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ART. XX.—*The Relationships of some American and Old World Birches;* by M. L. FERNALD. (With Plates V–VI.)

[Contributions from the Gray Herbarium of Harvard University, New Series, No. xxiii.]

A RECENT attempt satisfactorily to identify some birches from the alpine summits of New England has made it necessary to study in detail certain species of the Old World. In this detailed study so many well-known European and Asian forms have been found identical with trees and shrubs of America which have ordinarily passed as endemic, that the following notes are offered as a partial solution of the difficulties which have long surrounded the species of *Betula*. The writer has been specially fortunate in having constant access to a large suite of specimens in the Gray Herbarium which were examined and labelled by Regel in the preparation of his monograph on the Betulaceæ in DeCandolle's Prodromus.* The material in the United States National Herbarium and in the Herbarium of the Geological Survey Department of Canada has been generously loaned by Messrs. F. V. Coville and J. M. Macoun, the collections of the Arnold Arboretum have been placed at his disposal, and valuable specimens and notes on northwestern forms have been freely furnished by Professors L. F. Henderson and C. V. Piper. Thus it has been possible to examine a very complete representation of the genus.

The birches are trees of boreal range. Unknown in the southern hemisphere and the tropics, they abound throughout the northern and mountainous sections of North America, Europe and Asia, reaching a more extreme northern range on both continents than any other trees.† By Regel and other

* Regel in DC. Prodr., xvi, part 2 (1864), 161–189.

† See F. A. Michaux, Hist. des Arb., ii, 129, and Sylva, ii, 47; Sargent, Silva, ix, 46; Rehder in Bailey, Cyc. Am. Hort., i, 158.

early students of the group various European and American species were considered essentially identical; but among recent authors there has been an increasing tendency to regard nearly all American forms as endemic, and to maintain as organically distinct trees growing, for instance, on the American and the Asian sides of Behring Sea.

That there is not only a strong similarity, but a marked proportion of identity, in the herbaceous floras of the circumboreal regions has long been recognized; and, although the tendency to ignore this almost axiomatic truth has been conspicuous in the work of certain American as well as European botanists, the increasing evidence of its validity has forced itself upon the attention of others. This similarity in the boreal floras of the eastern and western hemispheres was very emphatically pointed out by Sir Joseph Hooker in his discussion of the Distribution of Arctic Plants.* Although our knowledge of the distribution and relationships of plants has very greatly increased since Hooker's tabulation was made, his outlines still furnish an approximately accurate basis for generalizations. If we consider the boreal distribution of some well-known northern genera whose species were then clearly interpreted, we shall find that of the 61 Arctic species of *Carex* recognized by Francis Boott, 58 extend southward into temperate Europe, 51 into temperate America, and 43 into temperate Asia; of the 16 Arctic *Junci* recognized by Hooker all 16 extend into temperate Europe, 15 into temperate America, and 14 into temperate Asia; of Hooker's 24 Arctic species of *Saxifraga*, 19 extend into temperate America, 17 into temperate Europe, and 14 into temperate Asia. This estimate is altered from that of Hooker only in so far as recent data has been immediately accessible to the writer; but it does not, of course, take into account such well-known species as *Carex riparia*, *C. Pseudo-Cyperus*, *Juncus tenuis*, etc., which occur in temperate regions of both hemispheres, though not within the Arctic Circle, but which, if counted, would increase the number of identical species in the eastern and western hemispheres.

Toward the warmer regions of each continent the number of identical plants rapidly diminishes, and the proportion of endemic species becomes very great. But in view of the marked similarity of the herbaceous vegetation of northern Europe, Asia and North America, it seems only logical to expect a notable proportion of identities between the trees and shrubs of boreal range, especially when, as in *Betula* and *Salix*, several species extend nearly or quite to the northern limits of

* J. D. Hooker, Trans. Linn. Soc., xxiii, pt. 2, 251–358; see also Gray, Mem. Am. Acad., n. s., vi, 377–449, and extract "Flora of Japan," in Sci. Pap. of A. Gray, selected by C. S. Sargent, ii, 124–141.

vegetation and are rapidly spread by means of their thin-winged or hairy fruit. In fact, this relation of the Alaskan willows to those of the Old World is brought out by Mr. F. V. Coville in his scholarly monograph on the Willows of Alaska,* in which he recognizes 23 species, 2 of them circumpolar in distribution, and 9 others occurring in Siberia. That is, of the 23 willows recognized by Mr. Coville in Alaska, only 12, or scarcely more than one-half, are endemic North American species. A similar detailed study of northeastern *Salices* will, it seems to the writer, likewise show a closer relationship between certain other American and Old World forms than has been generally recognized.

The examination of the birches by the writer has led to the uniting of some well-known American and Old World trees and shrubs. The conclusions reached in his studies, and certain details of the studies themselves, may best be presented by discussing separately the species which have been specially examined.

§ **Albæ.** Trees or shrubs: the wing two or three times as wide as the achene; rarely only a little broader.

Betula alba.

The original *Betula alba* of Linnæus† seems to have embraced both the common white birches of northern and central Europe. In 1788, however, Roth distinguished the two trees: "Betula *alba*. B. foliis ovato-acuminatis inciso-serratis scabris, ramis erectis strictis"; and "Betula *pendula*. B. foliis ovato-acuminatis inciso-serratis glabris, ramis flaccidis pendulis."‡ This separation of the two trees by Roth has been very generally ignored by recent European authors, nevertheless, and the species with pubescent ("scabrous") leaves and upright branches, the true *Betula alba* as interpreted by Roth, is universally known abroad as *B. pubescens*, Ehrh.,§ while the smooth-leaved species with pendulous branches, the *Betula pendula*, Roth., is ordinarily known by its later name, *B. verrucosa*, Ehrh.

By some authors, as Prantl‖ and Guerke,¶ these two white birches are treated as distinct species, while by others the entire group is regarded as a polymorphous species with many subspecies and varieties. Rehder, in Bailey's Cyclopedia of American Horticulture, disposes of the forms in this way,

* Proc. Wash. Acad. Sci., iii, 297-362 (1901). † Sp., ii, 982 (1753).
‡ Roth, Fl. Germ., i, 404, 405 (1788). § Beitr., v, 160, vi, 98 (1790-91).
‖ Prantl in Engler & Prantl, Nat. Pflanzenf., iii, pt. 1, 45.
¶ Pl. Eur., ii, 47, 48.

recognizing *Betula alba*, with the two subspecies, *B. pendula*, Roth (*B. verrucosa*, Ehrh.), and *B. pubescens*, Ehrh., each with numerous marked variations. Mr. Rehder, however, keeps separate from the Old World *B. alba* the American *B. papyrifera* and *B. occidentalis*.

