SOME FOSSIL LEAVES OF THE ULMACEÆ FROM THE KAREWA DEPOSITS OF KASHMIR

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Introduction

The material described in this paper is mainly derived from collections made at Laredura partly by Dr. R. R. Stewart in 1935, and partly by the author in 1939. There are also two leaf fragments gathered by Dr. H. de Terra from Gogajipathri and Liddarmarg; and one leaf impression collected by Stewart in 1936 from Ningal Nullah. The plant-bearing outcrops lie in the Baramulla-Gulmarg region and are assigned the Lower Pleistocene age (De Terra and Paterson, 1939).

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List of the Species

Species	Localities	References to Figures
Ulmus Wallichiana	Laredura, 6,000 ft.	Figs. 1, 2
Ulmus campestris ..	Gogajipathri, 8,800 ft. and Laredura, 6,000 ft.	Figs. 3, 4, and 8
Ulmus laevigata ..	Laredura, 6,000 ft. and Ningal Nullah, 9,000 ft.	Figs. 5, 6, 7
Ulmus sp. ..	Liddarmarg, 10,600 ft.	Figs. 9, 10

Description

Order : Urticales.

Family : Ulmaceæ.

The family is represented in the Karewa flora by a number of leaf impressions, all referable to the modern genus *Ulmus*. The genus *Ulmus* probably had a fairly wide distribution in the Valley during the Lower Pleistocene, which is evidenced by the discovery of one or the other species from four different localities including Laredura, Ningal Nullah, Gogajipathri and Liddarmarg. The genus includes three species

two of which, *viz.*, *Ulmus Wallichiana* Planch. and *U. lævigata* Royle are discovered together from the beds at Laredura. The third species, *Ulmus campestris* Linn., has been found from Gogajipathri. Fruits of *Ulmus* spp. are small and are provided with circular wings, like samaras of *Litchi*. They are likely to be represented in the fossil beds as they are capable of flight over long distances like the samaras of *Acer* and *Fraxinus*, which have also been discovered in the beds that have yielded leaves of these genera, but a very close study of the present collections has failed to bring to light any fruits of this genus.

Genus *Ulmus* Linn.

The genus includes three well determined species, the modern representatives of which are still growing in the Kashmir Valley and the nearby regions. One more leaf fragment, which could not be determined specifically, is also described.

Key to the Species

I. *Leaves large—*

(*a*) Base very oblique ; laterals 15–17 pairs, running straight and parallel .. .. *U. Wallichiana*

(*b*) Base not so oblique, leaves comparatively smaller ; laterals 12–13 pairs, curved and not strictly parallel. *U. campestris*

II. *Leaves much smaller, base rounded or cordate—*

Laterals about 10 pairs running straight and parallel..... *U. lævigata*

Ulmus Wallichiana Planch.

(Pl. XI, Figs. 1–2)

Plate XI, Figs. 1–2 are two natural size photographs of a leaf and its counterpart ; a small piece from the base on left-hand side in one specimen (Pl. XI, Fig. 1) got chipped off while splitting the clay to expose the two counterparts. The leaves are elliptic oblong in outline and measure 3·3 inches long by 1·2 inches in the broadest part, which is midway between the base and apex. The lamina, which is uniformly broad for most of its length, narrows down into a wedge-shaped base, and ends towards its upper part into a slightly curved acute apex. Margins are not well preserved but their dentate nature is clearly seen towards the apical part in Fig. 1. A small curved petiole almost complete in one leaf and slightly broken in its counterpart is also preserved.

