The Palaeobotanist, **32**(1): 35-43, 1984.

OCCURRENCE OF ANACARDIACEOUS WOODS IN THE TERTIARY OF WESTERN INDIA

J. S. GULERIA

Birbal Sahni Institute of Palaeobotany, 53 University Road, Lucknow 226 007, India

ABSTRACT

The present paper deals with two fossil woods of the family Anacardiaceae showing closest resemblance with the woods of the extant genera *Gluta* L. and *Mangifera* L. The former is described from the Banaskantha District of Gujarat and the latter from the Jaisalmer District of Rajasthan. The occurrence of these woods during the Tertiary in the above areas indicates that the climatic conditions were definitely more humid at the time of deposition of these woods than the present dry desertic conditions.

Key-words — Anacardiaceous woods, *Glutoxylon*, *Mangiferoxylon*, Gujarat, Rajasthan, Tertiary, India.

सारांश

पश्चिमी भारत के तृतीयक युग से ऍनाकार्डिएसी कुल की काष्ठें – जसवंत सिंह गुलेरिया

इस शोध-पत्र में ऍनाकार्डिएसी कुल के वर्तमान ग्लूटा लिने एवं मेंजिफ़ेरा लिने की काष्ठों से घनिष्ठतम् सजातीयता व्यक्त करने वाले दो काष्ठाश्मों का वर्णन किया गया है। पहला काष्ठाश्म गुजरात के बनासकाँठा जनपद से तथा दूसरा राजस्थान के जैसलमेर जनपद से वर्णित किया गया है। उपरोक्त क्षेत्रों में तृतीयक युग में इन काष्ठाश्मों की उपलब्धि यह इंगित करती है कि वर्तमान शुष्क मरुद्भिदी परिस्थितियों की अपेक्षाकृत इन काष्ठाश्मों के निक्षेपण के समय निश्चित रूप से अधिक नम जलवायवी परिस्थितियाँ विद्यमान थीं।

INTRODUCTION

VERY little work has been done so far on the Tertiary megaflora of western India (Gujarat & Rajasthan). The earliest known megafossils from Gujarat are two palms, viz., *Palmoxylon mathurii* and *P. seriatum* and a cylindrical reed-like stem *Culmites cutchensis* belonging to the family Gramineae described by Sahni (1932, 1964) which are believed to come from the Cretaceous of district Kachchh. However, the locality and the age of these monocot fossils is doubtful and may most probably be Tertiary. Ghosh and Ghosh (1959) were the first to describe a dicot wood from the Tertiary beds of Kachchh. Subsequently, Prakash and Dayal (1968), Lakhanpal *et al.* (1975), Awasthi *et al.* (1980), Lakhanpal and Guleria (1981), Awasthi *et al.* (1982), Lakhanpal and Guleria (1982), Guleria (1983, 1984), Guleria and Lakhanpal (in press) have described a number of fossil woods, leaves and fruits. They belong to the following families: Combretaceae, Dipterocarpaceae, Lauraceae, Leguminosae, Lythraceae, Moraceae, Palmae, Pandanaceae, Podocarpaceae, Sapindaceae, Sterculiaceae and Rutaceae. The only other record of megafossil from Gujarat is a fossil wood of *Terminalia* described by Mahabalé and Deshpande (1965) from Ghala in the Surat District.

From Rajasthan, La Touche (1911, p. 34) reported the occurrence of angiosperm leaves from Barmer Sandstone. Later on, Bose (1949, 1950, 1952), Kaul (1951), Lakhanpal and Bose (1951) and Lakhanpal (1964) described a few angiospermic leaf-impressions and fruits from the Palaeocene-Eocene beds of the Barmer District. Some of them have been assigned to the families Guttiferae and Palmae. Das Gupta (1977) reported the occurrence of fossil leaves belonging to the family Combretaceae, Euphorbiaceae and Verbenaceae. Recently,

Deshmukh and Sharma (1978) described a few dicot leaf impressions resembling *Alnus*, *Betula*, *Sapindus* and *Ulmus* belonging to the temperate families alongwith a vegetative twig of *Salvinia*. Without going into details, it is pointed out that the identification of the dicot leaf-impressions of Deshmukh and Sharma are wrong and need reinvestigation as they have tried to match their leaves with the European forms without giving any thought to the morphological characters of their fossils. For example, the margin of the leaves in their type 'A' and 'B' are entire whereas in the comparable form (*Ulmus*), the margins are serrate. In addition to these impressions, Garg (1977) reported a solitary piece of a palm wood from the Deccan Trap beds of the Banaswara District.

