RECOGNIZABLE SPECIES OF TERTIARY PLANTS FROM DAMALGIRI IN THE GARO HILLS, ASSAM

R. N. LAKHANPAL
Birbal Sahni Institute of Palaeobotany, Lucknow

INTRODUCTION

IN November 1938 the Director, Geological Survey of India, sent Professor B. Sahni a small collection of fossil plants for examination. The collection consisting of 34 unregistered specimens, mostly of leaf impressions, was made by Sir Cyril S. Fox " from Eocene beds at 500 yards south of Damalgiri Bungalow (25°32'N.: 90°7'E.), Garo Hills ". Incidentally, there are at least three " Damalgiris " in the Garo Hills district. The one from which these fossils were collected lies eleven miles west of Tura, the district headquarter.

In 1945 Professor Sahni gave the collection to Dr. G. S. Puri for investigation, but as the latter had to leave for studies abroad soon after, the material was passed on to me. A short note about these fossils was published by me (1947) in *Palaeobotany in India*, VI.

Most of the impressions are too poorly preserved to be identified specifically. However, a few species can be recognized in the collection and are described in this paper. The number of species is too small to be treated collectively as a flora and to draw conclusions about its palaeoecology and palaeogeography. However, in the discussion of each species the habit and distribution of its modern equivalent are given to suggest the living conditions of the fossil.

MATERIAL AND METHOD

Dr. R. C. Misra of the Geology Department, University of Lucknow, has very kindly examined the rock specimens for me and reports as follows:

" In the hand specimen the rock is greyish white in colour, with small patches stained yellow with secondary iron oxide. It is moderately compact and foliated. Originally, most likely, a shale, now it is metamorphosed to a phyllite.

" Under the microscope a transverse section shows the foliated nature of the rock. Much of the material is clayey and does not react with polarized light. Very fine elongated laths of Sericite are, however, clearly observed. In a section parallel to the foliation planes organic material of rich brown colour is prominent.

" The rock has suffered a moderate degree of metamorphism."

The fossils are preserved as leaf impressions. The nature of preservation is rather poor and there is no cuticle on the surface of the leaves.

The identifications of the fossils are based on their resemblances with leaves of the modern species and were carried out at the herbaria of the Indian Botanic Garden, Sibpur, and the Forest Research Institute, Dehra Dun.

SYSTEMATIC DESCRIPTION AND DISCUSSION OF EACH SPECIES

All the species are angiospermic, belonging to the subclass Dicotyledoneae. They are arranged here according to the scheme followed by Willis (1951, pp. i-xlix) based on Engler's system of classification.

ORDER—URTICALES

FAMILY—ULMACEAE

Trema garoensis sp. nov.

Plate 1, Figs. 1, 2

Description—Leaves simple, ovate-oblong; average length 8·5 cm.; average width 4·2 cm.; apex? acute; base inequilateral, triplinerved; petiole 1-2·5 cm. long, slightly curved, grooved; midrib slender, slightly curved; secondaries 9 pairs, lowest about 4·5 cm. long, coming off at the base at an angle of 45°, angle of divergence slightly more in the second pair but gradually decreasing towards the apex to about 30°, individual veins curving up along the margin to join with the next upper ones in loops; tertiaries very slender, running curved across the secondaries in broad cross-ties, some bifurcating and

each limb joining the next secondary; margin thinly serrate; texture rather membranous.

Discussion — The shape and venation of the leaf with serrate margin and inequilateral base strongly suggest affinities with *Trema*. The triplinerved base, very small serrations, grooved petiole and the texture and size of the leaves are mostly like those of the living *T. orientalis* Bl. There is also considerable resemblance with *T. amboinensis* Bl., but in the latter the leaves are larger.

It has not been possible to find any described fossil leaf resembling *T. garoensis*.