The venation is strict-pinnate and reticulate. A stout midrib arises from the oblique base and runs in the lamina gradually thinning out towards the apical part: It follows a curved course dividing the lamina into unequal halves. 16–17 secondaries, which are about half as thick as the midrib, diverge from the latter, on either side, at acute angles. The origin of the laterals, especially in the lamina above the middle, is mostly alternate, but some laterals towards the lower portion tend to become sub-opposite ; they run straight to the

margins, parallel to one another, and each ends in a marginal tooth. The laterals, as well as the midrib, have left shallow grooves in the impression (Fig. 1) and stand out in the form of ridges in its counterpart. A comparison with modern leaves of this species shows that the former is an impression from the lower surface of the leaf whereas its counterpart represents the upper surface. The tertiary ribs are not well developed. The finer reticulation consists of a well preserved net-work of small, oval, or circular meshes, which are seen at some places in Fig. 2.

The fossils are identical with modern leaves of *Ulmus Wallichiana* Planch., a common western Himalayan elm.

Number of specimens.—Ten only.

Occurrence.—Laredura, at 6,000 ft. in the Pir Panjal Range, Kashmir.

Collection.—R. R. Stewart, 1935.

Registered numbers of figured specimens.—Pl. **XI**, Fig. 1=L 620 ; Pl. **XI**, Fig. 2=L 621.

Ulmus lævigata Royle

(Pl. **XI**, Figs. 5–6 ; Pl. XII, Fig. 7)

This species is based on a number of leaves, two of which are illustrated in natural size in Pl. **XI**, Figs. 5, 6. The figured leaves are ovate in outline measuring 1·15 inches long by ·35 inch in the broadest part, which lies midway between base and apex. One leaf (Pl. XI, Fig. 5) is slightly broken on one side along the margin. This specimen was coated in field with a thick layer of rubber solution, which has completely obscured the finer reticulations. The margins are mostly broken in the impressions but their serrate nature in one leaf (Pl. **XI**, Fig. 6) is clearly seen at some places in Fig. 7, which represents a part of the leaf enlarged to five diameters. Base is rounded, or slightly sub-cordate. Apex is acute.

The venation is strict-pinnate and reticulate. A fairly strong midrib runs in the lamina gradually thinning out towards the apical part. It usually runs straight but in Fig. 5 it follows a slightly curved course in a part of the lamina. 10–13 pairs of laterals, which are almost as thick as the midrib, diverge from it at acute angles ; they run straight in the lamina parallel to one another ; their manner of origin is mostly opposite, but some of them arise rarely in an alternate manner. The laterals usually end in the marginal teeth, which are mostly sharp pointed. The tertiary and finer reticulations are greatly obscured in one leaf and are badly preserved in the other, but the finer reticulation is seen at some places in the enlarged photograph.

The fossils are identical with *Ulmus lævigata* Royle, the small leaved elm of the Punjab Himalayas.

Number of specimens.—Eight only.

Occurrence.—Laredura, at 6,000 ft. and Ningal Nullah, at 9,000 ft, Pir Panjal Range, Kashmir.

Collection.—R. R. Stewart, 1935.

Registered numbers of figured specimens.—Pl. XI, Fig. 6=N 161 Pl. XI, Fig. 5=N 186.

Ulmus campestris Linn.

(Pl. XI, Figs. 3, 4 and Pl. XII, Fig. 8)

Two leaf fragments on which this species is based are illustrated in Fig. 3 on Plate XI and Fig. 8 on Plate XII ; one leaf is slightly broken at apex and along one side and the other fragment is broken at the base and both margins. The leaf lamina, which probably had an elliptic-oblong shape, narrows down to a slightly cuneate and oblique base. The narrowed nature of the lamina towards the upper part of the leaf is suggestive of its having an acute apex. The fragments vary only very slightly in size and the larger measures 2·5 inches long by 1·4 inches in the broadest part, which lies midway between base and apex. The margins seem to be biserrate.

The venation is strict-pinnate and reticulate. A fairly stout midrib runs in the lamina from the base gradually thinning out towards the apical part, and seems to divide the lamina into slightly unequal halves. 10–11 Secondaries, which are hardly half as thick as the midrib, diverge from the latter on either side at different angles. The lower pairs of laterals diverge at open angles, whereas the upper few pairs arise at acuter angles. The origin of the laterals is opposite as well as alternate ; they tend to run parallel to one another in the lamina, and end in the marginal teeth. The tertiary ribs are generally not well preserved but they are seen faintly in one specimen. Plate XI, Fig. 4, which is a photograph of a part of the leaf enlarged to about five diameters, shows a nicely preserved network of fine rectangular or pentangular meshes of the finer reticulation.