The most conservative treatment of the group was, in some particulars, that of Regel in DeCandolle's Prodromus, though many of his varieties have proved of little value. There Regel recognized two species of white birches (his section *Albæ*), *Betula alba*, L., and *B. microphylla*, Bunge. *B. alba*, however, he divided into nine subspecies:

verrucosa, with numerous varieties, from Europe, Asia and America;
populifolia, a well-known strictly American tree;
mandshurica, a local Asian tree;
latifolia, with varieties, from central and northern Asia to Japan and Kamtschatka;
occidentalis, with varieties, from North America;
papyrifera, with varieties, from North America and Siberia;
pubescens, with varieties, from Europe, Asia and North America;
tortuosa, from northern Europe and Siberia;
excelsa, a doubtful form referred to by earlier authors.

Thus it is clear that Regel, the most devoted student of the birches, found it impossible to distinguish as clear species the diverse trees and shrubs which pass as white or canoe birches.

The recently accumulated material shows that Regel's course was perhaps the most philosophic of any which has been proposed. Yet the primary characters of the trees, first clearly distinguished by Roth, are generally so constant that it seems better to the writer to recognize as species, i. e., as centers of variation, the two forms designated by him. These were the true *Betula alba*, with mostly stiff and ascending branches, the young branchlets puberulent or pubescent and the ovate often doubly serrate leaves more or less pubescent beneath, at least when young; and *B. pendula*, with more flexuous branches, the branchlets glabrous or verrucose with resiniferous atoms, and the deltoid or rhombic-ovate often simply serrate leaves glabrous, and more or less glutinous at least when young. These two trees in their characteristic forms are now very well understood abroad, though some of their reduced forms present perplexing problems. But since the days of Regel the American trees have been very generally regarded as endemic species, and it is to the discussion of this question that special attention is here directed.

Betula alba (as interpreted by Roth).

As already stated, *Betula alba*, L. (as interpreted by Roth) has passed in Europe as *B. pubescens*, and under this latter name it is ordinarily distinguished from *B. pendula*, Roth (*B. verrucosa*, Ehrh.). The species is generally recognized as occurring through northern and central Europe and across Asia, and by Regel and his followers it was regarded as likewise American, though by recent authors it has been excluded from our flora. The typical form of *B. alba* is the large White Birch of northern Europe, with ascending branchlets, puberulent or hairy twigs, and ovate or rhombic-ovate leaves more or less pubescent beneath, especially when young.

The representative of this tree in America is our common Paper or Canoe Birch, *Betula papyrifera*, Marsh.* (*B. papyracea*, Ait.†), which was discussed in detail by Michaux in his Sylva.‡ There Michaux wrote at such length as "will not be deemed superfluous by persons who justly appreciate the importance of precise ideas on subjects like the present," of the Canoe Birch (*B. papyracea*), the European White Birch (*B. alba*, including, at least in the illustration, *B. pendula*, Roth), and the American White or Old Field Birch (*B. populifolia*).

Michaux's plate of *Betula papyracea* is of a northern form very closely approaching var. *cordifolia*, Regel; and in commenting upon this tree he said "the bark is of a brilliant white, like that of the White Birch of Sweden, and, like that too, it is almost indestructible. . . . . This bark, like that of the European species, is devoted to many uses," which are very fully enumerated. In his discussion of the European *B. alba* he said, "The trunk and limbs of the large trees are covered with a thick bark, whose epidermis is white and perfectly similar to that of the White Birch [*B. populifolia*] and the Canoe Birch [*B. papyracea*]. The small branches likewise resemble those of the species just mentioned [*B. papyracea*], being slender, flexible, and of a brown color spotted with white." He then discussed the uses of the European White Birch, concluding his remarks with: "Such are the principal uses of the European Birch, all the valuable properties of which are completely united in the Canoe Birch of North America." In his discussion of *B. populifolia*, Michaux further said: "The trunk of this species is clad in a bark of as pure white as that of the Canoe Birch and of the European Birch; but its epidermis, when separated from the cellular tissue, is incapable of being divided, like that of the two preceding species, into thin sheets; which constitutes an essential

* Arbust. Am., 19 (1785). † Hort. Kew, iii, 337 (1789).
‡ Michaux, Sylva, ii, 50-57.

difference." And in his summary of characteristics, he said: "The White Birch of Europe and the Canoe Birch resemble each other in their wood, their bark, and their ample proportions, which are perhaps superior in the American species. They differ in the form of their leaves, and they grow on very different soils: the Canoe Birch is exclusively attached to rich lands constantly cool, and capable of yielding an abundant harvest of corn or of clover, and it propagates itself naturally only in that part of North America which corresponds in climate to the 54th and 55th degrees of latitude in Europe."

These distinctions pointed out by Michaux are not, however, of such fundamental importance as to prove the American Canoe Birch (*Betula papyrifera*) organically distinct from the White Birch (*B. alba*, L., *B. pubescens*, Ehrh.) of Europe. Michaux made no distinction in his Sylva between the true *Betula alba* and the smooth-leaved and smaller *B. pendula*, Roth. His plate was of the latter plant, which has more deltoid leaves than the true *B. papyrifera*, but is quite like another American tree soon to be discussed. The foliage of the true *B. alba* is, nevertheless, as will be seen on comparison of American and European material, so similar as to present no apparent distinctive feature. The Canoe Birch in its best development, which Michaux places at a height of 70 feet, is found in deep soil on hillsides; but, had that keen observer been permitted to remain longer in our northern regions and to have explored the upper slopes of our mountains, he would have found the same tree there growing from the crevices of bare ledges—quite as barren a soil as that occupied by the European tree, which, by his own statement, may be 70 or 80 feet high. The more southern occurrence of the American tree is at least negative evidence of its identity with the tree of Scandinavia, northern Germany and Russia, for, as is now well known, the isotherms which cross New England pass far to the north in Europe, and the vegetation of northern New England and adjacent Canada has more than once been compared with that of Scandinavia. In fact, Michaux himself, in discussing the range of the Canoe Birch, said: "This part of North America, though situated 10 degrees further south, very nearly resembles Sweden and the eastern part of Prussia, not only in the face of the soil, but in the severity of the climate." Thus the comparative notes of Michaux leave little by which to distinguish the American from the European tree; and it is further worthy of note that in Boswell Syme's enumeration of the uses of the bark of the European tree he says: "In Russia it is applied to the same purposes for which that of the Canoe Birch is used in North America, boats being formed of it that are nearly as light and portable as those made

by the Red Indians of Canada."* There is, then, no evidence from the descriptions and comparisons of Michaux and other well-informed European authors that the American *Betula papyrifera* is separable from the true *B. alba* of northern Europe.

The American tree presents numerous but apparently inconstant variations in the size and toothing of its leaves, and the size of its strobiles and achenes. These variations, however, are very closely matched by specimens in American herbaria of the European *Betula alba* (*B. pubescens*, Ehrh.). If, for example, we compare branches collected by Robert Chalmers at Campbellton, New Brunswick, in 1887, or Rydberg's No. 1,005, from the Black Hills of South Dakota (distributed as *B. occidentalis*) with a Bohemian specimen from Tausch and Russian material from Regel; Macoun's Cypress Hills (Assiniboia) material (No. 5,919) with Christiania (Norway) material from Blytt; a sheet in the Gray Herbarium, collected on Lake Winnipeg by Bourgeau, with Hampe's No. 1,321 from the Hartz Mts., in central Germany; or Clement's No. 2,919 from Nebraska and Medford (Massachusetts) material of Wm. Boott's with the 1807 sheet of *B. pubescens* sent by Regel to the Gray Herbarium; we cannot help being impressed by the identity of the pubescence, leaf-outline, strobiles, etc. Other comparisons of American and European specimens emphasize this identity; so that, in view of these facts and the essential similarity of bark, branches and stature, as pointed out by Michaux and others, there seems no question that *Betula papyrifera* is the true *B. alba* of Linnæus.

