NANDORIOXYLON SAKSENAE GEN. *ET* SP. NOV.—A NEW GYMNOSPERMOUS WOOD FROM THE KAMTHI STAGE OF CHANDRAPUR DISTRICT, MAHARASHTRA STATE, INDIA*

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ABSTRACT

A new gymnospermous wood *Nandorioxylon saksenae* gen. *et* sp. nov. from the Kamthi Stage of Chandrapur District, M. S., has been described. It is characterized by lobed homogeneous pith, 0.8—1.3 cm, devoid of secretory canals, secretory cells, presence of air cavities and a ring of parenchymatous sheath of thin-walled, narrow and rectangular cells in between the pith and endarch primary xylem ; distinct growth rings, 1-3 seriate radial pitting, xylem rays homogeneous, 1-36-celled, cross-field pits 1-7 (1-3), cupressoid.

INTRODUCTION

A number of pieces of petrified woods were collected during field trips in the years 1975—77 from Nandori Buzrug (20°12′ ; 79°02′), a small village five kilometers east of Warora on the main Nagpur-Chandrapur P. W. D. Road. Of these some of the woods were very big, 2-2.5 metres in length and 40-90 cm in diameter found exposed in a nala cutting. Others were collected as stray pieces exposed in the nearby fields. Most of the pieces found in the nala cutting were of secondary wood only and about a dozen pieces showed presence of pith and primary xylem.

DESCRIPTION

The wood NB P3/76 is well preserved, silicified, decorticated showing pith and primary xylem. It is 20-31 cm long and 9.8-13.8 cm broad and reddish brown in colour (Text-fig. 1 ; Pl. 1, Fig. 1). In cross section it shows eighteen distinct growth rings both macro- and microscopically (Text-fig. 1 ; Pl. 1, Fig. 2). Autumn wood 1-5 cells wide, cells rectangular, 19×40 μm, thick-walled, tangentially flattened with narrow lumen. Spring wood 195-251 cells wide, cells are squarish, 43×41 μm and thick-walled. There is an abrupt change in the cell size from autumn wood to spring wood (Text-fig. 3 ; Pl. 1, Figs. 2 & 3).

Tracheids show uni-triseriate (usually 1-2 seriate) araucarioid pitting on the radial walls. Uniseriate pits are circular, flattened, separate or contiguous (Text-figs. 6 & 7). Biseriate pits are circular, flattened or hexagonal, opposite or alternate and contiguous (Text-fig. 8 ; Pl. 1, Figs. 7 & 8). Triseriate pits are hexagonal, alternate and contiguous (Pl. 1, Fig. 10). Bars of sanio are observed in uniseriate separate and biseriate opposite condition (Text-fig. 6). Circular pits are 14.6×15.5 μm with 5.5×5.8 μm pore. Hexagonal pits are 11.3×13.6 μm with 4.8×5.8 μm pore. The pit pore is invariably round or oblique.

Xylem rays are simple, homogeneous, mostly uniseriate, rarely biseriate, 1-36 celled, 7 cells being the average height of 50 counts (Text-fig. 15 ; Pl. 1, Fig. 11). The cells are

