

CONIFER WOOD FROM NEW SITES OF GANGAPUR FORMATION, INDIA

S. R. MANIK and SHYAM C. SRIVASTAVA

*Birbal Sahni Institute of Palaeobotany,
Lucknow 226 007, India*

(Received: July 15, 1990)

Abstract

Investigation of fossil woods from new locations, namely; Yamanpalli and Godepalli have depicted for the first time, the occurrence of two wood genera: *Araucarioxylon* and *Podocarpoxylon* from Gangapur Formation in Pranhita — Godavari Graben. This finding supports that the conifers were the significant part of the vegetation in the mid part of Mesozoic. Of the conifers dominated floral assemblage, *Podocarpaceae* appeared to be the commonest family because of its representation enormously in the form of its leaf, wood and palynomorph.

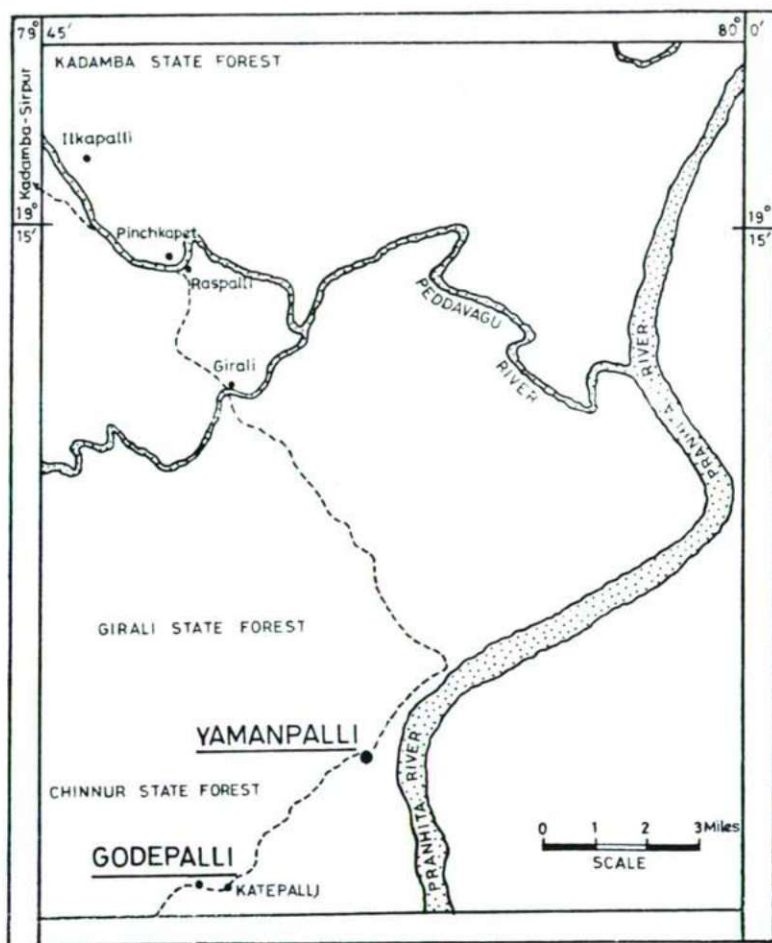
Key words: Xylotomy, fossil, Lower Cretaceous, India.

Introduction

Plant bearing beds from Gangapur Formation have been known to occur since KING (1881) enlisted the fossil plants, viz, *Taeniopteris*, *Ptilophyllum*, *Elatocladus*, *Cheirolepis* and *Araucarites*. After a long hiatus, KUTTY (1969) initiated the search in the same area and while dealing with the stratigraphy of the Upper Gondwana formations recognized Gangapur Formation entirely upon the basis of floral fossils. Gangapur Formation unconformably overlies Kota Formation therefore the author separated the flora of Gangapur and adjacent beds from Kota Formation assessed the age to be of Middle-Upper Jurassic. Following this comprehensive report, RUDRA (1972, 1982) also presented a systematic account of Upper Gondwana stratigraphy and sedimentation of Pranhita — Godavari Valley and during the survey, he could identify Gangapur Formation near Yamanpalli in the eastern part of the outcrop bearing some calcareous fossil wood. However, author did not give the details of the plant remains. Subsequently, BOSE et al. (1982) described mega- and palynofossils from Gangapur Formation. The fossil assemblage is composed of ferns, cycadophytes and conifers. Notable among these floral constituents are: *Gleichenia nordenskiöldii*, *Taeniopteris*, *Ptilophyllum cutchense*, *Elatocladus kingianus* and *Pagiophyllum marwarensis*. Besides, palynofossil comprise about 64 taxa out of which the dominant component is the *Araucariacites* — *Callialasporites* complex and stratigraphically important forms occurring in microflora are: *Trilites tuberculiformis*, *Ischyosporites crateris*, *Cooksonites variabilis*, and *Microcachridites antarcticus*. These authors considered the age of these outcrops upon mega-micro-

