SOME MACROSCOPIC PLANT-REMAINS REFERRED TO THE BETULACEÆ FROM THE KAREWA DEPOSITS OF KASHMIR

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(With Three Plates)

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Introduction

The material described in this paper was collected partly by Dr. R. R. Stewart in 1935 and 1936 and partly by the author in 1939 and 1941 from the Lower Karewa deposits of Kashmir, which are exposed at an altitude of 6,000 ft. near the village of Laredura(Lat. 34° 7′; Long. 74° 21′)and in a grassy meadow that lies at an elevation of 9,000 ft. on the right bank of Ningal Nullah (Lat. 34° 4′; Long. 74° 19′). In addition, this paper also describes two leaves of *Alnus nepalensis* from a collection of fossil plants made in 1910 by the late Mr. C. S. Middlemiss from Liddarmarg (Alt. 10,600 ft.; Lat. 33° 48′; Long. 74° 39′), Pir Panjal, which was lent to the author by the Director, Geological Survey of India.

The majority of the fossils excepting a few female cones referable to *Betula* and *Alnus*, and four other specimens, which favourably compare with pieces from the bark of *Betula*, are leaf-impressions, most of which on account of their well preserved venation could be specifically determined with the modern flora of the Himalayas.

The present paper was prepared under the guidance of Prof. B. Sahni, SC.D., F.R.S., to whom I am highly indebted for his invaluable help and stimulating criticism. I am also thankful to Dr. R. R. Stewart, Professor of Botany and Principal, Gordon College, Rawalpindi, for the invaluable help he gave me in identifying the fossils in his herbarium during the years 1937–39.

I must acknowledge with thanks the research grants from the Vice-Chancellor, University of the Punjab, and Principal of the Khalsa College, Amritsar, and a Research Fellowship from the Lucknow University to enable me to carry on my work at Lucknow.

For a loan of the Middlemiss's material and a photograph of a leaf of *Alnus nepalensis* I am thankful to the Director, Geological Survey of India. My wife has helped me in correcting the proofs.

Systematic List of the Species

Alnus nepalensis D. Don.
Alnus nitida Endl.
Betula utilis D. Don.
Betula alnoides Buch-Ham.
Betula sp. A.
Betula sp.
Alnus sp.
Betula sp.

Description

Order: Fagales

Family: Betulaceæ

The Betulaceæ is represented in the Karewa flora by a few specimens of female cones in addition to leaf impressions, which are identified with two distinct modern genera, namely, *Betula* and *Alnus*; besides these, the collections contain a few specimens of *Betula* bark as well. The two genera include four well determined species, two belonging to each genus, and one incompletely determined species of *Betula*; all of these are based on leaf fragments.

Leaves of the Betulaceæ, whether living or fossil, are not difficult to determine but to assign female cones to their respective species is a very hard task, especially when the latter occur as small fossil fragments. The modern female cones of the two species of *Betula* are distinguished from each other by the nature of fruiting bracts, which are deeply 3 lobed in *B. utilis* D. Don., whereas in *B. alnoides* Buch-Ham. the bracts are slightly two lobed. The size of the modern female cones of the two species of *Alnus* varies a good deal and the species can be separated from each other on this character alone; the cones measure 1–1·3 inches in length in *Alnus nitida* Endl., while their size in *Alnus nepalensis* D. Don. ranges between ·5 and ·8 inch.

Our fossil cones are not only fragmentary but are rather poorly preserved and do not show much structural detail. They occur in the clay in a longitudinal plane. Two cones of *Alnus*, which were slightly better preserved than the rest, were ground to show up some details of structure in a longitudinal section. One of them, being too brittle and soft, was partly lost in grinding while the second specimen was successfully ground to show up some structure, which is brought out in a photograph in Pl. XXI, Fig. 21.

In the year 1910 the late Middlemiss (1911, p. 122) recognised among his collections from Liddarmarg two leaves of *Alnus*, which have now been specifically determined by the author as *Alnus nepalensis* D. Don. The late Dr. S. K. Mukerjee (see de Terra and Wodehouse, 1935, p. 2) also recognised in de Terra's collections of 1932 a few leaves of *Alnus* from the same locality, which are also identified by the author with *A. nepalensis* (Puri, 1941, p. 8).

KEY TO THE GENERA

I. Leaves serrate, cones large and elongated .. .. *Betula* (i)
II. Leaves entire, cones small and oval .. .. *Alnus* (ii)

1. *Leaves*

(i) *Genus Betula* Linn.

This genus includes two distinct fossil species, the modern representatives of which occur at the present time in the Himalayas; there are two more leaf fragments, which are undoubtedly referable to this genus but they do not seem to match any modern species of *Betula* that grows to-day in the Himalayan region.

The cones could not be referred to either of the two modern species, on account of their fragmentary nature and the reasons outlined above.

In addition to leaves and cones a few specimens of thin outer coverings from the bark of *Betula* sp. are also described here. These specimens being badly preserved do not show any cellular structure; hence it has not been possible to identify them with any modern species of *Betula,* although they show a good deal of resemblance to *B. utilis.*

Key to the Species—

I. Leaves small, oblong ovate .. .. *B. utilis* and *Betula* sp. A.
  (i) Secondaries fewer, 6–7 pairs, arising wide part .. *B. utilis* (1)
  (ii) Secondaries, 10–11 pairs, closely situated .. *Betula* sp. A (3)

II. Leaf large, ovate, secondaries many, 18–19 pairs .. *B. alnoides* (2)

(1) *Betula utilis* D. Don.

