SOME FOSSIL LEAVES AND FRUITS OF THE ACERACEÆ FROM THE KAREWA DEPOSITS OF KASHMIR, WITH REMARKS ON THE PAST AND PRESENT MAPLE FORESTS OF THE KASHMIR VALLEY

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Received July 5, 1945

(Communicated by Professor Birbal Sahni, F.A.SC., F.R.S.)

(With Six Plates)

CONTENTS

Introduction

The material described in this paper comprises a score of fossil leaves and a few fruits of the genus *Acer*, which come from the Lower Karewa deposits of Kashmir. Most of the specimens are derived from the author's collections of 1939 and 1940 and some from Stewart's collections of 1935 and 1936

from the beds exposed along the Pir Panjal side of the valley at Laredura and Ningal Nullah; however, there are four leaf-fragments of *Acer oblongum*, two samaras and an incomplete leaf of *Acer pentapomicum*, which are described from collections made from Liddarmarg (from two different spots) by Middlemiss (1911, pp. 121–22) in 1910 and de Terra in 1932.

I am highly indebted to Prof. B. Sahni, F.R.S., for guidance and encouragement during the preparation of this paper. I am equally grateful to my old teacher Dr. R. R. Stewart, for helping me in identification of the fossil leaves, and for innumerable facilities extended to me during my stay in the Gordon College for the period of two years (1937–1939). It is my pleasant duty to thank the Director, Geological Survey of India, for the loan of Middlemiss's collection and for the photographs of *A. oblongum* reproduced in Plate XXIII. My grateful thanks are also due to the Vice-Chancellor, University of the Punjab and Principal Jodh Singh of the Khalsa College, Amritsar, for a research scholarship from the University and the authorities of the Lucknow University for the award of a Research Fellowship for my work on the Karewa floras at Lucknow. I am glad to acknowledge the assistance my wife has given me in correcting the proofs.

Plant-bearing Localities

A detailed description of the localities is given elsewhere (Puri, 1944) but a brief account of these may be given here as follows:—

Locality L.—Laredura, near Dangarpur, seven miles from Baramulla towards Gulmarg, height about 6,000 ft., above sea-level.

Locality N.—Ningal Nullah, about five miles south of Dangarpur village in a grassy meadow about a furlong from the bridge over the Ningal Nullah stream and near Botapathri village at an altitude of 9,000 ft.

Locality 3 *L.*—" Liddarmarg, in the stream bed 500 ft., west of the shepherds' huts, the beds dip 6 degrees north-east and are at 10,600 ft. "

Locality K 14/948.—" Liddarmarg, in two stream beds near the present Gujar (herdsmen) encampment, the dip of the bed is of the usual slightly inclined character, the altitude is 10,600 ft. above the sea-level."

Systematic List of the Species

Acer oblongum Wall.

Acer pentapomicum J. L. Stewart.

Acer villosum Wall.

Acer pictum Thunb.

Acer sp. A

Acer sp. B

Acer sp. C

Acer sp. D

Acer Cæsium Wall.

Acer sp.

DISTRIBUTION OF THE FOSSIL SPECIES IN THE KAREWAS

	Laredura alt. 6,000 ft.	Ningal Nullah alt. 9,000 ft.	Liddarmarg alt. 10,600 ft.
Acer oblongum ..			×
Acer pentapomicum ..		×	×
Acer villosum ..	×	×	
Acer pictum ..		×	
Acer sp. A ..	×		
Acer sp. B ..		×	
Acer sp. C ..	×		
Acer Cæsium ..		×	
Acer sp. D ..	×		
Acer sp. ..	×		
Acer sp. ..			×

DESCRIPTION

The family Aceraceæ is represented in the Karewa floras by five fully determined and five incompletely identified species; out of the latter five, four are based on leaf fragments, which in addition to being distinct from one another, do not seem to match any modern species of *Acer* growing at the present time in the Himalayas. The fifth species is based on a few fragments of fruits, which are difficult to determine specifically on account of the lack of knowledge regarding the fruits of modern species.

Leaves of *Acer*, whether modern or fossil, possess a definitely characteristic shape, which together with venation and nature of the margin of the lobes (if the leaf is lobed) serve as diagnostic features for different species.

Most of the leaves are fragmentary but they are well preserved as regards details of venation. One leaf fragment from Stewart's collection from Laredura was heavily coated in the field with rubber solution, which has greatly obscured the tertiary and finer reticulation, with the result that they have not been brought satisfactorily in the natural size photograph of the specimen.

KEY TO THE SPECIES

Leaves.—

I. Leaves undivided .. .. *A. oblongum*

II. Leaves palmatilobed.—

(i) Three-lobed:

(*a*) Margin entire.—Large, lobes acute at apex, laterals conspicuous, parallel and form two or more series of distinct loops below the margin .. .. *Acer* sp. B

Small, lobes acuminate at apex, laterals not so conspicuous, upper somewhat parallel, do not form loops below the margin .. .. .. *Acer* sp. A

(*b*) Margin definitely crenate, laterals fairly conspicuous, do not form clear loops below the margin *Acer villosum*

(*c*) Margin doubtfully toothed, laterals quite conspicuous, bifurcate below the margin and form loops .. .. *Acer pentapomicum*

(ii) Five-lobed: Large, laterals more or less obsolete *Acer* sp. D

(iii) Lobes either 3 or 5 (?): Large, laterals conspicuous and arcuate .. .. *Acer* sp. C

(iv) Five- or seven-lobed: Large, laterals somewhat conspicuous, soon break up in the lamina to form meshes .. .. *Acer pictum*

Fruits.—

I. Large.—Nut not preserved, reticulations of the wing large and clear .. .. *Acer Cæsium*

II. Small.—Nut preserved, reticulations fine and small .. *Acer* sp.

1. *Leaves*

Acer oblongum Wall.

(Plate XXIII, Figs. 1–4 and Pl. XXIV, Fig. 5)

The specimens referred to this species are four leaf-fragments, which are well preserved impressions as regards details of venation. Pl. XXIII, Fig. 2 is a natural size photograph of a complete leaf; there are two more leaf fragments, which are almost complete; the fourth specimen (Pl. XXIII, Fig. 3) is entirely broken on one side along its breadth. The complete leaf is broadly ovate in outline with a broad rounded base and acute apex. The margins are entire.

The venation is pinnate-looped with a tri-nerved base. A strong midrib starts from the base and runs straight in the lamina, gradually thinning out towards the apex. In Pl. XXIII, Fig. 2 the two basal secondaries, which are as strong as the midrib, arise very close to the base on its either side in opposite fashion and run straight towards the margins; the basal pair and the midrib form a tri-nerved base, which gives a pseudopalmate appearance to the venation. The midrib gives off, above the base, 8–9 secondaries on either side at slightly obtuse angles. The laterals, which are well preserved and about half as thick as the midrib, shoot out mostly in an alternate manner but there are some which are sub-opposite. The basal pair of secondaries gives off a number of small branches on its lower side (Pl. XXIII, Fig. 2). At some places there arise between the two strong laterals one or two weak secondaries, which are very thin and do not reach the margins but break up into large meshes in the lamina. The midrib and the secondaries have left shallow grooves in some specimens (Pl. XXIII, Fig. 2 and Pl. XXIV, Fig. 5), which seem to be impressions from the lower surface of the leaf; the other two leaf-fragments are probably impressions from the upper surfaces. The laterals bifurcate into two branches, which form loops below the margins (Pl. XXIII, Fig. 4). Tertiary ribs are numerous; they may arise from the midrib, the laterals, or the branches of the laterals, and anastomose with one another to form large meshes of various shapes and sizes in the area enclosed by the two secondaries. These tertiary meshes are clearly seen in the photograph which represents a small part of a fragment enlarged to five diameters. There is a well preserved finer reticulation, which consists of a network of smaller meshes occurring in a large tertiary mesh.

