Studies on fossil gymnospermous woods Part XII: Two new species of *Agathoxylon* from Permian sediments of Chandrapur District, Maharashtra

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Lower Gondwana (Permian) fossil localities occurring in Chandrapur District of Maharashtra state, have brought to light several well preserved petrified gymnospermous woods. The present paper deals with the detailed description of two new species of *Agathoxylon, A. gondwanensis* sp. nov. and *A. andrewsii* sp. nov. The discovery of two new species of *Agathoxylon* adds to the diversity of Lower Gondwana flora of Chandrapur District.

Key-words– Petrified gymnospermous woods, *Agathoxylon,* Lower Gondwana, Permian, Maharashtra, India.

PALAEOBOTANICAL investigations have been carried out on petrified woods occurring in the Lower Gondwana sediments of West Bengal, Bihar, Madhya Pradesh and Maharashtra. Agashe and his associates concentrated work on the fossil woods of Chandrapur District, Maharashtra since 1971, although fossil woods from this area were first described by Sahni (1932) followed by other workers, viz., Chitaley (1949), Biradar and Bonde (1981, 1984), Chandra and Prasad (1979, 1981), Mahabale and Vagyani (1980), Maheshwari (1972), Pant and Singh (1987), Prasad (1982, 1986), Prasad and Chandra (1978a, b, 1981), Vagyani and Jamane (1986), Vagyani and Raju (1981, 1986) and Vagyani and Mahabale (1974).

Agashe and Chitnis (1971) described *Prototaxoxylon andrewsii,* but later Agashe (1977) placed it under a new genera *Prototaxopitys andrewsii,* due to the presence of pith and primary xylem. Agashe and Gowda (1978, 1981) described *Araucarioxylon loharense* and *Zalesskioxylon barakarense* and *Prototaxoxylon chandrapurense*; Agashe *et al.* (1981) described *Araucarioxylon surangei* and *Araucarioxylon lathiense*; Agashe and Prasad (1984a, b, 1989) described *Araucarioxylon kothariensis, Australoxylon wejgaonese, A. pantii, A. bhivkundense, Zalesskioxylon gondwanense, Z. sarandaensis, Agathoxylon zarenense, Agathoxylon vesturaense, Kamthioxylon chandrapurense and Kamthioxylon mahabaleii* from different localities of Chandrapur District.

Chitaley (1949), Biradar and Bonde (1981, 1984), Chandra and Prasad (1979), Mahabale and Vagyani (1980), Prasad (1982, 1988) and Prasad and Chandra 1978a,b, 1980, 1981 have described *Nandorioxylon saksenae, Prototaxoxylon mahabalei, Z. lepekhinae. Dadoxylon chandaensis, Kamthioxylon adhariense. Parapaleoxylon satnauriense, Sclerospiroxylon marguerierae, Taxopitys surangei, Taxopitys indica Australoxylon kanhargaoense, A. longicellularis Paleospiroxylon heterocellularis.*

Vagyani and Mahabale (1974) described *Planoxylon indicum;* Vagyani and Raju (1981, 1986) described *Araucarioxylon nandorii* and *Australoxylon maheshwarii* from Nandori of Chandrapur District of Maharasthra. Agashe and Shashi-Kumar (1996, 1997) described *Araucarioxylon wejgaoense* and *Zalesskioxylon andrewsii* from Wejgaon locality of Chandrapur District.

The petrified woods were collected from Lohara and Rangenapalli areas of Chandrapur District. Lohara is 25 km from Chandrapur on Chanda-Mul Road. Rangenapalli is situated at a distance of 256 km south east of Chandrapur. The area is very rich in petrified woods.

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The petrified woods were subjected to detailed anatomical investigation by employing standard methods of sectioning.

Agathoxylon (Andreanszky) Greguss (1955)

Among the petrified woods collected and investigated from Chandrapur District, two petrified woods show combination of characters belonging to living genus *Agathis* i.e., *Agathis australis, A. ovata,* and *A. palmerstonii* of the family Araucariaceae and *Callitris cupressiformis* and *Fitzroya* cupressoides (Greguss, 1955) belonging to the family *Cupressaceae*. *Agathoxylon* shows combination of characters belonging to the living genus *Agathis, Callitris and Fitzroya*. Three species of *Agathoxylon viz., Agathoxlyon zaranense, A. vesturaense* (Agashe & Prasad, 1989) *A. maheshwarii* (Vagyani & Jamane, 1986) have already been described from Chandrapur District.

