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PALAEOSPIROXYLON — A NEW GYMNOSPERMOUS WOOD FROM RANIGANJ COALFIELD, INDIA

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ABSTRACT

Palaeospiroxylon heterocellularis gen. et sp. nov., collected from Bonbahal Colliery, Raniganj Coalfield, West Bengal, India has been described. The salient features of the wood are the presence of secretory cells in pith, endarch primary xylem, mixed type of tracheid wall pitting and spiral thickenings in the secondary xylem.

Key-words — *Palaeospiroxylon*, *Gymnospermous wood*, Upper Permian, Raniganj Coalfield (India).

सारांश

पेलियोस्पाइरॉक्सीलॉन — रानीगंज कोयला-क्षेत्र, भारत से एक नवीन अनावृतबीजी काष्ठाश्म —
माजेटी नरसिंह वर प्रसाद एवं शैला चन्द्रा

बनबहल कोयला-खान, रानीगंज कोयला-क्षेत्र, पश्चिम बंगाल, भारत से एकत्रित **पेलियोस्पाइरॉक्सीलॉन हेटेरोसेल्युलेरिस** न० प्रजाति व न० जाति का वर्णन किया गया है। मज्जा में स्रावी कोशाओं की उपस्थिति, अन्तरारम्भ आद्य दारू, मिश्रित वाहिनिकी भित्ति गर्तन तथा उत्तर दारू में कुन्तल स्थूलनायें इस काष्ठाश्म के प्रधान लक्षण हैं।

INTRODUCTION

SEVERAL fossil gymnospermous woods have been described from Raniganj Coalfield by various authors Sahni, (1925 in Bradshaw); Sahni (1932); Fox, (1934); Rao (1935); Maheshwari (1965, 1967). Shani (in Bradshaw, 1925) described a wood under the name *Dadoxylon* sp. from the Raniganj Coalfield near Asansol. Also in 1932, Sahni described *Dadoxylon zalesskyi* from Kumarpur near Asansol which Maheshwari (1967) revised as *Kaokoxylon zalesskyi* because of the presence of sclerotic cells in the pith. Fox (1934) described *Dadoxylon kumarpurensis* from Kumarpur beds. In 1935, Rao described a new species of *Dadoxylon*, *D. parbeliense* from a sphaerosiderite collected from Parbelia Colliery. Maheshwari (1965) described *Dadoxylon ningahense* from the Ningah Colliery and *Dadoxylon jamuriense* (with pith, primary xylem & secondary xylem) from West Jamuria Colliery of the Raniganj Coalfield. In 1967, he also described *Damudoxylon waltonii*, *Megaporoxylon krauselii* and *Trigonomyelon raniganjense* from West Jamuria Colliery, Raniganj Coalfield.

However, so far no wood with secretory cells in the pith, endarch primary xylem, mixed type of tracheid pitting and spiral thickenings in the secondary xylem tracheids is known from the Raniganj Coalfield. Also this fossil wood is quite distinct from hitherto known woods of Indian Lower Gondwana and is therefore described as a new form genus.

DESCRIPTION

The material consists of a single piece of petrified wood measuring 29 cm in length and 11 cm in diameter. The specimen is carbonaceous and well-preserved.

***Palaeospiroxylon* gen. nov.**

Generic Diagnosis — Pith with secretory cells; primary xylem endarch; secondary xylem with mixed type of pitting, spiral thickenings running clock wise and anti-clockwise.