Our fossil leaves are identical in all respects with *Acer oblongum*, a simple leaved Himalayan maple, which is also found in plains.

No. of specimens.—Ten only.

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

Collections.—C. S. Middlemiss, 1910, and H. de Terra, 1932.

Registered Nos. of figured specimens.—Pl. XXIII, Fig. 1 = K14/948 *a*; Pl. XXIII, Fig. 2 = K14/948 *a* 23; Pl. XXIII, Figs. 3, 4 = K14/948 *a* 13″; Pl. XXIV, Fig. 5 = K14/948 *a* 9.

Acer pentapomicum J. L. Stewart

(Plate XXIV, Figs. 6–8)

This species is based on two leaf-fragments, one of which (Pl. XXIV, Fig. 8) is evidently a three-lobed leaf, but the other specimen (Pl. XXIV,

Fig. 6) may have had probably a five-lobed lamina. The former specimen comes from Liddarmarg and the latter was collected from Ningal Nullah. The Liddarmarg fragment, which measures 2·1 inches long by 1·5 inches in the broadest part, must have been broader than long. Leaf lamina is palmatifid with two completely preserved lobes, which are more or less ovate in outline. Margins of the lobes are entire; apices are acute, and the base of the leaf lamina seems to have been slightly rounded.

The Ningal Nullah specimen is palmati-partite; there is a wide sinus between the two lobes; and the fragment is broader than long and measures 1·3 inches long by 1·8 inches in the broadest part. The lobes are ovate in shape with acute apices and irregularly coarsely serrate margins; the teeth are blunt.

The venation is palmate-reticulate consisting probably of 3 primary ribs, which arise from the base of the leaf and end in the apices of the lobes. In both the fragments, only two primary ribs are preserved. The primary veins give off a number of secondaries at slightly acute angles in a pinnate manner; the secondaries, which are about half as thick as the main ribs, run straight in the lamina and bifurcate near the margins into two relatively thinner branches, each of which forms a small loop by anastomosing with branches of the superior and inferior laterals (Pl. XXVI, Fig. 7). The loops are ovate in shape and their convexities face the margins. Tertiary ribs arise from the main ribs as well as the secondaries and anastomose variously to form meshes of different shapes and sizes in the area enclosed by the two laterals (Pl. XXIV, Fig. 7). There is a finer reticulation consisting of a network of small polygonal or rectangular meshes, which are occupied in the large meshes of the tertiary reticulations.

Our fossil leaves are identical in all respects with *Acer pentapomicum* J. L. Stewart, a small tree of the inner Himalayan dry valleys.

Number of specimens.—Four only.

Occurrence.—Liddarmarg, at 10,600 ft. and Ningal Nullah, at 9,000 ft. Pir Panjal, Kashmir.

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

Registered Nos. of figured specimens.—Pl. XXIV, Figs. 6, 7 = Loc. 1 N6; Pl. XXIV, Fig. 8 = Loc. 3 L 16″.

Acer villosum Wall.

(Plate XXIV, Figs. 9, 10)

The specimen described here is a palmately lobed leaf of which only two lobes are preserved, the third being greatly damaged. The fragment is

broader than long and measures 1·8 inches long by 2·3 inches in the broades part. The lobes are somewhat ovate in shape; the lower lobe is probably smaller than the middle and the sinus between the two lobes is narrow and acute. The margins are irregularly crenate. The lobes have acute apices. Base of the leaf seems to be cordate.

The venation is palmate and reticulate consisting of three primary ribs each of which runs straight in its respective lobe. The primary ribs give off on either side at acute angles a number of secondary veins, which can only be seen in the complete lobe in the photograph (Pl. XXIV, Fig. 9). The secondaries are obscured in the rest of the leaf due to the application of a thick coat of rubber solution. The laterals, which are about half as thick as the primary ribs, diverge in an alternate manner. They give off a number of smaller branches on both sides and the latter being very thin are often indistinguishable from the tertiary ribs, which form large rectangular or polygonal meshes; the meshes can be clearly seen in a part of the leaf, which is enlarged to five diameters in the photograph (Pl. XXIV, Fig. 10). There is a finer reticulation, which consists of a fine, well preserved network of smaller meshes that are occupied in the tertiary meshes.

The fossil leaf is identical in all respects with *Acer villosum* Wall., a large tree of the Western Himalayas.

Number of specimens.—Six only.

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

Collectors.—R. R. Stewart, 1936 and G. S. Puri, 1940.

Registered No. of figured specimen.—L 193.

Acer pictum Thunb.

(Plate XXV, Fig. 11)

Plate XXV, Fig. 11 is a natural size photograph of a leaf-fragment, which measures 2·9 inches long by 3·5 inches in the broadest part. The leaf-lamina is palmately lobed; the number of lobes, on account of the fragmentary nature of the specimen, cannot be definitely ascertained, but from the number of the primary veins it appears that the leaf was probably 5 or 7 lobed. Base of the leaf seems to be cordate.

The venation is palmate-reticulate consisting of 7 main ribs, which are fairly stout and diverge from the base of the leaf towards the lobes in the apex of which they end. The photograph shows one badly preserved lobe in which the main rib is seen tapering gradually towards the apex. The

laterals make slightly deep grooves in the fossil, which seems to be an impression from the lower surface of the leaf.

The primary ribs give off a number of small secondary veins, which are comparatively very thin and feeble. The secondaries do not run straight but fluctuate in the lamina following a zigzag and wavy course. They diverge from the main ribs at different angles, and on account of their extremely thin nature soon get lost in the tertiary reticulation, which is also composed of ribs of almost the same thickness. Meshes of the tertiary reticulation are more or less rectangular or roughly pentangular in shape. There is a finer reticulation, which is composed of very small rectangular or polygonal meshes occupied in the large tertiary reticulations.

Our fossil fragment is identical in all respects with *Acer pictum* Thunb., a handsome medium-sized tree of the Himalayas.

Number of specimens.—Six only.

Occurrence.—Ningal Nullah, at 9,000 ft., Pir Panjal, Kashmir.

Collector.—G. S. Puri, 1940.

Registered No. of figured specimen.—Loc. 1 N7.

Acer sp. A

(Plate XXV, Figs. 16, 17)

Plate XXV, Fig. 16 is a natural size photograph of a three-lobed leaf, which measures 1·9 inches long by 2·3 inches in the broadest part. One of the basal lobe is partly missing in the leaf; the two others also are slightly broken at the tips. The leaf is slightly broader than long with an ovate outline and a cordate base. Each lobe which is also ovate in outline is broader at the base and abruptly tapers into an acuminate apex. The sinus between the two lobes is wide and obtuse and it extends to about one-third of the way in the lamina; the margins are entire.

