ON *SAHNIOXYLON RAJMAHALENSE*, A NEW NAME FOR *HOMOXYLON RAJMAHALENSE* SAHNI, AND *S. ANDREWSII*, A NEW SPECIES OF *SAHNIOXYLON* FROM AMRAPARA IN THE RAJMAHAL HILLS, BIHAR

M. N. BOSE & S. C. D. SAH
Birbal Sahni Institute of Palaeobotany, Lucknow

ABSTRACT

The name *Sahnioxylon rajmahalense* is here adopted for the petrified wood *Homoxylon rajmahalense* Sahni, as the generic name *Homoxylon* was already used by Hartig in 1848 for a different type of fossil wood belonging to the Abietineae.

Two recently collected large specimens of *Sahnioxylon rajmahalense*, throwing further light on the anatomy of the secondary wood, are briefly described. Diagnosis of the genus *Sahnioxylon* is given based on all the available information.

A new species of *Sahnioxylon*, *S. Andrewsii*, is described on the basis of a specimen from Kulkipara near Amrapara, in the Rajmahal Hills, Bihar. Comparisons of the species have been made with *Sahnioxylon rajmahalense*, *Cycadeoidea*, *Raumeria* and *Colymbetes*.

INTRODUCTION

IN 1932 Professor B. Sahni described as *Homoxylon rajmahalense* an interesting petrified wood from an unknown locality in the Rajmahal Hills, Bihar. There was, at that time, some doubt about the provenance of the specimen. However, several specimens of *Homoxylon rajmahalense* have recently been found at different localities in the Rajmahal Hills (BHARDWAJ, 1952; HSÜ & BOSE, 1952), and its occurrence in the Rajmahal series is now definite.

Professor Sahni believed *Homoxylon rajmahalense* to be a fossil angiospermous wood devoid of vessels, and he compared it with the modern homoxylous Magnoliaceae (SAHNI, 1931, 1932). Gupta (1933, 1934) suggested that comparison was also possible with the Bennettitales. Professor Sahni himself (1935, 1938) had not excluded this possibility. Hsü and Bose (1952) compared their specimens of *Homoxylon rajmahalense* from Amarjola with *Bucklandia* and remarked, "... the comparison is so close as to leave hardly any doubt about *Homoxylon rajmahalense* being the secondary wood of a Bennettitalean plant". In fact, they even suggested that it may be identical with *Bucklandia Sahnii*. Bose remarked that its resemblance with *H. rajmahalense* was so close that on the basis of secondary wood alone it would be very difficult to distinguish between the two.

Recently Dr. H. N. Andrews informed us about a paper published in 1848, in which Hartig gave an account of a fossil coniferous wood, *Homoxylon Blasii*, from the Cretaceous of Wetteran, N. Germany. A photostat copy of this paper was kindly sent to us by Professor C. A. Arnold. Hartig had assigned *Homoxylon Blasii* to Abietineae while, as indicated above, *Homoxylon rajmahalense* Sahni has been shown to be a Bennettitalean wood. It is thus evident that much before Professor Sahni described *H. rajmahalense* from the Rajmahal Hills, the generic name *Homoxylon* was applied by Hartig for a very different type of fossil wood and Dr. Andrews is of the opinion that a new generic name should be given to the Rajmahal wood. In view of this we are now adopting the name *Sahnioxylon* for *Homoxylon* Sahni. Consequently the species *Homoxylon rajmahalense* would now be known as *Sahnioxylon rajmahalense*.

DIAGNOSIS OF THE GENUS *SAHNIOXYLON* NOM. NOV.

Wood compact, characterized by sharply marked growth-rings and composed of tracheids and rays. Spring and autumn zones sharply marked under the microscope, autumn wood more developed than spring wood. Medullary rays numerous, crowded, 1-4-seriate and 1-56 cells high. Pitting in the radial section most characteristic. Late wood possessing tracheids with multiseriate or biseriate, contiguous or separate bordered pits, early wood tracheids showing a wide range of pitting varying from scalariform to multiseriate, pore of pits elliptical. Pits in the field 1-12, pores elliptical.