The fossils on account of their shape, size, number of laterals, etc., are identified with living leaves of *Ulmus campestris* Linn. to which they are identical in all respects.

Number of specimens.—Two only.

Occurrence.—Gogajipathri, at 8,800 ft., and Laredura, at 6,000 ft., in the Pir Panjal Range, Kashmir.

Collections.—H. de Terra, 1932 and G. S. Puri, 1940.

Registered numbers of figured specimens.—Pl. XI, Fig. 3=Loc. 2 G 6 ; Pl. XII, Fig. 8=L 823/2.

The Fourth Species

(Pl. XII, Figs. 9 and 10)

In addition to the three above described species there is one more leaf fragment, which resembles *Ulmus Wallichiana* Planch. in some features and in others it compares with *Ulmus campestris* Linn.; there are, however, a few additional features, which are entirely new to either of the two species. Pl. XII, Fig. 9 is a natural size photograph of the fragment, which is badly broken on apex, base and the two margins ; its venation is very clearly preserved and characteristic of the

genus. The laterals are seen in the photograph in the form of well marked ridges, which show that the fossil is probably an impression from the upper surface of the leaf.

The features of this leaf are compared to the modern leaves of the two fossil species in a tabular form below :—

Characters	*Ulmus* sp. (Pl. XII, Figs. 9–10)	*U. Wallichiana* Planch. (Pl. XI, Figs. 1, 2)	*U. campestris* Linn. (Pl. XI, Figs,3, 4 and Pl. XII, Fig. 8)
1. Shape of the lamina	Not known exactly but resembles more with *U. campestris* Linn. than the other species.	Elliptic oblong	Probably elliptic
2. Numer of the laterals	About 8 pairs in the fragment, which is almost complete and a complete leaf might have, at the most, three or four pairs more.	16–17 pairs.	10–11 pairs.
3. Nature of the laterals (i) angle of origin (ii) manner of divergence	Arise at acute angles and resemble *U. Wallichiana* in this feature; they are curved and do not run parallel.	Arise at acute angles; they are straight and run parallel.	Arise at comparatively less acute angles, and the lower pairs arise at open angles; they are curved and do not run exactly parallel.
(iii) Branches of laterals	Some laterals give off branches near the margin.	Laterals do not give off branches.	One or two laterals give off branches near the margins.
	Secondaries arise at unequal distances.	Arise at equal distances.	Do not arise at equal distances.
Tertiary ribs	Very well marked out and conspicuous, form cross-ties, or sometimes large, rectangular meshes; they are about half as thick as the laterals.	Not seen in a large part of the leaf; in modern leaves they are thinner than the laterals and are not at all well marked out.	Not seen in the fossil, but in modern leaves they are as conspicuous as in *U. Wallichiana*.
5. Finer reticulations	Meshes smaller, like *Ulmus Wallichiana*.	Meshes small.	Meshes comparatively larger.

From the above comparison it seems that this leaf cannot be placed in either of the two species ; therefore, it is described separately as *Ulmus* sp., which is different from all modern species of *Ulmus* represented in the flora of the Himalayas.

Number of specimen.—One.

Occurrence.—Liddarmarg at 10,600 ft., in the Pir Panjal Range, Kashmir.

Collector.—H. de Terra, 1932.

Registered number of the figured specimen.—Loc. 3 L 100.