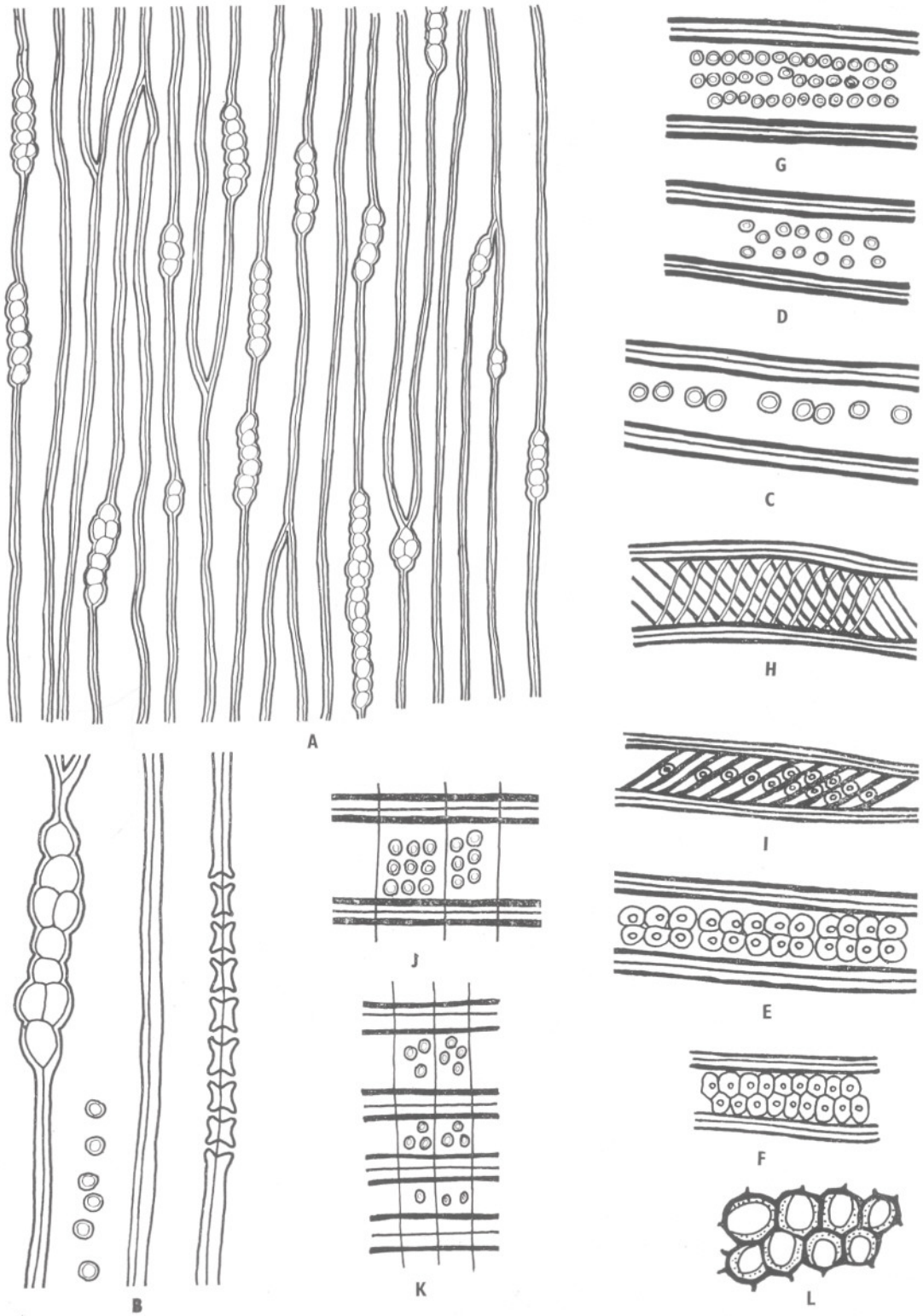
Genotype — Palaeospiroxylon heterocellularis sp. nov.