1. FURTHER OBSERVATIONS ON *SAHNIOXYLON RAJMAHALENSE*

Professor Sahni's type specimen was incomplete, giving only the details of secondary wood. But the specimens described by Hsü and Bose (1952), though fragile, were complete, having a fairly big pith, a broad zone of secondary xylem, phloem and bark, and furnished a more complete information about the anatomy of various regions of the stem. During a recent visit to the Rajmahal Hills, one of us (SAH) collected several large specimens, consisting of very well-preserved secondary wood, showing a close general resemblance with *Sahnioxylon rajmahalense*. However, two of these specimens show some characters which were not observed so far and are described below.

Description of New Specimens

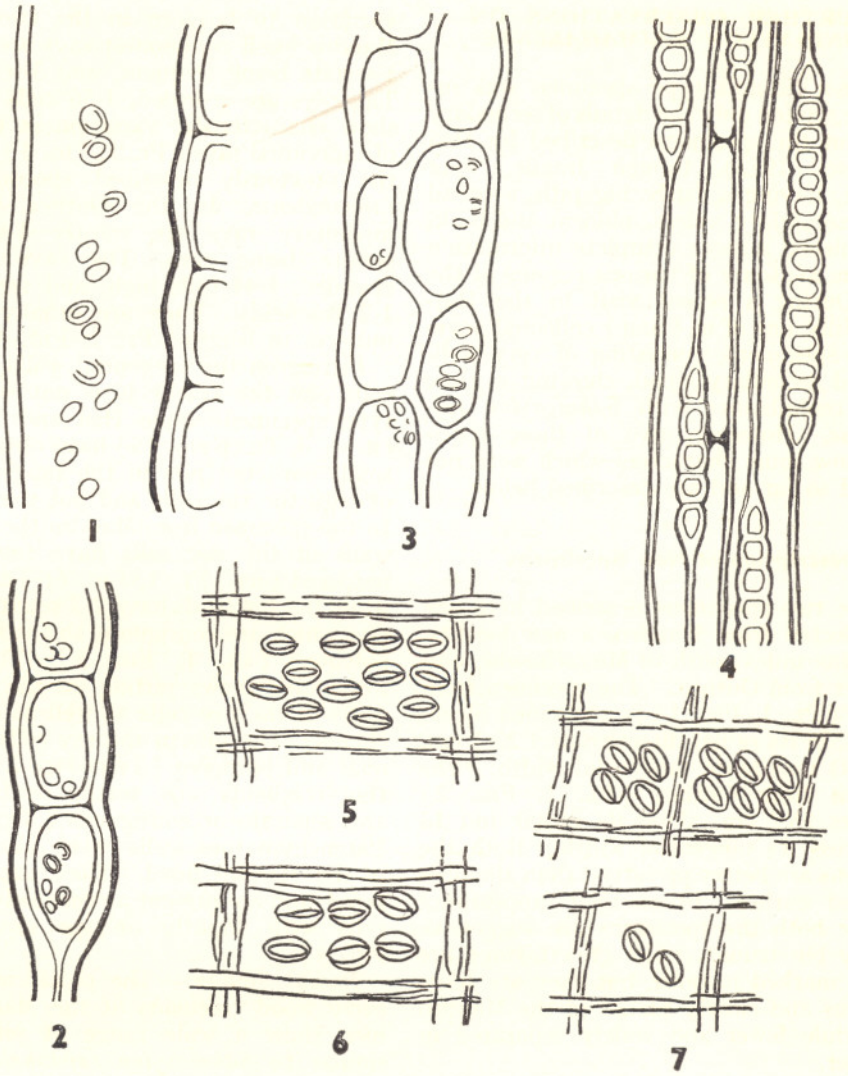
Of the two specimens described here one was collected from Mandro, a new locality about nine miles south of Mirzachowki, and the other from Onthea. The specimen from Mandro (PL. 1, FIG. 1) is a silicified block, 21·2 cm. in its radial direction and 23·3 cm. across its maximum tangential width. The specimen from Onthea (PL. 1, FIG. 2) measures 16·2 cm. along its radial and 13 cm. across its tangential width. Both the specimens are better preserved than the ones described earlier. From their appearance and size both the specimens are suggestive of fairly big trunks. The growth-rings are sharply marked in both, but they are more numerous and closely placed in the Mandro fossil while fewer and widely separated in the other.