Modern Distribution of the Ulmaceæ

The family Ulmaceæ, which includes 130 species distributed in 13 genera of modern plants is, at the present time, well represented in the tropical and extra-tropical regions of the world. The most northerly point of its occurrence in the New World is 43° 30′, whereas it reaches 58° N. and 66° 59′ N. in Asia and Europe respectively. The chief genera are *Ulmus, Celtis* and *Trema.*

The genus *Ulmus*, with 18 species, is distributed mainly in the North temperate zone, and occurs also in the mountainous regions of tropical Asia. Two species, namely, *Ulmus montana* and *U. campestris* are typically British ; the latter is also found in north-western Europe and western Asia, and occurs in India probably as a cultivated tree at Ghoragali in the Murree Hills.

In India we have only five species—of which two (*Ulmus Wallichiana* and *U. lævigata*) are common elms of the Western Himalaya ; one species (*U. lancifolia*) is the Eastern Himalayan elm found in Sikkim, Bhutan, Assam, Chittagong and Burma ; *U. parvifolia* an evergreen shrub, occurs wild, according to Brandis, in Nubra, northern Kashmir ; the fifth Indian species is *U. campestris*, the common elm of Europe, which occurs in Baluchistan and the Kurram Valley.

Modern Distribution of the Fossil Species

The Karewa flora includes four species of *Ulmus*, three of which are definitely determined but one leaf-impression could not be specifically determined on account of its fragmentary nature.

Ulmus Wallichiana—the common West Himalayan elm—is a large deciduous tree, which occurs from the Indus to Nepal at 3,500 to 10,000 ft. (not in gregarious patches), among the coniferous as well as broad-leaved forests. It usually grows in moist ravines but it is not uncommon on dry slopes, where it is mostly stunted. It is able to colonise landslips, banks of ravines and other waste places with amazing rapidity.

In the " mixed coniferous forests of Grahan Nal," Parbatti Valley, Punjab, *Ulmus Wallichiana* occurs at 7,000 ft. to 9,000 ft. in association with *Cedrus Deodara, Abies Pindrow, Picea morinda, Juglans regia, Corylus colurna, Celtis australis, Acer* spp., etc. (Champion, 1936, p. 243).

It also occurs in the "eastern oak—fir forest of Garhwal Himalaya" with *Abies Pindrow, Picea morinda, Quercus semecarpifolia, Q. dilatata, Aesculus indica, Acer Cæsium, Corylus colurna, Rubus niveus, Rosa macrophylla, Skimmia Laureola, Syringa Emodi, Viburnum* spp., *Hedera Helix*, etc., etc. (Champion, *loc. cit.*, p. 245).

The "moist temperate deciduous forests of Dwali", Western Almora division, Kumaon, are composed of *Ulmus Wallichiana, Aesculus*

indica, *Acer Cæsium*, *A. pictum*, *Carpinus viminea*, *Betula alnoides*, *Juglans regia*, *Fraxinus micrantha*, *Quercus semecarpifolia*, *Corylus colurna*, *Cornus macrophylla*, *Rhus punjabensis*, *Taxus baccata*, *Berberis* sp., *Prunus undulata*, etc., etc. (Champion, *loc. cit.*, pp. 257–58). At Saran, in the Kagan Division of Hazara, *Ulmus Wallichiana* is associated with *Juglans regia*, *Acer Cæsium*, *Aesculus indica*, *Prunus padus*, *Pinus excelsa*, *Viburnum fœtens*. The same forests of the Sutlej Valley in the Punjab comprise of *Ulmus* spp., *Acer Cæsium*, *A. pictum*, *A. villosum*, *Aesculus indica*, *Betula alnoides*, *Carpinus* sp., *Celtis australis*, *Fraxinus micrantha*, *Juglans regia*, *Pyrus lanata*, *Prunus cornuta*, *Abies Pindrow*, *Cornus* sp., *Corylus colurna*, *Rhododendron arboreum*, *Rhus* sp., *Viburnum* spp., etc., etc. (Champion, *loc. cit.*, p. 258).

In Kashmir the species occurs in the Valley proper, Gurez, the Jhelum Valley, Keran, Kishtwar, Marwa Dacchan, Muzaffarabad, Ramban, and the Sindh Valley.