Thus, it is evident from the above resumé that none of the megafossils reported so far from the western India belong to the family Anacardiaceae. Hence, it was thought that the woods of this family which have been collected from two different parts of western India, viz., Banaskantha District of Gujarat and Jaisalmer District of Rajastan be reported together. The occurrence of fossil woods near the village Charanka (Map 1) in the Banaskantha District had been reported long back by Wynne (1872, p. 117). The author collected the fossils for the first time from this area in November-December, 1980. During the same field excursion he collected the Tertiary dicot woods from near village Habur (Map 1) in the Jaisalmer District. To my knowledge, this forms the first record of the Tertiary dicot woods from anywhere in Rajasthan.

The wood specimens which come from the Banaskantha District of Gujarat belong to the Khari Series which is Lower Miocene in age (Biswas & Raju, 1973). The age of the wood specimen from the Jaisalmer District is uncertain. However, the abundance of petrified dicot woods in the locality and the assemblage under investigation indicate that they belong to Tertiary. It is interesting to note that these woods were found scattered on a small hillock of the Pariwar Formation (Cenomanian). The overlying rocks are absent in the locality. Tertiary rocks in the vicinity are of Palaeocene-Eocene (Sanu & Khuiala formations) age (Das Gupta, 1977). Contrary to the Palaeogene assemblage, the dicot woods collected from this locality (which will be described elsewhere) show Neogene type of assemblage. Hence, for the time being the age of this fossil wood may be considered probably ?Upper Tertiary.

Family — Anacardiaceae

Genus — *Glutoxylon* (Chowdhury) Prakash & Tripathi, 1969

1976 *Melanorrhoeoxylon* Prakash & Tripathi, 1976.

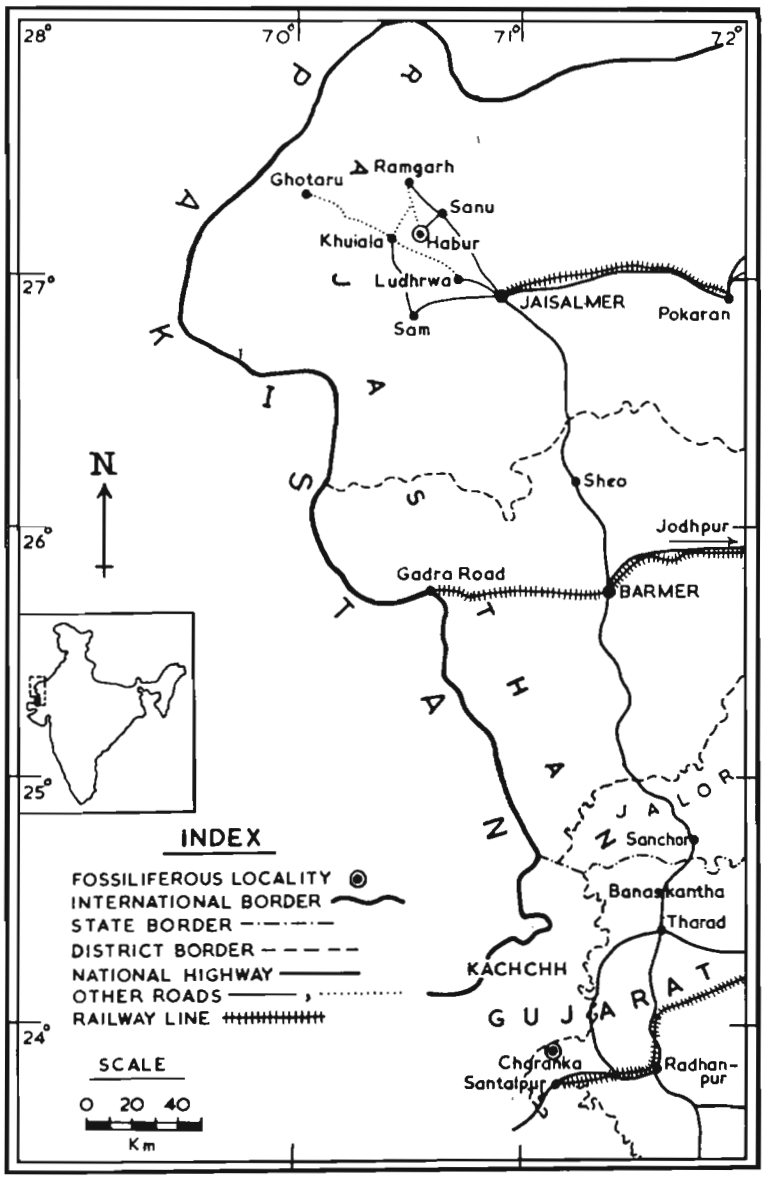
Glutoxylon burmense (Holden) Chowdhury, 1952

1978 *Glutoxylon kalagarhense* Trivedi & Ahuja, p. 135 figs 1-4.