Transverse Section — The secondary xylem is chiefly composed of tracheids compactly arranged in radial rows and entirely devoid of vessels. Growth-rings sharply marked in both, but the spring wood zone is more developed in the Mandro wood. In the Mandro wood the cells of the spring wood tracheids are 3-4 times bigger than the cells of the autumn wood tracheid, while in the Onthea specimen the cells of both the spring and autumn wood appear to be almost equal in size. In other features both the woods are identical to *Sahnioxylon rajmahalense*.

Tangential Section — Sections of specimen from both the places show well-preserved medullary rays. There is, however, some variation to be seen in the two. In the Mandro fossil commonest rays are 2-seriate, 1-seriate being frequent, and 3-seriate rare. The rays are crowded, 1-56 cells high, and show characteristic variation in the height of individual rays (PL. 1, FIG. 3) as seen in the previously described specimen of *S. rajmahalense*. In the Onthea wood the medullary rays are mostly 1-seriate, 2-seriate being rare. The rays are more crowded, 1-44 cells high, and separated by 1-2 tracheids. They are usually long and uniform in length (PL. 1, FIG. 4).

Pitting on the tangential walls of the ray cells and the tracheids is not seen in the type specimen, while Hsü and Bose (loc. cit., p. 3, TEXT-FIG. 15) have observed some small bordered pits in the tangential walls of only the ray cells and not the tracheids. In the specimen from Mandro the tangential walls of the ray cells have several small bordered pits (PL. 1, FIG. 6; TEXT-FIG. 3) while the tracheids have 2-3 seriate bordered pits which are contiguous and flattened into polygons (PL. 1, FIG. 5). The Onthea wood also shows pitting on the tangential walls of the ray cells as well as of the tracheids. The pits in the ray cells are small, oval and bordered (TEXT-FIG. 2). Pits on the tracheids are small, oval, bordered and separate or contiguous (TEXT-FIG. 1). Parenchymatous cells were also observed in the Mandro fossil. These are few, scattered, and are present as vertically elongated cells with slightly oblique septa (TEXT-FIG. 4).

Radial Section — The radial walls of the early wood tracheids of the Mandro specimen show a wide range of pitting, very similar to *Sahnioxylon rajmahalense*. Narrower tracheids have 1-3 rows of small, circular or oval, bordered pits and pointed end walls, while the wider ones have multiseriate pits in 4-5 rows (PL. 1, FIG. 8.) as well as scalariform bordered pits (PL. 1, FIG. 7). The end walls of the wider tracheids are somewhat rounded. The pores of all the bordered pits are narrow, slit-like and usually horizontally placed. The late wood tracheids have one or two rows of small, circular, contiguous or separate bordered pits; when biseriate, these may be opposite, sub-opposite or alternate. The Onthea wood, however, almost always shows scalariform and transitional types of pitting in the spring wood tracheids, the multiseriate type being extremely rare. No



TEXT-FIGS. 1-7 — *Sahnioxylon rajmahalense* (Sahni) Comb. nov. 1, tangential walls of the tracheids of Onthea wood showing small, scattered bordered pits. × 400. 2, ray cells of Onthea wood showing pits in the tangential walls. × 400. 3, ray cells of Mandro wood in tangential section showing bordered pits in the tangential walls. × 400. 4, parenchyma cells in tangential section of Mandro wood. × 100. 5, 6, bordered pits in the field, in Mandro wood, with elliptical and horizontally placed pores. × 400. 7, bordered pits in the field, in Onthea wood, with elliptical and inclined pores. × 400.

pitting has been observed in the autumn wood tracheids.

Pits in the field are fairly well preserved in both the specimens. In the Mandro fossil there are 2-12, mostly 6-10, bordered pits with narrow and usually horizontally elongated pores (PL. 1, FIG. 9; TEXT-FIGS. 5, 6). In the specimen from Onthea they are 2-6. The pores are narrow, slit-like but inclined at an angle (PL. 1, FIG. 10; TEXT-FIG. 7).

Giant and commissural cells, similar to the ones described by Professor Sahni, were observed in the specimens from both the localities.

Discussion

From the foregoing description it is apparent that the Mandro specimen is completely in conformity with the already known

description of *Sahnioxylon rajmahalense*. However, it gives further information about three important characters. Firstly, that the xylem rays may be as much as 56 cells in height. Secondly, it shows the pitting on the tangential walls of the tracheids, a character not known so far. And lastly, it indicates the presence of xylem parenchyma in the secondary wood.