Betula alba, forma *occidentalis*.

In the discussion of *Betula papyrifera* in his Silva, Professor Sargent refers† to the tree of the northwest coast, a form which "differs from the eastern [*papyrifera*] in its greater height and rather darker colored bark, in its more pubescent branchlets, which sometimes do not become glabrous until their second season, although vigorous shoots of young plants in the east are often clothed with thick pubescence, and in its rather larger leaves, which, on the lower surface, are also more pubescent." Later, however, the same author has identified‡ this large tree with *B. occidentalis*, Hooker,§ not the small tree or half-shrub taken for *B. occidentalis* by Nuttall and other American authors, including Sargent, Silva, ix, 65, t. 453; and he concludes that the bark "is very different from that of the eastern tree, and it is probably best to consider it a species."

* Syme, English Botany, viii, 184.
† Sargent, Silva, ix, 59.
‡ Sargent, Bot. Gaz., xxxi, 238 (1901).
§ Fl. Bor.-Am., ii, 155 (1839).

The original material of *Betula occidentalis* came from the Strait of Juan de Fuca; and if we examine specimens from that region we shall find them matching in every character of pubescence, leaves and strobiles large forms of eastern *B. alba* (*B. papyrifera*), as already intimated by Professor Sargent.* Branches collected by Professor L. F. Henderson in 1888 on the Gulf of Georgia, essentially a continuation of the Strait of Juan de Fuca, are clearly *B. occidentalis*, as shown by a tracing at the Arnold Arboretum of the original Scouler specimen. These specimens from the Gulf of Georgia have some of the branchlets strongly hirsute with sordid hairs mixed with abundant resiniferous atoms, while other (perhaps older) branchlets appear quite glabrous. In the original description of *B. occidentalis*, Hooker emphasized the abundance of resin, though nothing was said of hairs upon the branchlets. This character, however, is extremely variable, as shown by a large suite of specimens from Washington and British Columbia; and, admitting this inconstancy in the amount of resin and pubescence, the Gulf of Georgia branches seem to the writer quite inseparable from many sheets representing *B. alba* (*B. papyrifera*) from different sections of America. In such characters as are shown in herbarium material they are identified with the following among other specimens: Almota Creek, Whitman Co., Washington (*Piper*, No. 3,570), very resiniferous but not hairy, thus matching the original description; Cascade Mts. and Sumass Prairie, lat. 49°, British Columbia (*Lyall*), the latter the type of *B. alba*, subsp. *occidentalis*, *β*, *commutata*, Regel, the branchlets resiniferous but not hairy, thus agreeing with Hooker's original description; Pend d'Oreille River, Washington (*Lyall*), branchlets quite as hairy as in the Gulf of Georgia tree; Hill City, South Dakota (*V. Bailey*, sheet No. 230,000, U. S. Nat. Herb.), branchlets hairy; Black Hills, South Dakota (*Rydberg*, No. 1,005), branchlets hairy; Queenstown Heights, Ontario (*Macoun*, Herb. Geol. Surv. Can., No. 23,636), branchlets resiniferous, hirsute at tips; Goat Island, Niagara Falls, New York (*Coville*, sheet No. 294,829, U. S. Nat. Herb.), branchlets puberulent; Bald Eagle Ridge, Center Co., Pennsylvania (*Porter*), branchlets as in Gulf of Georgia specimens; North Conway, New Hampshire (*Wm. Boott*), branchlets as in last; Mountain Rock, Ellsworth, Maine (*Fernald*), branchlets resiniferous, slightly hairy; Manuels, Newfoundland (*Robinson* and *Schrenk*, No. 139), branchlets as in last. Other specimens from the coastal region of Washington and British Columbia are quite like some eastern branches. Thus Lake and Hull's plant from Tukanon River, Washington, and Macoun's No. 23,639 from Vancouver, are inseparable from

*Silva, l. c., Bot. Gaz., l. c.

a Niagara specimen collected by Asa Gray; and Piper's No. 1,128 from Whatcom Co., Washington, cannot be distinguished from Lowrie's material from Bald Eagle Mt., Blair Co., Pennsylvania (sheet No. 149,835, U. S. Nat. Herb.), and the old specimen of Wm. Oakes's from Topsfield, Massachusetts, referred by Regel to *B. occidentalis*, var. *commutata;* and in their leaves these trees very closely approach a Canoe Birch growing at Oak Island, Revere, Massachusetts, and well-known to the local botanists from its lustrous brown bark. From herbarium specimens, then, there is no character by which to separate the northwestern *Betula occidentalis* from the eastern *B. alba* (*papyrifera*).

The important character upon which Professor Sargent lays stress in his recent note* is the color of the bark, which in the northwestern tree is usually brown. This character alone seems hardly sufficient to separate specifically the two trees, especially in view of such brown-barked trees in the East as that on Oak Island; a tree growing at the foot of Mountain Rock, Ellsworth, Maine (represented in the Gray Herbarium), with gray-brown bark strongly tinged with plum-color; and Robinson and Schrenk's No. 139, from Newfoundland, in which the old bark, though becoming pale, retains much of the brown which is often seen in young trees. Furthermore, it is worthy of note that the Pacific Coast tree is not thoroughly constant in its bark. The Henderson plant of 1888, from the Gulf of Georgia (essentially the type locality), was sent to the late Sereno Watson, who called it *B. occidentalis.* Subsequently, however, Professor Henderson, writing under date of December 9, 1897, of the difficulties in studying this group, said: "Just where *B. papyrifera* leaves off and *B. occidentalis* begins, I am, and always have been, at a loss to say." He then comments upon a tree which "is undoubtedly *B. papyrifera* in every respect," adding, "and I have no doubt that my number 1,712, from the shores of Lummi Island, Gulf of Georgia, sent Mr. Watson in '88, and referred by him to *B. occidentalis*, is the same thing." Thus it would seem that *Betula alba* (*papyrifera*) is not constant in its pale bark in the East, and that *B. occidentalis* of the Northwest may not always be distinguished by its dark bark.