floral evidence somewhere near Jurassic — Cretaceous boundary probably within the Lower Cretaceous. Further upon palynological investigations RAMANUJAM et al. (1979, 1980) have affixed the age Lower Cretaceous (= Neocomian) for Gangapur Formation. Lately, RAO et al. (1983) confirmed the observations made by earlier workers regarding the dominant and stratigraphically significant palynomorphs. SUKH-DEV and RAJNI KANTH (1988) made further additions of plant megafossils and confirmed the age Lower Cretaceous for the Gangapur Formation.

Lithologically, Gangapur Formation is made up of conglomerates sandstone and shale (KARUNAKARAN, 1975). Sandstone is ferruginous and bears underlying Kota



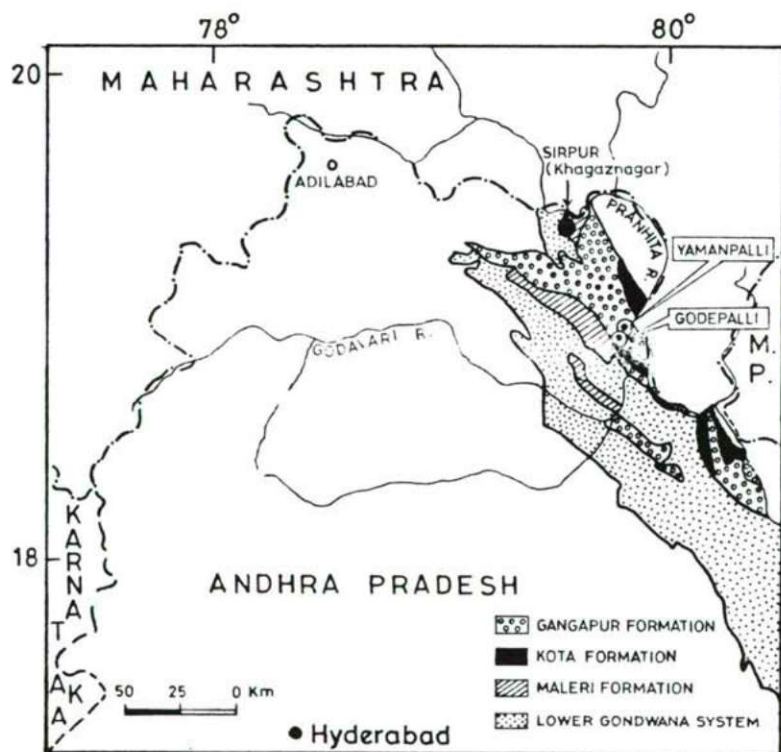
Text-fig. 1.

Map showing fossil localities /after Toposheet No. 56 $\frac{M}{16}$ Chanda-Adilabad District, Andhra Pradesh, India.

fossil plants. Plant fossils are particularly found in finer sediments, namely, mudstone, siltstone and the carbonaceous shale but fragments of fossil woods are found littered or embedded in sandstone.

The present floral collections comprising mainly the petrified woods have been made from the outcrop located near Yamanpalli ($79^{\circ}50'58''$: $19^{\circ}6'$) and Godepalli (= Gundepalli, $79^{\circ}47'48''$: $19^{\circ}4'$), Kadamba Block, Kagaznagar, Adilabad District, Andhra Pradesh. These new sites also lie under Gangapur Formation and the occurrence of these woods in plenty has confirmed the observations made earlier for the extension of Gangapur Formation in the eastern part of Pranhita Godavari Graben.