The venation is palmate-reticulate. It consists of three main ribs, which run straight and end in the apices of the lobes. The primary ribs give off five to six pairs of lateral veins, which arise at acute angles in a pinnate manner. The laterals are almost half as thick as the primaries. The secondary ribs which arise in the basal lobe on the outer side from the primaries, make a sharp curve under the margins and anastomose with the superior secondaries to form a series of simple loops (Pl. XXV, Fig. 17). The secondary ribs that arise from the inner side of the basal primary rib anastomose with the secondaries that arise from the primary rib of the central lobe. The tertiary reticulation is in the form of

large meshes, which are of different sizes and shapes. There is a well preserved finer reticulation, which is clearly seen in the photograph (Pl. XXV, Fig. 17).

The fossil nicely resembles modern leaves of the genus *Acer*, but it does not match any living species that now grows in Kashmir or anywhere in the north and north-west Himalayas and it may belong to a species, which has become extinct from this part of India. Comparisons with foreign species in the Herbarium of the Forest Research Institute, Dehra Dun, also failed to attain its specific determination.

Number of specimens.—One only.

Occurrence.—Laredura, at 6,500 ft., Pir Panjal, Kashmir.

Collecter.—G. S. Puri, 1940.

Registered No. of figured specimen.—L 670.

Acer sp. B

(Plate XXVI, Figs. 21–23)

This species is based on a three-lobed simple leaf of *Acer*, which may be described as follows. The leaf is broadly ovate in shape and is broader than long. It measures 3·5 inches long by 4·6 inches in the broadest part. Base of the leaf though slightly broken, seems to have been cordate. The lobes are ovate with broad basal regions and narrow tapering apices. The sinus between the lobes is somewhat acute in shape and extends about half way in the lamina. Margins of the lobes are entire. The lateral lobe on the left-hand side in the photograph (Pl. XXVI, Fig. 21) is fractured and the broken fragments are lying jumbled together under and over the leaf.

The venation is palmate-reticulate; it consists of three main primary ribs, each of which diverges from the base and runs in its respective lobe in an almost straight course. Each primary rib gives off 10–15 pairs of secondary veins which are conspicuous and almost half as thick. The secondaries are arranged on a primary rib in a pinnate manner; they shoot out at slightly acute angles and after running straight for about three-fourth of its length curve upwards to form near the margin a series of loops which anastomose to form an infra-marginal vein below the margin (Pl. XXVI, Fig. 22). The tertiary reticulation is composed of large meshes, which are of different shapes. They break up into smaller meshes, which constitute the finer reticulations. Both tertiary and finer reticulations are clearly seen in the photograph (Pl. XXVI, Fig. 23), which represents a part of the leaf enlarged to five diameters.

The fossil does not resemble any living species of *Acer* represented in the present-day flora of Kashmir and the north-west Himalayas. Comparisons with foreign species also failed to determine it specifically.

Number of specimens.—One only.

Occurrence.—Laredura at 6,500 ft., Pir Panjal, Kashmir.

Collector.—G. S. Puri, 1939.

Registered No. of the figured specimen.—L 547.

Acer sp. C

(Plate XXVII, Figs. 24–25)

Although this species shows some resemblance to the fossil leaves referred to *Acer* sp. A and *Acer* sp. B, it seems to be clearly distinct from them and may be described separately. Pl. XXVII, Fig. 24 is a natural size photograph of the leaf-fragment. On account of the fragmentary nature of the specimen it cannot be definitely ascertained whether it is a three-lobed leaf or the number of lobes is five or more. It measures 2·8 inches long by 3·7 inches in the broadest part. The leaf-lamina, which is broader than long, had probably an ovate shape; the base of the leaf and the apices of the lobes are not preserved. The sinus between the lobes is somewhat acute and seems to run fairly deep in the lamina. The margins are entire.

The venation is palmate-reticulate; three main primaries traverse the three incompletely preserved lobes, and give off a number of secondary veins in a pinnate manner. The secondaries arise at slightly obtuse angles and a few pairs in the upper part of the central lobe gradually curve upwards and become arcuate near the margin. Some secondaries, which arise in the lower part of the middle lobe, do not reach the margin but begin to break up and anastomose with inner secondaries of the lateral lobes. These secondaries are relatively thinner than the upper secondaries, which are about half as thick as the primary ribs. A few upper pairs of secondaries form a single series of simple loops, which anastomose with one another to form an inframarginal vein running close to the margins. In between the two strong secondaries there arise one or two weaker secondaries, which soon break up and anastomose to form meshes of the tertiary reticulations. These meshes are large, and are of different shapes. The finer reticulation consists of very small meshes, which are occupied in by the larger tertiary meshes.

The fossil leaf does not resemble any living species of *Acer* growing in India at the present time and it seems to be a new species, which have become extinct from this part of the world. It shows some resemblance to *Acer*

sp. A and *Acer* sp. B, but the differences are fairly well marked out to constitute it a new species. The differences between the three species are brought out in the following table:—

Characters	*Acer* sp. A (Pl. XXV, Figs. 19, 20)	*Acer* sp. B (Pl. XXVI, Figs. 21–23)	*Acer* sp. C (Pl. XXVII, Figs. 24–25)
1. Size ..	Small leaf	A larger leaf about twice or sligtly more than sp. A	It is largest of the three species. The fragment, which is about half of a leaf is more or less of the same size as sp. B
2. Lobes ..	Definitely three-lobed	Definitely three-lobed	May be three-lobed or more
3. Lateral veins	Thin and more or less obsolete. Not arcuate. Outer laterals in the lateral lobes and upper in the central lobe form indistinct simple loops. The laterals in the lower part of the central lobe and those arising from the inner side in the lateral lobes break up and anastomose to form tertiary reticulation	Very well developed and prominent. Slightly arcuate. All laterals form a series of loops, which anastomose to form an infra-marginal vein running parallel to the margins	Well developed and prominent. Very arcuate; only the upper laterals in the central lobe and outer laterals of the outer lobes form a single series of loops which anastomose to form an infra-marginal vein running close to the margin. The laterals in the lower portion of the central lobes are of the same nature as those in species A

Number of specimens.—One.

Occurrence.—Ningal Nullah at 9,000 ft., Pir Panjal, Kashmir.

Collector.—G. S. Puri, 1940.

Registered No. of figured specimen.—Loc. 1 N 8.

Acer sp. D

(Plate XXVIII, Figs. 26–27)

Plate XXVIII, Fig. 26 is a natural size photograph of a leaf-fragment; and a portion of its counterpart is illustrated in Fig. 27 on the same plate. In the counterpart, the margin and apex of one of the lateral lobes is clearly preserved. The palmately lobed leaf, which is probably 5 lobed, is distinctly broader than long and measures 2·6 inches long by 5 inches in the broadest part. Base is cordate; the margins of the lobes are entire. The sinus between the lobes is not clearly seen in the photographs on account of the fractured nature of the leaf. Apex of one lobe, which is completely preserved, is acuminate.

The venation is palmate-reticulate consisting of 5 prominent main ribs, which have left deep grooves in Fig. 27 and stand out in the form of ridges

in Fig. 26. The former specimen is an impression from the lower surface of the leaf, while its counterpart (Fig. 26) represents the upper surface. The main ribs diverge from the base in a palmate fashion and give off in the lamina a few very obscure laterals, which are neither prominent enough to be distinguished from tertiary ribs, nor they seem to reach the margins in the case of the outer ribs. A close meshwork with large meshes, here and there, constitutes what may be called a finer reticulation.

The leaf fragments do not compare any modern species of *Acer* represented in the present-day flora of the Himalayas; therefore, it is described here as a distinct type under *Acer* sp. D.