(Plate XIX, Figs. 1, 2 and Pl. XX, Figs. 7, 8)

Plate XIX, Fig. 1 is a natural size photograph of a leaf fragment, which is about half of the leaf representing one side of the midrib only, the other part of the lamina being greatly damaged on the margin as well as apex and base. It is well preserved regarding details of venation and measures 1·34 inches by ·9 inch in size. The leaf lamina probably had an ovate outline with a broad base and acute apex. Comparison with a living leaf (Pl. XIX, Fig. 2) of this species shows that the above description of the fossil leaf is not far from satisfactory. A small curved petiole, which is ·3 inch long, is also preserved in the fossil. Another fragment assigned to this species is illustrated in a natural size photograph No. 7 on Plate XX. This, too, is equally badly preserved but shows an acute apex and serrate margin, for which it is figured here.

The venation is strict-pinnate and reticulate. A strong midrib runs in the fragment slightly thinning out in the upper part. 5 to 7 secondaries, which are almost half as thick as the midrib, arise on either side in an opposite, sub-opposite or alternate manner at irregular distances and diverge in the lamina making acute angles with the midrib. The lowermost secondary on the right-hand side in one fossil fragment (Pl. XIX, Fig. 1) gives off two small and thin branches. Two or three other basal secondaries also give off thin branches close to the margin and the latter, being as thin as the tertiary ribs get mixed and even lost in the meshes of the tertiary reticulations. The tertiaries are likewise thin, but conspicuous; they run irregularly in the area occupied by the two laterals forming large rectangular meshes, which are well brought out in a part of the leaf (Pl. XX, Fig. 7) enlarged to five diameters in another photograph (Pl. XX, Fig. 8). There is a finer reticulation, which consits of a network of small oval meshes; these being poorly preserved are not brought out satisfactorily in the photographs.

The leaf fragments are identical in all respects with modern leaves of *Betula utilis* D. Don. (see Pl. XIX, Fig. 2), a high level birch of the Himalayas, which is a common element of the modern alpine forests of Kashmir.

No. of specimens.—Ten only.

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

Collectors.—R. R. Stewart, 1935, G. S. Puri, 1941.

Registered Nos. of figured specimens.—Pl. XIX, Fig. 1 = L 500; Pl. XX, Fig. 7 = N 7.

(2) *Betula alnoides* Buch.-Ham.
(Plate XIX, Figs. 3–4)

Plate XIX, Fig. 3 is a natural size photograph of a fossil leaf, which is almost complete and measures 3·6 inches long by 1·6 inches in the broadest part. The margins are serrate; teeth are small and blunt (Pl. XIX, Fig. 4). The leaf lamina, which had probably an ovate shape, gradually narrows from the middle upwards into an acute apex and downwards into a wedge-shaped base.

The venation is thin and fine, but it is fairly well preserved and conspicuous; it is strict-pinnate and reticulate. A fine midrib, which thins out still further in the upper part, gives off on its either side about 18 secondaries which are also fine and about half as thick as the midrib; they diverge from the midrib at acute angles and usually arise in an opposite manner becoming alternate in the upper part of the lamina. They run in the lamina parallel to one another and finally end in the marginal teeth. A number of much finer tertiary ribs arise from the secondaries to meet (with each other) about half way in the area enclosed by the two laterals to form cross-ties or large rectangular meshes, which are clearly brought out in a part of the leaf enlarged to five diameters in Pl. XIX, Fig. 4. The finer reticulation is in the form of small meshes, which are of different shapes and sizes.

The fossil leaf nicely matches in shape, margins and all other details of venation with modern leaves of *Betula alnoides* Buch-Ham. and in the absence of any difference between the two, the fossil is identified with this species.

No. of specimens.—One only.

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

Collector.—G. S. Puri, 1941.

Registered No. of figured specimen.— L 804/3.

(3) *Betula* sp. A
(Plate XX, Fig. 6 and Pl. XXI, Fig. 17)

The specimens described below are two almost complete leaves, both of which are slightly broken at apex; the smaller leaf measures 1·38 inches long by ·95 inch in the broadest part, which is about midway between base and apex. The leaf lamina is ovate-oblong in outline with a semi-cordate base and acute apex. The margins are closely sharp serrate; the marginal teeth are mostly thick and pointed but a few of these are further subdivided into smaller teeth and as a result of these the margins look irregularly biserrate (Pl. XXI, Fig. 17) at some places.

The venation is thin, but prominent; it is strict-pinnate and reticulate. A thin midrib arises from the base, and gradually thins out as it traverses the lamina towards the apex. 10–11 pairs of secondaries, which are not even half as thick as the midrib, diverge from it at angles of about 40 degrees in an opposite and a rarely alternate manner; they are equidistant and run parallel in the lamina, and end in the marginal teeth. The tertiaries form regular meshes, which are rectangular in shape; these are well preserved and clearly seen at some places in both specimens. The larger meshes of the tertiaries are occupied by a close network of still smaller meshes, which constitute the finer reticulations.

Our fossil leaf fragments undoubtedly belong to the genus *Betula*; however, they do not match leaves of any species of *Betula* represented in the present-day flora of the Himalayas and may constitute a new type, which has probably become extinct from this part of the world since the pleistocene. Although the differences from the modern species are fairly marked out to constitute our fossil a distinct new species, the author has preferred the conservative course and has described it here as *Betula* sp. A and its salient features are compared to the two modern species so as to bring out the differences clearly in the following table:—

Characters	*B. utilis* D. Don. (Pl. XIX, Figs. 1,2)	*B. alnoides* Buch Ham. (Pl. XIX, Figs. 3, 4 and Pl. XX, Figs. 7–8)	*Betula* sp. A (Pl. XX, Fig. 6 and Pl. XXI, Fig. 17)
1. Outline ..	Probably broadly ovate	Oblong ovate	Oblong
2. Base ..	Broad	Wedge-shaped	Semi-cordate
3. Margins ..	Sharply serrate	Bluntly serrate	Serrate and rarely biserrate
4. Secondaries :			
(i) their number ..	6–7 pairs	17–18 pairs	10–11 pairs and the broken part may have one or two pairs more
(ii) their nature ..	Thick and arise wide apart	Thin and arise closely situated	Much thinner and comparatively more closely situated

No. of specimens.—Two only.