The anatomical studies of these petrified woods have revealed the presence of two families of Coniferales, viz., *Araucariaceae* and *Podocarpaceae* which have been represented by genera *Araucarioxylon* and *Podocarpoxylon* respectively.



Text-fig. 2.

Map showing Gondwana formations of Pranhita-Godavari Graben, Adilabad District, Andhra Pradesh. (Drawn after Dr. M. K. ROY CHOWDHURY, Director General, Geological Survey of India. Geological and Mineral Map of Andhra Pradesh, 1973, refer. Karunakaran, 1975).

Results

TAXONOMY

Order: *CONIFERALES*

Family: *Araucariaceae*

Araucarioxylon amraparens (SAH and JAIN)
BOSE and MAHESHWARI

(Pl. I, figs. 1—6; Text-figs. 3A, B)

Description — Growth rings measures 3800 μm to 3960 μm in width but usually indistinctly marked by thin bands of late wood tracheids. Late wood zone 60 μm to 90 μm in width, or 2—3 cells wide, cells are 16 μm to 20 μm in diameter, tangentially flattened, compactly arranged squarish to rectangular, thick-walled cells in radial rows. Early wood contributes more than 70% of the growth ring, ranges from 85 to 105 cells wide, tracheids comparatively thin walled, oval, squarish to polygonal in shape arranged in radial rows, radial diameter 40—60 μm , tangential diameter 30—40 μm , tangential wall of tracheids usually smooth but their radial walls show pitting and pits numerous, uniseriate or biseriate, alternate, contiguous, hexagonal in shape about 16 μm in diameter, having oval to circular orifices, 4—6 μm in diameter; parenchyma and Bars of Sanio absent; xylem rays numerous, 4—6 per millimeter, uniseriate, 16 μm wide and varying from 2 to 10 cells or 40—245 μm high (represented in the form of elongated barrel-shaped cells in tangential section), pits in the cross-field not observed.

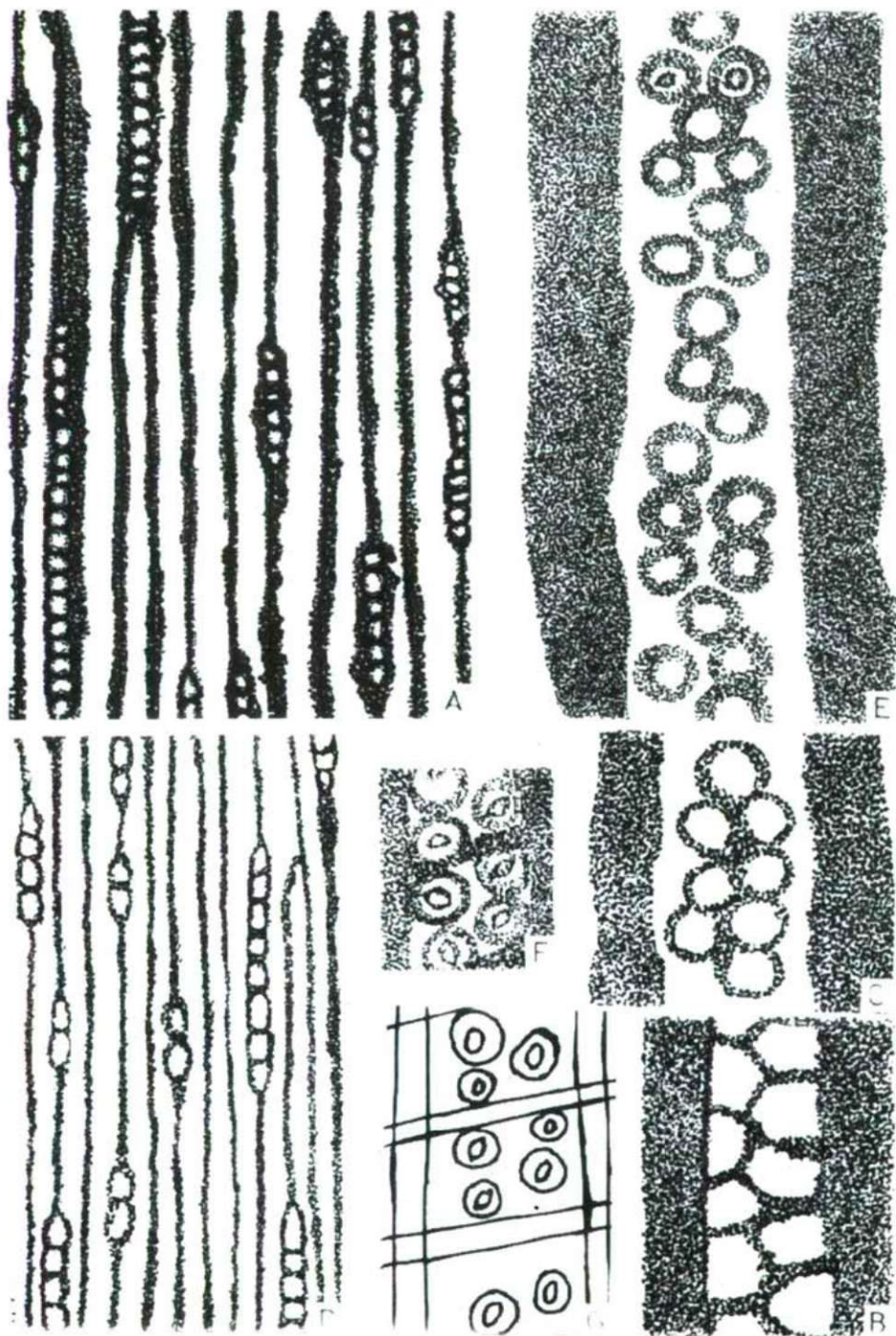
Syntype — B. S. I. P., Slide No. 35603.