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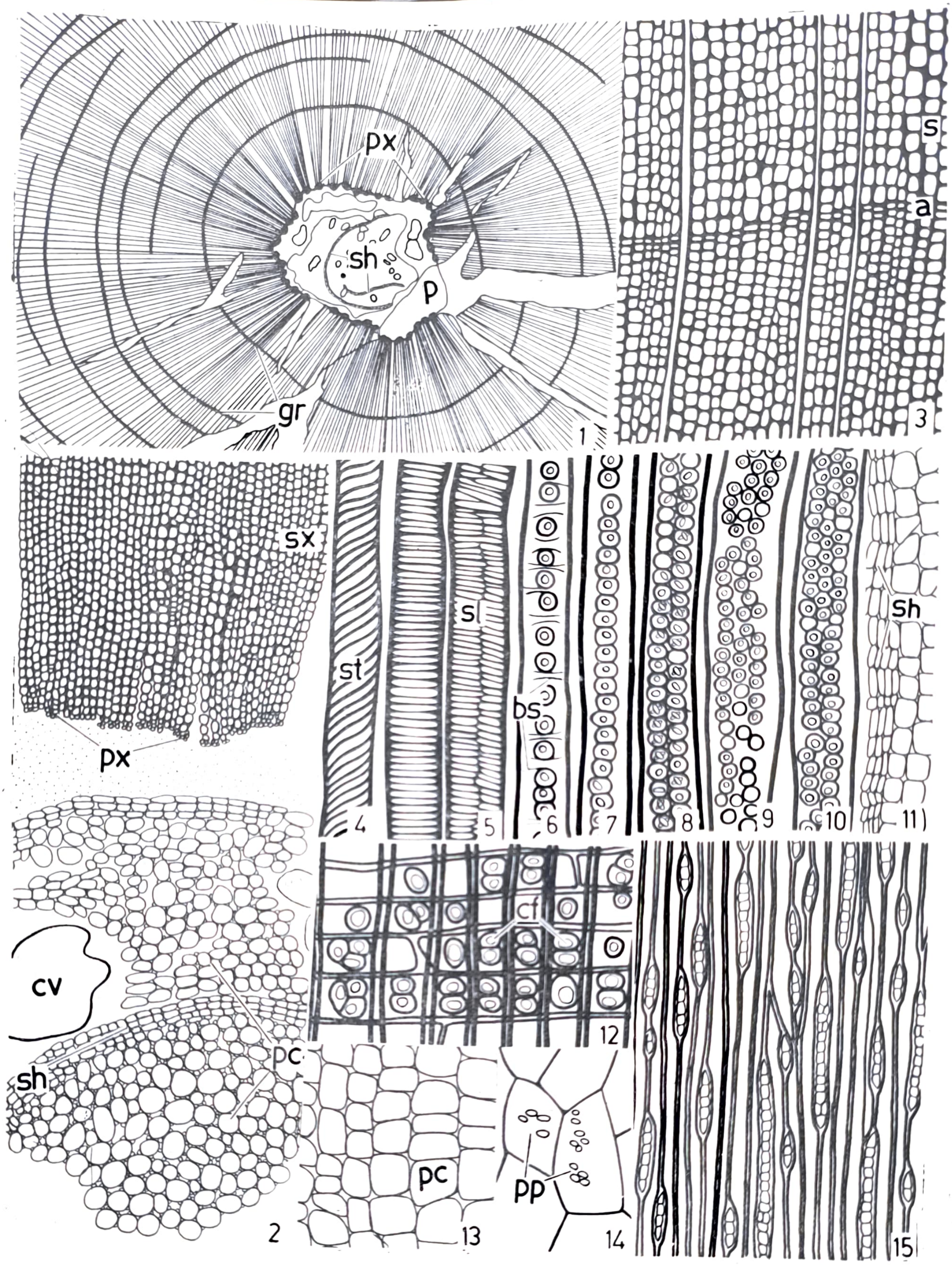

Text-figs. 1-15. *Nandorioxylon saksenae* gen. *et* sp. nov., Fig. 1. T. S. of a wood showing pith—*p* and sheath layers—*sh* ; primary xylem—*px* and growth rings—*gr* : Note the irregular cavities in the pith ×2.5. Fig. 2. The same, a part magnified to show primary xylem—*px*, secondary xylem—*sx*, cavities—*cv*, sheath—*sh* and pith cells—*pc* : Note the intercellular spaces in between the pith cells—*pc* and tangentially elongated rectangular cells of the sheath—*sh* ×28. Fig. 3. T. S. of a secondary wood showing autumn wood—*a* and spring wood—*s* ×50. Fig. 4. L. S. of a protoxylem cell showing spiral thickenings—*st* ×50. Fig. 5. L. S. of metaxylem cell showing scalariform thickenings—*sl* ×50. Fig. 6. L. S. of a tracheid showing uniseriate, separate pitting and bars of sanio—*bs* ×170. Fig. 7. The same showing uniseriate flattened, contiguous pits ×187. Fig. 8. The same showing biseriate, alternate, contiguous pits ×187. Fig. 9. The same showing multiseriate alternate pits ×187. Fig. 10. The same showing a transition of bi-triseriate, alternate, contiguous pits ×187. Fig. 11. Pith in L. S. showing vertically elongated sheath cells—*sh* ×50. Fig. 12. R. L. S. showing 1-7, large bordered cross-field pits—*cf* ×187. Fig 13. L. S. of pith showing radially arranged, thin-walled squarish to rectangular pith cells—*pc* ×50 Fig. 14. The same showing presence of small simple pits—*pp* on the pith cells ×262. Fig. 15. T. L. S. showing uni-biseriate, 2-19-celled xylem rays ×50.

elongated 33×22 μm, thin-walled, smooth and non-pitted. The resinous tracheids can easily be recognised on account of the presence of biconvex resin plugs in them. Xylem parenchyma is absent.

Cross-field pits are 1-7 but mostly 1-3, large, bordered and cupressoid, measuring 15.2×15.5 μm. When the pits are 1-3, they are very large and occupy the entire cross-field area. Pit pore is 9.9×9.3 μm, broadly oval to elongated (Text-fig. 12 ; Pl. 1, Fig. 12).