The second Karewa species—*Ulmus lævigata* (*U. villosa*)—is the small-leaved elm of the Punjab Himalaya, which occurs at lower elevations than the former species. In the valleys of Punjab rivers it ascends to as high as 10,500 ft., but usually it is not commonly found above 7,000 ft. It is fairly common in Kashmir occurring in the Valley proper, and Kamraj, Kishtwar, Marwa Dacchan, Muzaffarabad, Ramban and the Sindh Valley. Eastwards it occurs at Munali, Kulu and extends as far as the Pabar Valley. It is also found in Hazara and Murree Hills, the adjoining regions of Kashmir.

The third Karewa species—*U. campestris*—which is the common elm of Europe, occurs in India in the Kurram Valley at 7,000–9,000 ft. and in Baluchistan. It is cultivated in Kashmir and also in Ghoragali in the Murree Hills.

SUMMARY

1. The family Ulmaceæ is represented in the Karewa flora (Pleistocene) of the Kashmir Valley by four species belonging to the single genus *Ulmus*; three of these, namely, *U. Wallichiana*, *U. lævigata*, and *U. campestris* are based on leaf impressions collected by De Terra, Stewart and the author from Laredura, Ningal Nullah and Gogajipathri; the fourth is an incompletely determined species, based on a leaf fragment collected at Liddarmarg by De Terra in 1932.

2. At the present time the family, with its 13 genera and 130 species of modern plants, is distributed in the tropical and extra-tropical parts of the globe, whereas the genus *Ulmus* is mainly represented in the north temperate zone; however, some species are also found in the mountainous regions of tropical Asia.

3. Of the three species described in this paper, two (*U. Wallichiana* and *U. lævigata*) are found in the Western Himalaya, while the third (*U. campestris*), an European elm, occurs in the Kurram Valley, and is also cultivated in Kashmir and Ghoragali in the Murree Hills. The former two species are also common in Kashmir occurring in the Valley and other parts of the Jammu and the Kashmir Territories.

LITERATURE CITED

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De Terra, H. and T. T. Paterson (1939) "Studies on the Ice Age in India and associated human *cultures*," Carnegie Institution, Washington.

EXPLANATION OF PLATES

All figures in Plates XI–XII are from untouched negatives. Figured specimens are preserved in the Botany Museum, University of Lucknow.

PLATE XI

Ulmus Wallichiana Planch.

Fig. 1. Leaf fragment (impression of the lower surface). R. R. Stewart collection, L 620 Laredura, 6,000 ft. Nat. size.

Fig. 2. Counterpart of Fig. 1, L. 621. Nat. size.

Ulmus campestris Linn.

Fig. 3. Fossil leaf impression. H. de Terra collection. Loc. 2 G. 6 Gogajipathri, 8,800 ft. Nat. size.

Fig. 4. A part of the leaf (marked ×× in Fig. 3) enlarged to show meshes of the tertiary and finer reticulations. ×*Ca.* 5.

Ulmus lævigata Royle.

Fig. 5. Fossil leaf. R. R. Stewart collection. L 186 Laredura, 6,600 ft. Nat. size.

Fig. 6. Leaf impression. R. R. Stewart collection. N 161 Ningal Nullah. Nat. size.

Fig. 7. A part of the leaf (marked ×× in Fig. 6). Enlarged to show serrate margin; meshes of tertiary and finer reticulation. ×*Ca.* 5.