Trema is a tropical or subtropical genus. *T. orientalis* is a small, fast-growing evergreen tree. It has a remarkable capacity for springing up on forest clearings, landslips and wherever the ground is exposed. In such places it is generally the first tree to appear coming up gregariously. It is distributed at the foot of the Nepal and Sikkim Himalayas, in Bengal and Bihar, extending southwards to Travancore. In Burma it is reported from Rangoon and Myitkyina districts. It is common in Ceylon and Malayan Islands. *T. amboinensis* occurs in Sikkim, Assam, Chittagong, Burma, Singapore and the Andaman Islands. It has the same habit as *T. orientalis* of which it is considered as a larger form.

Collection — Syntypes, Nos. GH 16 and GH 18.

ORDER—RANALES

FAMILY—LAURACEAE

Neolitsea sahnii sp. nov.

Plate 1, Figs. 3, 4

Description — Leaves simple, elliptical; length 9-10·5 cm.; width 3·2-3·8 cm., widest near the middle; apex not preserved; base broadly obtuse, almost rounded, slightly inequilateral, triplinerved; petiole about 2·7 cm. long, slightly curved, fairly stout; midrib prominent, straight; a pair of lateral primaries coming off at base, each about 6·5 cm. long, slightly curved near the base and then running straight towards the margin at an angle of about 20°; secondaries start arising from the midrib at about one-third of its length from the base, approximately 10 pairs, angle of divergence about 60° decreasing towards the apex, each secondary curving up near the margin, running convex to it and then joining with the next upper secondary in a loop; tertiaries very slender, running as cross-ties between the secondaries, enclosing rectangular areas, some arising directly from the midrib to join with the lateral veins; margin entire; texture smooth.

Discussion — The form and texture of the leaves are typically lauraceous. The triplinerved character in Lauraceae is met with in *Neolitsea* and *Cinnamomum*. In *Cinnamomum*, however, the lateral primaries are very prominent and extend almost to the apex. *Neolitsea zeylanica* Merr. presents a very close resemblance with our specimens in having the same shape and size, the triplinerved base, the lateral primaries running to about two-thirds the length of the leaf, and the tertiaries running parallel across the secondaries forming rectangular meshes. In the allied species *N. foliosa* Gamble the leaves are longer and the base sub-triplinerved, i.e. the lateral primaries coming off a little above the base. This tendency of sub-triplinerved base is also found in some leaves of *N. zeylanica*, but far less in frequency than in *N. foliosa* and in *N. sahnii* this seems to be altogether absent.

There are two fossil species of *Neolitsea* known to the author, *N. Gardneri* Bandulska, from the Upper Eocene of Bournemouth, England (BANDULSKA, 1926), and *N. lata* MacGinitie from the Middle Eocene of Central Sierra Nevada, U.S.A. (MACGINITIE, 1941). None of these is very closely comparable with *N. sahnii*. *N. lata* is bigger in size, narrower at the base, has smaller number of secondaries, and its lowest pair of secondaries does not come off from the base as in *N. sahnii*. In shape *N. Gardneri* seems more like the present fossil, but the figure of *N. Gardneri* is not clear enough to make out the details of its structure for comparison. It looks slightly longer and narrower and has fewer secondaries. The structure of its cuticle is given, but it cannot be compared as the cuticle of *N. sahnii* is not preserved.

The living *Neolitsea* is a small to middle-sized evergreen tree. It is distributed through the Philippine Islands, Java, Indo-Malayan Archipelago to Burma and India. *N. zeylanica* occurs in Mergui and Tavoy districts of Burma; Assam in eastern India; Nilgiris, Madras and Coimbatore in southern India; and, as the name implies, in Ceylon.

I have named this species after my teacher, the late Professor B. Sahni, F.R.S., as a token of respect and affection.

Collection — Holotype, No. GH 2; paratype, No. GH 11.

ORDER — MALVALES

FAMILY — TILIACEAE

Grewia foxii sp. nov.