Pl. 1, figs 1-4

The description is based on two small pieces of petrified woods which are dark brown in colour. Although the specimens are twisted and crushed they exhibit fairly good preservation.

Topography — Wood diffuse porous (Pl. 1, fig. 1). *Growth rings* indistinct. *Vessels* small to large (mostly medium to large), t.d. 44-280 μm, r.d. 48-300 μm, circular to oval in shape, sometimes flattened due to compression, solitary or in radial multiples of 2-3, 5-10 per sq mm; tyloses abundant, sometimes completely occluding the vessels (Pl. 1, fig. 1); vessel members 380-860 μm in length with slightly oblique end walls; perforations simple; intervessel pits 8-10 μm in diameter, bordered, alternate, circular to oval with lenticular aperture. *Parenchyma* paratracheal as well as apotracheal (Pl. 1, fig. 1); paratracheal parenchyma scanty, forming 1-2 celled sheath around the vessels; apotracheal parenchyma in the form of narrow bands, irregularly spaced, 5-9 per mm, mostly 1-3 (4-5) cells wide; parenchyma cells circular to oval, sometimes flattened. *Xylem rays* simple and fusiform (Pl. 1, figs 2, 3), simple rays fine, 1-2 (mostly 1) seriate or 8-24 μm wide, homo-to weakly heterocellular (Pl. 1, fig. 4), 4-17 cells or 80-400 μm in height; fusiform rays 3-4 cells or 80-88 μm wide with single radial gum duct in the middle (Pl. 1, fig. 3);



MAP 1

24-36 per mm, tangential height of upright ray cells 40-56 μm, radial length 36-48 μm, tangential height of procumbent cells 16-24 μm and radial length 60-96 μm. *Fibres* aligned in radial rows between the two consecutive xylem rays, thick-walled, non-septate.

Affinities — The above characters indicate that the fossil in all its anatomical features shows close similarity with the modern wood of *Gluta*.

Chowdhury (1934, 1936) instituted the genus *Glutoxylon* for the fossil wood resembling *Gluta* and such woods of *Melanor-*

rhoea which have thin apotracheal bands of parenchyma while describing *Glutoxylon assamicum* from the Tertiary of Assam. In 1952, he transferred *Glutoxylon assamicum* to *G. burmense* (Holden) Comb. nov. alongwith many other genera and species (Chowdhury, 1952, p. 376). This species was further reported by Chowdhury and Tandon (1952), and Ghosh and Taneja (1961) from the Tertiary beds of Midnapur District, West Bengal and Tripura respectively. Prakash and Tripathi (1969) emended the diagnosis of *Glutoxylon* Chowdhury (1936) while reporting *G. burmense* from a new locality of Hailakandi in Cachar District of Assam. Further, on the basis of their study of living woods of *Gluta* and *Melanorrhoea* they observed that the woods of these two genera can be divided into two groups. One of the groups includes all the species of *Gluta* and those *Melanorrhoea* having thin apotracheal parenchyma bands 1-7 (usually 2-4) cells wide and the second group includes only some species of *Melanorrhoea* which possess thick apotracheal parenchyma bands 1-10 (usually 3-7 or 8) cells wide. From this study they suggested that the fossil woods showing resemblance with the former group be named as *Glutoxylon* and those belonging to the latter group be named as *Melanorrhoeoxylon*. They formally instituted the genus *Melanorrhoeoxylon* for accommodating the woods of the latter group in 1976. However, Hou (1978) in his latest work on the family Anacardiaceae has merged the genus *Melanorrhoea* into *Gluta* taxonomically. As the two genera are taxonomically similar and the genus *Gluta* has the priority over *Melanorrhoea* so only *Gluta* occurs in the modern flora. In the light of Hou's work the genus *Melanorrhoeoxylon* Prakash & Tripathi (1976) has become synonymous to the earlier known genus *Glutoxylon* (Chowdhury) Prakash & Tripathi (1969) hence the genus *Malanorrhoeoxylon* is superfluous. Therefore, it is being rejected vide article 63 of the International Code of Botanical Nomenclature (Stafleu, 1978). As a consequence the two known species of *Melanorrhoeoxylon*, *M. cacharense* Prakash & Tripathi (1976, pp. 82-88, pl. 1, figs 1-5) and *M. garbetaense* Roy & Ghosh (1981, pp. 338-352, pl. 4, figs 23-27) are now renamed as *Glutoxylon cacharense* (Prakash & Tripathi) comb. nov., and *Glutoxylon garbetaense* (Roy & Ghosh) comb. nov.