Locality — Yamanpalle, Gangapur Formation, Pranhita Godavari Graben Adilabad District.

Age — Lower Cretaceous.

Text-fig. 3.

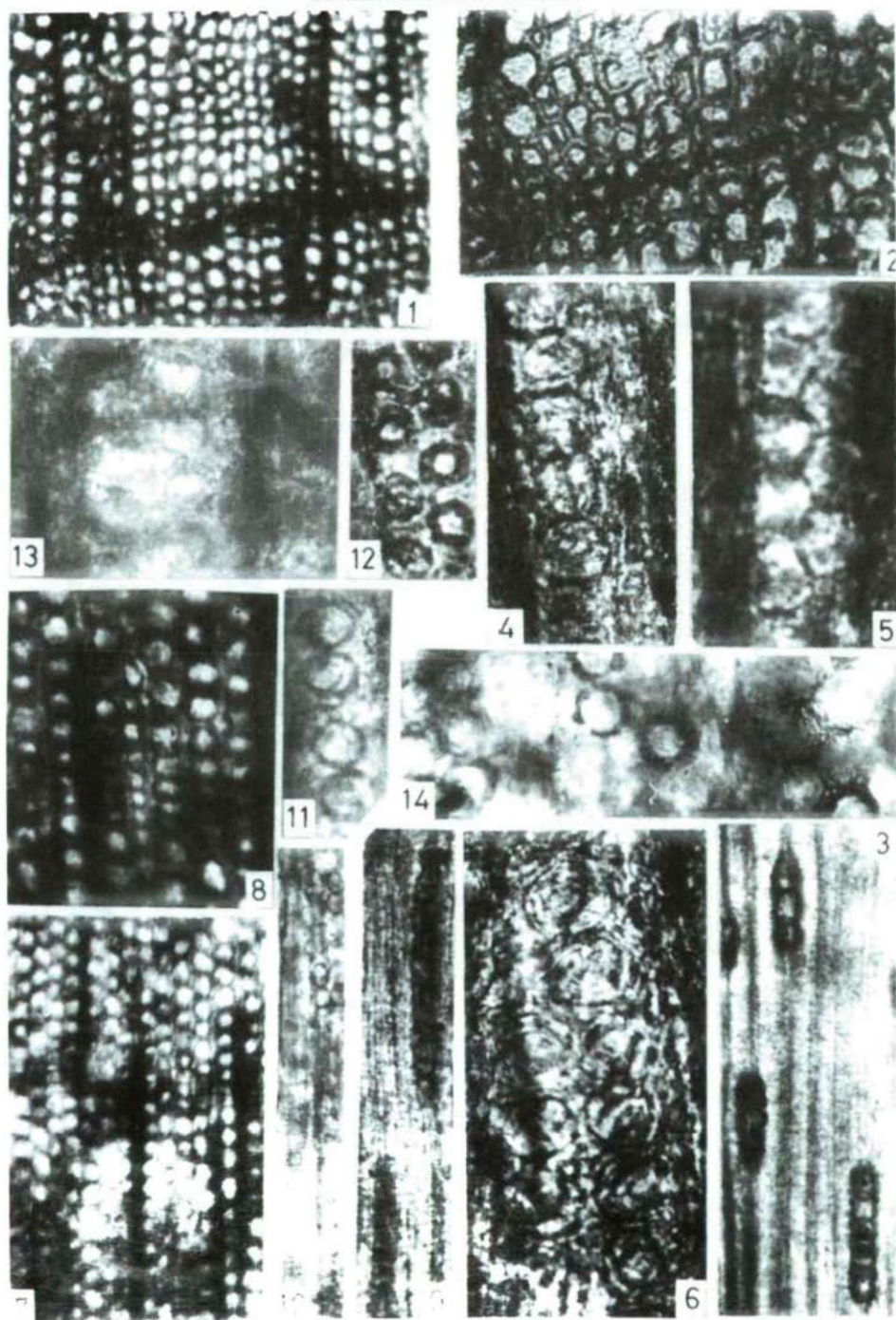
- A. *Araucarioxylon amraparens* SAH and JAIN 1964; tangential longitudinal section showing uniseriate xylem rays. Slide No. 35 603—II, $\times 100$.
- B. Radial longitudinal section showing biseriate, alternate, hexagonal pitting. Slide No. 35 603—III, $\times 500$.
- C. *Araucarioxylon* sp., radial longitudinal section showing biseriate, circular pitting. Slide No. 35 865—III, $\times 500$.
- D. *Podocarpoxylon* sp. tangential longitudinal section showing uniseriate xylem rays. Slide No. 35863—II, $\times 100$.
- E. Radial longitudinal section showing circular pitting. Slide No. 35 864—III, $\times 500$.
- F. *Podocarpoxylon parthasarthyi*; radial longitudinal section showing cross-field pitting. Slide No. 35 855—III, $\times 500$.
- G. Radial longitudinal section showing oblique apertures in the cross-field pitting. Slide No. 35 855—III, $\times 500$.