Number of specimens.—Two (counterparts of a leaf).

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

Collector.—G. S. Puri, 1940.

Registered Nos. of figured specimens.—Pl. XXVIII, Fig. 26 = L 803 *a*; Pl. XXVIII, Fig. 27 = L 803 *b*.

2. *Fruits*

Acer Cæsium Wall. (vel. affinis)

(Plate XXV, Figs. 12, 13)

The specimen described under this species is fragment from a wing of one half of a double samara. The seed portion of the fruit is altogether missing and the wing too is not completely preserved. It measures 1·55 inches long by ·6 inch in the broadest part. The wing is straight and shows a network of strong veins. The veins seem to diverge from the thickened side along its entire length; they arise at slightly obtuse angles and run straight towards the other edge of the wing; most of the veins soon start bifurcating dichotomously and go on repeatedly forking up to the edge. The forked branches anastomose with one another and form a sort of network.

Number of specimens.—One only.

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

Collector.—R. R. Stewart, 1935.

Registered No. of figured specimen.—L 160.

Our fossil seems to have a close resemblance in size, shape, reticulation, etc., with modern samara of *Acer Cæsium* Wall. (Pl. XXV, Fig. 13).

Acer sp.

(Plate XXV, Figs. 14, 15)

The present species is based on a winged nut of a double samara of *Acer*. Pl. XXV, Figs. 14, 15 are natural size photographs of a samara and its counterpart. Neither of the specimens is well preserved. The entire specimen measures 1·28 inches in length, and consists of the lower seed portion (seen in the photograph as a thick dark diamond-shaped body), which is ·33 inch long by ·25 inch in the middle broadest part. The upper thin membranous part is the wing. From the thick and solid side of the wing there arise a large number of veins, which traverse the body of the wing. These veins are seen in the form of reticulations in the photograph.

As the fossil is only half of a double samara, it is not possible to specifically determine it. No systematic book on the Indian flora gives any description of the samaras; therefore, the identification could not be attained with our present state of knowledge.

Number of specimens.—One and its counterpart.

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

Collector.—H. de Terra, 1932.

Registered Nos. of figured specimens.—Pl. XXV, Fig. 14 = Loc. 3L 50; Pl. XXV, Fig. 15 = Loc. 3L 51.

Acer sp.

(Plate XXV, Figs. 18, 19, 20)

Plate XXV, Figs. 18, 19, 20 illustrate in natural size three specimens of fruits of *Acer*, which are again very difficult to assign to their species. Two of them (Pl. XXV, Figs. 18, 19) seem to have some resemblance in shape and size and may have belonged to the same species but the third specimen (Pl. XXV, Fig. 20) in its shape seems to be different. All specimens are represented by a nut and a complete wing, in which reticualations are clearly seen. The nut is more or less oblong in Figs. 18 and 19, but in Fig. 20 it seems to be rather four-sided and shows some pitted structure.

As it is not possible to determine any of these samaras specifically, they are described here under *Acer* sp.

No. of specimens.—Three only.

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

Collector.—G. S. Puri, 1939.

Registered Nos. of Figured specimens.—Pl. XXV, Fig. 18 = L 720; Pl. XXV, Fig. 19 = L 721; Pl. XXV, Fig. 20 = L 549.

Modern Distribution of the Aceraceæ

The family Aceraceæ, which includes more than 150 species belonging to two genera *Dipteronia* and *Acer* is, at the present time, confined to the Northern Hemisphere mostly in the north temperate region and in the mountains of tropical countries.

The two species of *Dipteronia* are confined to Western China and the second genus *Acer,* which includes about 150 modern species, occurs in the Northern Hemisphere. The maples are mostly hill species well represented in Europe, North America and Asia. The region lying between the Eastern Himalayas and Central China has the greatest number of species. Out of a total of 85 species reported from China as many as 67 are confined to this country, which is probably the richest in the world for Acerous plants. Quite a large number of species occur in Japan also. In Europe, the Balkan peninsula and the Western Caucasus are the richest regions for maples, which are distributed throughout the Mediterranean countries. In America, the species of *Acer* are found in the mountains of South Canada, and the region between Oregon and Mexico. It may be interesting to point out that the species of *Acer* found in the Atlantic countries are different from those reported from the Pacific side.

In India there are about 15 species of *Acer,* which are hill types; all of these with the exception of two species (one of which *A. isolobium* is confined to Burma, and the other *A. niveum* occurs both in Assam and Burma), occur in the Himalayas. Some of the Himalayan species, *e.g., A. oblongum* and *A. lævigatum* also occur outside the Himalayas and they are recorded from Assam and Manipur; another Himalayan species *A. Thomsoni* extends as far east as Assam and Burma.

Three species, namely, *A. pentapomicum, A. villosum* and *A. Cæsium,* are Western Himalayan while the following six, *A. Hookeri, A. sikkimense, A. stachyophyllum, A. Thomsoni, A. Papilio,* and *A. Campbellii,* are distributed in the Eastern Himalayas. There are four species, namely, *A. oblongum, A. lævigatum, A. caudatum* and *A. pictum,* which are common to both the Western and the Eastern Himalayan regions.

Modern Distribution of the Fossil Species

Our fossil types include three species, which are exclusively Western Himalayan in their present-day distribution and the remaining two species inhabit both the Eastern and Western Himalayas.

(i) *Acer oblongum* Wall., a low-level Himalayan species, which has been discovered in the fossil state at an elevation of 10,600 ft. at Liddarmarg

in the Pir Panjal, is met with at the present time in the outer Himalayan ranges and valleys from the Jhelum to Bhutan, ascending from plains to the altitude of 6,000 ft. It is also recorded from Assam and Manipur. At lower elevations the tree usually occurs in moist ravines and on river banks; it grows along the banks of Kotri river in the United Provinces at 2,000 ft. and is found even at lower altitudes in the Dehra Dun Valley. In the low-lying valleys of Siwalik Hills it is common. In plains it occurs as a cultivated tree. In Kashmir it is found only at Chineni and Mirpur and is also recorded from the Murree Hills, Bashahr, Simla, Mussoorie (to 6,500 ft. alt.), Garhwal, Naini-Tal, Kumaon, etc.

(ii) *Acer pentapomicum* J. L. Stewart, is usually a tree of the Inner Himalayan dry valleys but it also occurs in the Western Himalayas between the Jhelum and the Sutlej Valley at altitudes of 2,500–7,000 ft; it is also recorded from Kunawar; from the Jhelum westwards it is reported from Malakand (the Kagan Valley) at 6,000 ft.

In Kashmir, it grows at Keran, Kishtwar, Marwa Dachhan, Ramban and Muzaffarabad. In the inner arid valleys of almost all the Punjab rivers it occurs usually growing on dry slopes; in Hazara it occurs on the banks of dry ravines.

Its common associates in the inner valleys, where it is more or less gregarious in dry localities, are *Quercus Ilex* and *Fraxinus xanthoxyloides*.

(iii) *Acer villosum* Wall., is a large tree of the Western Himalayas, which occurs between the Jhelum and Kumaon at altitudes of 7,000–9,000 ft. It does not seem to grow in Kagan, the Murree Hills or Kashmir but Hooker (1875, Vol. I, p. 695) records it from Kashmir (he does not mention any locality).