Pith heterogeneous, irregularly oval in shape, measuring 9×4 mm in size, made up of irregular parenchymatous cells intermixed with dark secretory cells and secretory matter (Pl. 1, fig. 1). The pith cells in longitudinal section cylindrical in shape with dark secretory matter in between them (Pl. 1, fig. 2). The *primary xylem* is endarch (Pl. 1, fig. 3). In cross section the primary xylem tracheids abutting the pith are 5-13 in number, circular-barrel in shape. The protoxylem is formed by spiral form tracheids followed by the scalariform metaxylem. The secondary xylem consists of bordered pitted tracheids. The *secondary xylem* is pycnoxylic type, represented by early wood and late wood, showing sharp growth rings (Pl. 1, fig. 1). In cross section the early wood tracheids are 60-110 in width, isodiametrical-polygonal in shape measuring 20×24-48×60 μm in size with thin walls and wide lumen. The late wood zone is represented by 4-8 compactly arranged tracheids, rectangular in shape measuring 14×16-12×24 μm with thick walls and reduced lumen. The *medullary rays* in cross section are placed at an interval of 1-11 tracheids. The rays are homogeneous, uniseriate — partly biseriate, 1-18 cells high. The ray cells are circular-barrel in shape measuring 18-40 μm in height and 14-24 μm in width. The tangential tracheid walls show uniseriate-partly biseriate, circular, bordered pits measuring 8-10 μm in diameter (Pl. 1, fig. 6; Text-fig. 1B). The tangential diameter of the tracheids is 36-88 μm. The height and seriation of medullary rays have been studied from 2 cm away from the pith (Pl. 1, fig. 4) and from the outer most region of the wood (Pl. 1, fig. 5; Text-fig. 1A). This study has revealed that the height and seriation of medullary rays increases towards outer most region of the wood (Tables 1, 2). The *pits* on the radial walls of tracheids 1-3 seriate, rarely 4 seriate (Pl. 1, figs 7-9; Text-fig. 1C-G). The radial diameter of the tracheids is 60-104 μm. Pitting is of mixed type, i.e. araucarioid and abietoid type of pits are found in the same or in different tracheids of the same specimen (Pl. 1, figs 8, 9; Text-fig. 1D-G). Pits measure from 14-20 μm in diameter, and they are circular, bordered, separate (contiguous when hexagonal). The pit pores are subcircular, borders are not well-preserved at many places. The crossfield pits are up to 9 (Pl. 1, fig. 10; Text-fig. 1J, K); circular-subcircular, bordered with subcircular pit pores, measuring 6-12 μm in diameter. The *spiral thickenings* of both radial and tangential walls of the tracheids measure up to 4-8 μm thick running clockwise-anticlockwise, inclined at an angle of 40°-60° (Pl. 1, figs 11, 12; Text-fig. 1H, I). Quite often the tangential tracheid wall spirals are not preserved. The radial wall spirals usually pass across the border of the pits but otherwise they pass through the space between the separate pits. In cross section the secondary wood tracheids show broad transparent bands on the inner side of the tracheids which represent the spiral thickenings (Pl. 1, fig. 13; Text-fig. 1L).

Palaeospiroxylon heterocellularis sp. nov.

Specific Diagnosis — Pith irregularly oval, heterogeneous, parenchymatous cells intermixed with dark secretory cells; *primary xylem* endarch; *secondary xylem* pycnoxylic; *growth rings* sharply marked; late wood 4-8 tracheids wide, rectangular, compactly arranged; early wood tracheids isodiametrical-polygonal, 60-110 tracheids wide; *medullary rays* homogeneous, 1-2 seriate, 1-18 cells high; tangential tracheid walls show 1-2 seriate, circular bordered, separate-contiguous pits; radial tracheid walls show 1-3 seriate, rarely 4 seriate, mixed type of pits; crossfield pits up to 9, circular-oval, bordered with subcircular pit pores; radial and tangential walls of the secondary xylem tracheids show spiral thickenings running clockwise-anticlockwise, inclined at an angle of 40°-60°.

Holotype — Birbal Sahni Institute of Palaeobotany Museum specimen no. 35310.