The tendency of another dark-barked northwestern tree to become quite as pale as the eastern Canoe Birch will be noted in the discussion of a species soon to be considered; but in this connection it is worth while to note a tendency to darkening of color which has been observed in certain other northwestern plants. It is well known that many species of *Carex* growing in shade or in southern areas have pale or hyaline scales, while

* Bot. Gaz., l. c.

the same plants in exposed or alpine situations have the scales brown, chestnut, or even nearly black.* On the Pacific slope of North America, especially from the Cascade and Coast Ranges to the coast of Oregon, Washington, British Columbia and Alaska, this tendency is likewise very conspicuous. It is well shown in such plants as *Carex praticola*, Rydb., in the Vancouver Island form described as *C. pratensis*, var. *furva*, Bailey; *C. pennsylvanica*, in the variety *vespertina*, Bailey; *C. aurea*, in the Vancouver plant, and in Suksdorf's No. 35 from Falcon Valley, and F. Binn's material from Port Ludlow, Washington; *C. limosa*, in the variety *stygia*, Bailey; *C. filiformis*, var. *latifolia*, in the Vancouver plant, and Hall's No. 607 from Oregon, Suksdorf's No. 51 from Klikitat Co., Washington, and Geyer's No. 72 from Oregon; and *C. rostrata*, in the Vancouver plant, and Piper's No. 994 from Seattle, and Suksdorf's Nos. 55 and 56 from the Cascade Mts. of Washington. The same tendency has likewise been noted in *Eleocharis* and *Juncus*. Without attempting here a discussion of the conditions which tend to produce upon our northwest coast the darkening of scales or other chartaceous portions of plants, it may be suggested that the brown color ordinarily seen in the Canoe Birch of Vancouver and the coastal region of Washington and British Columbia is perhaps due to the same physiological cause.

Emphasis has likewise been laid† upon the great height of this northwestern tree as compared with the eastern *Betula alba* (*papyrifera*). Yet it is interesting to note that David Lyall (whose specimens from the Lower Frazer River are a close match for Hooker's original description and for the tracing of the Scouler specimen) specially commented upon the tree as "growing to the height of 60 or 70 feet," ‡ while Piper's Whitman County trees are much lower. Since the brown-barked *Betula occidentalis* differs, then, only in this somewhat inconstant color of the bark from the ordinarily pale-barked *B. alba*, and since it is often no taller than the eastern tree, it seems to the writer hardly worthy special recognition, and that the tree was well treated by Professor Sargent in the Silva as a local tendency of the white-barked tree.

Betula alba, var. *glutinosa*.

Besides the ordinary Canoe Birch and its brown-barked form of the Pacific slope, there are many tendencies of *Betula alba* in America which deserve special comment. A single tree

* See, for example, Boott, Ill. ii, 98, etc.; Holm, this Journal, 4th series, ii, 218; Fernald, Proc. Am. Acad., xxxvii, 500, 504.

† Sargent, Silva, l. c., Bot. Gaz., l. c. ‡ Lyall, Jour. Linn. Soc., vii, 134.

left standing, after the widespread devastation of forest fire, by the Wassataquoik River, near Mt. Katahdin, in Maine, is conspicuous on account of its pendulous "weeping" branches, small leaves and essentially straight peduncles. Though in habit this tree is strikingly like *B. pendula*, its leaves place it nearer *B. alba*. In fact, the material matches perfectly a specimen sent to the Gray Herbarium by Regel, from Finland, of *B. alba*, var. *glutinosa*, Trautv.,* the form *pendula*† figured by Reichenbach (Ic. Fl. Germ., xii, t. 625) as *B. pendula*, though not the species of Roth. This Wassataquoik Valley tree may be known as *Betula alba*, var. *glutinosa*, Trautv. This form (*B. glutinosa*, Wallr.‡) is treated by various European authors as a natural hybrid between *B. alba* (*pubescens*) and *B. pendula*,§ but the apparent absence from Maine of *B. pendula* renders this origin of the tree improbable.

Betula alba, var. **cordifolia.**

Another tree more common in the mountainous portions of New England than *Betula alba*, var. *glutinosa*, differs from the ordinary Canoe Birch only in its cordate-ovate leaves. In this character it is very constant, however, and seems to deserve the varietal recognition given it by Regel as *B. alba*, subsp. *papyrifera*, β, *cordifolia*,‖ (*B. cordifolia*, Regel, Mon. 28, t. 12, figs. 29–36). The species, *B. cordifolia*, was based upon one of de la Pylaie's specimens from Newfoundland, and in his later treatment of the tree Regel cited two sheets in the Gray Herbarium, one from Mt. Katahdin, Maine, the other from Lake Superior. The tree is common on the upper wooded slopes of Katahdin and other mountains of northern New England, becoming a dwarf shrub at their summits, where it has passed as *B. papyracea*, var. *minor*, Tuck. Tuckerman's original material and description, however, was of another form soon to be noted. The tree or shrub of the mountainous districts of New England, with cordate leaves, pubescent on the veins beneath, may be known as *Betula alba*, var. **cordifolia** (Regel). Its range is a broad one, from northern Labrador (*C. A. Kenaston*, sheet No. 25,240, U. S. Nat. Herb.) and Newfoundland to New Brunswick, Maine, the White Mountains, New Hampshire, Lake Superior, Iowa (*B. Fink*, No. 109), Alberta, British Columbia, Idaho, and Washington.

* Trautv. ex Regel, Mon. Bet. (1861), 20.
† Regel, l. c., 23.
‡ Sched. Crit., 497 (1822).
§ See Koehne, Deutsch Dendr., 109; Guerke, l. c., 48.
‖ Regel in DC., l. c., 166.

Betula alba, var. **minor.**

The dwarf alpine shrub which was described by Tuckerman as *Betula papyracea*, var. *minor*,* is represented in the Gray Herbarium by material from Tuckerman himself. It is not, perhaps, the commonest dwarf Canoe Birch of the White Mountains, but is a form with the small elliptic- or truncate-ovate leaves strongly glutinous and quite without pubescence. From the comparatively narrow wings of the samaras in Tuckerman's specimens, Regel took the plant to be a form of *B. davurica*, Pallas, of eastern Asia, and upon the Tuckerman sheet he based his *B. davurica*, *β*, *americana*.† The shrub is, however, more properly a phase of *B. alba*, and it occurs likewise on the North Summit of Mt. Katahdin, where it sometimes has the leaves smaller firmer and more glutinous than on Mt. Washington; in Gaspé and in Labrador; and in the mountains of Saskatchewan, Assiniboia and Alberta, where it intergrades with *B. microphylla*. Though ordinarily distinguished from *B. alba*, var. *cordifolia*, by its elliptic- or truncate-ovate glabrous leaves, smaller erect strobiles, and smaller samaras, this second dwarf Canoe Birch shows tendencies to integrade with that form. In its most characteristic development this shrub of the New England mountains matches *B. tortuosa*, Ledebour,‡ described from the Altai Mts. of central Asia, where it had likewise been mistaken by Ledebour for *B. davurica* of Pallas. The range of *Betula tortuosa* has since been extended through northern Russia to Silesia, Finland, Lapland and Greenland, where it is sometimes treated as a species, but by Koehne and by Guerke as a form of *B. alba* (*B. pubescens*, var. *tortuosa* (Ledeb.) Koehne).§