It is recorded from Jaunsar (altitude 8,000 ft.) Simla, the Ganges Valley, Tehri Garhwal (altitude 9,000–10,000 ft.) and Garhwal (alt. 9,000 ft.).

(iv) *Acer pictum* Thunb. is a handsome medium-sized tree, which occurs throughout the Himalayan ranges from the Indus to Bhutan at altitudes of 4,000–9,000 ft. It also occurs in the Trans-Indus territory and extends as far east as China and Japan. In Hazara it occurs at 8,000 ft., and also grows in the Murree Hills, where it is fairly common.

In Kashmir the species grows in Kamraj, the Kashmir Valley, Kishtwar, Marwa Dachhan, Ramban and the Sind Valley. It also occurs in Simla, Deoban, Jaunsur, Mussoorie and Landour.

(v) *Acer Cæsium* Wall. is the commonest maple of the Western Himalayas, which grows abundantly from Nepal westwards at altitudes of 7,000–10,000 ft.;

it may ascend to 12,000 ft. at some places and occasionally occurs at as low elevations as 4,000 ft.

In the mixed forests, where it is commonly associated with *Abies Pindrow, Pinus excelsa, Taxus baccata, Aesculus indica, Ulmus Wallichiana, Prunus Padus,* it often forms gregarious patches in shady places, or in valleys.

It is quite common in the Kagan Valley, Hazara, Chitral, the Murree Hills and the neighbouring Galis.

In Kashmir it grows abundantly at Sonamarg, the Kishenganga Valley, Kamraj, the Jhelum Valley, the Lidder Valley, Gurez, Keran, Kishtwar, Marwa Dachhan, Muzaffarabad, etc.

Along the outer Himalayan ranges this maple is the most widely distributed species occurring at Chamba, Bashahr, Jaunsar, Simla, Chakrata, Garhwal, Tehri Garhwal, the Pindari Valley, Kumaon, etc., etc.

The Species of *Acer* in the Modern Temperate Forests of the Western Himalayas

In the moist temperate deciduous forests the three Western Himalayan species of *Acer* occur gregariously in association with broad-leaved genera, *e.g.*, in Dwali, Western Almora Division (Kumaon in the United Provinces). *Acer Cæsium* and *Acer pictum* are found in association with *Aesculus indica, Carpinus viminea, Ulmus Wallichiana, Betula alnoides, Juglans regia, Fraxinus micrantha, Quercus semecarpifolia, Corylus colurna, Cornus macrophylla, Rhus punjabensis, Taxus baccata, Spiræa* (Champion, 1936, pp. 257–58).

In the Sutlej Valley (Punjab) we have the three species of *Acer,* namely *A. Cæsium, A. pictum, A. villosum* occurring together with *Aesculus indica, Betula alnoides, Fraxinus micrantha, Carpinus* sp., *Celtis australis, Juglans regia, Pyrus lanata, Ulmus* spp., *Abies Pindrow, Prunus cornuta, Corylus colurna, Cornus* spp., *Rhododendron arboreum, Rhus* sp., *Taxus baccata,* etc., etc. (Champion, *loc. cit.*, p. 258).

The same species of *Acer* aslo occur in Kulu and Hazara and the floristic composition of the forests is more or less similar to the forests at the above-mentioned places.

In the " Western oak-fir forests of Garhwal Himalayas " *Acer Cæsium* occurs with *Abies Pindrow, Picea Morinda* and several broad-leaved species, namely, *Quercus semecarpifolia, Q. dilatata, Ulmus Wallichiana, Aesculus indica, Corylus colurna, Rosa macrophylla, Rubus* sp., *Syringa Emodi,* etc. (Champion, *loc. cit.*, p. 245).

Acer Cæsium is associated with more or less the same species in the forests of Deoban (Chakrata division) also.

A few species of *Acer* occur in Pulga forests of the Parbatti Valley in Kulu and in the Sutlej Valley. In the former forests its associates are *Abies Pindrow, Pinus excelsa, Picea Morinda, Taxus baccata, Quercus semecarpifolia, Corylus colurna, Pyrus lanata* and species of *Rosa, Viburnum, Rubus, Spiræa,* and in the latter place the most common species occurring with them are *Abies Pindrow, Quercus semecarpifolia, Betula alnoides, B. utilis, Rhododendron campanulatum, Cotoneaster* sp., etc. (Champion, *loc. cit.*, pp., 245–46).

In the "western mixed coniferous forests of the Sutlej Valley" *Acer Cæsium, A. pictum* and *A. acuminatum* occur in association with the three most common Western Himalayan oaks, namely, *Q. incana, Q. dilatata* and *Q. semecarpifolia,* and several conifers including *Picea, Cedrus, Abies, Pinus excelsa* and *Taxus* (Champion, *loc. cit.*, p. 242).

In the "western mixed conifer forests of Grahan Nal, Parbatti Valley (Punjab)" *Acer* spp. occurs with *Abies, Picea, Cedrus, Juglans regia, Corylus colurna, Celtis australis, Ulmus Wallichiana* and here the oaks are not associated with maples (Champion, *loc. cit.*, p. 243). Similarly, in the broad-leaved forests of the Kashmir Valley, where the species of *Acer* are fairly abundant, we do not have a trace of oaks but the former are associated with *Populus ciliata, Juglans regia, Aesculus indica, Salix Wallichiana, Ulmus Wallichiana,* etc., etc.

"*Quercus dilatata–Acer* forests" are common in the Central Himalayas at an altitude of 7,000–8,000 ft. A little above the elevation zone of *Quercus incana, e.g.,* in Garhwal Himalayas *A. Cæsium* occurs with the three common species of oaks, *Betula alnoides, Carpinus viminea, Machilus Duthiei, Rhamnus purpurea,* etc. (Champion, *loc. cit.*, p. 235).

Past Distribution of the Genus *Acer*

Although an exhaustive account of the past distribution of the family is outside the scope of this paper, it may perhaps be useful to write a few lines regarding the existence of the Aceraceæ in time.

Fossil leaves and fruits belonging to several species of *Acer,* either closely related or identical with modern species, have been discovered from the Tertiary rocks of Europe and North America. In the Arctic regions they have occurred in a fairly good number during the Tertiary Period and southwards the genus was comparatively better represented then than to-day. From the geographical distribution of maples during the Tertiary times it may be conjectured that the genus *Acer* was probably more widely spread in the past than at the present time.

MAPLE FORESTS OF THE KASHMIR VALLEY DURING THE PLEISTOCENE

The maples seem to have been more widely spread in the Valley during the Pleistocene than at the present time; out of a total of ten species recognised from the Karewas only three—*Acer Cæsium, A. acuminataum* and *A. pictum* are now seen in the Valley. The quantitative representation of the fossil species goes to show that the *Acer* spp. had occupied a fairly prominent position in the vegetation of that time and they might have formed extensive belts in forests of broad-leaved trees.

Acer oblongum, a tropical species of the Sub-Himalayan zones, which occurred on the northern slopes of the Pir Panjal Range at Liddarmarg during the Pleistocene, probably in association with several broad-leaved species, namely, *Machilus odoratissima, M. Duthiei, Phœbe lanceolata, Ficus Cunia, Buxus papillosa, B. Wallichiana, Mallotus phillipinensis,* in forests of *Quercus incana* and *Quercus glauca,* has now totally disappeared from these regions since the early Pleistocene.