TEXT-FIG. 1

TABLE 1 — HEIGHT AND SERIATION OF MEDULLARY RAYS 2 cm AWAY FROM PITH

S. No.	Height of medullary rays in terms of ray cells								No. of medullary rays counted
	1	2	3	4	5	6	7	8	
I	3	20 (2)	9 (3)	6 (1)	1 (1)	1 (1)		1 (1)	41 (9)
II	2	18	11 (2)	1	5 (1)	1 (1)			38 (4)
III	5	21 (4)	10 (2)	1 (1)	2 (2)		1 (1)		40 (10)
IV	7	17	9	5 (1)				1	39 (1)
V	3	16	20 (1)	2	1				42 (1)
Total counts	20	92 (6)	59 (8)	15 (3)	9 (4)	2 (2)	1 (1)	2 (1)	200 (25)

*Figures in the brackets indicate the number of occurrence of biseriate or partly biseriate medullary rays.

Locality — Bonbahal Colliery, Raniganj Coalfield, West Bengal, India.

Horizon & Age — Raniganj Formation, Upper Permian.

COMPARISON AND DISCUSSION

While dealing with the classification of Palaeozoic gymnospermous woods, considerable emphasis is laid on the pith and its detail structures. For example, the form genus *Kaokoxylon* has been instituted by Kräusel (1956) to accommodate woods showing sclerotic nests dispersed in the pith. Likewise the form genus *Barakaroxylon* Surange & Maithy (1961) shows secretory canals as well as secretory cells in the pith. Except for this small variation, the details of primary xylem and the secondary xylem in the two genera are similar to the form genus *Dadoxylon* Endlicher (1847). Thus several form genera of woods show little variation in the primary xylem and secondary xylem but show different kinds of pith. This problem has been discussed by Lepekhina (1972) while dealing with the classification of Dadoxylae. Therefore the main emphasis was laid on the structure of pith, in addition to the characters of the primary xylem and the secondary xylem.

However, mostly decorticated secondary woods are found from the Palaeozoic sedi-

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TEXT-FIG. 1 — **A.** Tangential longitudinal section showing the height and seriation of medullary rays from the outer most region of secondary wood × 112. **B.** Tangential longitudinal section showing tangential tracheid wall pits × 225. **C.** Radial longitudinal section showing uniseriate pits × 225. **D.** Radial longitudinal section showing biseriate opposite pits × 225. **E.** Radial longitudinal section showing biseriate opposite contiguous pits × 225. **F.** Radial longitudinal section showing biseriate alternate contiguous pits × 225. **G.** Radial longitudinal section showing 3 seriate opposite-alternate pits × 225. **H.** Radial longitudinal section showing spiral thickenings running clock-anticlockwise × 225. **I.** Radial longitudinal section showing spiral thickenings running over the pit border × 225. **J, K.** Radial longitudinal section showing crossfield pits × 225. **L.** Cross section showing broad transparent bands on the inner side of the tracheids representing spiral thickenings × 225.

TABLE 2 — HEIGHT AND SERIATION OF MEDULLARY RAYS FROM THE OUTER MOST REGION OF WOOD

S. No.	Height of the medullary rays in terms of ray cells																		No. of medullary rays counted
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
I	1	5	4	1	3	4 (2)	3 (2)	1 (1)	1 (1)		1 (1)								24 (7)
II		2	1	5	2 (1)	4 (2)	5 (1)	1	1										21 (4)
III		9 (2)	4 (1)	3	2	2	3	1 (1)	1 (1)	1 (1)									26 (6)
IV	3	8	3 (1)	4 (1)	4	1	3					1						1 (1)	28 (3)
V	1	9	9		3 (1)	1	2 (1)	2		1 (1)		1 (1)							29 (4)
Total counts	5	33 (2)	21 (2)	13 (1)	14 (2)	12 (4)	16 (4)	5 (2)	3 (2)	2 (2)	2 (1)	1 (1)						(1)	128 (24)

*Figures in the brackets indicate the number of occurrence of biseriate or partly biseriate medullary rays.

ments as the delicate, vulnerable primary xylem and the pith get easily detached or destroyed from the secondary wood, during the process of fossilization. Thus the taxonomy of Palaeozoic fossil woods follow two parallel series of generic names:

1. Woods with pith, primary xylem and the secondary xylem.
2. Woods with only secondary xylem.

Although this nomenclatural system may not be natural one, but it is useful and convenient for identification and classification of Palaeozoic gymnospermous woods.