If we compare specimens collected by the late Edwin Faxon at "Willis's Seat" on Mt. Washington, New Hampshire, and Altai material of *Betula tortuosa* sent to the Gray Herbarium from the Imperial Herbarium at St. Petersburg, we shall find the former differing only in its glabrous branchlets. This want of pubescence is, however, quite as conspicuous in a Lapland specimen from Regel of his *B. alba*, subsp. *tortuosa a genuina*. If, again, we compare the original sheet of Tuckerman's *B. papyracea*, var. *minor* from the White Mountains with the plate of *B. tortuosa* in Flora Danica (xvii, t. 2918) we shall find them too close for ready separation. Specimens from Mt. Katahdin are, furthermore, quite inseparable from Rosenvinge's No. 160 from Greenland, distributed from the Botanical Museum of Copenhagen as *B. odorata*, var. *tortuosa* and represented by sheet No. 2,044 in the Herbarium of the Geological Survey of Canada; and various Mt. Washington speci-

* Tuck., this Journal, xlv, 31 (1843).
† Regel in DC., l. c., 175 (1864).
‡ Fl. Ross. iii. 652 (1849).
§ Deutsche Dendr. 109 (1893).

mens are practically identical with Rosenvinge's Nos. 174 and 210 from Greenland. This shrub or dwarf tree offers considerable variation in the outline and toothing of its leaves, but no more than does the same form abroad; and since the young branchlets and leaves are sometimes pubescent as in *B. alba* its treatment as a dwarf variety seems the wiser course, and the shrub may be known as *Betula alba*, var. **minor** (Tuckerman).

Betula alba, var. **carpatica.**

A shrub growing on Anticosti Island at the mouth of the St. Lawrence (*Macoun* in Herb. Geol. Surv. Can., No. 23,823) differs somewhat markedly from other American forms. It is nearest *Betula alba*, var. *minor*, but differs in its broadly rhombic leaves, mostly cuneate at base and permanently pubescent beneath, especially on the nerves. This shrub is undoubtedly the *B. borealis*, Spach* (*B. pumila*, γ *borealis*, Regel, Mon. Bet. 55, t. 13, figs. 38, 39), described from Newfoundland, and it is identified with Regel's description of *B. pubescens*, ζ *carpatica*† (*B. carpatica*, Waldst. and Kit. in Willd. Sp. iv, 464). The specimens, except in their more abundant pubescence (in this matching Regel's "folia subtus in venarum axillis saepe barbata"), are well matched by a Lapland sheet distributed by Regel as *B. pubescens*, var. *carpatica;* and they are equally well matched by a sheet distributed by Fries as *B. glutinosa*. This plant, *B. glutinosa* of Fries, not Wallroth, is treated by Guerke as identical with *B. carpatica*. The same form is well represented in Flora Danica (xvi, t. 2851) as *B. odorata*, var. *rhombifolia*, Lange, with *B. odorata*, var. *carpatica*, Lange (*B. carpatica*, Waldst. and Kit.) cited as a synonym. Guerke, however, does not identify *B. rhombifolia*, Tausch, with *B. carpatica*, and considering this doubt it is least confusing to call the plant *Betula alba* var. **carpatica** (Waldst. and Kit.). The same form occurs in the Herbarium of the Canadian Geological Survey from Banff, Alberta (*Sanson*, Nos. 22,298 and 22,444), though in its somewhat resiniferous branchlets the first cited specimen tends toward *B. microphylla*, Bunge. An old specimen collected by Dr. Richardson on the Franklin Expedition (sheet No. 23,628, Herb. Geol. Surv. Can.) is apparently the same.

BETULA PENDULA.

Betula pendula, var. *japonica.*

Aside from *Betula papyrifera* and *B. occidentalis* the only birch of the section *Albae* generally recognized in America until within three years has been *B. populifolia*, a purely

* Spach, Ann. Sci. Nat., ser. 2, xv, 196 (1841). † Regel in DC., l. c. 168.

American species quickly distinguished by its comparatively low stature and southern range, its chalky white or gray-flecked close and scarcely defoliating bark, its glossy extremely caudate-attenuate deltoid leaves, its compact grayish brown fruiting strobiles averaging 3^{cm} long and 6^{mm} thick, and the samara rarely 3·5^{mm} broad. Very recently, however, three trees have been described from northwestern America as unique American species: *Betula kenaica*, W. H. Evans,* from Alaska; *B. alaskana*, Sargent,† from Saskatchewan and Alaska; and *B. fontinalis*, Sargent,† the Rocky Mountain half-shrub which has there passed as *B. occidentalis*.

The writer has not seen the original material of *B. kenaica*, but a large suite of specimens collected by Messrs. Coville and Kearney in the type region, on the Harriman Alaska Expedition, has been placed in his hands by Mr. Coville. This series of 15 sheets in the United States National Herbarium is supplemented by very important notes by Mr. Coville on the color of the bark, etc.

The first specimens cited by Professor Sargent for his *Betula alaskana* are one of Bourgeau's collected on the Saskatchewan during the Palliser Expedition, and Macoun's material from Prince Albert, Saskatchewan, collected in July, 1896 (not 1876 as originally published). The other material came from Alaska and the tree is said to be "the 'canoe birch' of all travellers in Alaska, and it is the common birch tree of the Yukon Valley." The Bourgeau plant, the first specimen cited by Professor Sargent and consequently (for want of any specially indicated specimen) to be regarded as the type, is in the Gray Herbarium. This plant was labelled by Regel and was included by him in the Prodromus as *B. alba*, subsp. *verrucosa* δ *resinifera*, a form otherwise known to him from Amur, near Udskoi (latitude 55°) on the Okhotsk Sea, and from the neighboring province, Transbaikalia. *B. verrucosa*, var. *resinifera* was distinguished by Regel from the typical *B. verrucosa* by the densely resiniferous branchlets, a character very conspicuous in the Bourgeau specimen, but less marked in Macoun's Saskatchewan material. And although in *B. kenaica* the twigs were originally described as "not resin-dotted," later collections show the character to be inconstant and that the twigs are sometimes quite as glandular or resiniferous as in the Bourgeau specimen of *A. alaskana;* and furthermore, *B. alaskana* has the twigs only "more or *less* verrucose with conspicuous resinous glands," so that little stress should be laid upon this character.