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

Collectors.—G. S. Puri, 1941 and R. R. Stewart, 1936.

Registered Nos. of figured specimens.—Pl. XX, Fig. 6 = L 774/4; Pl. XXI,. Fig. 17 = L 200.

(ii) *Genus Alnus* Linn.

Two species belonging to this genus are represented in the Karewa flora by a number of leaf fragments and a few specimens of female cones. The leaves are well preserved impressions, two of which are almost complete, but a few others are incomplete fragments. The cones, unlike the leaves, are rather poorly preserved, and do not show sufficient structural details to enable us to identify them with one or the other modern species. They were coated, when collected, with varnish and canada-balsam, which although obscured all structure, proved helpful in a way that the tissues of the cones became sufficiently hardened by impregnation of the balsam; one of them was successfully ground to show some internal structure in a longitudinal plane.

Key to the Species—

I. Leaf broadly ovate with acute apex, secondaries 10–12 pairs, not parallel; tertiaries form rectangular meshes .. *A. nitida* (1)

II. Leaf ovate-oblong with a more or less rounded apex, secondaries 16–17 pairs, parallel; tertiaries form conspicuous cross-ties .. .. *A. nepalensis* (2)

(1) *Alnus nitida* Endl.

(Plate XX, Figs. 12–13 and Pl. XXI, Fig. 14)

Plate XX, Fig. 12 is a natural size photograph of a fossil fragment, which is about three-fourth of the entire leaf representing the apical portion only, the basal part being missing. The specimen is poorly preserved except for the apical part, which shows all details of venation. It measures 3·6 inches long by 2·2 inches in the broadest part. The leaf lamina, which probably had a broadly ovate outline, gradually narrows upwards into an acute apex. From the shape of the fragment it seems that the leaf had probably a broad base, and comparison with living leaf of this species does not contradict this suggestion. The margins are entire. Plate XX, Fig. 13 illustrates another fragment, which is a counterpart from the tip of the larger fragment figured here.

The venation is pinnate-looped and reticulate. A strong midrib, which has left a fairly deep groove in the impression at some places, follows a zig-zag course in the lamina; it gradually thins out towards the apex and gives off 8 to 9 secondaries, which are about half as thick as the midrib; the laterals arise in an alternate manner at almost equal distances. The secondaries unlike the midrib run staright and tend to lie parallel to one another; they bifurcate in the lamina while still away from the margins and the two branches run wide apart and slightly curve upwards and downwards to anastomose with similar branches of the superior and inferior secondaries respectively, thus, a series of simple loops is formed beneath the margins (Pl. XXI, Fig. 14). From the convex side of the loops there arise 2 to 3 small, equally thick branches, which anastomose with one another to form an almost indistinct second series of angular loops that lies comparatively closer to the margins (Pl. XXI, Fig. 14). The midrib and the laterals have left fairly deep grooves in the leaf, which seems to be an impression of the lower surface. The tertiary ribs arise from the laterals as well as the midrib and anastomose midway in the lamina to form large rectangular or pentangular meshes (Pl. XXI, Fig. 14). The finer reticulation is very clear and it is composed of a network of small oval or rectangular meshes, which are occupied in the larger meshes of the tertiary reticulations.

Our fossils resemble living leaves of *Alnus nitida* Endl. in all details of venation and in the absence of any difference between the two the former are identified with this species.

Number of specimens.—Two only.

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

Collector.—G. S. Puri, 1939.

Registered Nos. of figured specimens.—Pl. XX, Fig. 12 = L 543; Pl. XX, Fig. 13 = L 544.

(2) *Alnus nepalensis* D. Don.

(Plate XX, Fig. 11 and Pl. XXI, Figs. 15, 16)

The fossil fragments described under this species are two leaf impressions, which are fairly well preserved and show details of venation clearly. They vary in size from 2·7 inches by 1·9 inches (in the almost complete specimen) to 3·2 inches by 2·25 inches (in the half complete leaf). Outline of the lamina is ovate in one and ovate-oblong in the other specimen. Base is narrowed and somewhat rounded. Apex is broken, but seems to have been acute, comparison with a living leaf of this species justifies this assumption. The margins are entire.

The venation is pinnate-looped and reticulate. A stout midrib runs in the lamina retaining almost the same thickness throughout. 8 pairs of laterals, which are half as thick as the midrib, arise in the fragment (Pl. XXI, Fig. 11) and there are 16 pairs in the complete leaf (Pl. XX, Fig. 16) ; they diverge from the midrib in an opposite, sub-opposite and, rarely in an alternate manner. Two or three lower pairs of laterals in one specimen (Pl. XX, Fig. 11) and almost all secondaries, excepting two or three pairs near the apex in the other leaf (Pl. XXI, Fig. 16), shoot out from the midrib at open angles, which almost become right angles in two or three lowermost laterals in the complete leaf. There is a good deal of difference in the angles at which the secondaries diverge in living leaves, but in all cases they run parallel and are constant in number. Similar variations are also seen in the fossil leaves described here. The laterals are more or less equidistant and run straight towards the margins keeping a uniform distance between them. On reaching the margins they suddenly curve upwards to anastomose with their superiors and form a continuous series of loops, which runs below and parallel to the margins. This inframarginal vein which is seen in the upper part on the left-hand side in one specimen (Pl. XX, Fig. 11) and towards the basal part on the left-hand side in the other (Pl. XXI, Fig. 16) is a characteristic feature of this species. The midrib and the secondaries have left fairly deep grooves in the fossils, which seem to be impressions of the lower surface. The tertiary ribs are prominent and form cross-ties in the area enclosed by two secondaries; these enclose a well preserved network of smaller meshes, which are of different shapes and slightly different sizes. The latter constitute a finer reticulation, which is clearly seen in a part of the leaf (Pl. XX, Fig. 11) enlarged in the photograph (Pl. XXI, Fig. 15) to five diameters.