Mukherjee (1942 a, b, c) and Ghosh (1958) described two new species of *Glutoxylon*, viz., *G. bengalensis* from the Tertiary of Bangla Desh and *G. chowdhurii* from the Pleistocene of Manipur. However, both these species were merged into *G. burmense* by Awasthi in 1966 while recording this species and describing a new species *G. cuddalorense* from the Cuddalore Series of South India. Recently *G. burmense* has also been reported by Prakash and Awasthi (1971), Prakash (1973), Roy and Ghosh (1979) from the Upper Tertiary beds of Assam, Burma and West Bengal respectively. Further, Kramer (1974) reported this species from the Tertiary beds of Sumatra and Borneo giving its up to date synonymy. Lemoigne (1978) described a new species, *Glutoxylon symphonoides* from the Tertiary of Ethiopia. Another species, *G. kalagarhense* sp. nov., was reported by Trivedi and Ahuja (1978) from the Mio-Pliocene beds of Kalagarh, Bijnor District of Uttar Pradesh. Thus, the author is aware of only six species of *Glutoxylon* known so far. Of the six species, *G. kalagarhense* Trivedi & Ahuja (1978) shows all the characters of *G. burmense*, hence it is placed under the same. Since the anatomical characters of the present fossil are also in conformity with *G. burmense*, therefore, it is put under the same species.

On comparing the present fossil with the modern woods of *Gluta* (including former *Melanorrhoea*) it was found that *Gluta travancorica* Bedd. (F.R.I. Xylarium slide no. 7440) shows closest resemblance with the fossil.

According to Hou (1978, p. 8) *Gluta* now consists of 30 species distributed in Madagascar, India, Burma, Thailand, Indochina, China and throughout Malesia. *Gluta travancorica* is found in the south-west coast of India (in dense moist forests of South Travancore) and in the Thirunelveli District of Tamil Nadu. The present fossil wood of *Gluta* from the north-west of Gujarat shows that the genus was wide spread in India during the Upper Tertiary.

B.S.I.P. Museum Specimen nos. 35480, and 1/2379.

Locality — Charanka, 23°53′: 71°10′30″ Chorar Island), about 15 km north

of Santalpur, Banaskantha District, Gujarat.

Horizon — Khari Series.

Age — Lower Miocene.

Genus — *Mangiferoxylon* Awasthi emend.

Mangiferoxylon assamicum Prakash & Tripathi, 1970

Pl. 1, figs 5-7

The description is based on a single piece of petrified wood measuring 5 cm in length and 2 cm in diameter. The preservation is fairly good.

Topography — Wood diffuse porous (Pl. 1, fig. 5). *Growth rings* distinct delimited by thin apotracheal parenchyma band. *Vessels* small to large (mostly small to medium) t.d. 80-220 μm, r.d. 88-220 μm, circular to oval in shape, mostly solitary or in radial multiples of 2-4, 3-6 per sq mm, sometimes filled with gummy material, tyloses not seen; vessel members 240-580 μm in length with slightly oblique end walls; perforations simple; intervessel pits bordered, 6-10 μm in diameter, circular to oval with linear to lenticular aperture. *Parenchyma* both paratracheal and apotracheal (Pl. 1, fig. 5); paratracheal parenchyma vasicentric, mostly aliform to confluent; apotracheal parenchyma forming continuous to short broken narrow bands, 1-3 cells wide also delimiting the growth rings; parenchyma cells round, oval to angular in shape or sometimes flattened near the vessels, t.d. 80-110 μm, r.d. 96-166 μm. *Xylem rays* fine, 1-2 (3) cells (approximately 60% rays are uniseriate and 40% biseriate) or 20-64 μm wide; ray tissue heterogeneous (Pl. 1, figs 6, 7); rays heterocellular consisting of procumbent cells in the middle portion and upright cells at one or both the ends of the ray (Pl. 1, fig. 6), 10-18 per mm, 4-16 (21) cells or 120-400 (480) μm in height; tangential height of upright cells 32-36 μm and radial length 20-32 μm; tangential height of procumbent cells 12-20 μm and radial length 40-60 μm. *Fibres* aligned in radial rows between two consecutive rays, oval to angular in shape, t.d. 10-20 μm, r.d. 16-24 μm, thick-walled, septa sometimes present.

Affinities — The above noted characters show that the fossil resembles the modern wood of the genus *Mangifera* Linn. of the family Anacardiaceae (Pearson & Brown, 1932, pp. 314-319, Heimsch, 1942, pp. 136-137, Metcalfe & Chalk, 1950, p. 456; Brazier & Franklin, 1961, p. 21; Anonymous, 1963, pp. 289-295; Miles, 1978).