A comparison of the original descriptions of *Betula kenaica* and *B. alaskana* shows no point by which they can be sep-

* Bot. Gaz. xxvii, 481 (1899). † Bot. Gaz. xxxi, 236, 239 (1901).

arated. Both are trees commonly with red-brown or brown-gray bark, both have the twigs smooth or resiniferous, the leaves dark green above, paler beneath and ultimately quite glabrous. The fruiting catkins are described in practically the same terms. *B. kenaica* is common in the region of Kenai Peninsula and Kadiac Island; while *B. alaskana* is characterized as "the 'canoe birch' of all travellers in Alaska," and the range given includes "the Alaskan coast on the shores of Lynn Canal . . . ; and westward." Since Lynn Canal lies on the coast in the same latitude as Kenai Peninsula and scarcely 500 miles to the eastward, the general range covered by Professor Sargent's "westward" may well include the type region of *Betula kenaica.*

A comparison of specimens of *Betula kenaica* and *B. alaskana* likewise fails to reveal any distinctions. For instance, Coville and Kearney's No. 2,423 of *B. kenaica* (sheet No. 373,620 in the U. S. Nat Herb.) is quite inseparable from Macoun's Prince Albert material (No. 12,952*a*, Herb. Geol. Surv. Can.), one of the original specimens cited for *B. alaskana;* and neither of these specimens can be separated in habit, twigs, leaves or pubescence from No. 20,327 of the Canadian Geological Survey Herbarium, material collected by R. G. McConnell near Dawson City on the Yukon, where *B. alaskana* is said to abound. Furthermore, although the Bourgeau specimen of *B. verrucosa*, var. *resinifera*, the first cited specimen of *B. alaskana*, is young, its leaf-outline and very resiniferous twigs seem quite identical with those of Coville and Kearney's No. 2,412 of *B. kenaica* (sheet No. 373,618, U. S. Nat. Herb.). There is, then, no question that *Betula alaskana* described in 1901 is identical with *B. kenaica*, published in 1899.

Both Mr. Evans and Professor Sargent had their species compared at St. Petersburg, before publication, with Siberian material; and it is certainly very unfortunate that these comparisons were not more satisfactorily made, since very many sheets in the Gray Herbarium, as well as the United States National Herbarium, show what appear to be identical branches collected in Asia over a wide range of country,—from Kamtschatka to northwestern Siberia (Yenisei River), south to Japan, Mandschuria, Mongolia and Sungaria. This Asian tree was treated by Regel in the Prodromus as *Betula alba*, subsp. *mandshurica* and *latifolia*, while the more strongly resiniferous were included in his subsp. *verrucosa*, δ *resinifera.* The form treated by Regel as subspecies *latifolia* had, however, been described by Siebold* in 1830 as *Betula japonica.*

* Verh. Batav. Gen., xii (1830), 25.

In Asia as in northwestern America the abundance of resin on the branchlets seems to vary without any accompanying change in leaf-outline or other character perceptible in the specimens; and by comparison with well authenticated Asian specimens of *Betula verrucosa*, Ehrh. (*B. pendula*, Roth), *B. mandshurica*, Regel, and *B. latifolia* (*B. japonica*) with its vars. *Tauschii* and *kamtschatica*, essentially all the available material of the American *B. kenaica* (including *B. alaskana*) can be exactly matched. Thus such specimens as Coville and Kearney's Nos. 1,408, 1,422, and 2,425 of *B. kenaica* (Nos. 373,608, 373,609, 373,622, U. S. Nat. Herb.) and an old sheet in the National Herbarium from Fort Simpson (Mackenzie District) are good matches for Japanese material collected by Maximowicz and distributed as *B. alba*, subsp. *latifolia* α *Tauschii*, Regel (represented in the Gray Herb. and by sheet No. 25,341 in the U. S. Nat. Herb.). These specimens also match too closely the original description and figure of var. *Tauschii*, Regel.* Further material of var. *Tauschii* collected by Maximowicz in Mandschuria and distributed from the Imperial Herbarium at St. Petersburg (represented in Gray Herb. and by sheet No. 25,345, U. S. Nat. Herb.) has the leaves more coarsely and irregularly toothed than the specimens previously cited, but in this it is not distinguishable from Coville and Kearney's No. 2,412 of *B. kenaica* (sheets Nos. 373,618, 373,619, U. S. Nat. Herb.) nor from the Bourgean specimen, type of *B. alaskana;* nor does this foliage differ from that of specimens collected by Korjhinsky at Blagovyeschensk, Amur (represented in Gray Herb. and by sheet No. 273,721 in U. S. Nat. Herb.). Furthermore, these specimens cannot be separated by any apparent character from Kamtschatkan material sent to the Gray Herbarium by Regel as his *B. latifolia*, var. *kamtschatica*, and they are quite like his original figure of that variety;† while Macoun's Saskatchewan specimen (No. 12,952*a*) and McConnell's Dawson specimen (No. 20,327) of *B. alaskana*, and Coville and Kearney's Nos. 1,442, 1,444, 1,445, and 1,626 of *B. kenaica* (sheets Nos. 373,610, 373,611, 373,612, 373,616, U. S. Nat. Herb.) are quite as inseparable from Regel's original description and figure of *B. alba*, subsp. *mandshurica*.‡ It is thus very evident that *Betula kenaica* and *B. alaskana* cannot be treated as local American trees, but that they are quite identical with the well-known *B. pendula* or with the Asian tree which was described by Siebold in 1830 as *B. japonica*, and figured in its various forms by Regel in 1865.

* Bull. Soc. Imp. Nat. Mosc., 1865, 399, t. 7, figs. 11–14 (repr. Bemerkungen über die Gattungen Betula und Alnus (1866) 12, t. 7, figs. 11–14).

† Bull. Soc. Imp. Nat. Mosc., l. c., figs. 16–20.

‡ Bull. Soc. Imp. Nat. Mosc., l. c., fig. 15.

This Asian tree, which presents indiscriminate variation in the size and toothing of its leaves and the abundance of resin on its branches, was treated by Miquel* as a variety of the Eurasian *Betula alba;* while by Rehder it is more properly considered a variety of the subspecies *B. pendula* (*B. verrucosa*). This disposition of the tree seems most advisable, since typical *B. pendula* crosses northern Asia and is distinguished from the trees which Siebold called *B. japonica* and Regel called *B. latifolia* only by an inconstant tendency of the leaves to be more cuneate at base. The form of the tree with broad leaves rounded or truncate at base, common in northern Asia, and including much of *B. kenaica* and *B. alaskana*, should be known, then, as *Betula pendula*, Roth, var. *japonica* (Siebold), Rehder in Bailey Cyc. Am. Hort. i, 159.

Reference has been made to the tendency of *Betula alba* to develop brown bark when it occurs upon the northwest coast of America. Similar reddish or brown bark likewise ordinarily distinguishes the northwestern tree which has been called *B. kenaica* (*B. alaskana*) from the true *B. pendula.* But this is not a sufficiently constant character to separate it specifically from the Asian specimens which so closely match it in every detail shown in the herbarium. The writer has been unable to find any clear statement that the bark of *B. pendula*, var. *japonica*, is either white or brown. Bourgeau, however, who had previously remarked upon the abundance of *Betula papyrifera* on Ile Royale, Lake Superior,† and who was consequently familiar with the ordinary white-barked tree, referred the Saskatchewan tree without question to that species;‡ and Macoun referred his Prince Albert tree without comment to *B. papyrifera.* The fact that these acute collectors of the first mentioned specimens of *B. alaskana* saw in their Saskatchewan trees only the white-barked *B. papyrifera* is sufficient evidence that the brown bark of *B. alaskana* is not a character to be confidently relied upon. Furthermore, Mr. Coville writes of *B. kenaica* under date of March 12, 1901: "In certain individual trees, however, and perhaps on exposure to certain climatic conditions the layers of the bark separate and the bark turns white as in *papyrifera.* This factor has made it difficult for the collectors who have observed the tree to tell whether in upper Cook's Inlet there is a white-barked birch distinguishable from *kenaica.*" Sheets Nos. 373,611, 373,619, and 373,620 in the United States National Herbarium show strips of lichen-covered bark of *B. kenaica* no darker

* Miquel, Ann. Bot. Mus. Lugd. Bat. ii, 136.