Remarks — Identical woods have been reported from the adjacent locality Godepalli but because of lack of distinct growth rings, these specimens have not been included under *A. amraparensis* rather have been treated here as *Araucarioxylon* sp. (Text-fig. 3C). However, their occurrence in this particular locality is quite meagre. MAHESHWARI (1972) has identified both genera *Dadoxylon* and *Araucarioxylon* on the basis of secondary wood only. According to him *Araucarioxylon* is characterized by uniseriate xylem rays and *Dadoxylon* by multiseriate xylem rays. In view of the diagnosis of the two genera, most of the araucarian woods described earlier under the name *Dadoxylon* have not been transferred to *Araucarioxylon* (BOSE and MAHESHWARI, 1974). The present wood differs from *Araucarioxylon agathioides* (KRÄUSEL and JAIN) BOSE and MAHESHWARI, in the absence of pits having cross-shaped aperture and 2—8 cross-field pits. *Araucarioxylon bindrabunense* (SAH and JAIN 1964) comb. nov. also differentiates itself in the character of 1—45 cells high medullary rays and 4—12 bordered pits in the cross-field area. From the *Araucarioxylon mandroense* SAH and JAIN 1964 comb. nov., present wood can be distinguished by the character of distinct growth rings and distinct cross-field pits in the early and late wood tracheids. *Araucarioxylon rajmahalense* SAHNI, 1931, possesses distinct 2—3 radial pitting in early wood and uniseriate pitting in the late wood. *Araucarioxylon santalense* SAH and JAIN, 1964, has got microscopically indistinguishable growth rings and 2—6 cross-field pits, however, this feature completely lacks in the present wood. The present wood resembles most to *Araucarioxylon amraparensis* SAH and JAIN 1964 in general specific characters, described from Amrapara, Rajmahal hills, Bihar.

