The Palaeobotanist 66(2017): 217–222
0031–0174/2017

Saprophytic fossil fungi from the Early Cretaceous sediments of the Rajmahal Hills, Jharkhand, India

B.D. SHARMA[1], D.R. BOHRA[2], O.P. SUTHAR[3] AND R. HARSH[4]

[1]*Kath Mandi, Narnaul 123 001, India.*
[2]*4B/7, Partap Nagar, Jodhpur 342 001, India.*
[3]*Botany Department, Govt. Girls College, Balotra 344 022, India.*
[4]*Botany Department, M.S. Govt. Girls College, Bikaner 334 001, India.*

(Received 23 June, 2016; revised version accepted 06 May, 2017)

ABSTRACT

Sharma BD, Bohra DR, Suthar OP & Harsh R 2017. Saprophytic fossil fungi from the Early Cretaceous sediments of the Rajmahal Hills, Jharkhand, India. The Palaeobotanist 66(2): 217–222.

Occurrence of two kinds of fossil fungi in forms of non–septate (coenocytic) and septate mycelia and unicellular spores (conidia) in thin sections of silicified cherts of Nipania and Sonajori localities in the Rajmahal Hills, Jharkhand are described. In the former locality mycelia and hyphae are non–septate, conidia numerous and nucleated on the 'bark' of the *Pentoxylon* stem while in the latter (Sonajori) mycelia and hyphae are septate with only few conidia in the integument of an ovule of *Araucarites mittrii*. There is no earlier record of saprophytic fossil fungi from the Rajmahal Hills.

Key–words—Saprophytic fossil fungi, *Pentoxylon*, *Araucarites*, Early Cretaceous, Rajmahal Hills, India.

भारत में झारखंड की राजमहल पहाड़ियों के प्रारंभिक चाकमय अवसादों से प्राप्त सेप्रोफाइटी जीवाश्म कवक

बी.डी. शर्मा, डी.आर. बोहरा, ओ.पी. सुथार एवं आर. हर्ष

सारांश

राजमहल पहाड़ियों में निपानिया एवं सोनाजॉरी बस्तियों के सिलिकीभूत चर्टों के तनु खंडों में गैर–पटयुक्त (कोइनोसायटिक) व पटयुक्त माइसीलिया एवं एक कोशिक बीजाणुओं (कोनीडिया) के रूप में दो तरह के जीवाश्म कवक मिले हैं। पूर्व की बस्तियों में माइसीलिया व हायफे गैर–पटयुक्त, *पैंटॉक्सीलॉन* तना की छाल पर कोनीडिया असंख्य और केंद्रक हैं जबकि *एरौकेराइटिस मित्रयाई* के बीजांड के अध्यावरण में केवल कुछ कोनीडिया सहित परवर्ती (सोनाजॉरी) माइसीलिया एवं हायफे पटयुक्त हैं। राजमहल पहाड़ियों से सेप्रोफाइटी जीवाश्म कवक का पहले का कोई अभिलेख नहीं है।

सूचक शब्द—सेप्रोफाइटी जीवाश्म कवक, *पैंटॉक्सीलॉन, एरौकेराइटीज,* प्रारंभिक चाकमय, राजमहल पहाड़ियां, भारत।

INTRODUCTION

THE present investigation of saprophytic fossil fungi is the first report from the area. Now a days the fungi are not included in plants (Bold *et al.*, 1987; Taylor *et al.*, 2014) and are described separately. The fungi occur either as saprophytes or parasites on plants and animals. There are aquatic as well as terrestrial fungi (Webster, 1980; Ainsworth, 1973; Alexopoulos & Mims, 1979; Bold *et al.*, 1987, etc.). The mycelium is either coenocytic and non–septate (Zygomycetes) or septate (Deuteromycetes, Ascomycetes, Basidiomycetes, etc.). Multiplication is either by budding, fragmentation or by definite asexual or sexual processes. In the present material fragmentation and asexual spores (conidia) are the modes of reproduction.