Of the two species—*A. pentapomicum,* and *A. pictum* and other incompletely determined species of *Acer,* which during the Pleistocene, were probably associated with *Ulmus Wallichiana, Ulmus lævigata, Aesculus indica, Carpinus faginea, Alnus nitida, Rosa macrophylla, Quercus dilatata, Q. Ilex, Viburnum cotinifolium, Engelhardtia Colebrookeana,* etc., etc., at Laredura, only one (*A. pictum*) is still present in the valley; the other species has now taken to more favourable climatic regions.

Of the other two species, namely, *A. villosum* and *A. Cæsium,* which occurred at Ningal Nullah in an altogether different association, composed of *Salix Wallichiana, S. denticulata, Salix* spp., *Populus ciliata, Populus nigra, Rhamnus purpurea, Juglans regia, Aesculus indica, Pyrus Malus,* etc. *A. villosum* has again disappeared from the Kashmir Valley. The flora at this locality (Ningal Nullah) during the Pleistocene was characterised by the absence of oaks, laurels, figs, box, etc., which are tropical species and in this respect it has a good deal in common with the modern flora of the Kashmir Valley adjoining the northern slopes of the Pir Panjal Range.

SUMMARY

1. The paper describes about ten species of the Aceraceæ five of which are completely determined; the remaining include four leaf species, which do not match any modern species of the Himalayas; one species, *viz., A. Cæsium* is based on a few fragments of fruits, the other bits of samaras could not be specifically determined by comparison with any modern species.

2. The modern distribution of the Aceraceæ brings to light the absence from the Kashmir Valley of three species (*A. oblongum, A. penta-*

pomicum and *A. villosum*) which occur in the fossil state in the Karewa beds. However, the other two species, namely *A. Cæsium* and *A. pictum*, are important constituents of the broad-leaved forests of the Valley as well as the northern slopes of the Pir Panjal Range. The modern distribution of the fossil species in the Himalayan regions is given together with their different associates in different types of forests.

3. A comparison of the modern maple forests of the Kashmir Valley with those of the Pleistocene period shows that the oaks and laurels, which must have occurred during the Pleistocene in association with maples, are altogether absent from the valley at the present time. This fact shows that the climate of the valley has changed since the early Pleistocene times.

4. The inclusion in the fossil flora of the Aceraceæ does not alter the general conclusions already expressed by the author regarding the changes of climate and altitude of the Valley since the early Pleistocene times.

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Explanation of Plates

All the photographs in Plates XXIII–XXVIII are from untouched negatives. Figured specimens excepting those of *Acer oblongum* (Figs. 1-5), which are the property of the Geological Survey of India, are preserved in the Botany Museum, University of Lucknow. (Sahni Collection).

Plate XXIII. *Acer oblongum* Wall.

Fig. 1. Leaf (impression of the upper surface). Middlemiss collection, G.S.I. No. K 14/948 *a*, Liddarmarg. Nat. size.

Fig. 2. Leaf (impression of the lower surface) showing tri-nerved base. Middlemiss collection, G.S.I. No. K 14/948 *a* 23, Liddarmarg. Nat. size.

Fig. 3. Leaf (impression of the upper surface). Middlemiss collection, G.S.I. No. K 14/948 *a*, 13, Liddarmarg. Nat. size.

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

Plate XXIV

Acer oblongum Wall.

Fig. 5. Leaf (impression of the lower surface). Middlemiss collection, G.S.I. No. K 14/948 *a*, 9, Liddarmarg. Nat. size.

Acer pentapomicum J. L. Stewart

Fig. 6. Leaf impression. G. S. Puri collection, Loc. 1 N 6, Ningal Nullah. Nat. size.

Fig. 7. A part of the leaf (marked × in Fig. 6) enlarged to show nature of the laterals; tertiary and finer reticulations. ×*Ca.* 5.

Fig. 8. Leaf impression. de Terra collection, Loc. 3 L 16″, Liddarmarg. Nat. size.

Acer villosum Wall.

Fig. 9. Leaf (impression of the upper surface). R. R. Stewart collection, L 193, Laredura. Nat. size.

Fig. 10. A part of the leaf (marked ×× in Fig. 9) enlarged to show nature of the laterals; tertiary and finer reticulations. × *Ca.* 5.

PLATE XXV

Acer pictum Thunb.

Fig. 11. Leaf (impression of the lower surface). G. S. Puri collection, Loc. 1 N 7, Ningal Nullah. Nat. size.

Acer Cæsium Wall.

Fig. 12. Wing of a fossil samara, R. R. Stewart collection, L 160, Laredura. Nat. size.

Fig. 13. Winged nut of a modern double samara for comparison with the fossil (Fig. 12).

Acer sp.

Fig. 14. Samara (one half) showing the basal nut and wing. de Terra collection, Loc. 3 L 50, Liddarmarg. Nat. size.

Fig. 15. Counterpart of Fig. 14. Loc. 3 L 51, Liddarmarg. Nat. size.

Acer sp. A

Fig. 16. Leaf (impression of the upper surface). G. S. Puri collection, L 670, Laredura. Nat. size.

Fig. 17. A part of the leaf (marked ×× in Fig. 16) enlarged to show nature of the laterals; tertiary and finer reticulations. ×*Ca.* 5.

Acer sp.

Fig. 18. Samara. G. S. Puri collection, L 720, Laredura. Nat. size.

Fig. 19. Samara. G. S. Puri collection, L 721, Laredura. Nat. size.

Fig. 20. Samara. G. S. Puri collection, L 549, Laredura. Nat. size.

PLATE XXVI. *Acer* sp. B

Fig. 21. Leaf (impression of the upper surface). G. S. Puri collection, L 547, Laredura. × *Ca.* ½ Nat. size.

Fig. 22. One lobe of the leaf (marked 1 in Fig. 21) enlarged to show the loops of the laterals and inframarginal vein. ×*Ca.* 4.

Fig. 23. A part of the leaf (marked ×× in Fig. 21) enlarged to show tertiary and finer reticulation. ×*Ca.* 5.

PLATE XXVII. *Acer* sp. C

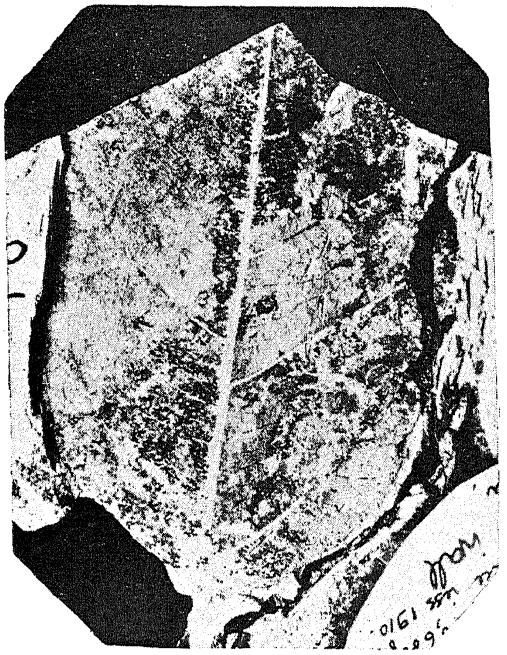
Fig. 24. Leaf impression. G. S. Puri collection, Loc. 1 N 8, Ningal Nullah. Nat. size.

Fig. 25. A part of the leaf (marked ×× in Fig. 24) enlarged to show tertiary and finer reticulations. ×*Ca.* 3.