Plate I

- 1—6. *Araucarioxylon amraparensis* SAH and JAIN 1964.
 1. Cross-section showing growth rings with early and late wood. BSIP Slide No. 35 603—I, $\times 50$.
 2. Cross-section magnified to show early wood and late wood. BSIP Slide No. 35 603—I, $\times 100$.
 3. Tangential longitudinal section showing uniseriate xylem rays. BSIP Slide No. 35 604—II, $\times 100$.
 4. Radial longitudinal section showing uniseriate, hexagonal, contiguous pits. BSIP Slide No. 35 602—III, $\times 500$.
 5. Radial longitudinal section showing biseriate, alternate, hexagonal pits. BSIP Slide No. 35 603—III, $\times 500$.
 6. Radial longitudinal section showing circular pitting tending to be arranged in parallel rows. BSIP Slide No. 35 605—III, $\times 500$.
- 7—14. *Podocarpoxylon parthasarthyi* SAHNI 1931.
 7. Cross-section showing growth ring with early and late wood. BSIP Slide No. 35 855—I, $\times 50$.
 8. Cross-section magnified to show early wood and late wood. BSIP Slide No. 35 855—I, $\times 100$.
 9. Tangential longitudinal section showing xylem rays. BSIP Slide No. 35 856—II, $\times 100$.
 10. Tangential longitudinal section showing pitting. BSIP Slide No. 35 856—II, $\times 200$.
 11. Radial longitudinal section showing uniseriate, circular pitting. BSIP Slide No. 35 855—III, $\times 500$.
 12. Radial longitudinal section showing biseriate, circular pits. BSIP Slide No. 35 856—III, $\times 500$.
 13. Radial longitudinal section showing pits in the cross-field area. BSIP Slide No. 35 855—III, $\times 500$.
 14. Radial longitudinal section showing solitary, circular pits tending to be arranged alternate appearing hexagonal due to compression. BSIP Slide No. 35 856, $\times 500$.



The radial pitting in the present fossil wood shows typically araucaroid pitting having hexagonal, alternate, contiguous pits. However, at places the radial pits tend to be opposite and circular. Such a pitting is also reported in *A. amraparense*. Like *A. amraparense*, rays are uniseriate, 2 to 10 cells high. Cross-field pits are not observed in the present fossil wood due to ill-preservation.

On account of the presence of above said characters the present wood has been placed under *Araucarioxylon amraparense* (SAH and JAIN) BOSE and MAHESHWARI, 1974.

Family: *Podocarpaceae*

Podocarpoxyton parthasarthyi (SAHNI)
BOSE and MAHESHWARI

(Pl. I, figs. 7—14; Text-figs. 3F, G)

Description — Growth rings presents but not conspicuous, indistinctly marked by late wood tracheids. Late wood zone 80 to 90 μm or 3—4 cells wide comprising compactly arranged tangentially flattened rectangular thick-walled tracheids of 18 μm in diameter. Early wood zone quite wide consisting of 20 to 50 tracheidal cells, tracheids comparatively thin walled, oval, circular or polygonal with wide lumen arranged in radial rows, radial diameter 42—50 μm and tangential diameter 28—40 μm , tangential wall usually smooth, but rarely it shows circular pitting, rays frequency 4—6 rays/mm. Xylem rays uniseriate, rarely biseriate, 1 to 20 cells or 30 to 550 μm in height, pits numerous, mostly uniseriate, biseriate, when biseriate, opposite to subopposite, mostly solitary or contiguous, oval to circular 10 to 20 μm in diameter, aperturate circular 4—6 μm , rarely uniseriate pits present on tangential walls of tracheids, uniseriate 8—14 μm in diameter, cross-field pits 2—3 small, oval circular, cuppressoid having oblique aperture.

Syntype — B. S. I. P., Slide No. 35855.

Locality — Godepalli, Gangapur Formation, Pranhita-Godavari Graben, Adilabad District.

Age — Lower Cretaceous.