Primary xylem is endarch, 8-10-celled and arranged in groups (Text-figs. 1 & 2 ; Pl. 1, Fig. 1). In cross section there is no clear distinction between the primary and secondary xylem as they are arranged in the same radial rows but in the longitudinal section the primary wood shows spiral, scalariform and reticulate thickenings while the secondary wood shows bordered pits. The spiral thickenings represent the protoxylem elements (Text-fig. 4 ; Pl. 1, Fig. 5), scalariform and reticulate thickenings represent the metaxylem elements (Text-fig. 5). They gradually pass into the bordered pitted thickenings of the secondary wood.

Pith is lobed, measuring 0.8×1.3 cm. Eight such lobes are clearly seen (Text-fig. 1 ; Pl. 1, Fig. 1). Zeiller (1895) suggested that the lobed structure probably had some relation with the departure of the leaf or branch trace. According to Lepekhina (1972) the polygonal pattern of pith appears in those parts of trunk where introduction of leaf traces take place at the younger stage.

In T.S. the pith cells are isodiametric, 110×108 μm, thin-walled, parenchymatous and loosely arranged forming peculiar small triangular intercellular spaces (Text-fig. 2 ; Pl. 1, Fig. 4). The cells in L.S. are squarish to rectangular, broader than long, 114×140 μm and arranged in vertical rows (Text-fig. 13 ; Pl. 1, Fig. 13). At places the arrangement is disturbed and appears to be irregularly arranged giving polygonal appearance. 1-10, simple, small pits are seen on their radial walls (Text-fig. 14).

Sheath between the pith and primary xylem is present forming a zone of rectangular to elliptical, thin-walled, 5-6 celled parenchymatous sheath (Text-figs. 1 & 2; Pl. 1, Figs. 1 & 4). The cells in T.S. are 29×82 μm. Tangentially they are flattened and measure 51×16 μm (Text-fig. 11 ; Pl. 1, Fig. 13). They do not show any reticulate markings as seen in the transfusion sheath of *Dadoxylon indicum* Holden (1917).

COMPARISON AND DISCUSSION

The distinguishing characters of the present wood are (i) lobed homogeneous pith, devoid of secretory canals, secretory and sclerotic cells and presence of air cavities, (ii) presence of intervening sheath of rectangular, narrow, thin-walled cells in between the pith and primary xylem, (iii) endarch primary xylem, (iv) distinct growth rings, (v) 1-3 seriate araucarioid radial pitting, (vi) presence of bars of sanio, (vii) uniseriate, rarely biseriate xylem rays and (viii) 1-7, mostly 1-3, large, bordered cupressoid cross-field pits.

These characters broadly resemble with the genera like *Dadoxylon* Endlicher (1847) and *Trigonomyelon* (Zeiller, 1895) Walton (1925) but differs markedly from them in one or the other important characters.

The lobed pith, endarch primary xylem and araucarioid radial pitting suggest its affinity with *Trigonomyelon* (Zeiller) Walton (1925) but differs from it in having a homogeneous pith devoid of secretory cells and presence of parenchymatous sheath. In *Trigonomyelon* on the other hand, the pith is heterogeneous containing secretory cells. Only one species of *Trigonomyelon*, *T. raniganjense* Maheshwari (1967) possesses parenchymatous sheath but the present specimen differs from it in other characters such as homogeneous pith, isodiametric pith cells with peculiar triangular intercellular spaces, sheath cells 82 × 29 μm, presence of bars of sanio, 1-36 celled (average 7 cells) xylem rays and presence of resinous tracheids; whereas in *T. raniganjense* the pith is heterogeneous, sheath cells 30-90 × 60-75 μm, xylem rays 1-15 celled with 2-3cells as the average height and absence of resinous tracheids.