The specimen from Onthea, though similar in general, shows the following differences in detailed comparison. While in other specimens of *Sahnioxylon rajmahalense* the tracheids of the spring wood in transverse section look 3-4 times bigger than those of the autumn wood, there is not much difference in size of the corresponding cells of the Onthea specimen. In most of the other specimens majority of the rays are 2-seriate in tangential view, 1-3-seriate being frequent and 4-seriate rare; in the Onthea specimens 1-seriate are the commonest, 2-seriate being rare and 3-seriate hardly present. While these rays in other specimens are a characteristic mixture of short and long ones, in the Onthea specimen they are mostly long, the short ones being comparatively few. A seemingly important difference is noticeable in the radial section. In other specimens the pitting of the tracheids of the spring wood varies from scalariform to multiseriate bordered pits. The pits in the field are 1-12, mostly more than 6, with narrow slit-like pores usually horizontally placed. In the Onthea specimen the radial pitting on the tracheids is almost always of the scalariform type with intermediate type frequent and the multiseriate pits being extremely rare. Pits in the field do not exceed 6 in number and their narrow, slit-like pores are obliquely placed.

Our present knowledge of the species of *Sahnioxylon* is not wide enough to estimate the value of the above differences in relation to specific identification. The most important difference seems to be the predominance of scalariform pitting in the radial walls of the spring wood tracheids in the Onthea specimen, but here, too, the multiseriate pits are not altogether absent. Moreover, so far we have only a single specimen of the different-looking wood from Onthea, which itself is incomplete and insufficient for a thorough comparison needed for separating it into a different species. In view of these considerations, we are for the present including it in *Sahnioxylon rajmahalense* as a variety of the same species. When more and better specimens similar to the Onthea wood are available, this view can be revised.

2. *SAHNIOXYLON ANDREWSII* SP. NOV.

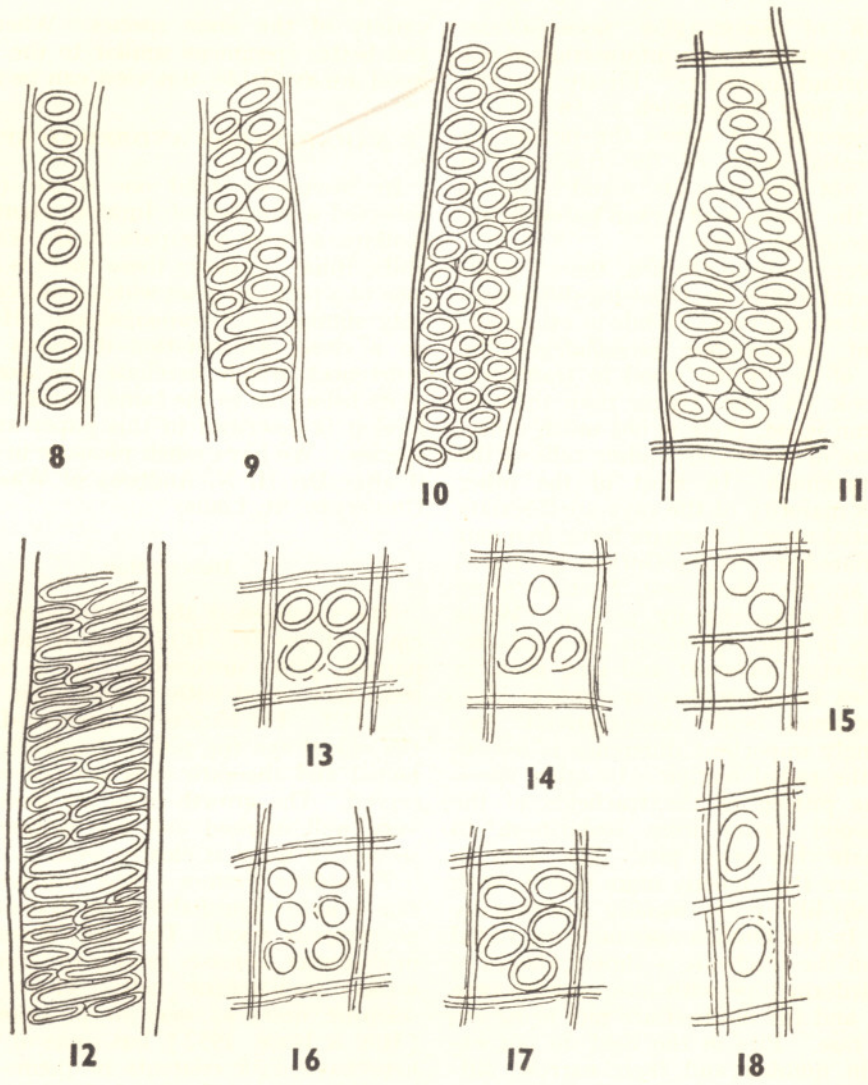
In November 1950 one of us (BOSE) collected a number of Jurassic plants from Kulkipara, near Amrapara, in the Rajmahal Hills, Bihar. Among these there is a specimen of a petrified stem which looks considerably similar to *S. rajmahalense*. However, on a closer examination it shows certain differences which preclude the possibility of its belonging to the same species. Therefore, it is described in this paper as a new species. We have much pleasure in naming it after Dr. H. N. Andrews of Washington University, St. Louis.