Agathoxylon gondwanensis sp. nov.

Specific diagnosis- Decorticated secondary wood showing distinct growth rings and there is clear demarcation of spring wood and autumn wood tracheids, medullary rays are 1-2 seriate mostly uniseriate, 2-25 cells high, on an average height of 8-10 cells, 1-4 seriate vestured radial pits, cross field pits 1-10 vestured.

Holotype - B.U.P.W. No.: 2001 along with slides deposited in Palaeobotany and Palynology Laboratory, Department of Botany, Bangalore University, Bangalore, India.

Locality- Lohara, Chandrapur district, Maharashtra.

Etymology- The specific epithet is derived from Gondwana.

Horizon & Age- Lower Gondwana (Permian).

Anatomical description- The material consists of decorticated secondary wood measuring 5 cms in length and 3 x 1.7 cms in thickness. In T.S. the secondary wood shows distinct growth rings. Spring wood tracheids and autumn wood tracheids are very distinct. The spring wood tracheids 65-135 cells thick, cells squarish with thick border measuring 2.22 mm x 4.07 mm. Autumn wood tracheids narrower with much flattened cells, 2-6 cells thick, measuring 0.10 mm x 0.14 mm (Pl. 1, Fig.1).

Tangential longitudinal sections show 1-3 seriate medullary rays, uniseriate rays represent 95 % and biseriate are represented by 5 % of total rays, 2-25 cells high on an average height of 8-10 cells, tangential pits are distinct (Pl. 1, Fig. 2; Text-fig. 1A).

Radial longitudinal section shows 1-4 seriate vestured radial pits, mostly 2 seriate with characteristic beaded appearance. The radial pits are arranged in various manner. The uniseriate circular pits are contiguous, biserate circular pits are alternate/ sub-opposite. The maximum diameter of radial pit is 14.3 μm and that of pits pore is 4.4 μm (Pl. 1, figs. 3-5; Text-figs. 1B & D). Crossfield pits are 1-10, simple commonly 2-4 occur/ cross-field. The average diameter of crossfield pits is 8.1 μm (Pl. 1, Figs. 6 & 7; Text-Figs. 1C & E).

Comparison- The diagnostic characters i.e., vestured radial pits and vestured / cupressoid cross field pits of petrified wood B.U.P.W. 2001 are comparable with *Agathoxylon*. The present wood differs from all

Text-figure →

Agathoxylon gondwanensis sp. nov. (B.U.P.W. No. 2001)

A. Transverse logitudinal section showing uni and biseriate medullary rays. x 250;

B. Radial longitudinal section showing biseriate circular alternate vestured pits, which show distinct beaded appearance. x 1000;

C. Radial longitudinal section showing three, four, circular vestured pits which are beaded. x 1000;

D. Radial longitudinal section showing uniseriate circular contiguous and free vestured pits and also biseriate circular, opposite pits. x 250;