On comparing the fossil with thin sections of the woods of *Mangifera indica* Linn., *M. altissima* Blanco, *M. sylvatica* Roxb, *M. longipes* Griff., *M. caloneura* Kurz, *M. zeylanica* Hooker, and *Mangifera* sp., it was found that the fossil shows closest resemblance with *M. sylvatica* though some of the specimens of *M. indica* also come closer to it (particularly F.R.I. Xylarium slide no. 6060). Usually these two species differ in the size of vessels, amount of parenchyma and the frequency of uniseriate and biseriate rays. *M. sylvatica* possesses relatively samaller vessels, lesser amount of parenchyma and lesser frequency of biseriate rays compared to *M. indica*.

To accommodate the fossil woods of *Mangifera*, Awasthi (1966) created the genus *Mangiferoxylon*. Only two species of this genus are known, viz., *Mangiferoxylon scleroticum* Awasthi (1966) from the Cuddalore Series of South India and *M. assamicum* described by Prakash and Tripathi (1970) from the Middle Tertiary of Cachar District in Assam. The latter has also been reported by Kramer (1974) from the Tertiary beds of Sumatra and Borneo and by Roy and Ghosh (1981) from the Miocene beds of Birbhum District, West Bengal. In addition, a fossil wood resembling *Mangifera* was reported by Ramanujam (1953) from South India who subsequently (1960) described it as *Anacardioxylon mangiferoides* showing its affinities with *Mangifera* and *Anacardium*. As *Anacardioxylon mangiferoides* does not show the characters of *Mangifera* (Awasthi, 1966, p. 134; Prakash & Tripathi, 1970, p. 24) so it is not comparable with the present fossil. *Mangiferoxylon scleroticum* (Awasthi, 1966) although shows close resemblance with the present fossil in size and frequency of the vessels, and in the amount of parenchyma yet it differs in having relatively fine, tall and almost all uniseriate rays (99%). Complete biseriate rays are altogether absent in it. Further, it differs in having abundant

sclerotic tyloses and non-septate fibres. *M. assamicum* Prakash & Tripathi (1970) which shows close similarity with the wood structure of *Mangifera indica*, shows general similarity with the present fossil. However, it differs in having relatively more and bigger vessels, broader parenchyma bands and predominantly biseriate rays (approx. 70%). In view of the study of thin sections of the woods of the two species, viz., *Mangifera indica* and *M. sylvatica* which sometimes show overlapping characters (as stated earlier), the differences of the present fossil with *Mangiferoxylon assamicum* are being considered as variable. Hence, the present fossil is placed under *Mangiferoxylon assamicum*.

The genus *Mangifera* consists of 41 species (Willis, 1973) of large to very large evergreen trees confined mainly to the Indo-Malayan region. *M. sylvatica* with which the fossil is best comparable occurs in Nepal, Sikkim and North Bengal and in the Khasi Hills. It is sporadic in the evergreen forests of Upper Assam, Surma Valley and in the Andaman islands. It also occurs in Bangla Desh, Thailand and Cambodia. The other species, *M. indica*, some specimens of which also show resemblance with the fossil, grows throughout India up to 900 m excepting the north-western part.

The occurrence of septate fibres in *M. assamicum* (Prakash & Tripathi 1970; Kramer, 1974) and in the present fossil (though rare); the broader rays 1-3 seriate; the rare occurrence of short homocellular rays in *M. assamicum* (Prakash & Tripathi, 1970, p. 23) and the absence of tyloses in the present wood warrants the revision of the generic diagnosis of the genus *Mangiferoxylon* Awasthi (1966) as it fails to cover these characters. Hence the genus *Mangiferoxylon* Awasthi (1966) is emended as follows.

Mangiferoxylon Awasthi emend.

Wood diffuse-porous. *Growth rings* indistinct to distinct, when distinct delimited by apotracheal (terminal) parenchyma. *Vessels* small to large, solitary or in multiples of 2-4 or more; vessels members medium to large with truncated or tailed ends; perforations simple; intervessel pit pairs usually large, circular to oval, alternate, bordered, with linear to lenticular apertures; tyloses present or absent. *Parenchyma* paratracheal and apotracheal; paratracheal parenchyma vasicentric to aliform and aliform-confluent; apotracheal parenchyma usually in fine bands sometimes short and broken; also delimiting the growth rings. *Xylem rays* fine, 1-3 seriate; ray tissue heterogeneous; rays mostly heterocellular, consisting of procumbent cells through the median thickened portion and marginal rows of upright cells; rarely short rays homocellular; crystals often present. *Fibres* thin to thick-walled, rarely septate to non-septate.

B.S.I.P. Museum Specimen no. 35481.

Locality — Isolated small mound about 1.5 km south-east of village Habur; 57 km north of Jaisalmer.