The homogeneous pith, endarch primary xylem, araucarioid radial pitting and many cross-field pits suggest its affinity with *Dadoxylon* (Lindley & Hutton) Endlicher (1847) but differs in having lobed homogeneous pith and complete ring of sheath in between pith and primary xylem. Only one species of *Dadoxylon*, *D. indicum* Holden (1917) possesses the intervening sheath-like layer in between the pith and primary xylem, but the intervening layer in *D. indicum* possesses definite reticulate markings similar to the transfusion tissue. Such markings are not seen in the present wood. It also possesses a heterogeneous pith and the endarch nature of primary xylem which is doubtful as pointed out by Kräusel *et al.* (1962), while in the present wood the pith is homogeneous and primary xylem is definitely endrach. In 1967, Maheshwari instituted a new genus *Damudoxylon*. Later on he (Maheshwari, 1972) transferred *Dadoxylon parenchymosum* Surange & Maithy (1963) and *D. jamuriense* Maheshwari (1965) under genus *Damudoxylon*. Maithy (1974) objected the views of Maheshwari and remarked that the placement of *Dadoxylon parenchymosum* and *D. jamuriense* under *Damudoxylon* is incorrect as *Damudoxylon* was originally instituted for the fossil woods with heterogeneous pith composed of parenchyma and secretory cells but the above two species possess homogeneous pith. So far no fossil wood has been recorded showing a transition from homogeneous pith to the pith having parenchyma and secretory cells, and thus the woods having parenchymatous pith should be kept separate from *Damudoxylon* Maheshwari.

As the present wood is not comparable with any of the other known genera and their species, it is treated as a new genus and named as *Nandorioxylon saksenae* gen. *et* sp. nov. The generic name is after the village Nandori Buzrug in Chandrapur District, Maharashtra State, from where it was obtained and the specific epithet is after Professor S. D. Saksena, an eminent palaeobotanist.

The so-called sheath might have been formed in between the pith and primary xylem by the activation of the outermost layer of the pith cells, functioning as a procambium-like layer either as a complete ring or in part in the form of a band, ramifying once or twice. Cells of this layer divide repeatedly forming a multilayered band of thin-walled rectangular or elliptical cells as many as 20-22 layers. The resultant sheath might be giving mechanical support to the pith from collapsing and also contributing to the production of large amount of pith cells as they have been taken the site for the deposition of food material in them.

Another interesting feature noticed in the present woods is the development of typical triangular air spaces amongst the pith cells. Formation of such air spaces has been observed in the plants growing in the water drained condition probably acting as a diaphragm. Such conditions are seen in many living hydrophytic members of Nymphaeaceae, Cyperaceae and Araceae. This character suggests the wet and moist climate during the late Permian period in the region from where this wood has been obtained.

Nandorioxylon gen. nov.

Genotype—Nandorioxylon saksenae sp. nov.

Generic Diagnosis—Pith lobed, homogeneous with parenchymatous sheath ; primary xylem endarch, radial pitting araucarioid, 1-3 seriate ; xylem rays uni-biseriate; cross-field pits many, cupressoid.

Nandorioxylon saksenae sp. nov.

Specific Diagnosis—Pith 0.8×1.3 cm, lobed, homogeneous, cells isodiametric, thin-walled, loosely arranged forming small triangular intercellular spaces. Sheath 5-6-celled wide forming a complete ring in between pith and primary xylem, cells rectangular, thin-walled. Primary xylem endarch, 8-10-celled. Growth rings distinct, autumn wood 1-5-celled, 19×40 μm ; spring wood 195-251-celled, 43×41 μm. Radial pitting 1-3-seriate, araucarioid, pits round, hexagonal, opposite or alternate. Round pits 14.6×15 μm with 6.3×5.7 μm pore, flattened pits 10.4×15.5 μm with 5.5×5.8 μm pore, hexagonal ones 11.3×13.6 μm with 4.8×5.8 μm pore. Bars of sanio present, xylem rays homogeneous uniseriate, sometimes biseriate (30%), 1-36 celled with 7 cells as average height. Tangential wall of tracheid smooth, resinous tracheids abundant. Cross-field pits 1-7 (mostly 1-3) large, bordered, cupressoid, 15.2×15.5 μm with broadly oval or elongated 9.9×9.3 μm pore.

Locality—Nandori Buzrug, District Chandrapur, Maharashtra State, India

Horizon—Kamthi Stage (Lower Gondwana).

Age—Late Permian (according to G. S. I.).

Type specimen—NB P3/76, Botany Department, University of Poona, Pune-411 007.