Plate 2, Fig. 5

Description — Leaf simple, ovate, asymmetrical, divided into two unequal halves; length about 5·7 cm.; width 4·3 cm.; apex broadly acute; base broad, inequilateral, triplinerved; petiole about 1·25 cm. long, slender, twisted; midrib broad at the base (2 mm.) narrowing sharply towards the apex, slender, curved; secondaries 8 pairs, lowest arising from the base, running to about two-thirds the length of the leaf; angle of divergence about 60° in the basal veins, gradually decreasing towards the apex, less in the narrower half of the leaf than in the broader; secondaries arcuate, curving upwards near the margin and then running along it towards the apex; tertiaries fairly prominent, thin, joining the secondaries in parallel cross-ties; the second pair of secondaries from the base short, forking into two, each merging into the tertiaries about half way between the midrib and the margin; near the base tertiaries also coming off on both sides of the midrib; tertiaries from the basal pair of secondaries on the outer side clearly visible going right up to the margin; margin mostly serrate, a little below the apex the serrations becoming blunt and at places rounded; texture thinly chartaceous.

Discussion — The size, the division of the lamina into two unequal halves, the inequilateral base, the mixed serrate-crenate margin and the twisted petiole of the fossil present a very close resemblance with the leaves of the living *Grewia tiliifolia* Vahl. The texture and the shape of the lamina are very characteristic. The venation also is very similar, but in *G. tiliifolia* the basal secondaries are generally not much curved although in the variety *G. tiliifolia* var. *argentia* Burret they are almost as arched as in the fossil. No fossil record of a *Grewia* resembling the present specimen is known.

Saporta used the name *Grewiopsis* for fossil leaves resembling those of *Grewia*. Plant remains belonging either to *Grewia* or to *Grewiopsis* have been described from Upper Cretaceous to Upper Tertiary beds of both the Old as well as the New World.

The living *Grewia* is confined to the tropical and subtropical regions of the Old World, i.e. Africa, Madagascar, Arabia, India, Burma, Ceylon, Andaman-Nicobar, Malay Peninsula, East Indies, Indo-China, extending to North Australia. The genus is fairly represented in India. *G. tiliifolia* is distributed in east Tropical Africa and India. In India it occurs in arid regions of Bengal, Bihar, central and southern India. *G. tiliifolia* var. *argentia* is found in Assam, Upper Gangetic Plain, central and southern India. Both *G. tiliifolia* and its variety *argentia* are moderate-sized tropical trees occurring in arid regions.

It is generally believed by the plant taxonomists that most probably the original home of *Grewia* was Equatorial Africa from where its line of distribution extended eastwards to India, Burma, Siam and Indo-China (NARAYANASWAMI & RAO, 1950). If this statement is correct, the eastward march of *Grewia* must have begun quite early because on the evidence of *G. foxii* it was present in the Assam region in Eocene times. Moreover, the fossil record shows that *Grewia* had a very wide distribution in the early Tertiary. In fact, it seems to have had a wider distribution in the past than at present. The present abundance of the genus in Africa may be due to the suitable environment which the plant got in that continent and may not be an indication of its origin there. *G. tiliifolia* var. *argentia* seems to be Indian in origin as it is not distributed in Africa and its fossil equivalent *G. foxii* has been found in the early Tertiary of Assam.

The species is named after the late Sir Cyril S. Fox who collected this material from Assam.

Collection — Holotype, No. GH 17.

FAMILY — BOMBACACEAE

Bombacites orientalis sp. nov.

Pl. 2, Figs. 6, 7

Description — Leaves large, digitately compound; each with five leaflets radiating from the tip of a long slightly curved petiole; preserved length of the petiole 12 cm., width 3·5 mm., slightly swollen at its junction with the leaflets, faint longitudinal grooves and ridges visible on the surface of the petiole. Leaflets five, oblanceolate; length varying from 10 to 14 cm., width about 3·2 cm.; apex not preserved; base acute and decurrent with the midrib to the point of junction with the

petiole; midrib stout, a slight longitudinal groove visible on one side (? upper); secondaries about a dozen, very narrow, sub-opposite in the apical half, alternate below, distance between two adjacent veins about 1 cm., decreasing towards the apex, angle of divergence about 55° in the secondaries on the outer side and about 70° in those towards the middle of the leaf; secondaries curving up near the margin but the formation of loops not clear; smaller veinlets forming network of irregular polygonal meshes; margin entire; texture fairly thick.