Non–septate mycelia are seen in association of 'bark' tissue (bark includes cortex and periderm portion) on a longisection of *Pentoxylon sahnii* stem. While the septate

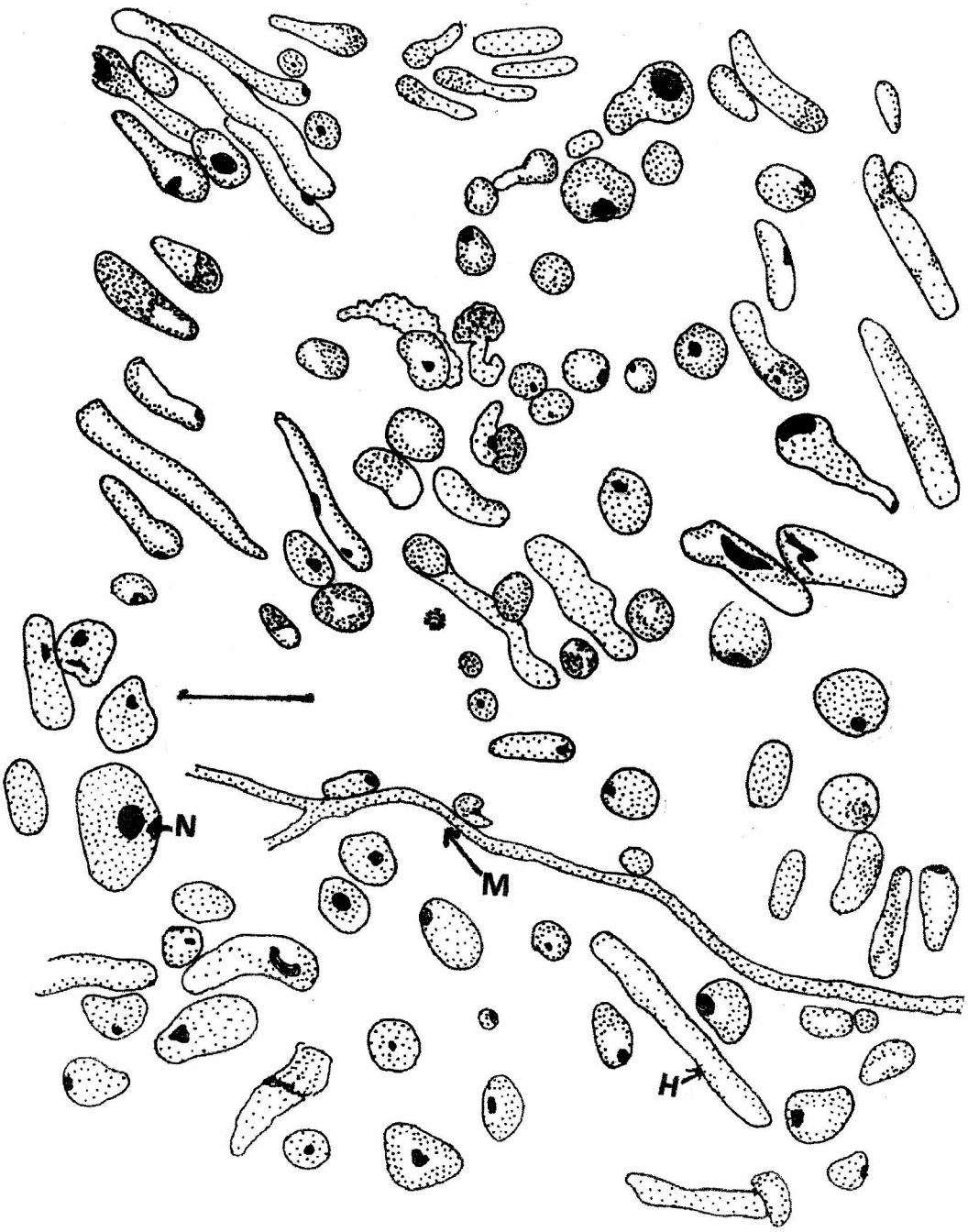

Fig. 1—Non–septate mycelium (M) and hyphae (H) and dark coloured nucleus (N). Fragmentation results in various sizes of hyphae. Spores (conidia) are produced either terminally or by fragmentation. Majority have black coloured nuclei (Bar = 25 μm) (Drawings from photographs).

PLATE 1

Non–septate saprophytic fossil fungus (Bar 30 μm).

1. Coenocytic non–septate hypae and originating–conidia (arrow) from the tips of hyphae and from the fragments (arrow).
2. A number of spores (conidia) of different shapes and sizes and black nuclei in them.
3. Hyphae and spores of different sizes.
4. Branching in hyphae and terminal origin of spores.