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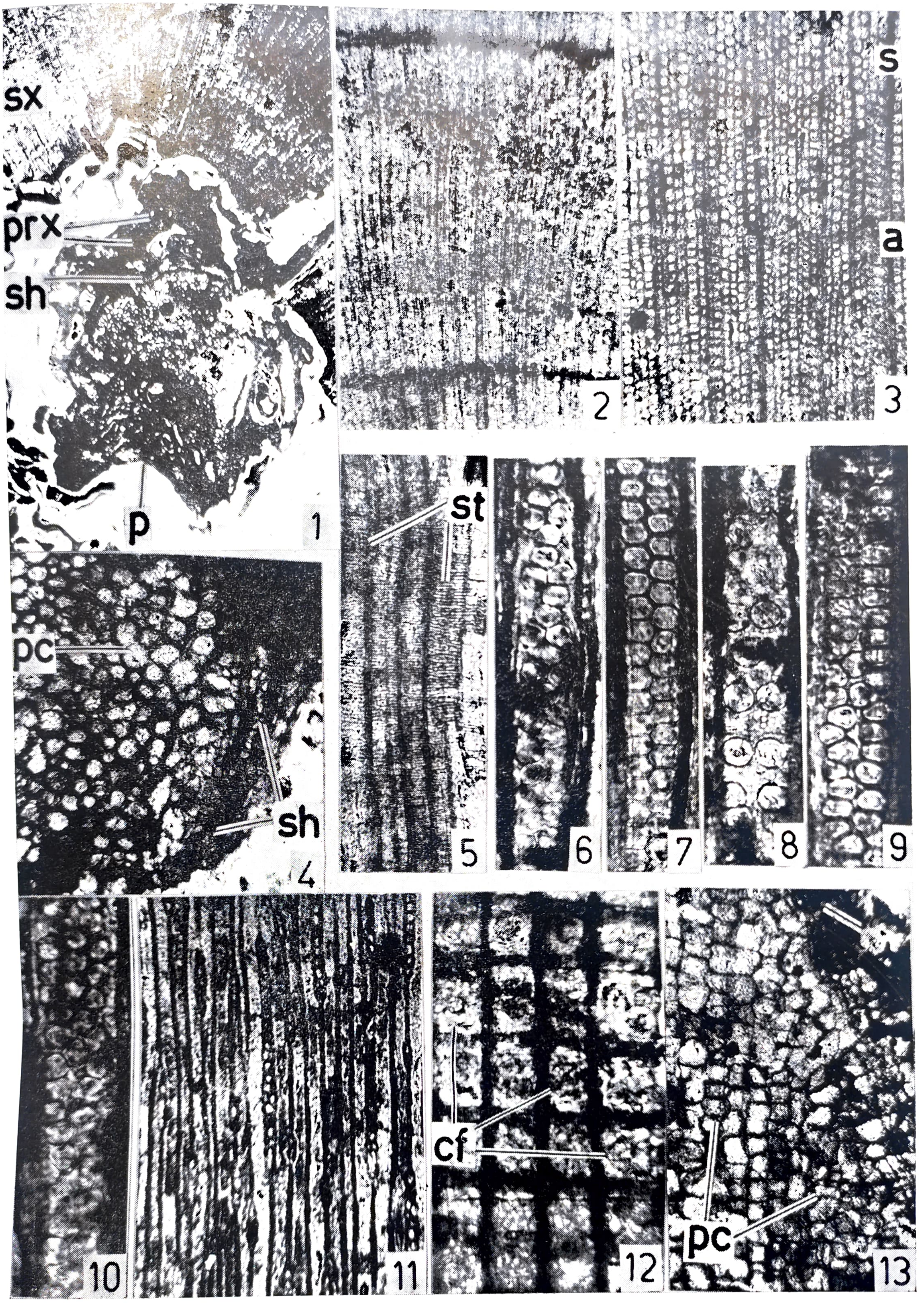
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EXPLANATION OF PLATE 1

Figs. 1-13. *Nandorioxylon saksenae* gen. *et* sp. nov. Fig. 1. T. S. of wood showing secondary xylem —*sx*, primary xylem—*prx* and pith—*p* : Note the lobed pith—*p* and sheath—*sh* ×6. Fig. 2. T. S. of secondary wood showing growth rings×17. Fig. 3. The same showing autumn wood—*a* and spring wood —*s*×40. Fig. 4. T. S. of pith showing thin-walled, isodiametric pith cells—*pc* and tangentially elongated, thin walled, rectangular cells of sheath—*sh*×42. Fig. 5. L. S. of protoxylem cells in primary xylem showing spiral thickenings—*st*×30. Fig. 6. L. S. of a tracheid showing a transition of uni-biseriate contiguous pits×325. Fig. 7. The same showing biseriate, hexagonal, alternate pits×325. Fig. 8. The same showing biseriate, hexagonal opposite pits×366. Fig. 9. A tracheid in L. S. showing transition of bi-triseriate, hexagonal contiguous pits×366. Fig. 10. The same showing multiseriate, hexagonal, contiguous pits×320. Fig. 11. T. L. S. showing uni-biseriate, 2-22-celled xylem rays×50. Fig. 12. R. L. S. showing 1—3, large, bordered cross-field pits—*cf*×253. Fig. 13. L. S. of pith showing radially arranged thin-walled, squarish pith cells—*pc* and thin-walled rectangular sheath cells—*sh*×39.