PLATE XII

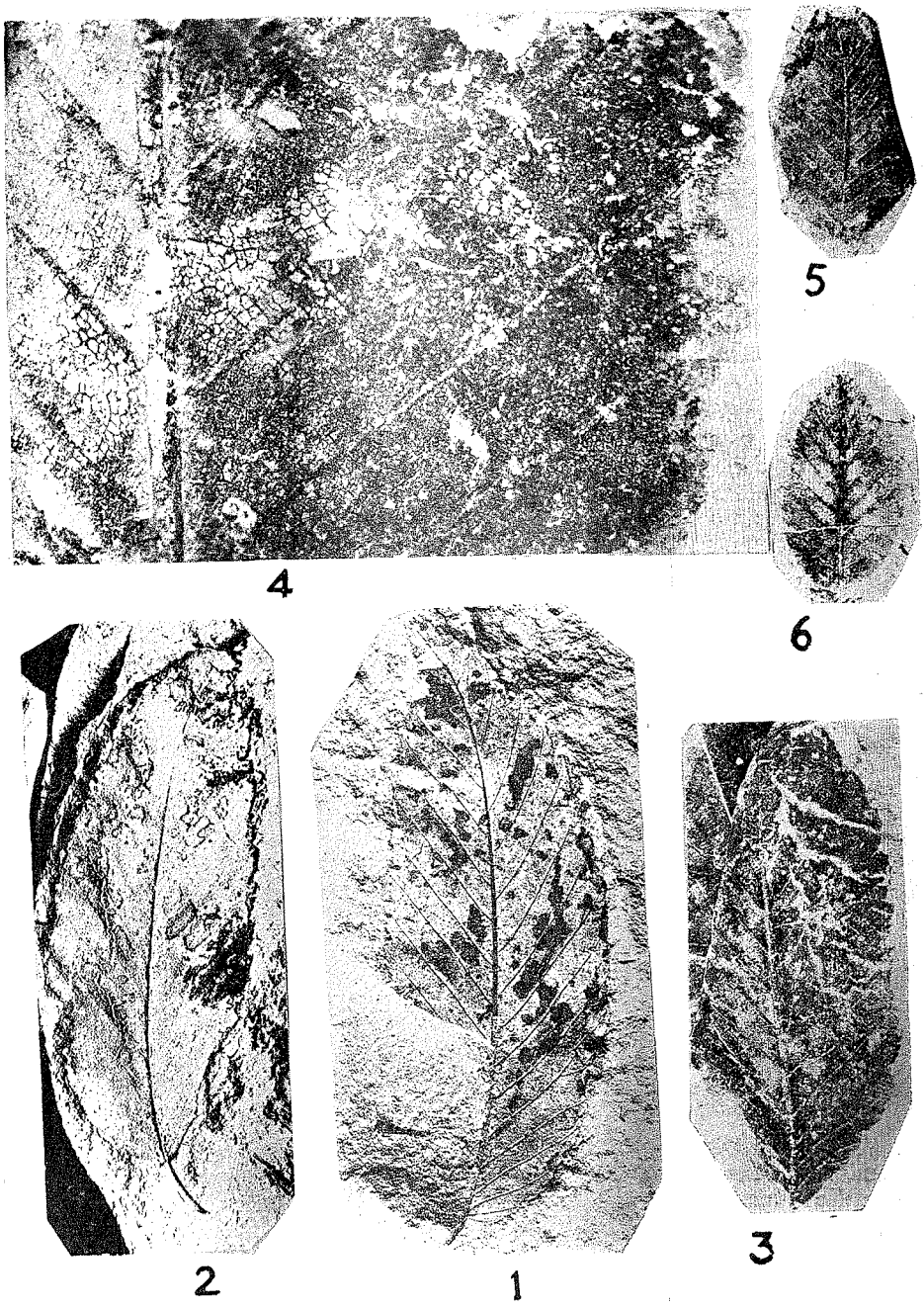
Ulmus campestris Linn.

Fig. 8. Leaf impression. G. S. Puri collection. L 823/2 Laredura, 6,000 ft. Nat. size.

Ulmus sp.

Fig. 9. Leaf impression. H. de Terra collection. Loc. 3 L 100 Liddarmarg, 10,600 ft. Nat. size.

Fig. 10. A part of the leaf (marked with ×× in Fig. 9) enlarged to show tertiaries and finer reticulations. ×*Ca.* 5.