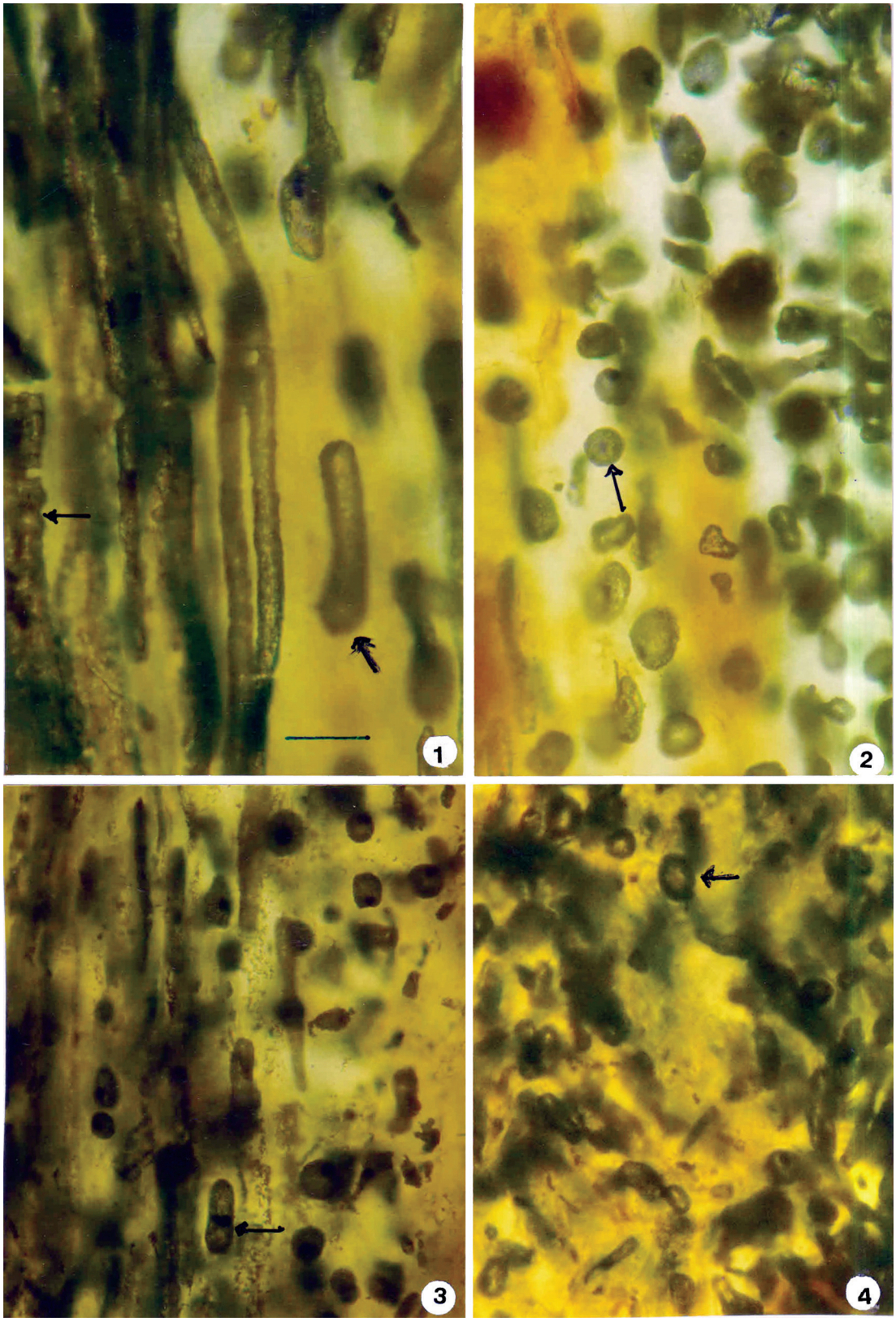

PLATE 1

mycelia are seen in association with the middle layer of integument of an ovule / seed of *Araucarites mittrii* Bohra and Sharma (1980). Petrifactions of *Pentoxylon sahnii* are reported from three localities, i.e. Amarjola (Sharma *et al.*, 2001), Sonajori (Sharma & Bohra, 1976) and Nipania (Srivastava, 1945; Sahni, 1948; Vishnu–Mittre, 1953; Bose *et al.*, 1985; Sharma, 2001; Sharma *et al.*, 2010, 2013). A large number of slides were prepared by the above mentioned workers from the Nipania cherts but none could observe the existence of saprophytic fossil fungi in association with the *Pentoxylon* stem or any other plant fossils from the area. During re–examination of earlier prepared slides of Nipania chert an association of saprophytic, non–septate fossil fungus was observed on the 'bark' of *Pentoxylon* stem in Slide No. BDN 202 Raj. N. The presence of septate mycelia is seen in the middle layer of integument of the ovules / seeds of the fossil araucarian cones. The fungi reported (both non–septate and septate forms) have neither destroyed nor deformed the host tissue and as such are called here as saprophytic fungi.

MATERIAL AND METHOD

The fossiliferous locality Nipania is situated about 8 km North–West of Amrapara Village on Pakur–Dumka Road in Santhal Pargana, Jharkhand. Sonajori Locality was discovered by Sharma and Bohra (1976). It is situated 5 km from Pakur on Pakur–Dumka Road in quarry no. 4. Sections cut by a diamond edge wheel and slides were prepared by the usual technique of grinding and polishing methods and mounted in dilute canada balsam.

DESCRIPTION AND DISCUSSION

Non–septate fossil fungi—In *Pentoxylon* stem surrounding the five or more endocentric steles is a cortex having scattered patches of sclerotic cells and the periderm layers (Srivastava, 1945; Sahni, 1948; Bose *et al.*, 1985; Sharma *et al.*, 2013). In this manuscript the cortex and periderm layers are combinedly called as 'bark'. In the bark portion of Slide No. BDN 202 / Raj N there are many mycelia, hyphae and nucleated spores (conidia) (Pl. 1.1–4). Mycelium (M) is narrow, coenocytic and non–septate (Fig. 1). Branching is rare. Hyphae (H) are little wider than the main mycelium. Conidia are produced from the tips of hyphae (Pl. 1.1–4). As such in the beginning the spore is inverted pear–shaped and thin walled (Fig. 1), on maturation the size of spore increases, wall becomes thicker and each has a dark coloured nucleus (N). The new hyphae which originate by fragmentation also have the dark coloured