PLATE XXVIII. *Acer* sp. D

Fig. 26. Leaf (impression of the upper surface). G. S. Puri collection, L 803 *a*, Laredura. Nat. size.

Fig. 27. A part of the counterpart of the leaf (Fig. 26) showing tip of a lobe. L 803 *b*. Nat. size.



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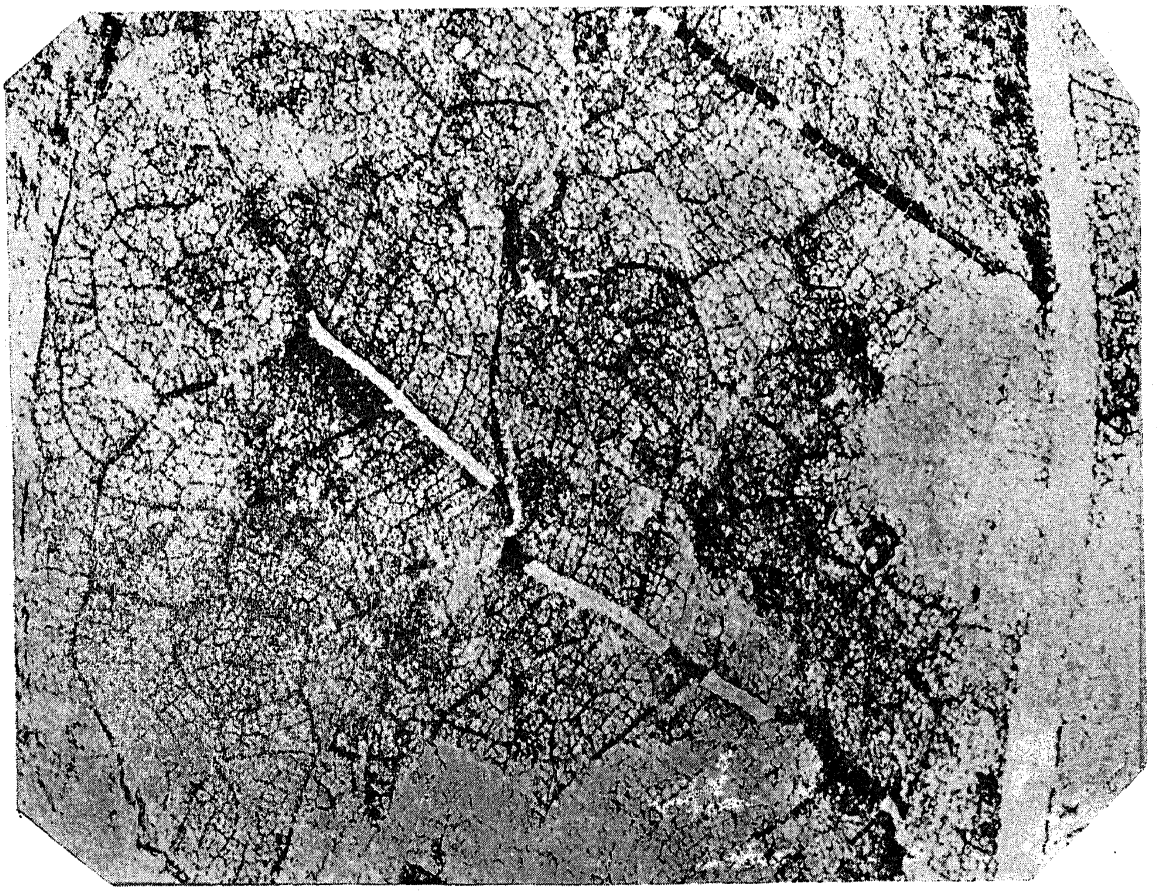

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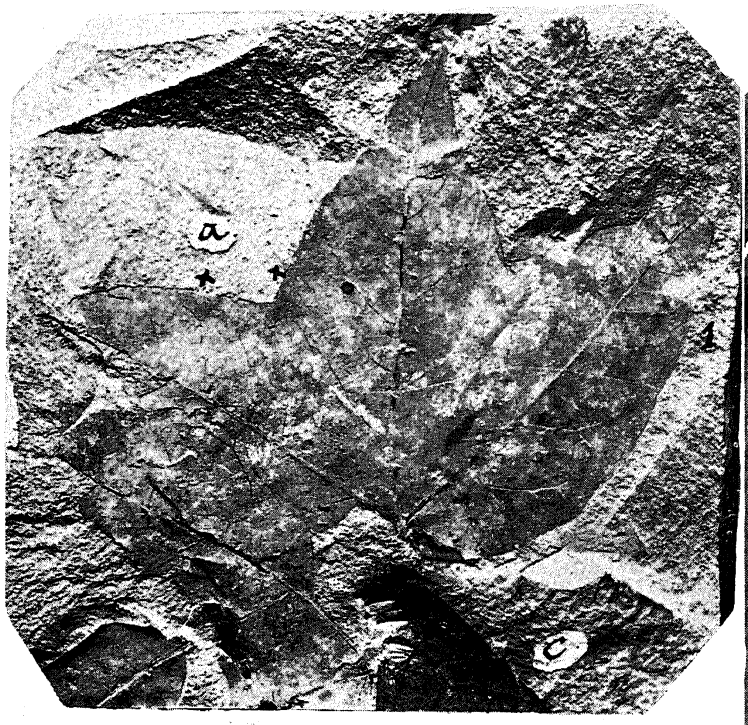

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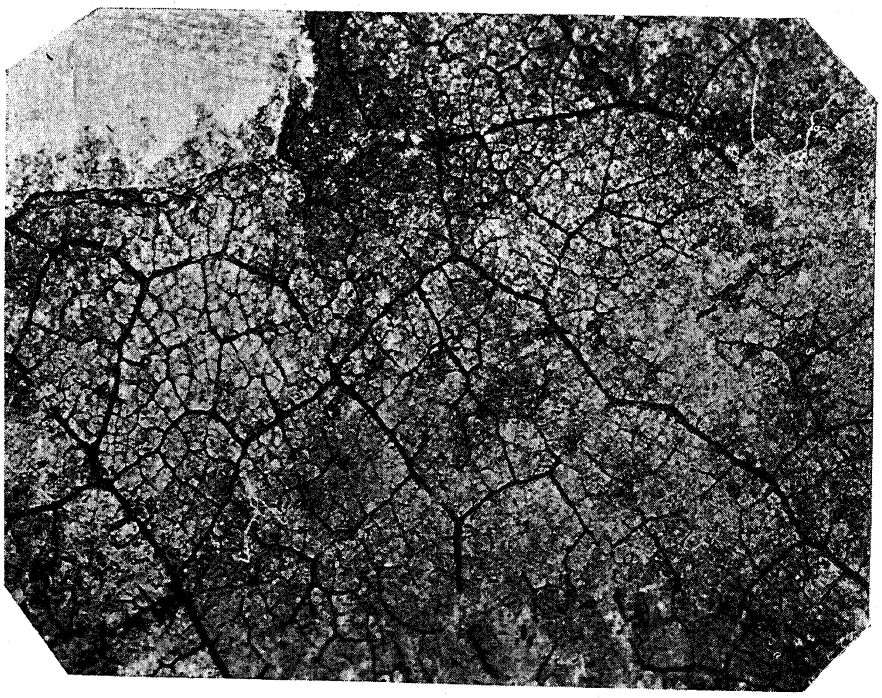