The secondary wood of *Palaeospiroxylon* resembles *Baieroxylon* (Greguss, 1961) Lepekhina, 1972 to some extent. The latter genus also shows mixed type of tracheidal pitting and spiral thickenings in the secondary xylem, but do not show pith and primary xylem. The crossfield pits of *Baieroxylon* are simple to cupressoid type whereas those of *Palaeospiroxylon* are circular-subcircular, bordered with subcircular pit pores.

The genus *Palaeospiroxylon* can be well differentiated from other genera by the presence of secretory cells in the pith, endarch primary xylem, mixed type of tracheidal pitting and the spiral thickenings in the secondary xylem. Kräusel (1949) coined the term mixed type of pitting (mischtypus) to denote araucarioid and abietoid type of pitting. The mixed type of pitting is supposed to be the transitional form between araucaroid and abietoid pitting. A large number of coniferous fossil woods, grouped in the family Protopinaceae are also characterized by this type of pitting. *Palaeospiroxylon*, therefore, shows affinities to the family Protopinaceae. Moreover, the presence of spiral thickening in the secondary wood suggests a more evolved condition as compared to the other known fossil wood genera of the Raniganj Coalfield.

From the Indian Lower Gondwana, we know only two genera of woods with pith, primary xylem and the secondary xylem with spiral thickenings. They are, however, different from the present new genus.

Prototaxopitys andrewsii (Agashe & Chitnis, 1971) Agashe (1977) is described from the Barakar stage of Jharia Coalfield. It differs from *Palaeospiroxylon* in having homocellular pith, araucarioid type of pitting and cupressoid crossfield pits. *Taxopitys indica* Prasad & Chandra (1978) is

described from the Kamthi Formation of Chandrapur District. It differs from the described genus in possessing mesarch primary xylem and araucarioid type of pitting.

Form genera like *Platyspiroxylon* Greguss (1961) and *Prototaxoxylon* Kräusel & Dolianiti (1958) resemble *Palaeospiroxylon* in having spiral thickenings in the secondary xylem, but they do not possess pith and the primary xylem. Thus *Palaeospiroxylon heterocellularis* is distinct from the hitherto known fossil woods of Indian Lower Gondwana and therefore a new form genus has been instituted for it.

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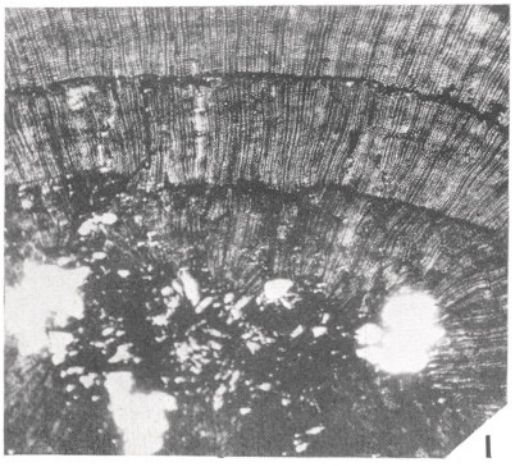
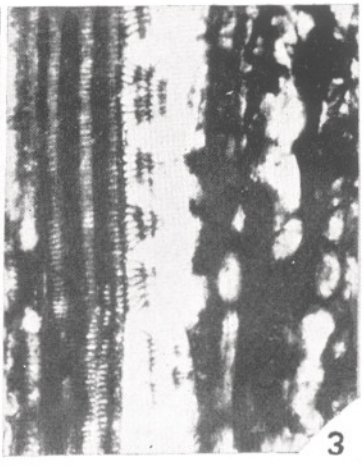
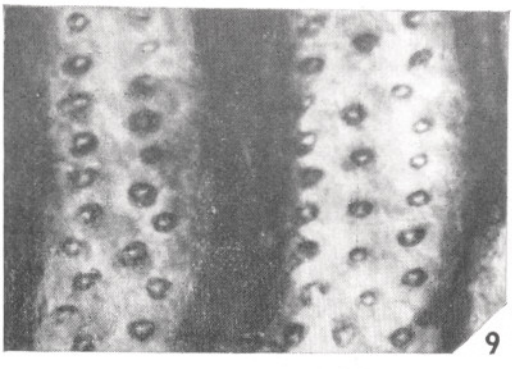
EXPLANATION OF PLATE