nuclear material but of different shapes and sizes (Pl. 1.1, 2; Fig. 1). Similar type and origin of conidia and coenocytic hyphae are present in some members of Oomycetes of Eumycota (Ainsworth, 1973; Webster, 1980; Sharma, 1992). The conidia originate from undifferentiated conidiophores, i.e. identical to hyphae. Sometimes, a hypha divides by fragmentation and each fragment converts into a spore or conidium (Pl. 1.1 arrow). In this non–septate fossil fungus the spores are produced in large number (Pl. 1.1–4; Fig. 1). Neither the sexual organs are visible in the slide nor ciliated structures on spores unlike many members of Oomycetes. The systematic position suggested here is thus tentative and needs further investigation.

Septate saprophytic fungus—A number of slides of the fossil female cones of *Araucarites mittrii* (C.S. & L.S.) have been studied and structures of fossil seed scale complexes (Florin, 1951; Vishnu–Mittre, 1954) and of the seeds are described (Bohra & Sharma, 1980; Suthar & Sharma, 1986). The material was collected from the quarry no. 4 of Sonajori Locality. Each seed scale complex has a single inverted ovule bearing a thick integument differentiated into thin sarcotesta, middle thick sclerotesta and a thin endotesta. Nucellus is free from integument and has a twisted micropylar end. Endosperm has a single archegonium and the embryo is dicotyledonous. In many of the sections of ovules / seeds the middle layer of integument has an association of septate mycelia and hyphae (P1. 2.1, 5). The septae are either incomplete or complete, transverse or little oblique (P1. 2.6 indicated by arrows). In some of the hypha cells, nuclei are also visible (Pl. 2.3, 4). The mycelium divides either by fragmentation (P1. 2.2, 3) or by production of conidia at the terminal ends of hyphae (P1. 2.4, 6) or all the cells produced by fragmentation of a hypha modify into conidia (P1. 2.4 arrow). The production of conidia is very low in comparison to that of the non–septate fungus described above. All the conidia are produced asexually by spores (observed here Pl. 2.7–10) and sexual reproduction remains unknown in these saprophytic fossil fungi as such, these are assigned to the fungi imperfacti group (Deuteromycetes). Ainsworth (1973) divided this subdivision into Blastomycetes, Hyphomycetes and Coelomycetes. Hyphomycetes have septate mycelium, and the undifferentiated hyphae which produce conidia terminally. The cells of the hyphae on fragmentation may modify into conidia. Alexopoulos and Mims (1979) divided Hyphomycetes into Moniliales and