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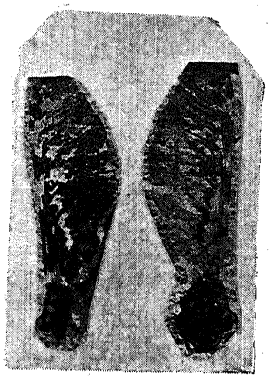

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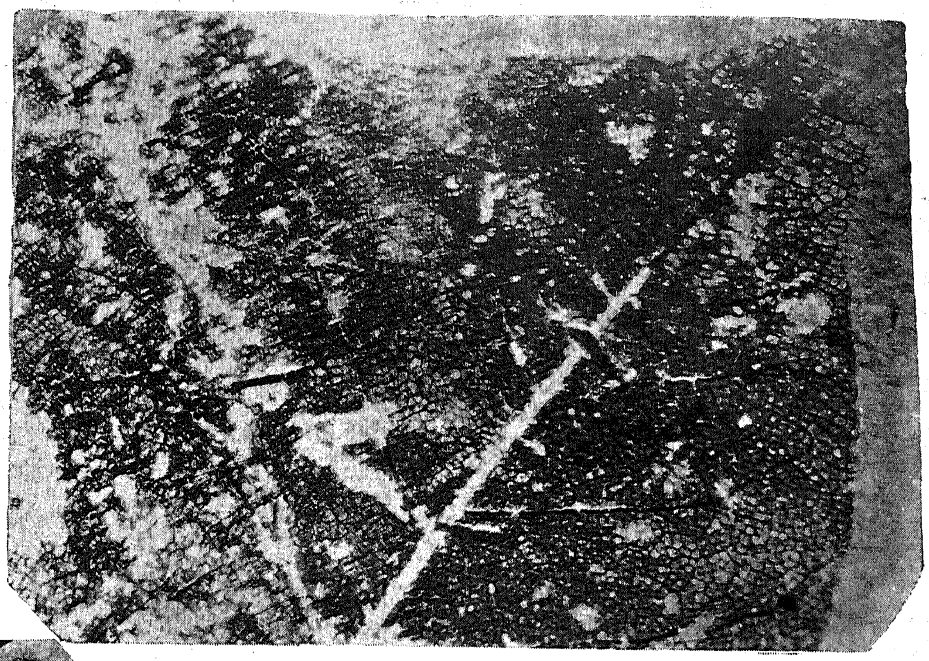

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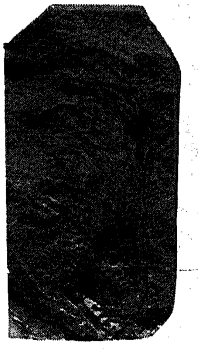

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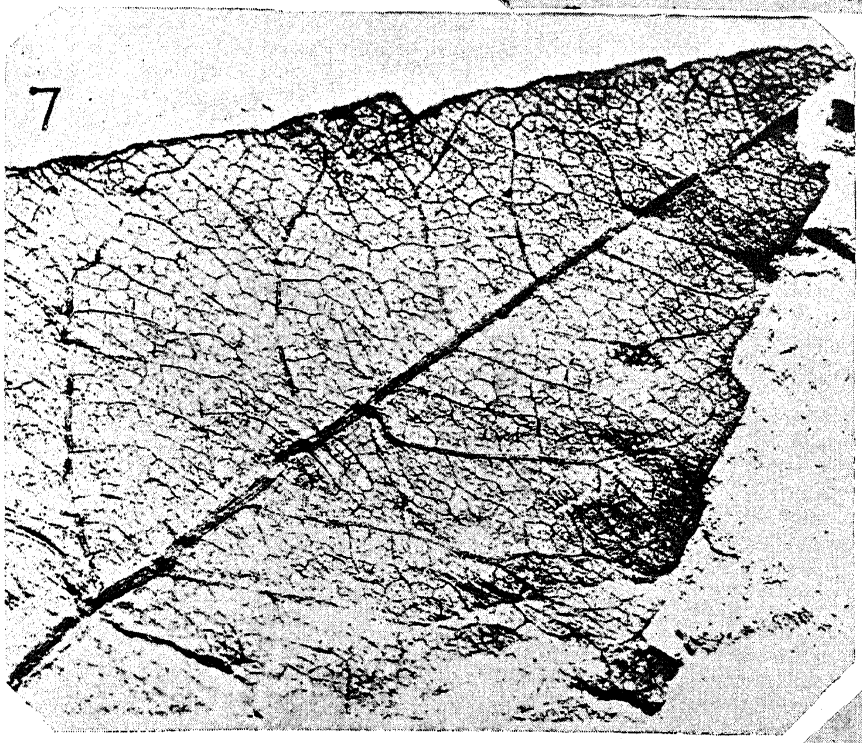

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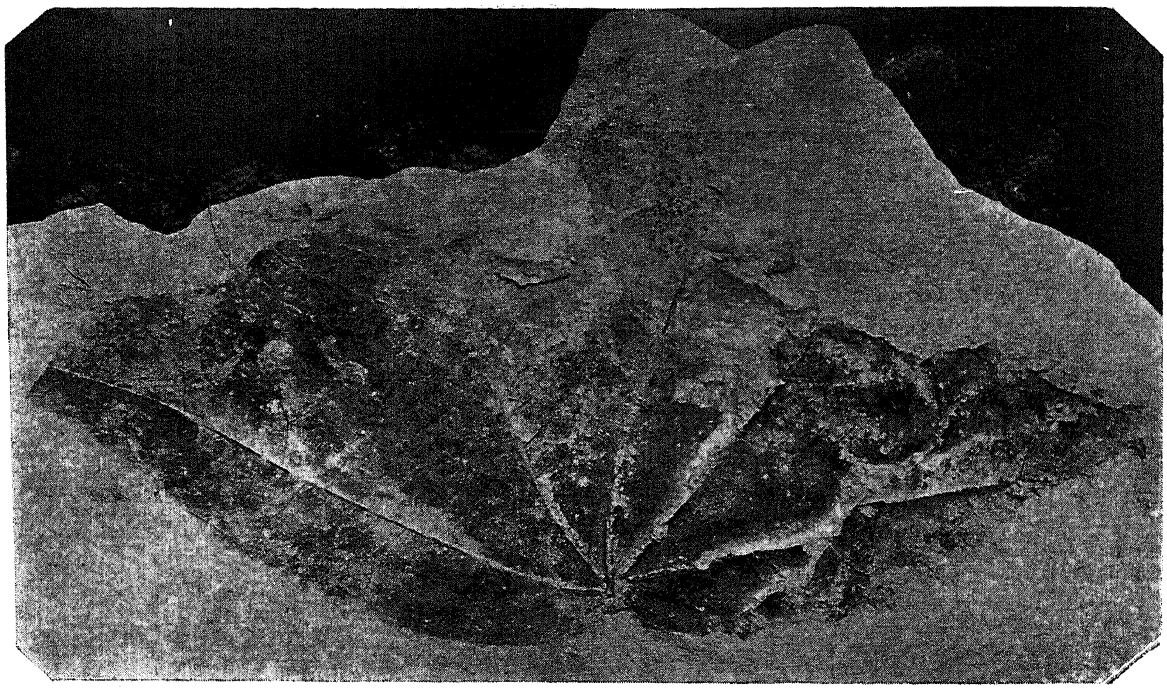

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