Remarks — A few wood specimens collected from Yamanpalli have also been identified as *Podocarpoxyton* sp. (Text-figs. 3D, E) but they could not be assigned definitively to *P. parthasarthyi* due to inadequate characters. Also it has been marked that their representation in this locality is poor. Fossil woods showing anatomical characters of the family *Podocarpaceae* have been usually described under three generic names viz. *Podocarpoxyton*, *Phyllocladoxylon* and *Mesembrioxylon* (GOTHAN 1905). Since these genera are based upon variable characters, all the fossil woods showing features of *Podocarpaceae* should be described under the generic name *Podocarpoxyton* GOTHAN (BANDE et al. 1984) as against *Phyllocladoxylon*

GOTHAN, *Circoporoxylon* KRÄUSEL and *Mesembrioxylon* SEWARD. LAKHANPAL et al. (1975) opined that the species of *Mesembrioxylon* be critically examined before changing en block all the species of *Mesembrioxylon* to *Podocarpoxyton*. So far, nine species of *Mesembrioxylon* have been known from the Mesozoic rocks of India which have been transferred by BOSE and MAHESHWARI (1974) under the genus *Podocarpoxyton*.

The present wood resembles most to *Podocarpoxyton parthasarthyi* SAHNI, 1931, described from Sriperumbudur group, in the characters of growth rings, xylem rays and pitting. However, it rarely shows biseriate xylem rays and 1—3 pits in the field whereas in *P. parthasarthyi*, usually rays uniseriate, and 2—6 round bordered pits present in the field. Such variable characters are usually noted in the same piece of wood. Therefore the present wood has been identified as *Podocarpoxyton parthasarthyi* (SAHNI, 1931) BOSE and MAHESHWARI 1974.

The Indian species of *Podocarpoxyton*, described by SAHNI (1931), RAMANUJAM (1953), BHARDWAJ (1953), SURYANARAYANA (1953), can be sharply distinguished from the present wood in one or the other character. *Podocarpoxyton schmidianum* SAHNI 1931, and *P. sahnii* RAMANUJAM 1953, both reported from Tiruvakkarai, distinguish themselves in the possession of 2—100 cells high xylem rays, 1 to 3 seriate rays and single fusiform pit in the field. *P. godavarianum* SAHNI, 1931 from Bogapalmila in the Godavari Graben, can be differentiated from the present wood in the absence of growth rings, presence of resinous parenchyma. Also pits in the cross-field area are 2—6 having slit-like pore. From *P. tirumangalense* described by SURYANARAYANA (1953) from Sriperumbudur, the present wood differs in the nature of field pitting. The genus *Podocarpoxyton tiruvakkaraiianum* RAMANUJAM (1953) from Tiruvakkarai differs in the bearing xylem rays 3—50 cells high, and a large single borderless pit in the field. *Podocarpoxyton indicum* BHARADWAJ, 1953 from Rajmahal hills, Bihar, though agrees with the present form in possessing growth rings but radically contrasts in the absence of rims of Sanio and xylem parenchyma. Also the genus *Podocarpoxyton rajmahalense* JAIN 1965, reported from Rajmahal hills, conspicuously contrasts from the present specimen in having Eiporen (simple, large pit), 1—2 pinoid type pitting in crossfield area.

Discussion

The floral assemblage composed of only woods make the flora of diminutive size. The abundance of woods, however, near Yamanpalli and Godepalli and there absence elsewhere in Gangapur Formation take on added significance. The conspicuous absence of other plant organs from these new localities is noteworthy. This kind of deposition where one of the plant organs is present in enormous number is indicative of a restricted microenvironmental setting. Similarly, as evidenced by palynological data, RAO et al. (1983) have deduced the paleoclimatic and environmental interpretations in and around depositional basin. In the present assemblage

representation of two genera, namely: *Araucarioxylon* and *Podocarpoxylon* has confirmed the earlier findings that conifers have been well represented in Gangapur Formation and show sporadic development. The taxa frequently met are: *Araucarioxylon*, *Araucarites*, *Araucariacites*, *Pagiophyllum*, *Podocarpoxylon*, *Elatocladus*, *Microcachryidites* and *Coniferoaulon*. Among these, *Elatocladus* the leaf, *Podocarpoxylon* the wood, and *Microcachryidites* the palynomorph belonging to family *Podocarpaceae* occur profusely in the flora. Consequently, *Podocarpaceae* appears to be the commonest family in the Mesozoic of Pranhita — Godavari Graben.

Further, the absence of cycadophytic wood also reflects an younger age to this deposit and that supports the placement of these beds under Gangapur Formation.

Acknowledgements

Authors are grateful to Dr. M. N. BOSE for providing one of us (SCS) the rich collection of fossil woods. Our thanks are also due to Dr. ANIL CHANDRA for providing us geological map of Andhra Pradesh and his help in the map drawing. We express our grateful appreciation to Drs. N. AWASTHI and M. B. BANDE for their useful discussion during the preparation of the manuscript.