Horizon — ?

Age — Tertiary (probably ?Upper Tertiary).

The occurrence of *Gluta* and *Mangifera* in the Banaskantha District of Gujarat and the Jaisalmer District of Rajasthan, respectively, during the Tertiary indicate more humid climatic conditions as compared to prevailing xeric and desertic conditions there.

ACKNOWLEDGEMENT

The author is grateful to the authorities of the Forest Research Institute, Dehradun for the facilities to consult the Xylarium.

REFERENCES

ANONYMOUS (1963). *Indian Woods*. II. Dehradun.

AWASTHI, N. (1966). Fossil woods of Anacardiaceae from the Tertiary of South India. *Palaeobotanist*, **14** (1-3): 131-143.

AWASTHI, N., GULERIA, J. S. & LAKHANPAL, R. N. (1980). A fossil dicotyledonous wood from the Pliocene beds of Mothala, district Kutch, western India. *Palaeobotanist*, **26** (3): 199-205.

AWASTHI, N., GULERIA, J. S. & LAKHANPAL, R. N. (1982). Two new fossil woods of Sapindaceae from the Tertiary of India. *Palaeobotanist*, **30** (1): 12-21.

BISWAS, S. K. & RAJU, D. S. N. (1973). The rock-stratigraphic classification of Tertiary sediments of Kutch. *Bull. Oil nat. gas Commn*, **10** (1-2): 37-45.

BOSE, M. N. (1949). Angiospermic remains from the Barmer sandstones. *Curr. Sci.*, **18**: 246-247.

BOSE, M. N. (1950). Fossil plants from Kapuria, Jodhpur, in "*Palaeobotany in India*" Editor R. V. Sitholey. *J. Indian bot. Soc.*, **29** (1): 34.

BOSE, M. N. (1952). Plant remains from Barmer District, Rajasthan. *J. sci. indus. res.*, **11B**: 185-190.

BRAZIER, J. D. & FRANKLIN, G. L. (1961). Identification of hard woods — A microscopic key. *Bull. Forest Prod. Res. Lond.*, **46**: 1-96.

CHOWDHURY, K. A. (1934). A fossil dicotyledonous wood from Assam. *Curr. Sci.*, **3** (6): 255-256.

CHOWDHURY, K. A. (1936). A fossil dicotyledonous wood from Assam. *Ann. Bot.*, **50** (199): 501-510.

CHOWDHURY, K. A. (1952). Some more fossil woods of *Glutoxylon* from south-east Asia. *Ann. Bot. N.S.*, **16** (63): 373-378.

CHOWDHURY, K. A. & TANDON, K. N. (1952). A new record for the fossil wood *Glutoxylon* from the southern part of West Bengal. *Curr. Sci.*, **21** (6): 161.

DAS GUPTA, S. K. (1977). The stratigraphy of the Rajasthan Shelf. *Proc. 4th Colloq. Indian Micropalaeont. Stratigr.*,: 219-233.

DESHMUKH, G. P. & SHARMA, B. D. (1978). Fossil plants from the Eocene of Barmer, Rajasthan (India). *Trans. Isdt Ucds*, **3** (2): 88-90.

GARG, R. L. (1977). Petrified wood from Deccan Trap, Banswara District, Rajasthan. *Indian Miner.*, **31** (1): 85.

GHOSH, S. S. (1958). A new record for the fossil wood *Glutoxylon* from Manipur. *Sci. Cult.*, **23**: 431-433.

GHOSH, S. S. & GHOSH, A. K. (1959). *Dipterocarpoxylon malavii* sp. nov. a new fossil record from the Pliocene of Kutch. *Sci. Cult.*, **25**: 328-332.

GHOSH, S. S. & TANEJA, K. K. (1961). Further record of *Glutoxylon* from the Miocene (?) of Tripura. *Sci. Cult.*, **27**: 581-582.

GULERIA, J. S. (1983). Some fossil woods from the Tertiary of Kachchh, western India. *Palaeobotanist*, **31** (2): 109-128.

GULERIA, J. S. (1984). Leguminous woods from the Tertiary of district Kachchh, Gujarat, western India. *Palaeobotanist*, **31** (3): 238-254.

GULERIA, J. S. & LAKHANPAL, R. N. (in press). On the occurrence of *Pandanus* from the Eocene of Kachchh, western India. *A. K. Ghosh Commemoration Vol.*

HEIMSCH, C. JR. (1942). Comparative anatomy of the secondary xylem in the "Gruinales" and "Terebinthales" of Wettstein with reference to taxonomic grouping. *Lilloa*, **8**: 83-198.

HOU, D. (1978). Florae Malesianae praecursores LVI. Anacardiaceae. *Blumea*, **24**, (1): 1-41.