Description

The specimen is about 6 cm. long and 6·5 cm. in diameter. It consists of only a very narrow pith surrounded by a compact secondary wood with growth-rings (PL. 2, FIG. 11). The bark is not preserved. With the naked eye the pith is hardly to be detected and the pith cells are not well preserved. The growth-rings are found to be very well marked and the pitting in the secondary wood is clearly seen.

Transverse Section — The transverse section is indistinguishable from that of a gymnospermous wood. The pith, about 3 mm. in diameter, consists mostly of large, thick-walled isodiametric cells. There are no sclerotic nests as seen in *S. rajmahalense* (HSÜ & BOSE, 1952), but some of the cells here have dark contents in them. Round the pith is the xylem with 24 clear growth-rings, consisting of tracheids and rays only. The primary xylem is endarch and not clearly recognizable in transverse section. The cells of the primary xylem are mostly polygonal and thin-walled. The tracheids of the secondary wood are quadrangular in section and compactly arranged in radial series. The autumn wood is more strongly developed than the spring wood. The tracheids of the spring wood have bigger diameter and are thinner-walled than those of the late wood (PL. 2, FIG. 12). Both uniseriate and multiseriate rays are present. Xylem parenchyma is not visible.

Tangential Section — The general shape and distribution of medullary rays are very



TEXT-FIGS. 8-18 — *Sahnioxylon Andrewsii* sp. nov. 8-11, part of early wood tracheids in radial section showing uni- to multiseriate bordered pits. 12, a tracheid showing scalariform pitting. 13-18, one to six pits in the field. All × 400.

similar to those of *Sahnioxylon rajmahalense* (PL. 2, FIG. 13). The medullary rays are 1-46 cells high, mostly biseriate, frequently uniseriate and rarely triseriate. The commonest rays are biseriate and they are between 10 and 30 cells high. Tangential pitting in the ray cells or the tracheids is not seen.

Radial Section — The radial section of the wood shows, to some extent, the details in the structure of the tracheids and the medullary rays. The pith cells in radial section are not clearly seen. They are thick-walled and are rectangular, closely compressed in vertical series. The primary xylem is formed of slender tracheids with spiral thickenings. In the secondary wood the pitting is only preserved in the spring wood and very rarely in the autumn wood next to it. In the spring wood, unlike the spring wood of *S. rajmahalense*, there is not much variation in the shape and arrangement

of the pits. They are mostly multiseriate and rarely uniseriate. When multiseriate (PL. 2, FIG. 14; TEXT-FIGS. 10, 11), they show numerous small, round-bordered pits, crowded in 2-3 series, very rarely 4. The pits cover nearly the whole width of the wall and are mostly round, sometimes slightly elliptic and either separate or contiguous. The arrangement is either alternate or sub-opposite. The pore is large and broadly elliptic. The bordered pits, when uniseriate, are either circular or oval and are either separate or contiguous (PL. 2, FIG. 16; TEXT-FIG. 8). Scalariform pitting is very rare; it is seen only at places near the primary xylem (PL. 2, FIGS. 15, 16), otherwise it is completely missing. Mixed with the multiseriate bordered pits at places, transitional stages are also met with (TEXT-FIG. 12). In the autumn wood the pits are mostly not preserved. When preserved, they are generally uniseriate, bordered, circular or slightly flattened and separate or contiguous (PL. 2, FIG. 17). The pore is fairly big and slightly inclined.