E. Radial longitudinal section showing 4-5, 10, circular vestured pits x 250.

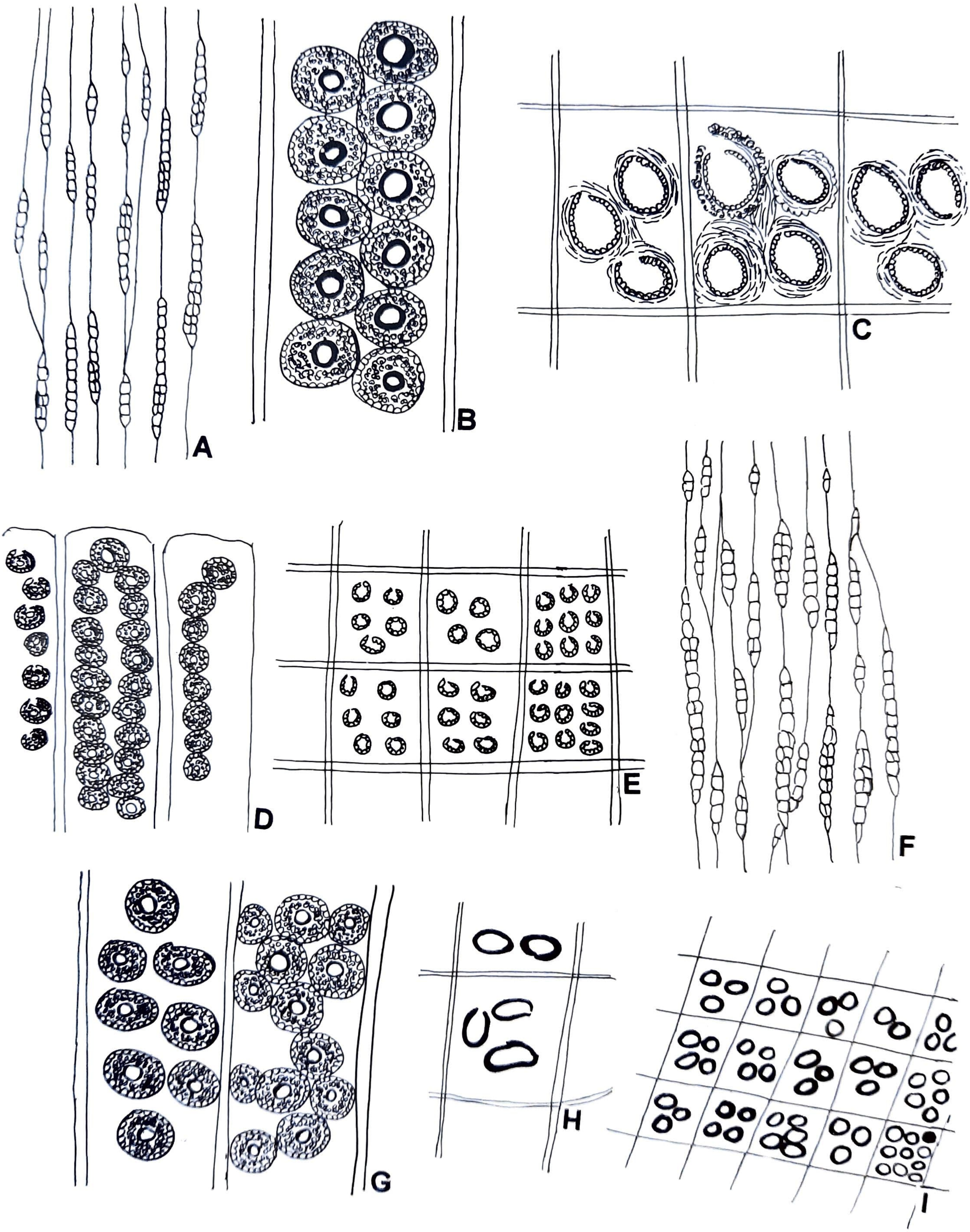
Agathoxylon andrewsii sp. nov. (B.U.P.W. No. 2203)

F. Transverse longitudinal section showing uni and biseriate meduallary rays. x 250;

G. Radial longitudinal section showing uniseriate circular opposite vestured pits and bi to triseriate circular opposite vestured pits. x 1000;

H. Radial longitudinal section showing 2 and 3 oval cupressoid pits. x 1000;

I. Radial longitudinal section showing 2-9 circular cupressoid pits. x 250.



Text-Figure

the known species of *Agathoxylon* in one or the other anatomical characters. In meduallary ray and radial wall pitting characters the present wood resembles *A. zaranense, A. vesturaense* (Agashe & Prasad 1989), *A maheshwarii* (Vagyani & Jamane, 1986) by having 1-2 seriate medullary ray 1-26 cells high on an average height of 8-10 cells. In *A. zaranense, A. vesturaense,* (Agashe & Prasad 1989), *A. maheshwarii* (Vagyani & Jamane 1986) and present wood radial pits are 1-4 seriate vestured. In crossfield pitting characters, the present wood does not resemble any of the modern or fossil forms, by having a maximum crossfield pit of 10.