† Bourgeau in letter to Sir Wm. Hooker, Palliser, Rep. Brit. N. A. Expl. Exped. 247.

‡ Bourgeau, l. c. 249; see also Hooker, ibid., 260; Gray, ibid., 263; Sullivan, ibid., 85, etc.

than is occasionally seen in *B. alba* (*B. papyrifera*) in the Northeast and already mentioned in the discussion of *B. occidentalis*. The color of the bark, then, furnishes no satisfactory reason to separate *Betula kenaica* from the Asian *B. pendula*, var. *japonica*.

Betula pendula (typical).

The broad-leaved var. *japonica* is not the only form of *Betula pendula* which crosses from Europe and Asia into North America. As already noted, the typical European *B. pendula* with leaves cuneate at base extends across northern Asia. Some of the specimens which have been referred to *B. alaskana* are quite inseparable in their leaves, branches, and strobiles from European specimens; and, furthermore, this characteristic European form extends southward and eastward in America to western Illinois, the Great Lakes, and the St. Lawrence Valley. Sheet No. 351,017 of the United States National Herbarium, collected as *B. populifolia* in woods at Warren, Illinois, by L. M. Umbach, is not distinguishable from sheet No. 25,340 from Sungaria in central Asia, nor from material in the Gray Herbarium collected in Sweden (*Blomberg*, No. 1,691). Sheet No. 261,119 of the U. S. National Herbarium, collected by Professor James Fowler in Ontario as *B. populifolia*, has the strobiles and leaves of *B. pendula* and it cannot be separated from material in the Gray Herbarium from Christiania, Norway (*Blytt*), and from St. Petersburg, Russia (*Regel*). A sheet in the Herbarium of the Geological Survey of Canada (No. 12,950), collected in the Province of Quebec as *B. populifolia* by W. Scott, is quite identical with sheet No. 149,801 of the U. S. Nat. Herb. from Savoy. Various other leaf-specimens from Quebec, Manitoba, and other regions of temperate North America are probably *B. pendula*, but without fruit it is at present unwise so to refer them. The American specimens cited were gathered as the endemic *Betula populifolia*, at least one of them in "woods"; and since undoubted *B. pendula* is found from the Saskatchewan Plains northward, there seems little question that the European tree, crossing Asia, is truly indigenous likewise in the northeastern sections of America, just as are *Coptis trifolia*, *Drosera rotundifolia*, *Viburnum Opulus*, *Lysimachia thyrsiflora*, and many other well known species* which occur in northern Europe, central and northern Asia, Japan, northwestern America, and northeastern America.

* Among them *Caltha palustris*, *Viola Selkirkii*, *Parnassia palustris*, *Potentilla palustris*, *Circaea alpina*, *Pyrola minor*, *Moneses grandiflora*, *Menyanthes trifoliata*, *Rumex persicarioides*, *Allium Schoenoprasum*, *Juncus effusus*, *Eriophorum gracile*, *Carex filiformis*, *Hierochloe borealis*, etc., etc. See Gray, Mem. Am. Acad., n. s., vi, 377–499; and Extract "Flora of Japan" in Sci. Pap. of A. Gray, selected by C. S. Sargent, ii, 124–141.

BETULA MICROPHYLLA.

Professor Sargent has recently referred* to the fact that the writer identifies the common brown-barked tree or half-shrub of the Rocky Mountains with Bunge's *Betula microphylla* described from the Altai of central Asia. Professor Sargent, however, was unwilling to identify the American tree with Bunge's species, and he accordingly proposed for it the new name *B. fontinalis*. But a further comparison of *B. fontinalis* and an authentic branch from the Altai of Bunge's species sent from the Imperial Herbarium of St. Petersburg to the Gray Herbarium, some of the original Tyan Shan material of Regel's *B. alba*, subsp. *soongorica*† in the Gray Herbarium and in the United States National Herbarium, the figures of Regel's *B. fruticosa*, var. *cuneifolia*,‡ and lastly the original detailed full-page description by Bunge of his *B. microphylla*,§ has more firmly convinced the writer that all three of these trees described from the Altai and the Tyan Shan ranges are one species, *B. microphylla*, Bunge; and that this species differs from *B. rhombifolia*, Nutt. (*B. occidentalis*, Nutt. and of many other authors, not Hook. *B. fontinalis*, Sargent) only in growing among the mountains of central Asia rather than among those of northwestern America.

A comparison of Bunge's original description of *Betula microphylla* with Nuttall's description of his *B. occidentalis*,‖ the tree subsequently called by Sargent *B. fontinalis*, shows no definite character of leaves, strobiles, samaras, nor twigs upon which the two may be separated; and Bunge's words, "epidermide trunci flavescente neque alba, primo intuito distinctissima,"¶ are certainly not inapplicable to the small tree of northwestern America described in the Botany of California "with close dark-colored bark (at length light brown)."** Furthermore, if we compare with the branch of *B. microphylla* sent from St. Petersburg to the Gray Herbarium the original specimen of Nuttall's *B. rhombifolia*†† (preserved in the Gray Herbarium and referred by Sargent to *B. fontinalis*), and such specimens as Macoun's from the North Saskatchewan and Dawson's from the Columbia River (Herb. Geol. Surv. Can., Nos. 23,620, and 23,624) or F. W. Anderson's material from McCarthey Mts., Montana (U. S. Nat. Herb. No. 25,261), we shall be perplexed to make out points of distinction. If we also compare with some of the original material of Regel's *B. alba*, subsp. *soongorica*, *β microphylla* from 5,000 ft. in

* Bot. Gaz. xxxi, 239.
† Bull. Soc. Imp. Nat. Mosc. (1868) vi—repr. Enun. Pl. Semenow. (1869) 99.
‡ Regel, Mon. Bet. (1861) 35. t. 7, figs. 16–23.
§ St. Pétersb. Mém. Savans Étrang. ii (1835) 606—reprint, Fl. Alt. Suppl. 84.
‖ Nutt., Sylva, i, 22, t. 7 (1842).
¶ Bunge, l. c.
** Watson, Bot. Cal. ii, 79.
†† Nutt., l. c. 24. t. 8.

the Tyan-Shan Mountains as represented in the Gray Herbarium and by sheet No. 25,339 in the U. S. National Herbarium, such specimens as V. Bailey's No. 5 from South Dakota, Coville and Leiberg's No. 81 from Nevada, and R. S. William's No. 404 from Montana (sheets Nos. 229,983, 275,933, and 290,087, U. S. Nat. Herb.); or Macoun's Devil's Lake plant, Dawson's South Kootenai Pass Plant, and Macoun's Crow Nest Pass Plant (Nos. 2,050, 23,623, and 24,368, Herb. Geol. Surv. Can.); or Lake and Hull's No. 790 from Washington, Rydberg and Bessey's No. 3,928 from Montana, Rydberg's No. 1,006 from the Black Hills, and A. Nelson's No. 1,647 from Wyoming, we shall be further perplexed in separating the American species from the Asian. Similar comparisons of American specimens with the figures of *B. fruticosa*, var. *cuneifolia* (which by Regel was identified with *B. microphylla*), lead to the same result. In view of this evidence and the essentially identical descriptions of Nuttall and Bunge, the writer is still unable to see in *Betula fontinalis*, Sargent (*B. occidentalis*, Nutt., not Hook. *B. rhombifolia*, Nutt., not Tausch) anything but *B. microphylla*, Bunge, of the mountains of central Asia.