KAUL, K. M. (1951). A palm fruit from Kapurdi (Jodhpur, Rajasthan Desert) *Cocos sahnii* sp. nov. *Curr. Sci.*, **20**: 138.

KRAMER, K. (1974). Die Tertiären hölzer Südost-Asiens. 2 Teil. *Palaeontographica*, **145B**: 1-150.

LAKHANPAL, R. N. (1964). Specific identification of the guttiferous leaves from the Tertiary of Rajasthan. *Palaeobotanist*, **12** (3): 265-266.

LAKHANPAL, R. N. & BOSE, M. N. (1951). Some Tertiary leaves and fruits of the Guttiferae from Rajasthan. *J. Indian bot. Soc.*, **30** (1-4): 132-136.

LAKHANPAL, R. N. & GULERIA, J. S. (1981). Leaf-impressions from the Eocene of Kachchh, western India. *Palaeobotanist*, **28-29**: 353-373.

LAKHANPAL, R. N. & GULERIA, J. S. (1982). Plant remains from the Miocene of Kachchh, western India. *Palaeobotanist*, **30** (3): 279-296.

LAKHANPAL, R. N., GULERIA, J. S. & AWASTHI, N. (1975). A podocarpaceous wood from the Pliocene of Kutch. *Geophytology*, **5** (2): 172-177.

LA TOUCHE, T. H. D. (1911). Geology of western Rajputana, Part-I. *Mem. geol. Surv. India*, **35** (1): 1-116.

LEMOIGNE, Y. (1978). Flores Tertiares de la Haute Vallee de L'omo (Ethiopie). *Palaeontogrphica*, **165B**: 89-157.

MAHABALÉ, T. S. & DESHPANDE, S. R. (1965). *Terminalioxylon tomentosum* sp. nov.: A fossil wood from Ghala (Gujarat State) belonging to the family Combretaceae. *Bull. bot. Surv. India*, **7** (1-4): 267-270.

METCALFE, C. R. & CHALK, L. (1950). *Anatomy of Dicotyledons*. **1**. Oxford.

MILES, A. (1978). *Photomicrographs of World Woods*. London.

MUKHERJEE, A. (1942a). A fossil dicotyledonous wood from Mainamati Hills. *Sci. Cult.*, **7** (7): 370-371.

MUKHERJEE, A. (1942b). Identification of fossil wood from the Lalmai range in Comilla, Bengal. *Sci. Cult.*, **7** (11): 572-574.

MUKHERJEE, A. (1942c). A fossil dicotyledonous wood from Mainamati Hills in Tipperah District, Bengal. *Q. Jl geol. Min. metall. Soc. India*, **14** (2): 75-82.

PEARSON, R. S. & BROWN, H. P. (1932). *Commercial Timbers of India*. **1**. Calcutta.

PRAKASH, U. (1973). Fossil woods from the Tertiary of Burma. *Palaeobotanist*, **20** (1): 48-70.

PRAKASH, U. & AWASTHI N. (1971). Fossil woods from the Tertiary of eastern India-11. *Palaeobotanist*, **18** (3): 219-225.

PRAKASH, U. & DAYAL, R. (1968). Fossil wood of *Terminalia* from Kutch. *Curr. Sci.*, **37** (8): 233.

PRAKASH, U. & TRIPATHI, P. P. (1969). On *Glutoxylon burmense* from Hailakandi in Assam, with critical remarks on the fossil woods of *Glutoxylon* Chowdhury. *Palaeobotanist*, **17** (1): 59-64.

PRAKASH, U. & TRIPATHI, P. P. (1970). Fossil woods from the Tertiary of Hailakandi in Assam. *Palaeobotanist*, **18** (1): 20-31.

PRAKASH, U. & TRIPATHI, P. P. (1976). Fossil dicot woods from the Tertiary of Assam. *Palaeobotanist*, **23** (2): 82-88.

RAMANUJAM, C. G. K. (1953). Fossil woods resembling *Mangifera*, *Shorea* and *Albizzia* in the Tertiary rocks of S. Arcot, India. *Curr. Sci.*, **22** (11): 336-337.

RAMANUJAM, C. G. K. (1960). Silicified woods from the Tertiary rocks of South India. *Palaeontographica*, **106B**: 99-140.

ROY, S. K. & GHOSH, P. (1979). On the occurrence of fossil woods of *Gluta* and *Anogeissus* from the Tertiary of West Bengal, India. *Geophytology*, **9** (1): 16-21.

ROY, S. K. & GHOSH, P. (1981). Fossil woods of Anacardiaceae from the Tertiary of West Bengal, India. *Palaeobotanist*, **28-29**: 338-352.