The fossils nicely match in shape, size, margins and all details of venation with living leaves of *Alnus nepalensis* D. Don., and in the absence of any difference between the two they are identified with this species.

Number of specimens.—Five only.

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

Collectors.—C. S. Middlemiss, 1910; R. R. Stewart, 1936 and G. S. Puri, 1941.

Registered Nos. of figured specimens.—Pl. XXI, Fig. 16= K 14/949 (i); Pl. XX, Fig. 11 = N. 120.

2. *Female Cones*

Betula sp.

(Pl. XX, Figs. 9, 10)

Two specimens (in counterparts) of female cones described here belong to the genus *Betula*. The specimens lie in the clay partly exposed in a roughly longitudinal section. They were painted with a thick rubber solution by Dr. Stewart in field immediately after they were collected. This treatment spoiled both specimens; and the rubber solution got so tenaceously stuck on the surface of the fossils that it could not be removed to clarify the obscured structure of the bracts, this has made it impossible to say whether they are three lobed or the lobes are two in number.

The fossil cone, which is almost complete, measures ·9 inch long by ·38 inch in the broadest part. It consists of a stout central axis, which slightly thins out towards the apical end. A large number of bracts, which are probably fairly strong, are compactly and closely arranged on it in a more or less spiral manner. This arrangement of the bracts on the axis is not very clearly seen in the photograph on account of the rubber solution but it is fairly clear in the specimen. The bracts arise from the axis at right angles; each bract is broader at the base but becomes narrowed towards the upper part which is seen towards the outer side in the photograph (Pl. XX, Fig. 10).

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

Number of specimens.—Two only.

Registered No. of figured specimen.—L. 25.

Collector.—R. R. Stewart, 1935.

On account of their badly preserved nature structural details of the cones are not clear enough as to afford comparison with female cones of the two modern species of *Betula*. Parker (1918, pp. 492, 493) gives the following distinguishing features of female cones of the two living species of *Betula*:—

Characters	*B. utilis* D. Don.	*B. alnoides* Buch Ham.
1. Length ..	Not more than 1·5 inches	Often 2–3 inches long
2. Bracts ..	Deeply three lobed, lobes are linear oblong	3 lobed, central lobe large and oblong, the two lateral lobes are small tooth-like
3. Fruit ..	It is narrower than the bract	It is broader than the bract
4. Wing of the fruit ..	It is narrower than the nut	It is broader than the nut

The above-mentioned features, which have a diagnostic value in living cones, are not seen in the fossils; therefore, it is impossible to identify them with the help of these. An attempt to grind the fossil in order to get the cross-sectional view was not successful; hence they could not be specifically determined.

Alnus sp.

(Plate XXI, Figs. 20–22)

Plate XXI, Fig. 20 is a natural size photograph of a female cone of this genus. At first the cone did not show any structure but on grinding it in a longitudinal plane it showed a central axis on which several bracts are arranged in a spiral manner. Pl. XXI, Fig. 21, which is a five diameters enlarged photograph of the cone, does not show the structure very clearly. The bracts are not well preserved on the left-hand side of the axis in the specimen, and due to the badly preserved nature of the cone the structure of seeds cannot be ascertained.

It measures ·8 inch long by ·6 inch in the broadest part.

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

Number of specimens.—Four only.

Registered Nos. of figured specimens.—N 230 and N 231 *a.*

Collector.—R. R. Stewart, 1936.

The fossil specimens resemble living female cones of *Alnus* and in the absence of any difference between the two they are identified with this genus. On account of the poorly preserved nature of the fossils their specific determination is not possible; however, the size of one specimen, which is probably a complete cone, agrees with living cones of *Alnus nepalensis* D. Don., which measure according to Parker (*loc. cit.*) from ·5 to ·8 inch long. The size of the second species, *viz.*, *Alnus nitida* Endl., is from 1 to 1·3 inches in length. The criterion of size may serve as a trustworthy diagnostic feature in living cones but much reliance cannot be placed on it in the study of fossils, especially when one is not sure whether the latter are complete specimens or not; therefore, the author hesitates to specifically determine these specimens.

3. *Bark Fragments*
Betula sp. *cf. B. utilis*
(Plate XXI, Figs. 18, 19)

Two specimens of thin sheets of bark which are identified as belonging to *Betula* may be described as follows:—

Plate XXI, Figs. 18, 19 are natural size photographs of counterparts of a piece of bark from the outer covering of a birch stem. The fossil bark is somewhat greyish-brown in colour, which could not be brought out in the photographs. The specimens do not show any cellular structure on their surface.

Number of specimens.—Four only.

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

Collector.—R. R. Stewart, 1935, G. S. Puri, 1941.

Registered Nos. of figured specimens.—Pl. XXI, Fig. 18=L 245, Fig. 19 = L 246.

The fossils have a fairly close resemblance to bark of *Betula utilis* though it is difficult to prove their identity with this species.

