdfast-like structure lends support to it's biogenic nature. Though, their presence in such old sediments needs further explanation. This occurrence needs to be substantiated with more finds. These structures are presently classed under 'dubiofossil'.

Misraea

Pl. 7, figs 6-8

Repository—Birbal Sahni Institute of Palaeobotany, Lucknow, Specimen nos. 35820-35825; Maithy & Babu, 1986, pl. 1, figs 1-7; Text-figure 1A-C.

Maithy and Babu (1986) described two species of *Misraea* from the Chopan Porcellanite Formation and Rohtas Limestone Formation, Semri Group exposed in Mirzapur, Uttar Pradesh. These structures are "triangular to subtriangular in outline, surface is convexly raised with an inner concave hollow depression with the body margin curved inward forming a rim; the rim area is either smooth or with transverse thickenings. The over all outline of the fossils smooth or with distinct perforations." On the basis of body margin two species of *Misraea* were recognised, viz., *M. vindhyanensis* and *M. psilata*.

Remarks—It is difficult to comment on these specimens which are preserved in formaldehyde. They have lost their characters and are fragile. The similar state of preservation in two different lithologies, viz., porcellanite and limestone needs explanation. To avoid breaking these fragile specimens we have refrained from rephotographing them and have used photographs prepared from the negatives available with the repository. At present we prefer not to comment on these specimens.

Organic plates

Organic plates have been recorded by Venkatachala and Rawat (1972, 1973) and Vishwanathaiah *et al.* (1975, 1976, 1977) from the Dharwar, Kaladgi and Bhima sediments. These are enigmatic fossils needing further study.

SUMMARY AND CONCLUSION

In all, 79 types of metaphyte and metazoan remains have been recorded from the Precambrian

sediments of India. These records are often not accompanied with essential details, viz., lithology of the area, thickness, lateral extent and details about upper and lower contact of the fossil bearing litho-unit. New genera have been instituted without proper description and comparison, even photographs of the reported specimen is often replaced by sketches. Though, it is obligatory to deposit the holotype in a repository and provide details of the specimen number, etc. authors have also not followed this necessary practice.

Fossils are often reported in various symposia/conference abstracts without sufficient details. Pending publication of detailed account such reports can be considered only tentative. To eliminate such short comings, not only the authors, but also the referees as well as journals should insist on bare minimum facts, viz., "accurate location data, a measured section, sample collection levels, the name of the person collecting the sample, the time when the trip was undertaken and all such related matters which help in establishing the authenticity of material being reported" (Radhakrishna, 1989). The detailed account of palaeontological material should accompany the description of each reported form, viz., size, magnification of photograph, repository, number of samples analysed and how many of them proved to be yielding, frequency of the specimen/s, etc. Strict adherance to ICBN or ICZN and complete list of comparison with existing genera or species while reporting new genera or species is a necessary pre-requisite for establishing validity of the report.

Other aspects which will help to eliminate the inadvertent mistakes include discussions, on the age of the bed vis-a-vis the recorded fossil and on the palaeoecology and the depositional environment of fossil assemblage. These discussions would help to judge the fossil assemblage more critically and avoid reporting fossils merely on the basis of apparent morphological similarity.

In this review we have tried to reassess the taxonomic validity and biogenicity of the reported forms and hope that it will help future workers not only to know about all the records at one place but also provide them sufficient background to reassess their validity. This re-evaluation indicates that amongst the metaphyte and metazoan records from India 26 categorise as 'true fossil', 18 as 'dubiofossil', and 28 as 'non fossil'. It has not been possible to 7 records due to insufficient information available on them. Amongst the metaphyte/metazoa considered authentic the oldest records are from 1,000 Ma. Most of the remaining authentic fossil records are from Cryogenian (850-650 Ma) or younger age. Thus, we may conclude that organisms may have achieved multicellularity around 1,000 Ma ago but proliferation of multicellular organisms took place only at the Terminal Precambrian.

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