Agathoxylon andrewsii sp.nov.

Specific diagnosis- Decorticated secondary wood showing distinct growth rings, 1-2 seriate, medullary rays mostly uniseriate, 1-31 cells high on an average height of 14 cells, 1-3 seriate vestured radial pits, cross field pits 1-9 cupressoid.

Holotype- B.U.P.W. No. 2203 along with slides deposited in Palaeobotany and Palynology Laboratory, Department of Botany, Bangalore University, Bangalore, India.

Locality- Rangenapalli Nala, Chandrapur District, Maharashtra.

Etymology -The specific epithet of present wood is given in honour of Prof. Henry N. Andrews for his significant contributions to the field of Palaeozoic palaeobotany.

Horizon & Age- Lower Gondwana, Permian.

Anatomical description- The material consists of decorticated secondary wood measuring 9 cms in length and 3 cms x 5 cms in thickness. In T.S. the wood shows distinct growth rings, spring wood tracheids are distinct, 45-135 cells thick, cells squarish with thick border measuring 2.17 mm x 3.66 mm. Autumn wood tracheids are narrower 2-6 cells thick, much flattened measuring 0.10 mm x 0.13 mm (Pl. 1, Fig.8).

Tangential longitudinal section shows medullary rays which are 1-2 seriate, mostly uniseriate, 1-31 cells high, average 14 cells of high. Uniseriate rays represent 90 % and biseriate rays are represented by 10 % of total rays. Tangential pits are distinct which are uniseriate and contiguous (Pl. 1, Fig. 10, Text-fig. 1F).

Radial longitudinal section reveals 1-3 seriate vestured radial pits, but mostly biseriate, radial pits show characteristic beaded appearance with distinct pit pore in centre. Radial pits are arranged in various manner. Uniseriate circular pits are contiguous/ sometimes separate, biseriate radial pits are alternate/sub-opposite, some of the pits are in groups of 2, 3 the maximum diameter of radial pit is 9.92 µm and that of pit pore is 4.6 µm (Pl. 1, figs. 11 & 12; Text-figs. 1G), cross field pits are 1-9 cupressoid oval commonly 2, 4, 5 pits occur per field. The average diameter of cross field pit is 6.45 µm (Pl. 1, Figs. 9 & 13; Text-figs. 1H & I).

Comparison - The present wood B.U.P.W. 2203 differs from all the described species of *Agathoxylon.* The wood is distinct in having medullary ray characters. In radial wall pitting the present wood resembles *Agathis* i.e., *A. australis, A. ovata* (Greguss 1955) by having 1-3 seriate vestured radial pits, but differs in medullary ray and cross field pitting.

PLATE →

Agathoxylon gondwanensis sp. nov. (B.U.P.W. No. 2001)