Modern Distribution of the Betulaceæ

The family Betulaceæ is represented in both hemispheres by more than 100 living species belonging to 6 genera. These occur in the north temperate regions of Europe, Asia and America; also in the mountains of tropical countries. In India, we have only four species, which are distributed in two genera; these are exclusively forest trees occurring at the present time throughout the Himalayas.

Modern Distribution of *Alnus*

Alnus.—The genus includes about 17 modern species of trees and shrubs chiefly represented in the north temperate zones; two species, which have been discovered in the Karewas in a fossil state, extend into the Himalayas and further India; some species occur in Mexico, Europe, within Arctic circle, North Africa, and West and North Asia.

In India we have two species, both of which are hill types occurring chiefly in the Western Himalayas though they have been recorded also from Assam and Burma.

Modern Distribution of the Fossil Species of *Alnus*

Alnus nepalensis Don. grows throughout the temperate Himalayas from the Ravi eastwards, usually at an altitude of 3,000–9,000 ft., but

occasionally it occurs at lower altitudes also. It is rather common between Chamba and the Mishmi Hills in Assam; and occurs also in Upper Assam and the Khasi Hills. It extends further east to Ava, on the Khaken Hills and in Yunan.

It has a gregarious growth along streams and moist shady ravines in the Western Himalayas; in the Eastern Himalayas and the hills of Burma it is mostly found on landslips or other exposed soils, but also occurs along moist ravines. In the Punjab Himalayas it is usually met with as a forest tree and rarely occurs along streams or shady ravines.

In the hills around Darjeeling *Alnus nepalensis* grows with *Bucklandia populnea*; both of which are able to colonise newly exposed soil and landslips with remarkable rapidity.

The available data from the authentic sheets of Herbaria seem to show that the species is probably absent from Hazara, the Murree Hills and Kashmir; however, it has been recorded from Bashahr, Kulu, Chamba, Naini-Tal, Garhwal, Nepal, etc.

In the "alder wood forests of Bengal" Champion (1936, p. 260) records it to be growing with *Trema orientalis*. In Kumaon and Garhwal it is associated with *Populus ciliata*, which has been found in a fossil state also at the same locality that has yielded leaves of *Alnus nepalensis*.

Alnus nitida Endl.—"The West Himalayan alder" grows at the present time in the Western Temperate Himalayas from Kashmir to Kunawar at an altitude of 5,000–9,000 ft. It occurs usually at 6,000 ft. in the regions lying westwards from the Jumna Valley. It is always met with along streams, rivers and moist ravines. In the Punjab Himalayas where it appears to be fairly common, it is reported from the Swat Valley, Chitral, Hazara and Kashmir. The Kashmir distribution of the species, with which we are specially concerned here, is rather interesting. It occurs in the Chineni forests in the Jammu Province, Kishtwar, Marwa Dachhan, Muzaffarabad, and Udhampur, which are situated on the outer ranges. The Kashmir Ramban Valley, the northern slopes of the Pir Panjal Range and the southern slopes of the Main Himalayas do not allow the growth of this species on account of changed climatic conditions since the Pleistocene times.

The species extends eastwards to the Parbatti Valley, Bashahr, Simla Hills, Kunawar, and Tehri-Garhwal. It is also common along streams and moist ravines in the dry valleys of the Inner Himalayan ranges. It generally grows in moist ravines in the forests of *Pinus longifolia*.

In the "moist temperate forest", it forms pure patches and occurs along streams in the Beas Valley, Kulu, gregariously with *Cratægus crenulata* (Champion, *loc. cit.*, p. 260).

Modern Distribution of *Betula*

Betula.—The genus includes about 40 modern species of trees or shrubs which are chiefly distributed in the north temperate zone; several species extend into the regions of very high latitudes and one or two are found even beyond the Arctic circle. The species extend as far south as the Himalayas and Southern China in the Eastern Hemisphere and in the New World they have been found in the most southern parts of the United States. Several European species occur in the alpine regions in North-Western and Western Europe, North Asia and North America. *B. nana,* a common British species occurs in Greenland.

Modern Distribution of the Fossil Species of *Betula*

Of the three Indian species, which are hill types, two have been found in a fossil state from the Karewas.

Betula utilis Don. is the high level birch of the Inner Himalayan ranges, which commonly occurs from Bhutan westwards at an altitude of 10,000–14,000 ft.; in the Kishenganga Valley in Kashmir it descends as low as 6,000–7,000 ft. It also extends to Western Tibet and China.

It reaches the uppermost limit of tree growth in the Himalayas and forms pure forests or grows in association with *Rhododendron campanulatum, R. anthopogon,* or sometimes with the conifers, namely, *Abies Webbiana, Juniperus, Larix* and *Pinus excelsa.* In Hazara besides *Pinus excelsa, Abies Webbiana,* and *Picea Morinda* it is associated with *Quercus semecarpifolia, Pyrus lanata, P. foliolosa,* and one or two species of *Salix.* Other genera, which are usually associated with *Betula utilis,* are *Ribes, Berberis, Lonicera, Polygonum, Sorbus,* etc., etc.

In the "alpine fir-birch forests of North Garhwal" it grows according to Champion (*loc. cit.*, p. 270) with *Abies Webbiana, Q. semecarpifolia, Pyrus foliolosa, Rhododendron campanulatum, Cotoneaster acuminata, Rosa sericea, Ribes glaciale, Rubus niveus, Lonicera* spp. and in the forests of Gompatung Chu in the Sikkim Himalayas it grows at an altitude of 12,500 ft. with *Abies densa, Juniperus pseudosabina, Rhododendron Wightii, Pyrus aucuparia, Salix Wallichiana, Juniperus recurva, Spiræa* sp., etc. (Champion, *loc. cit.*, p. 271).