Discussion — In general form of the leaves this species resembles *Eriodendron anfructuosum* D.C. and *Bombax* spp. However, in one point the resemblance is more with *E. anfructuosum*. While in *Bombax* the leaflets are stalked, in *Eriodendron* they are sessile as in the fossil. This condition is almost approached in *B. insigne* where the stalks of the leaflets are very small, but in this plant the number of leaflets is generally 7-9 and their size is much bigger.

For digitately compound fossil leaves of the type of *Bombax* with large leaflets having entire or toothed margins Berry (1916) gave the name *Bombacites*. All the fossil records of *Bombax* and *Bombacites* are based on single leaflets, while the present fossil shows leaflets joined together on a petiole. From the available figures *Bombax Sturtii* Etting. described by Chapman and Crespin (1933-34) from Australia is the only species which looks somewhat like *Bombacites orientalis* although this comparison is not very reliable, as the single figured leaflet of *B. Sturtii* is incomplete. Most of the other fossil species have toothed margins.

There is no available record of fossil *Eriodendron*. Some doubtful forms referred to *Bombax* have been described from the Cretaceous of America and Europe (BERRY, 1916). In the Tertiaries, *Bombacites* has been described from the Lower Eocene of America by Berry (op. cit.). In Europe, foliage of the type of *Bombacites* has been described mainly from the Upper Eocene, but a few species have also been reported from the other epochs of the Tertiary period. *Bombax flammeum* has been recorded by Menzel (1920) from the Tertiary of Cameroons, Africa. Two species of *Bombax*, *B. Sturtii* Etting. and *B. Mitchelli* Etting. have been described from the Eocene of western Australia by Chapman and Crespin (1933-34).

Eriodendron occurs mostly in America. *E. anfructuosum*, a moderate-sized, soft-wooded, deciduous tree is indigenous to Burma, Andamans, Malay Peninsula and Archipelago, western parts of Indian Peninsula and in Tropical America. Perhaps it also occurs in Tropical Africa.

Bombax malabaricum is a large deciduous tree most commonly found on flat alluvial soil near river-banks where it is often gregarious. It is often found scattered in mixed, usually deciduous, forests and even in *Sal* (*Shorea robusta* Gaertn.) forests. It occurs in regions showing a wide range of temperature and rainfall, but thrives best in a comparatively moist tropical climate. It occurs in tropical Eastern Himalayas and throughout the hotter forests of India to Burma and Ceylon. It is also distributed in Java and Sumatra.

B. insigne is common in upper mixed deciduous forests on well-drained often hilly ground. It also extends into evergreen or semi-evergreen forests on hill-slopes. It is essentially a tropical tree thriving best in temperatures with a maximum of 96°-110°F. and a minimum of 42°-60°F. and rainfall of about 40-150 in. Its natural home is Burma, Andamans, Chittagong, Malay Peninsula and the Western Ghats of India from North Kanara southwards.

Collection — Syntypes, Nos. GH 3 and GH 5.

AGE OF THE FOSSILS

As already mentioned, the present fossils were collected at 500 yards south of Damalgiri Inspection Bungalow in the Garo Hills district of Assam. According to further details supplied at my request by the Geological Survey of India, the collection comes from the Kopili stage. Kopili is the upper of the two stages into which Jaintia series of Assam is divided.

About the age of the Kopili stage Evans writes (1932, p. 176):

" The Kopili stage includes a number of fossil beds. From the Burmah Oil Company's collections, Mr. Eames has identified a number of forms suggestive of Middle Khirthar beds . . . it seems safe to assume that the Kopili stage, as a whole, is approximately equivalent to the Middle Khirthar, i.e. Upper Lutetian. "

According to this statement the stage is Middle Eocene in age. The Geological Sur-

vey has, however, suggested that the Kopili beds may be regarded as uppermost Eocene to Oligocene (HERON, 1939).