PLATE 2

Septate saprophytic fossil fungus (Bar 1 = 80 μm, 2 = 50 μm, 3–10 = 25 μm). →

1. A portion of longitudinal section of *Araucarites mittrii* ovule. Middle layer of integument of ovule has many mycelia.
2. A portion of ovule in 1 enlarged to show black septate mycelia.
3–6. Septate mycelia enlarged. In some cells of hyphae nuclei are visible (3, 4 indicated by an arrow). In 4 a hypha produces 4–5 conidia (indicated by an arrow). 6. Septations are seen (indicated by arrows).
7–10. Spores (conidia) globose.

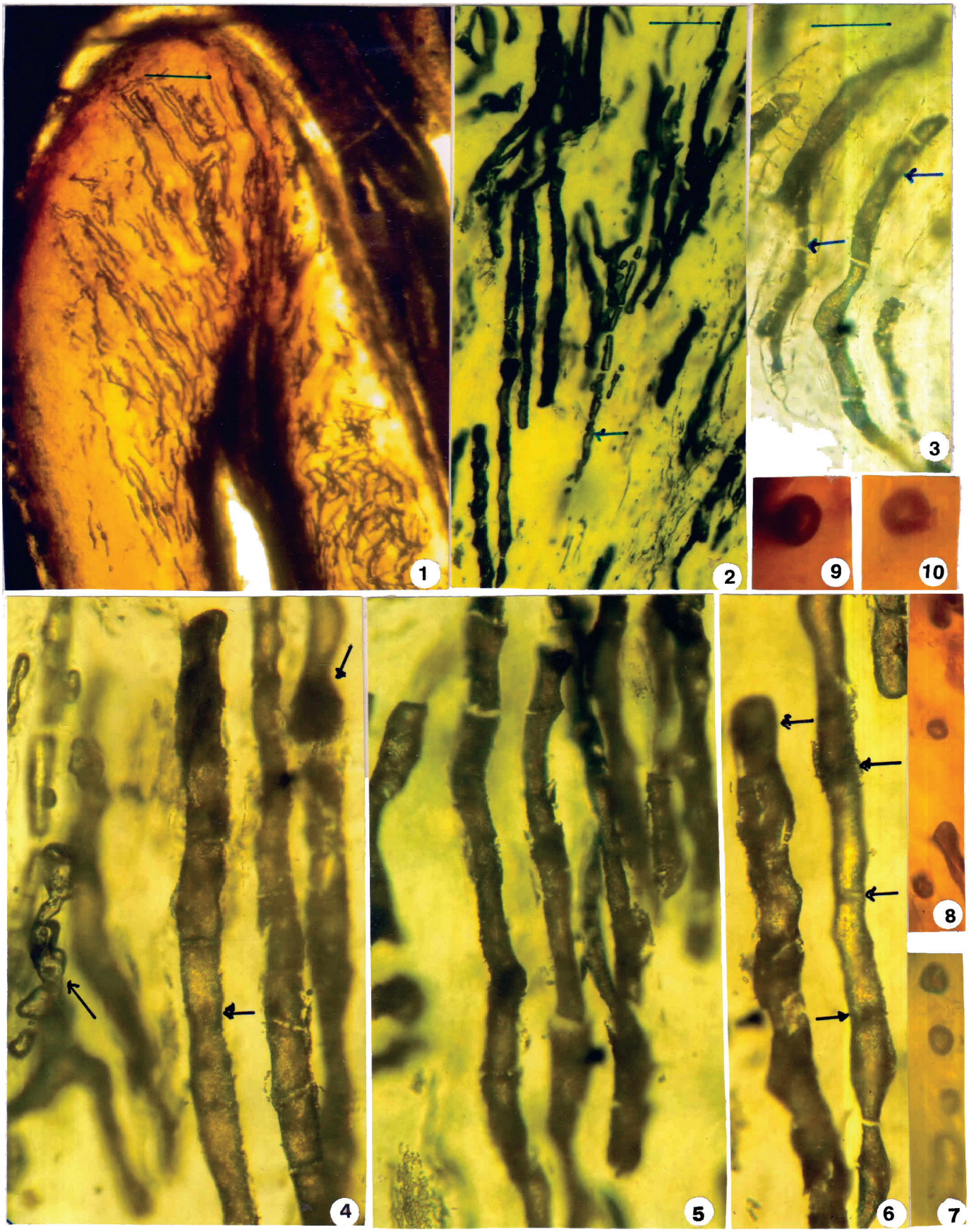

PLATE 2

Agromycetales. The present material (septate fossil fungus) has closer characters of Moniliaceae of Moniliales (Sharma, 1992). However, further investigations are required for the identifications upto the generic and specific levels.

Acknowledgements—*The authors are thankful to Professors Dr D.K. Purohit (Retd.) and Dr A. Bohra (Retd.) of the Department of Botany, JNV University, Jodhpur for help in identification and suggestions for the systematic positions of the fossil fungi described in this paper. Thanks are also due to the Hon'ble Referees for suggesting suitable modifications in the original manuscript.*

REFERENCES

Ainsworth GC 1973. In 'The Fungi'. An advanced Treatise Ainsworth GC, Sparrow FK & Sussman AS (Editors)—IV B: 1–7 Academic Press, New York.

Alexopoulos CJ & Mims CW 1979. Introductory Mycology (3rd Edition): 1–613. Wiley Eastern Ltd., New Delhi.

Bohra DR & Sharma BD 1980. *Araucarites mittrii* sp. nov. A petrified *megastrobilus* from the Rajmahal Hills, India. Ameghiniana 16(1): 3–9.

Bold HC, Alexopoulos CJ & Delevoryas T 1987. Morphology of plants and fungi. Harper & Row Publishers, New York.

Bose MN, Pal PK & Harris TM 1985. The Pentoxylon plant. Philosophical Transactions of the Royal Society, London 310B: 77–108.