It also occurs in the "birch-*Rhododendron* forest"; in the Sunderdhunga Valley (Western Kumaon) at an altitude of 12,500 ft.; it is associated with

Rhododendron campanulatum, Pyrus foliolosa, Viburnum nervosum, Rhododendron lepidotum, Lonicera parvifolia, Berberis sp. (Champion, *loc. cit.*, p. 272).

In Kashmir, it occurs in the Jhelum Valley, Gurez, Kamraj, Keran, Kishtwar, Marwa Dachhan, Muzaffarabad, Ramban, and the Sindh Valley.

On the northern slopes of the Pir Panjal, Kashmir, it forms a well marked zone at an altitude of 10,500–12,000 ft. and occurs in association with *Rhododendron campanulatum, Salix denticulata, Syringa Emodi, Pyrus foliolosa, Lonicera* sp., etc.

Betula alnoides Buch-Ham. occurs in the Himalayas from the Sutlej eastwards, chiefly in temperate and sub-tropical tracts at an altitude of 5,000–10,000 ft. also in the Khasi Hills, Manipur; and hills of Burma. At the higher altitudes it is generally mixed with oaks, and other broad-leaved species and conifers. In the Punjab Himalayas from Ravi eastwards it occurs in moist ravines.

It may be interesting to point out that this species does not grow in Hazara, the Murree Hills or Kashmir.

It is recorded from the Parbatti Valley, Kulu, the Bashahr State, the Simla Hills, Mussoorie, Naini-Tal and Garhwal.

Past Distribution of the Betulaceæ

Several species of the Betulaceæ have been described from leaf-impressions from Europe and America from the rocks varying in age from the Cretaceous to the Pleistocene. Some of the species have been based upon imperfect specimens, and identifications of quite a few species are unsatisfactory. Several workers have urged for a revision of Tertiary floras of America and Europe and in the absence of such revised treatises it is difficult to compile trustworthy data on the past distribution of the family. Leaves of *Alnus* and *Betula* have been recognised from Tertiary rocks of Europe and America and the presence of the family during this period cannot be denied but the author thinks it advisable to refrain from making list of the species for inclusion in this paper.

Summary

1. The present paper describes some fossil remains of the Betulaceæ from collections made by Middlemiss, Stewart and the author from the Lower Karewa Deposits of Kashmir, exposed along the Pir Panjal side of the valley at Liddarmarg, Ningal Nullah and Laredura. The material includes fossil leaves belonging to *Betula utilis, Betula alnoides, Betula* sp. A (which does

not compare with any modern species of the Himalayas), *Alnus nepalensis*, *Alnus nitida* and a few female cones of *Betula* sp. and *Alnus* sp. (which could not be determined specifically on account of the fragmentary nature of the specimens); a number of impressions, which favourably compare with thin sheets from the outer bark of *Betula utilis* are also present.

2. Of the four well-determined species, only one (*Betula utilis*) occurs in the Kashmir Valley at the present time; the other three species, though still occurring in the neighbouring regions, are absent from the Kashmir Valley proper, the northern slopes of the Pir Panjal Range and the southern slopes of the Main Himalayas.

3. The past and present distribution of the Betulaceæ is briefly discussed.

4. A comparison of the past and present distribution of the Betulaceæ does not alter the general conclusions, which were derived by the author from the general distribution of the Karewa flora as a whole.

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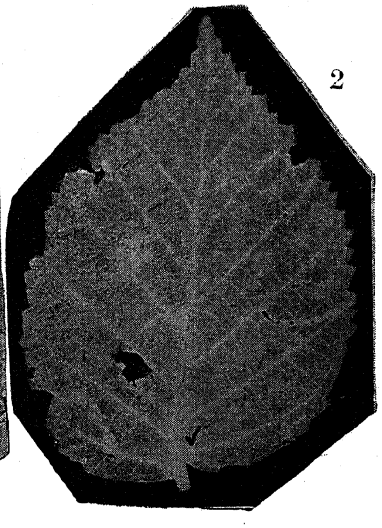

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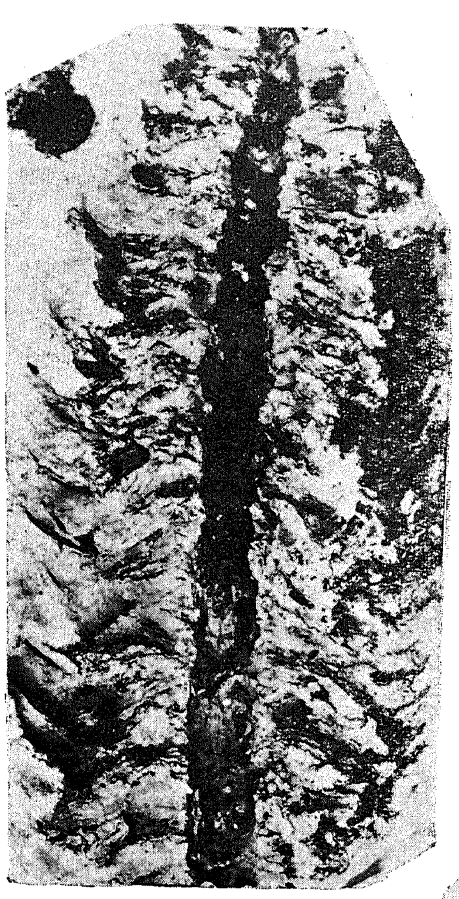

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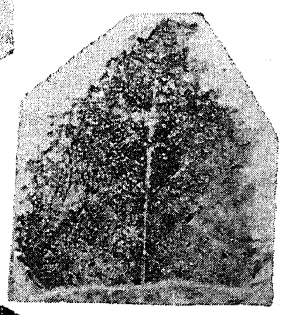