The medullary rays are thick-walled and the cells are rectangular. The pits in the field are small, circular and bordered. Their number varies from 1 to 6 (TEXT-FIGS. 13-17). Frequently a single large pit occupies the field (TEXT-FIG. 18). The arrangement and inclination of pores are not fixed.

Comparisons

In cross-section and in tangential section of the wood our species resembles very much *Sahnioxylon rajmahalense* in having clearly marked annual rings, quadrangular tracheids compactly arranged in radial rows, spring wood much less developed than the autumn wood, cells of the spring wood bigger in diameter and thin-walled than those of the autumn wood.

However, it differs from *S. rajmahalense* (HSÜ & BOSE, 1952) in having a very narrow pith and in the absence of sclerotic nests which are present in abundance in the parenchymatous cells of the pith of the latter species. The main difference, however, exists in the radial section of the two. The tracheids of the spring wood of *S. rajmahalense* show multiseriate circular pits as well as scalariform bordered pits, with several transitional stages between these two types; while in *S. Andrewsii* multiseriate bordered pits are the commonest, transitional stages are very rare, and scalariform bordered pits are present only near the primary xylem. In *S. rajmahalense* the bordered pits are 4 to 6-seriate, whereas in *S. Andrewsii* they are 2 to 3-seriate, rarely 4-seriate. No giant cells and commissural parenchyma have been noticed in the present species, but they are common in *S. rajmahalense*. In *S. rajmahalense* the medullary rays have scattered parenchyma, but they are entirely absent in the present species.

S. Andrewsii shows some close resemblance to some of the fossil cycadean stems, especially with some of the species of *Bucklandia*. *B. Sahnii* Bose, which is known to be quite near *S. rajmahalense*, resembles *S. Andrewsii* in the nature of the tracheids and medullary rays in cross-section as well as tangential section. But it differs chiefly in its radial view. *B. Sahnii* has scalariform pitting in the majority of the spring wood tracheids with transitional stages occurring between them, multiseriate round-bordered pits are also met with, and these, when present, are nearer the primary xylem. The pith in *B. Sahnii* is fairly broad and numerous thick-walled cells are present in the pith, whereas in *S. Andrewsii* the pith is very narrow and there are no such thick-walled cells. *B. indica* Seward shows resemblance with *S. Andrewsii* in having multiseriate bordered pits on the radial walls of the tracheids. There is, however, no scalariform pitting in *B. indica*, while in *S. Andrewsii* this character is seen. The medullary rays in *B. indica* are uniseriate, but in our specimen they are uni- to multiseriate.

The other important genera which show points of similarity with *S. Andrewsii*, but to a lesser extent, are *Cycadeoidea*, *Raumeria* and *Colymbetes*. In most of the Cycadeoideas the secondary xylem is formed mainly of tracheids with scalariform pitting; in *S. Andrewsii* multiseriate bordered pits are the commonest type present. However, in individual features our plant resembles a few species, e.g. *C. micromyele* Lignier and *C. Dartoni*. Both *C. micromyele* and *C. Dartoni* have tracheids with bordered and scalariform pits on their radial wall. The medullary rays in *C. micromyele* are uniseriate and 7-29 cells deep, but in *S. Andrewsii* they are uni- to triseriate and are 1-46 cells high. *Raumeria Reichenbachiana* Goeppert like *S. Andrewsii* has scalariform bordered pits in

addition to multiseriate bordered pits. But in *R. Reichenbachiana* scalariform pitting is more common, and the medullary rays here are much less deep than in *S. Andrewsii*. *Colymbetes Edwardsi* Stopes has also pits of various types ranging from circular, oval to scalariform, but the medullary rays here are biseriate and 4-30 cells deep.

ACKNOWLEDGEMENTS

We wish to express our sincere thanks to Drs. R. V. Sitholey and R. N. Lakhanpal for their valuable suggestions and for going through the manuscript. We are thankful to Professor C. A. Arnold for kindly sending us a photostat copy of the paper by Hartig.

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EXPLANATION OF PLATES

PLATE 1

Sahnioxylon rajmahalense (Sahni) comb. nov.