Florin R 1951. Evolution in Cordaites and Conifers. Acta Horti Bergiani 15(11): 285–388.

Sahni B 1948. The Pentoxyleae–a new group of Jurassic gymnosperms from the Rajmahal Hills, India. Botanical Gazette 110: 47–80.

Sharma BD 2001. Misinterpretations about the Pentoxyleae. Mesozoic gymnospermous group of plants. Palaeobotanist 50: 255–265.

Sharma BD & Bohra DR 1976. A new assemblage of fossil plants from the Jurassic of Rajmahal Hills, India. Geobios (France) 9(2): 111–123.

Sharma BD, Bohra DR & Suthar OP 2001. Some interesting plant fossils from the Mesozoic rocks of the Rajmahal Hills, India. Palaeobotanist 50(2): 207–212.

Sharma BD, Bohra DR, Suthar OP & Harsh R 2010. Present status of the Pentoxyleae. The Mesozoic gymnosperms. Phytomorphology 60 (1 & 2): 9–19.

Sharma BD, Bohra DR, Suthar OP & Harsh R 2013. Anatomical variations in Indian Mesozoic pentoxylean stems. Geophytology 42(2): 121–126.

Sharma OP 1992. Thallophyta. Tata McGraw Hill Publishing Company Ltd., New Delhi.

Srivastava BP 1945. Silicified plant remains from the Rajmahal Series of India. Proceeding of National Academy Science, India 15: 190–210.

Suthar OP & Sharma BD 1986. Petrified fructifications of conifers from the Jurassic of Rajmahal Hills, India. Geophytology 16(2): 159–165.

Taylor TN, Krings M & Taylor EL 2014. Fossil fungi. Academic Press, New York: 1–373.

Vishnu–Mittre 1953. A male flower of Pentoxyleae with remarks on the structure of the female cones of the group. Palaeobotanist 2: 75–84.

Vishnu–Mittre 1954. *Araucarites bindrabunensis* sp. nov a *megastrobilus* from the Rajmahal Hills, Bihar. Palaeobotanist 3: 103–106.

Webster J 1980. Introduction to Fungi (2nd Edition). Cambridge University Press, Cambridge.