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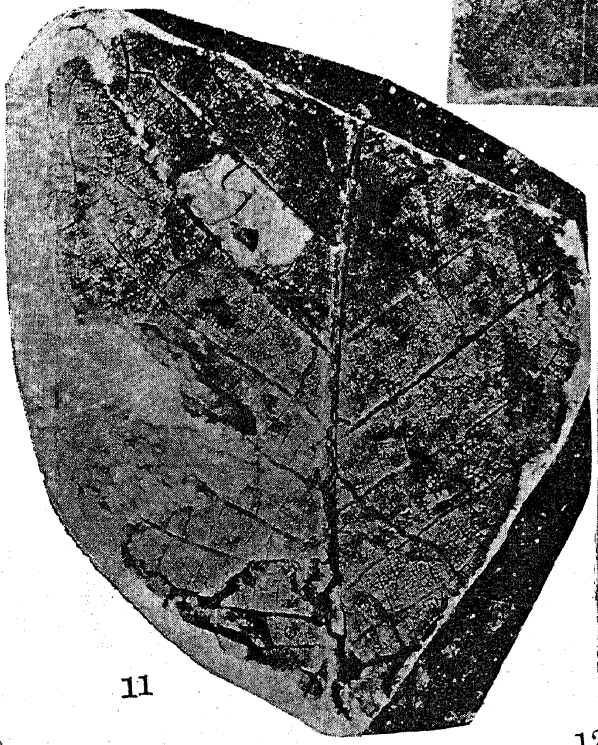

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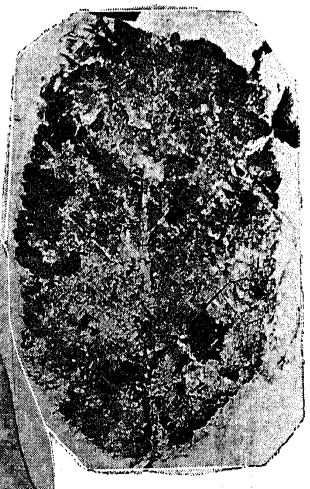

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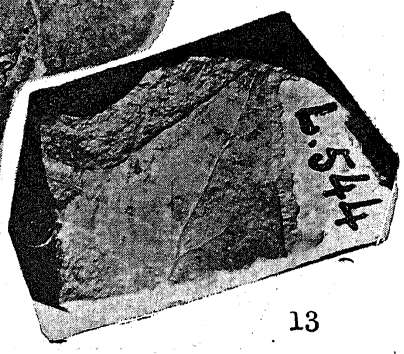

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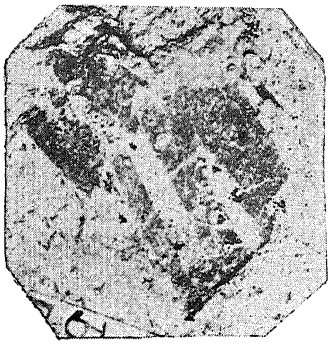

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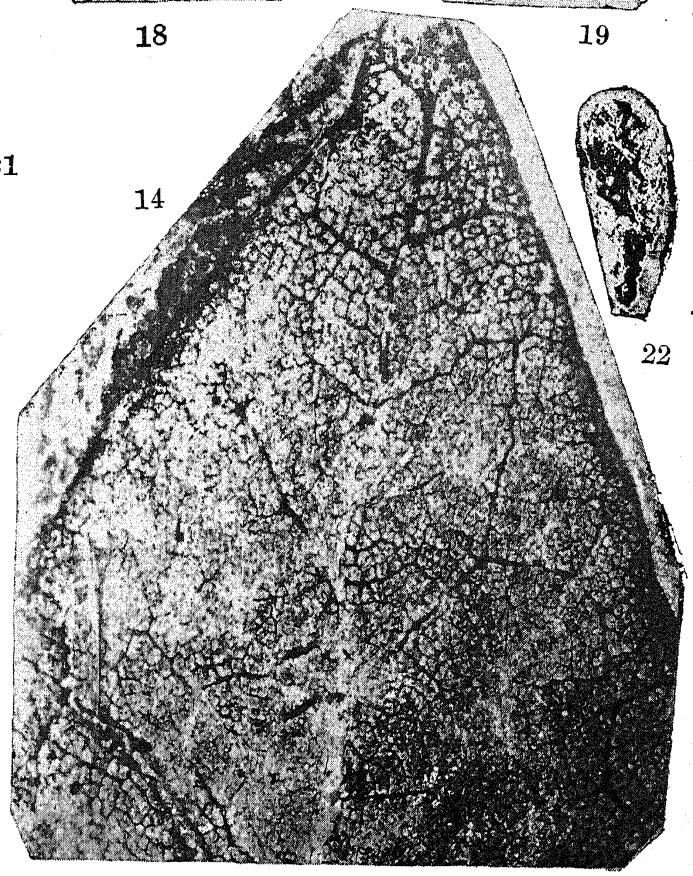

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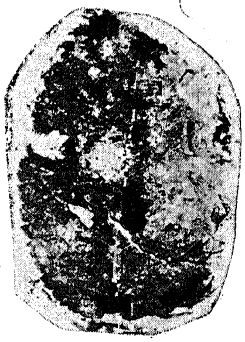