1. Specimen from Mandro showing crowded and narrowly separated growth-rings. Reg. No. 2628. Slightly less than × ½.

2. Specimen from Onthea showing fewer and widely separated growth-rings. Reg. No. 4375. × ½.

3. Tangential section showing the comparative size of the medullary rays. Specimen No. 2628. × 25.

4. Tangential section showing uniseriate and commonly long medullary rays. Specimen No. 4375. × 25.

5. Biseriate contiguous pits on the tangential walls of the tracheids. Specimen No. 2628. × 60.

6. Bordered pits on the tangential wall of a ray cell. Specimen No. 2628. × 640.

7. Radial section showing scalariform pitting in a spring wood tracheid. Specimen No. 2628. × 340.

8. Radial section showing multiseriate circular bordered pits with narrow elliptical pores in a spring wood tracheid. Specimen No. 2628. × 380.

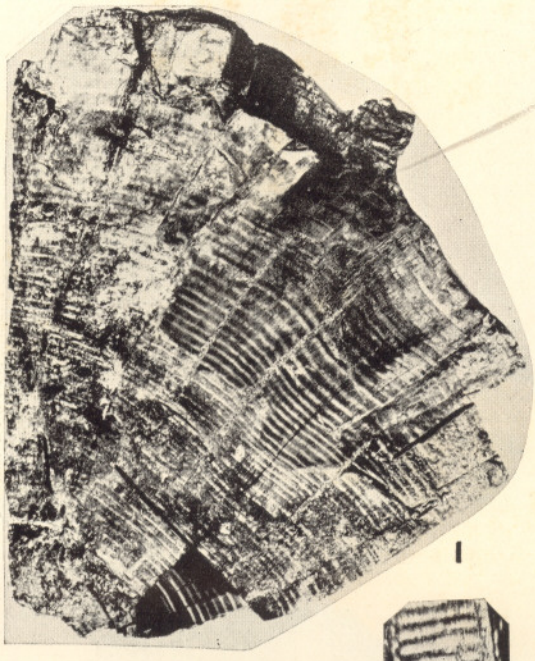
9. Radial section showing 8-12 pits in the field with narrow and horizontally placed pores. Specimen No. 2628. × 500.

10. Radial section showing 4-6 pits in the field with narrow slit-like and inclined pores. Specimen No. 4375. × 500.

PLATE 2

Sahnioxylon Andrewsii sp. nov.
(Reg. No. 3659)

11. Holotype showing a narrow pith and sharply marked growth-rings. Natural size.
12. Transverse section showing well-marked growth-rings. × 70.
13. Tangential section showing the general distribution of the uniseriate and multiseriate medullary rays. × 70.
14. Radial section showing multiseriate bordered pits. × 160.
15. Radial section showing the scalariform metaxylem. × 70.
16. Radial section showing scalariform pitting in a tracheid and also uniseriate bordered pits. × 340.
17. Radial section showing the uniseriate bordered pits. × 720.
18. Radial section showing the multiseriate round-bordered pits and the pits in field. × 380.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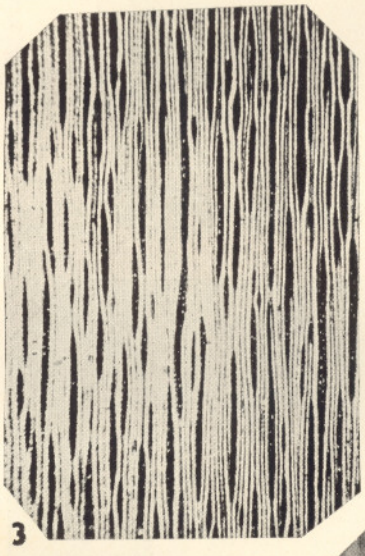
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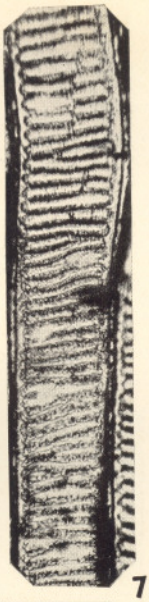
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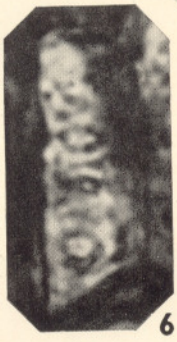
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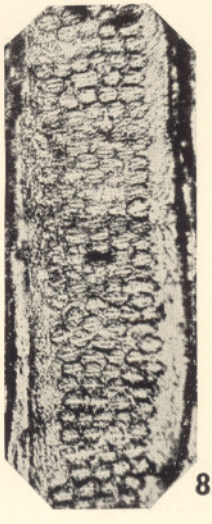
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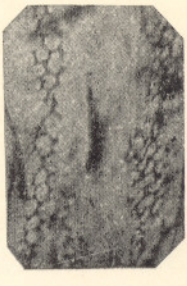
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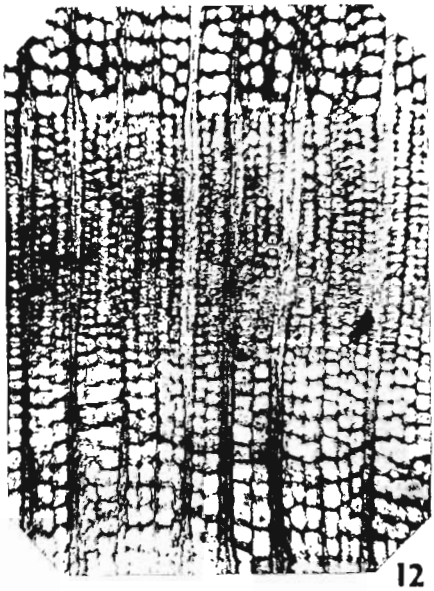