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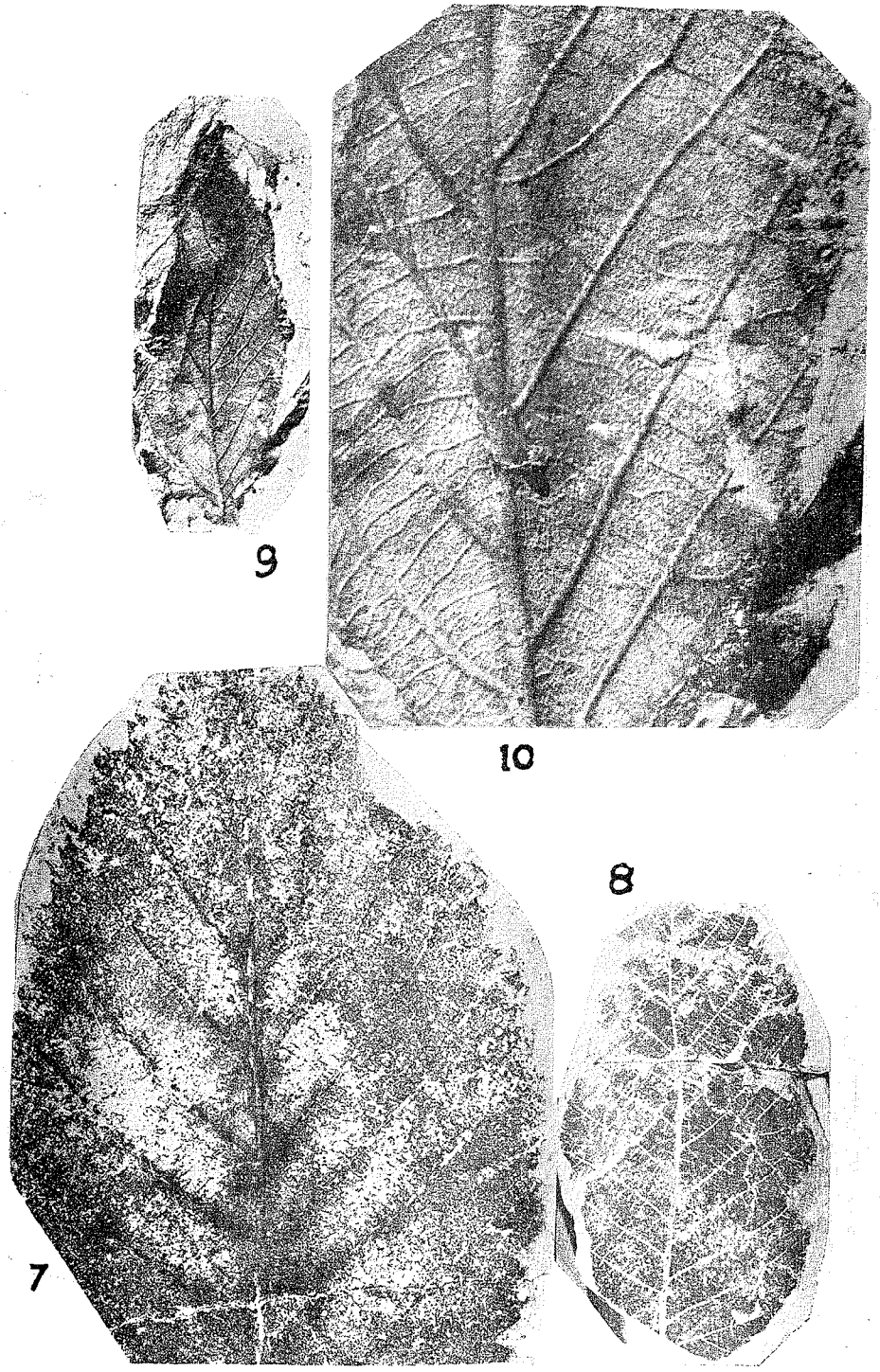

G. S. PURI

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