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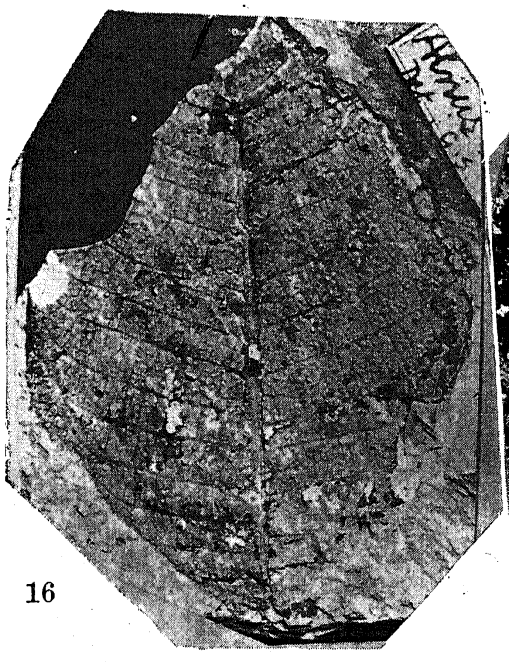

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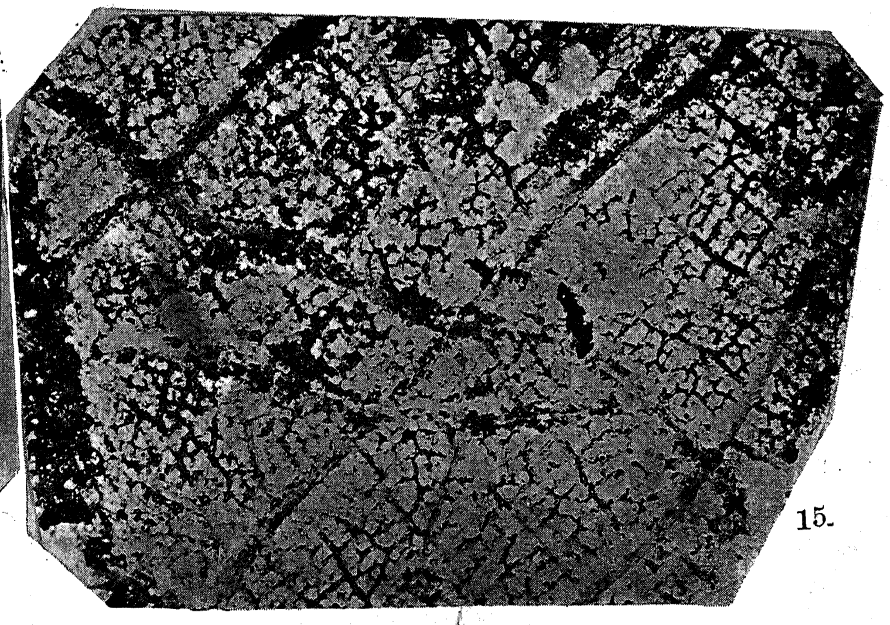

15.

Explanation of Plates

The photographs in Plates XIX–XXI are from untouched negatives. The figured specimens excepting one (Fig. 16), which is the property of the Geological Survey of India, are presented to Professor B. Sahni.

Plate XIX

Betula utilis D. Don.

Fig. 1. Fossil leaf fragment. R. R. Stewart collection, L 500, Laredura. Nat. size.
Fig. 2. Modern leaf for comparison with Fig. 1. Nat. size.

Betula alnoides Buch.-Ham.

Fig. 3. Leaf (impression of the upper surface). G. S. Puri collection, L 804/3, Laredura. Nat. size.
Fig. 4. A part of the leaf (Fig. 3) enlarged to show the nature of laterals; tertiary and finer reticulation. ×*Ca.* 5.

Plate XX.

Betula sp. A.

Fig. 6. Leaf impression. G. S. Puri collection, L 774/4, Laredura. Nat. size.

Betula utilis D. Don.

Fig. 7. Leaf fragment. R. R. Stewart collection, N 7, Ningal Nullah. Nat. size.
Fig. 8. A part of the leaf (Fig. 7) enlarged to show tertiary and finer reticulations. ×*Ca.* 5.

Betula sp.

Fig. 9. Female cone showing the structure in a longitudinal plane. R. R. Stewart collection, L 25, Laredura. Nat. size.
Fig. 10. The cone in Fig. 9 enlarged to show the scales. ×*Ca.* 5.

Alnus nepalensis D. Don.

Fig. 11. Leaf (impression of the lower surface). R. R. Stewart collection, N 220, Ningal Nullah. Nat. size.

Alnus nitida Endl.

Fig. 12. Leaf (impression of the lower surface). G. S. Puri collection, L 543, Laredura. Nat. size.
Fig. 13. Counterpart of the tip of the leaf (Fig. 12). L 544. ×*Ca.* Nat. size.

Plate XXI

Alnus nitida Endl.

Fig. 14. A part of the leaf (Pl. XIX, Fig. 12) enlarged to show loops of the laterals; tertiary and finer reticulations. ×*Ca.* 5.

Alnus nepalensis D. Don.

Fig. 15. A part of the leaf (Pl. XIX, Fig. 11) enlarged to show tertiary and finer reticulations. ×*Ca.* 5.
Fig. 16. Leaf (impression of the lower surface). Middlemiss collection, K 14/948 (i), Liddarmarg. Nat. size.

Betula sp. A

Fig. 17. Leaf impression. R. R. Stewart collection, L 200, Laredura. Nat. size.

Betula sp. cf. *B. utilis*

Fig. 18. Bark (impression). R. R. Stewart collection, L 245, Laredura. Nat. size.
Fig. 19. Counterpart of Fig. 18. L 246. ×Nat. size.

Alnus sp.

Fig. 20. Female cone. R. R. Stewart collection, N 230, Ningal Nullah. Nat. size.
Fig. 21. Cone (Fig. 21) enlarged to show nature of scales. ×*Ca.* 5.