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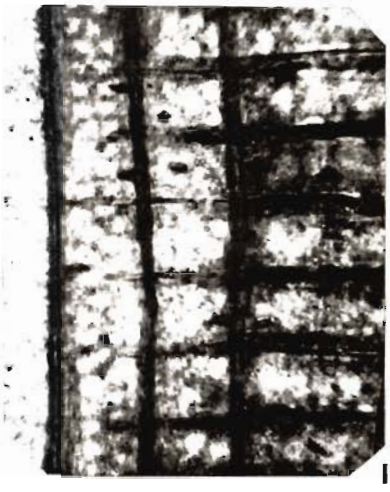

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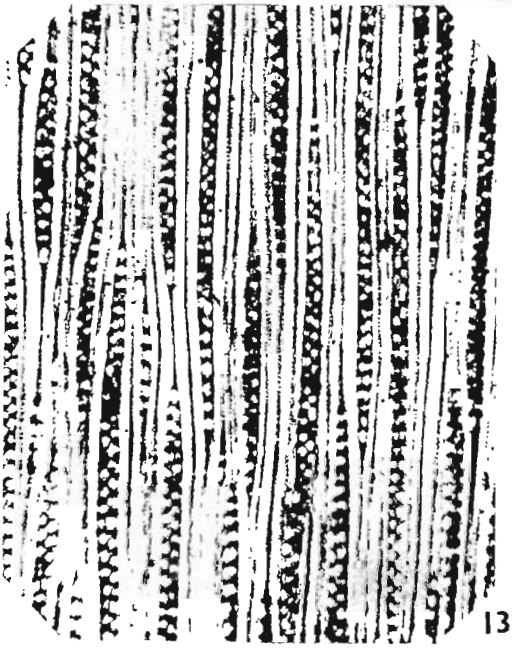

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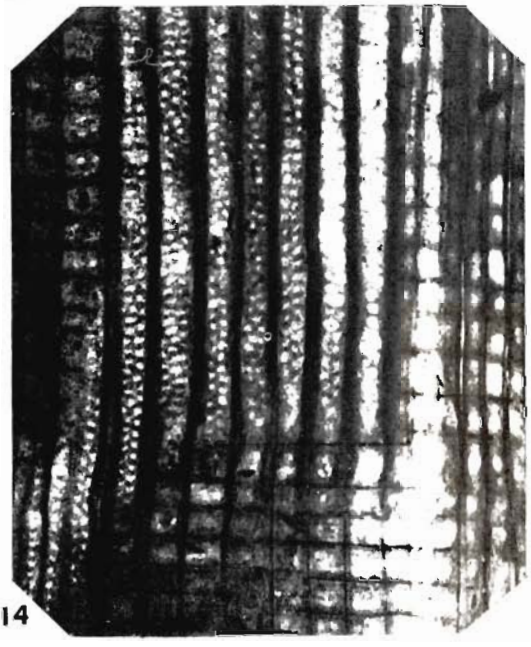

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