SAHNI, B. (1932). *Palmoxylon mathurii*, a new species of petrified palms from Cutch, western India. *Proc. 19th Indian Sci. Congr. Bangalore*, (*Abst*): 332.

SAHNI, B. (1964). *Revisions of Indian Fossil Plants. Part III. Monocotyledons*. Monograph. Birbal Sahni Institute of Palaeobotany Lucknow, pp. 1-89.

STAFLEU, F. A. (1978). International Code of Botanical Nomenclature. *Regnum Veg.*, **97**: Utrecht.

TRIVEDI, B. S. & AHUJA, M. (1978). *Glutoxylon kalagarhense* sp. nov. from Kalagarh. *Curr. Sci.*, **47** (4): 135.

WILLIS, J. C. (1973). *A Dictionary of the Flowering Plants and Ferns*. Cambridge.

WYNNE, A. B. (1872). Memoire on the Geology of Kutch, to accompany the map compiled by A. B. Wynne and F. Fedden during the season 1867-68 and 1868-69. *Mem. geol. Surv. India*, **9** (1): 1-293.

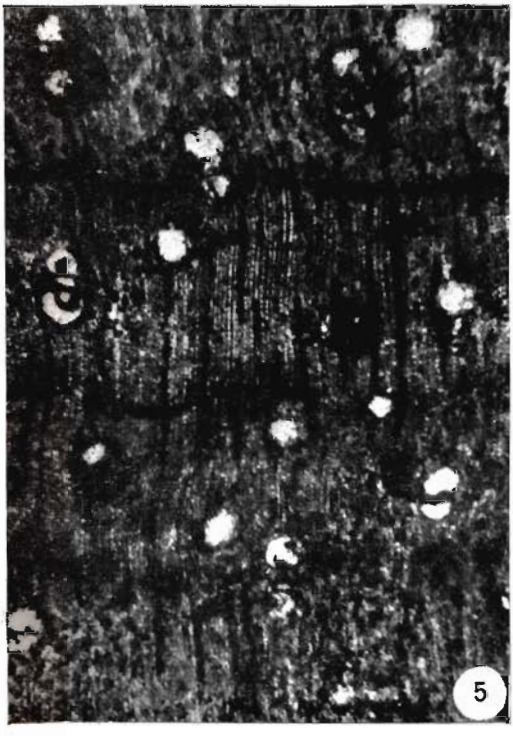
EXPLANATION OF PLATE

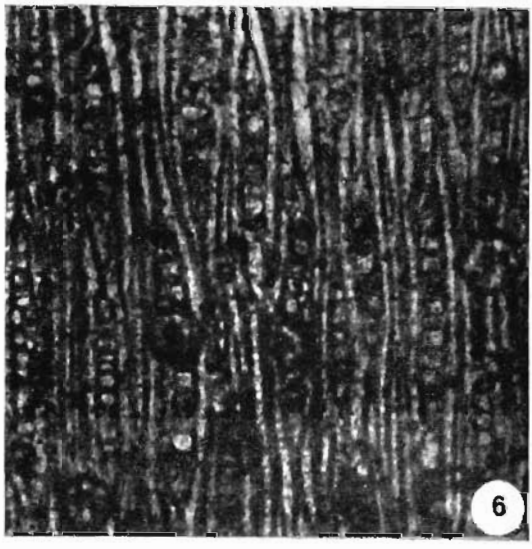
Glutoxylon burmense (Holden) Chowdhury, 1952

1. Cross section of the fossil wood showing the type and distribution of parenchyma and vessels with tyloses.× 30. Slide no. 6825.
2. Tangential longitudinal section of the fossil wood showing simple xylem rays.× 90. Slide no. 6826.
3. Tangential longitudinal section showing single fusiform ray with gum duct.× 90. Slide no. 6827.
4. Radial longitudinal section showing heterocellular xylem ray.× 90. Slide no. 6828.

Mangiferoxylon assamicum Prakash & Tripathi, 1970

5. Cross section of the fossil wood showing the type and distribution of vessels and parenchyma.× 15. Slide no. 6829.
6. Tangential longitudinal section of the fossil wood showing the xylem rays and their distribution. × 100. Slide no. 6830.
7. Radial longitudinal section of the fossil wood showing heterocellular xylem rays.× 90. Slide no. 6831.





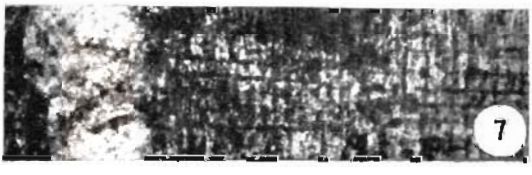


PLATE 1