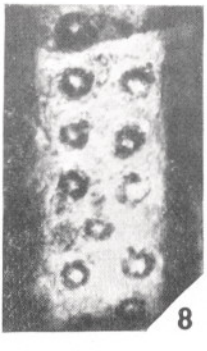
PLATE 1

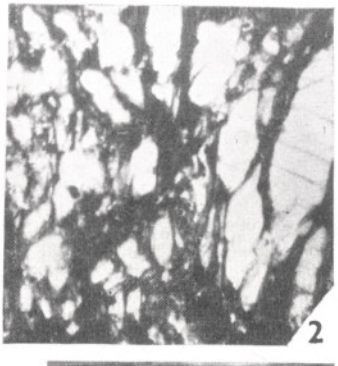
1. Cross section of the wood showing distinct growth rings and pith. × 8.
2. Longitudinal section of the pith showing irregular-cylindrical parenchymatous pith cells mixed with dark secretory matter and secretory cells. × 50.
3. Longitudinal section of the wood showing endarch primary xylem. × 150.
4. Tangential longitudinal section showing medullary rays near pith (2 cm away from pith). × 60.
5. Tangential longitudinal section showing medullary rays from the outer most region of the wood. × 60.
6. Tangential longitudinal section showing tangential tracheid wall pits. × 150.
7. Radial longitudinal section showing a tracheid with uniseriate pits. × 500.
8. Radial longitudinal section showing tracheid with biseriate opposite pits. × 500.
9. Radial longitudinal section showing 2-3 seriate mixed type of pits. × 500.
10. Radial longitudinal section showing crossfield pits. × 500.
11. Radial longitudinal section showing clockwise-anticlockwise running spiral thickenings in the tracheids. × 500.
12. Radial longitudinal section showing clockwise running spiral thickenings in the tracheids. × 500.
13. Cross section of early wood tracheids showing the broad transparent bands on the inner side of the tracheids representing the spiral thickenings. × 500.

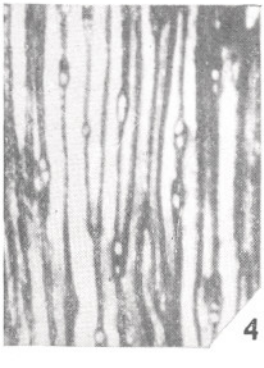


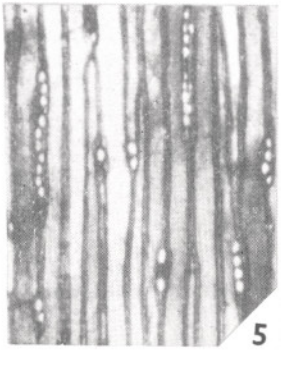


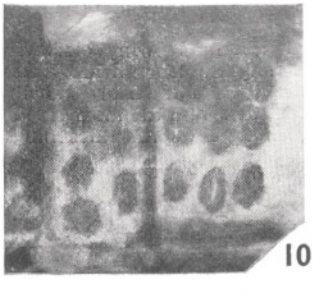












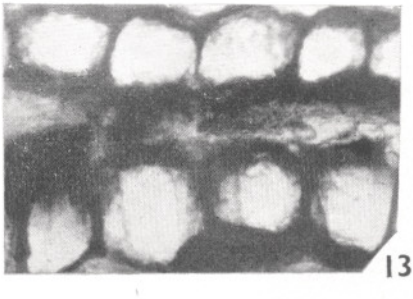


PLATE 1