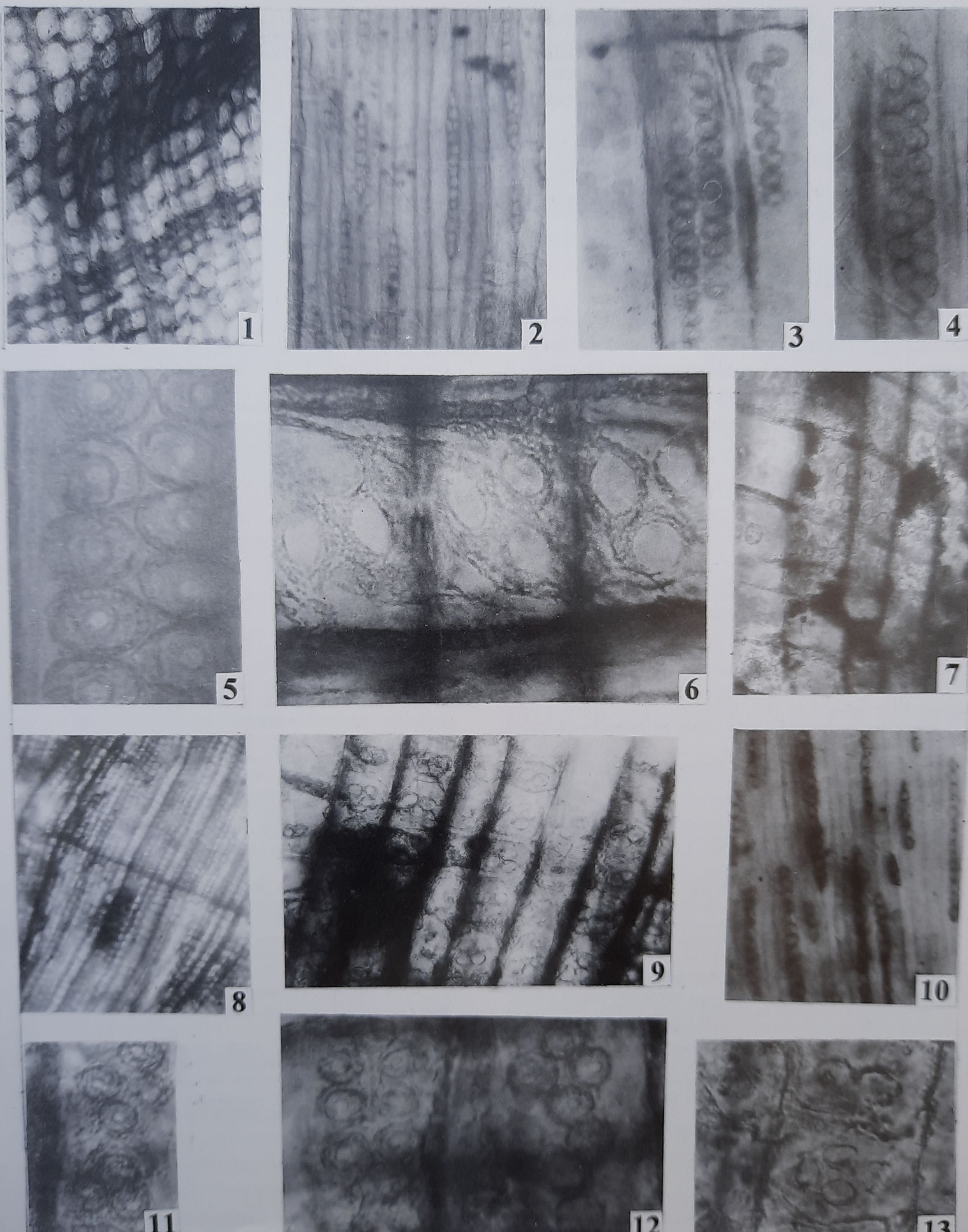
Figures

1. Transverse section showing growth rings. x 250.
2. Transverse longitudinal section showing uni and biseriate meduallary rays. x 250.
3. Radial longitudinal section showing biseriate circular, opposite vestured pits and uniseriate contiguous pits. x 400.
4. Radial longitudinal section showing biseriate circular alternate vestured pits. x 400.
5. Radial longitudinal section showing biseriate circular alternate vestured pits with distinct beaded appearance. x 1000.
6. Radial longitudinal section showing three, four circular vestured cross field pits which are slightly beaded. x 1000.
7. Radial loingitudinal section showing 3-6 vestured circular cross field pits. x 250.

Agathoxylon andrewsii sp. nov. (B.U.P.W. No. 2003)

Figures

8. Transverse section showing growth rings. x 100.
9. Radial longitudinal section showing 2-6 cupressoid cross field pits. x 250.
10. Transverse longitudinal section showing uni and biseriate meduallary rays. x 250.
11. Radial longitudinal section showing uniseriate partly biseriate circular vestured pits which are beaded in groups of 2, 4. x 1000.
12. Radial longitudinal section showing biseriate circular opposite vestured pits. x 1000.
13. Radial longitudinal section showing 2, 4 circular cupressoid cross field pits. x 1000.



PLATE

The wood resembles modern *Agathis ovata* Greguss (1955) and *Agathoxylon vesturaense* (Agashe & Prasad 1989), in cross-field pitting characters by having 1-9 to 13 vestured pits, but differs in medullary ray and radial wall pitting.

Two new species of *Agathoxylon* belonging to Araucariaceae add to our knowledge of Lower Gondwana petrified woods from Chandrapur District, Maharashtra.

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