

Fossil leaf of *Terminalia* from the Rajpardi Lignite mine, district Bharuch, Gujarat, India

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A fossil leaf of *Terminalia* resembling *Terminalia crenulata* Heyne ex Roth. is reported from the Rajpardi Lignite mine of Eocene age, situated near Ankleshwar and Bharuch in Gujarat, western India. The report forms the first record of leaf remains from the area. The fossil indicates moist tropical conditions at the time of its deposition.

Key-words – Fossil leaf, *Terminalia*, Combretaceae, Eocene, Gujarat, India.

INTRODUCTION

A number of angiosperm leaf-impressions belonging to *Bauhinia*, *Cassia*, *Ceriops*, *Cinnamomum*, *Ficus*, *Lagerstroemia*, *Millettia*, *Murraya*, *Pandanus*, *Syzygium*, *Terminalia* along with some other dicot and palm leaves have been described from the Eocene and Miocene sediments of Kachchh in North Gujarat (Lakhanpal & Guleria, 1981; 1982; Lakhanpal *et al.*, 1984, Bajpai & Singh, 1987). However, no fossil leaf has so far been reported from the Tertiary sediments of South Gujarat. The lignite mine, from where the present fossil is reported, lies about 35 km north-east of Bharuch on Ankleshwar-Rajpipla road at about 21° 43'35" Lat.:73° 13'30" Long. There is paucity of fossil leaf remains in the mine although the mine is fairly rich in carbonised woods. From this mine the author has already reported carbonised woods resembling *Sonneratia* and *Terminalia* (Guleria, 1991). A rich assemblage of palynofossils has also been reported from the mine (Phadtare & Thakur, 1990, Kar & Bhattacharya, 1992). There is difference of opinion about the precise age of the Rajpardi Lignite (Phadtare & Thakur, 1990; Guleria, 1991; Kar & Bhattacharya, 1992). However, based on detailed palynological assemblage the lignite has been assigned to Lower Eocene age (Kar & Bhattacharya, 1992).

SYSTEMATIC DESCRIPTION

Family- **Combretaceae**
Genus -*Terminalia* Linn.

Terminalia panandhroensis Lakhanpal & Guleria

1981 Fig. 1

The species is represented by three highly fragile specimens. One of them is fairly well preserved and hence selected for detailed study.

Leaf appearing symmetrical, elliptic-oblong, preserved lamina length 16 cm, maximum preserved width 8 cm; apex broken; base seemingly rounded; margin entire, slightly wavy, texture seemingly chartaceous, venation pinnate, eucamptodromous, primary vein (1°) massive, secondary vein (2°) appearing slightly to run along mid-rib before diverging out, moderately thick, angle of divergence varying from 60° in the lower region to 80° in the upper region, unturned very close to margin, tertiary veins (3°) fine, angle of origin OR to OA, pattern percurrent, rarely branched, obliquely arranged in relation to mid-vein, arrangement predominantly opposite, close; higher order venation not seen.

Specimen B.S.I.P. No. 37225.

Occurrence-Rajpardi Lignite mine, Bharuch District, South Gujarat:

Age-Lower Eocene

The fossil shows resemblance in all its characters with the leaves of extant *Terminalia* Linn. of the family Combretaceae. Leaves of a number of species of modern *Terminalia* were compared with the fossil. The fossil in general shows close resemblance with the leaves of *Terminalia tomentosa*. However, there is difference of opinion among the taxonomists about the exact systematic position of *T. tomentosa*. It has been considered as a complex comprising several plant groups with a



Figure 1. Fossil leaf of *Terminalia*, viz., *T. panandhroensis* Lakhanpal & Guleria; Natural size.

wide range of variations (Ramesh Rao & Paurkayastha 1972, p. 183). Systematic botanists and foresters used to consider this plant complex as one species until Parkinson (1937) showed, after critical examination, that *T. tomentosa* auct. div. actually is a mixture of *T. crenulata* Heyne ex Roth, *T. coriacea* (Roxb.) W. & A. and *T. alata* Heyne ex Roth. The fossil shows best resemblance with the leaves of *T. crenulata* being chartaceous in nature. It is difficult to differentiate the leaves of *T. coriacea* and *T. crenulata* morphologically except for their texture which is thicker in *T. coriacea*.

Fossil leaves of *Terminalia* have been described under three generic names, viz., *Terminalia* Linn., *Ter-*

minaliphyllum Velenovsky and *Terminaliophyllum* Geyler from different parts of the world. Twenty one species of *Terminalia*, three species of *Terminaliophyllum* and one species of *Terminaliphyllum* have been listed by Lakhanpal and Guleria (1981, p. 355). Some more *Terminalia* species, based on fossil leaves, have since been reported mostly from India and Nepal. They are listed here in order to update the data, indicating their affinities with modern comparable species, geological age and respective localities (Table 1).