Unfortunately, there has not been enough previous work on the Tertiary floras of this part of the world with which comparisons could be made for the correlation of strata. For the present there is no evidence against the early Tertiary age of the beds in which these fossils were collected.

REFERENCES

BANDULSKA, H. (1926). On the Cuticles of some Fossil and Recent Lauraceae. *Jour. Linn. Soc.* (*Botany*). **47**: 383-425.

BERRY, E. W. (1916). The Lower Eocene Floras of Southeastern North America. *U.S. Geol. Surv. Prof. Paper.* **91**.

CHAPMAN, F. & CRESPIN, I. (1933-34). The Palaeontology of the Plantagenet Beds of Western Australia. *Jour. Roy. Soc. West. Australia.* **22**: 103-136.

EVANS, P. (1932). Explanatory Notes to accompany a Table showing the Tertiary Succession in Assam. *Trans. Min. Geol. Inst. India.* **27**: 155-260.

HERON, A. M. (1939). General Report of the Geological Survey of India for the year 1938. *Rec. Geol. Surv. India.* **74**(1): 1-169.

LAKHANPAL, R. N. (1947). Tertiary Leaves from the Garo Hills, Assam. Palaeobotany in India — VI. *Jour. Ind. Bot. Soc.* **26**(4): 261-262.

MACGINITIE, H. D. (1941). A Middle Eocene Flora from the Central Sierra Nevada. *Carnegie Inst. Wash. Publ.* **534**: 1-178.

MENZEL, P. (1920). Über Pflanzenreste aus Basalttuffen des Kamerungebietes. *Beit. Geol. Erforsch. Deutsch Schutzgebiete.* **18**: 17-32.

NARAYANASWAMI, V. & RAO, R. S. (1950). A preliminary Note on the Indo-Burmese Species of *Grewia* Linn. *Jour. Ind. Bot. Soc.* **29**(4): 177-190.

WILLIS, J. C. (1951). A Dictionary of the Flowering Plants and Ferns. *Cambridge.*

EXPLANATION OF PLATES

PLATE 1

1, 2. *Trema garoensis* sp. nov. Leaves. Nos. GH 16 and GH 18 respectively. × 1.

3. *Neolitsea sahnii* sp. nov. Leaf. No. GH 2. × 1.

4. *N. sahnii* sp. nov. Incomplete counterpart of the same showing venation more clearly. No. GH 11. × 1.

PLATE 2

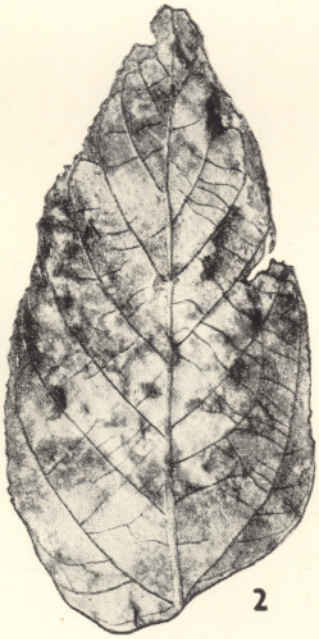
5. *Grewia foxii* sp. nov. Leaf. No. GH 17. × 1.

6. *Bombacites orientalis* sp. nov. Leaf. No. GH 3. × 1.

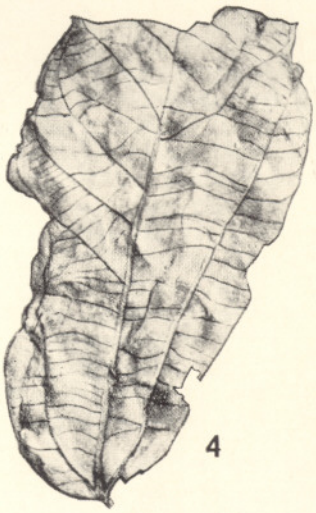
7. *B. orientalis* sp. nov. Leaf. No. GH 5. × 1.

1

3



2



4

5

6

7