References

- BANDE, M. B. and PRAKASH, U. (1984): A Podocarpaceous fossil wood from the Deccan Intertrappean beds of Malabar Hills, Bombay. — *Geophytology* 14, 171—177.
- BHARADWAJ, D. C. (1953): Jurassic woods from the Rajmahal Hills, Bihar. — *Palaeobotanist* 2, 59—69.
- BOSE, M. N., KUTTY, T. S. and MAHESHWARI, H. K. (1982): Plant fossils from the Gangapur Formation. — *Palaeobotanist* 30, 121—142.
- BOSE, M. N. and MAHESHWARI, H. K. (1974): Mesozoic conifers. In: Aspects and appraisal of Indian Palaeobotany (eds. SURANGE, K. R., LAKHANPAL, R. N. and BHARADWAJ, D. C.). — Birbal Sahni Institute of Palaeobotany, Lucknow, 212—223.
- JAIN, K. P. (1965): A new species of *Mesembrioxylon*, *M. rajmahalense* from the Rajmahal Hills, Bihar, India. — *Palaeobotanist* 13, 153—154.
- KARUNAKARAN, C. (1975): Geology and mineral resources of the states of India. Part VIII. — Andhra Pradesh Geol. Surv. India Misc. Publ. 30, 7—51.
- KING, W. (1881): The geology of the Pranhita — Godavari Valley. — *Mem. Geol. Surv. India* 18, 151—311.
- KUTTY, T. K. (1969): Some contributions to the stratigraphy of the Upper Gondwana formations of Pranhita — Godavari Valley — Central India. — *J. geol. Soc. India* 10, 33—48.
- LAKHANPAL, R. N., GULERIA, J. S. and AWASTHI, N. (1975): A Podocarpaceous wood from the Pliocene of Kutch. — *Geophytology* 5, 172—177.
- MAHESHWARI, H. K. (1972): Permian wood from Antarctica and revision of some Lower Gondwana wood taxa. — *Palaeontographica B*, 138, 1—43.
- RAMANUJAM, C. G. K. (1953): On two new species of *Mesembrioxylon* from the vicinity of Pondicherry, South India. — *Palaeobotanist* 2, 101—106.
- RAMANUJAM, C. G. K. and RAO, P. V. R. (1979): Palynological approach to the study of some Upper Gondwana clays at Ralapat near Asifabad in Adilabad District of Andhra Pradesh. — *Geol. Surv. India. Misc. Publ.* 45, 45—50.

- RAMANUJAM, C. G. K. and RAO, P. V. R. (1980): Palynological evidence for the age of some Upper Gondwana deposits in Adilabad District of Andhra Pradesh. — Proc. IV. Int. Palynol. Conf. Lucknow 2, 386—391.
- RAO, P. V. R., RAMANUJAM, C. G. K. and VARMA, Y. N. R. (1983): Palynology of the Gangapur beds, Pranhita-Godavari Basin, Andhra Pradesh. — Geophytology 13, 22—45.
- RUDRA, D. K. (1972): A discussion on the Kota Formation of the Pranhita-Godavari Valley, Deccan. — Q. Jl. geol. Min. Metall. Soc. India 44, 213—216.
- RUDRA, D. K. (1982): Upper Gondwana stratigraphy and sedimentation in the Pranhita-Godavari Valley, India. — Q. Jl. geol. Min. Metall. Soc. India 54, 56—79.
- SAHNI, B. (1931): Revision of Indian fossil plants, Part II: Coniferales (b. Petrifications). — Mem. geol. Surv. India. Palaeont. Indica n. s. 11, 51—124.
- SAH, S. C. D. and JAIN, K. P. (1964): Some fossil woods from the Jurassic of Rajmahal hills, Bihar, India. — Palaeobotanist 12, 169—180.
- SUKH-DEV and RAJNIKANTH, A. (1988): The Gangapur Formation: Fossil flora and stratigraphy. — Geophytology 18, 1—27.
- SURYANARAYANA, K. (1953): *Mesembrioxylon tirumangalense*, a new species from the Sripermatpur Group near Madras. — J. Indian bot. Soc. 32, 159—164.