On comparing the present fossil with the known Indian fossil *Terminalia* leaves it was found that the former shows closest resemblance with *Terminalia panandhroensis* Lakhanpal & Guleria, described from the Eocene sediments of Panandhro Lignite mine of district Kachchh in North Gujarat. Hence the present fossil leaves are placed under the same species. This species was widely distributed and has been reported as far as Meghalaya in the east and Gujarat in the west. It has been reported from Koilabas and Surai Khola areas of Nepal. In this context it is necessary to mention two things, (i) *Terminalia kachchhensis* Lakhanpal *et al.* (1984), a validly published species has somehow been ignored and not taken into consideration while dealing with *Terminalia* leaves by Prasad (1990), Lakhanpal and Awasthi (1992); Prasad (1994); (ii) *Terminalia* sp. Tripathi and Tiwari (1983) has been considered for comparison with *Terminalia* leaves by subsequent workers although it has already been pointed out by Lakhanpal *et al.* (1984, p. 255) that the species needs reinvestigation to establish its correct affinities. Awasthi and Prasad (1990) while reporting two species of *Terminalia* leaves, viz., *T. panandhroensis* Lakhanpal & Guleria and *T. palaeochebula* sp. nov; inadvertently missed the reference of *T. kachchhensis* described from the Lower Miocene sediments of Kachchh showing affinities with the leaves of *T. chebula* Retz. Hence they could not compare their *T. palaeochebula* with *T. kachchhensis* and created a new species. Since *T. kachchhensis* and *T. palaeochebula* are very close to each other and show close resemblance with the leaves of modern *T. chebula*, consequently *T. palaeochebula* Awasthi & Prasad (1990, pl. 5, fig 1, pl. 6, fig 1) is placed under the earlier known valid species, *T. kachchhensis* Lakhanpal *et al.* (1984). Fossil leaf of *Terminalia chebula* has also been reported by Awasthi (1992, p. 317) from Siwalik sediments of Poornagiri near Tanakpur in Uttar Pradesh.

The genus *Terminalia* consists of 250 species (Willis, 1973, p. 1136) of very large trees, widely distributed in the tropics of the world. *Terminalia crenulata* with which the fossil has been compared is a large deciduous tree

TABLE - 1

Fossil species	Modern comparable species	Age	Locality
1. <i>Terminalia panandhraensis</i> Lakhanpal & Guleria, 1981 Bajpai & Singh, 1987 Awasthi & Prasad, 1990 Ambwani, 1991 Prasad, 1994	{ <i>Terminalia crenulata</i> Heyne ex Roth. <i>T. coriacea</i> (Roxb.) W. & A. do <i>T. coriacea</i> (Roxb.) W. & A. do do	Eocene do Siwalik (Neogene) Palaeocene Siwalik (Mio-Pliocene)	Panandhro, Kutch, Gujarat Godhatad, Kutch, Gujarat Surai Khola, Nepal Cherrapunji, Meghalaya Koilabas, Nepal
2. <i>T. kachihensis</i> Lakhanpal et al., 1984 Syn. <i>T. palaeochebula</i> Awasthi & Prasad, 1990	<i>T. chebula</i> Retz. do	Lower Miocene Siwalik (Middle Miocene)	Near Goyela-Mokra, Kutch, Gujarat Surai Khola, Nepal
3. <i>T. koilabasensis</i> Prasad, 1990	<i>T. angustifolia</i> Jacq.	Lower Siwalik (Middle Miocene)	Koilabas, Nepal
4. <i>T. siwalica</i> Prasad, 1990	<i>T. pyriformis</i> Kurz	do	do
5. <i>T. tomentosa</i> W. & A. Bande & Srivastava, 1990	<i>T. tomentosa</i> W. & A.	Upper Tertiary or Quaternary	Mahuadanr, Patamu District, Bihar
6. <i>T. balugoloensis</i> Lakhanpal & Awasthi, 1992	<i>T. alata</i> var. <i>nepalensis</i> (Haines) Fernandez	Lower Siwalik (Middle Miocene)	Jawalumukhi, Himachal Pradesh
7. <i>T. miobelerica</i> Prasad (1994)	<i>T. belerica</i> Roxb.	Siwalik (Middle Miocene)	Kathgodam, Nainital District, Uttar Pradesh

**Terminalia* sp. reported by Tripathi & Tiwari, 1983 from the Lower Siwalik beds of Koilabas, Nepal has not been taken into account as it needs reinvestigation to establish its correct affinity (see Lakhanpal et al., 1984, p. 255)

** A doubtful *Terminalia* sp. reported by Mishra & Mathur, 1992, pp. 198, 201 has also not been considered here.

and is found in the central, southern and western India, Bihar, Orissa, Assam, and Myanmar (Ramesh Rao & Purkayastha, 1972, p. 199). The species is largely confined to moist deciduous although extending sometimes to semi-evergreen forests of India (Champion & Seth, 1968). Obviously, the fossil indicates existence of moist tropical conditions around Rajpardi during Eocene.

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