§ **Nanae.** Shrubs: wings of the samaras narrower than, or very rarely as broad as the achenes.

The Dwarf Birches like the Canoe Birches present such tendencies to intergradation that it is difficult to draw clear specific lines between them. Yet in America three fairly marked species or centers of variation can be distinguished. These are *Betula pumila*, L., with the young shoots normally pubescent with long soft hairs, and quite glandless, but in an extreme form with glands or resiniferous atoms mixed with the long pubescence; *B. glandulosa*, Michx., with the young shoots glandular or resiniferous, at most puberulent with close short hairs; and *B. nana*, L., a tiny shrub with the young shoots puberulent or finely pubescent, but not glandular. In its typical form confined to arctic and alpine regions of Greenland, Europe and Asia, *B. nana* is represented in America by

BETULA NANA, var. MICHAUXII.

A very dwarf birch with cinereous-puberulent glandless branches and tiny suborbicular or flabelliform leaves has been collected at various points in Newfoundland, Labrador, and the Hudson Bay region, and has been referred to *Betula nana*, L., or its var. *flabellifolia*, Hook. An examination of this material shows that the strobiles are made up of simple oblong scales, instead of the deeply three-lobed scales characteristic of *B. nana* and most other species of the genus.

This dwarf shrub of Newfoundland and Labrador is without question *Betula Michauxii*, Spach,* based upon the *B. nana* of Michaux, not L., and made by Spach the type of his section *Apterocaryon*. Subsequently the plant was raised to generic rank by Opiz,† and called *Apterocaryon Michauxii;* while, on the other hand, Regel in his first Monograph treated‡ the plant as a variety of *B. nana*, though he later recognized§ it as distinct. Habitally the plant is quite inseparable from the European *B. nana;* and since sheet No. 334,540 of the United States National Herbarium, from Nugsuak Peninsula in Greenland, shows strobiles with simple and variously divided scales, it seems that Regel's earlier treatment of the plant was wiser and that the Newfoundland and Labrador representative of *Betula nana* is var. *Michauxii* (Spach) Regel.

Betula pumila.

In its normal form *Betula pumila*, *L.*‖ has the leaves and branchlets quite glandless and in their youngest stages densely pubescent with silky hairs. The shrub, however, passes imperceptibly into a state (var. *glabrescens*, Regel) in which the branchlets and leaves are quite glabrous. This tendency is common, but apparently not of such constancy as to merit special recognition. It is interesting to find, however, that the specimens which represent this tendency are inseparable from *B. alpestris*, Fries,¶ of Greenland, Iceland, Scandinavia and north Germany, an identity which was at least suspected by Regel.** Such specimens in the Herbarium of the Geological Survey of Canada as Macoun's No. 23,840 from Anticosti and Waghorne's No. 23,821[b] from Labrador are quite inseparable from sheet No. 149,806 in the U. S. Nat. Herb. of *B. alpestris* from the Dovre Mts., Norway (*Ahlberg*) and a sheet in the Gray Herbarium from Lapland (*Andersson*), except in the length of the petiole. This character, however, is very inconstant and it seems to the writer an insufficient point on which to keep apart two plants which are otherwise inseparable. Nor are the extreme American plants otherwise different from the plate representing *B. fruticosa*, var. *humilis*, Reichenbach (Ic. Fl. Germ. xii, fig. 1280) and referred by Guerke to *B. alpestris*, and the plate of *B. alpestris* in Flora Danica (Suppl. t. 37). The name *B. pumila*, however, long antedates *B. alpestris*, Fries, and it should now be applied to the shrub of northern Europe as well as America. The true *Betula pumila* occurs in swamps from Labrador and Newfoundland west-

* Ann. Sc. Nat., ser. 2, xv, 195.
‡ Regel, Mon. Bet. (1861) 45.
§ Regel in DC. Prodr. xvi, part 2 (1864), 171.
¶ Summ. Veg. Scand. i, 212 (1846).
† Lotos, v (1855), 258.
‖ Mant. 124 (1767).
** Regel in DC., l. c. 173.

ward, and locally south to Morris Co., New Jersey, Champaign Co., Ohio, Lake Co., Indiana and McHenry Co., Illinois, in Greenland, northern Europe and Siberia. The leaves vary much in outline and in the degree of permanence of the pubescence; and the samaras in the breadth of the wings and achenes. Narrowly obovate and orbicular leaves are often found upon the same shrub, so that species or varieties based upon these characters (as *B. Grayi*, Regel, Bull. Soc. Imp. Nat. Mosc. xxxviii, 406, t. 6, figs. 9–13) have little value.

Betula pumila, var. *glandulifera*.

In the Great Lake region, however, and from there northward and westward, where *Betula pumila* meets *B. glandulosa*, it presents a perplexing form. In its long pubescence (when well developed) the shrub seems to be *B. pumila*, but mixed with the pubescence and sometimes upon the leaves are the characteristic glandular atoms of *B. glandulosa*. Ordinarily, though, the shrub is readily distinguished from the latter species by the longer pubescence of the young shoots. This intermediate and transitional form, *Betula pumila*, var. *glandulifera*, Regel in DC. l. c., occurs from western Ontario and Michigan to Minnesota, Saskatchewan and British Columbia, south to Idaho and Oregon.

Betula glandulosa.

*Betula glandulosa** presents two variations which in their extreme developments appear very distinct, but which again so mingle their characters as to be quite inseparable. Typical *B. glandulosa* is an upright shrub sometimes several feet high, but in exposed situations it becomes dwarfed and widespreading. In the typical form of the species the leaves are obovate, but occasionally on these shrubs orbicular or reniform leaves are found. This shrub with obovate leaves is most common in the interior of North America, from the Yukon and Mackenzie Rivers to Hudson Straits, south in the mountains to northern California, Utah, Colorado, and South Dakota; across the plains to Manitoba and Lake Superior; and through Labrador and locally to the higher mountains of northern New England. It is also in Greenland, Kamtschatka and the Altai Mountains.

On the eastern mountains (Albert, Katahdin and Washington), in Labrador, and in the Altai the shrub passes imperceptibly to a form with orbicular or reniform leaves, var. *rotundifolia*, Regel† (*Betula rotundifolia*, Spach‡); but on

* Michx., Fl. Bor.-Am. ii, 180 (1803). † Regel in DC., l. c. 172 (1864).
‡ Spach, l. c. 194 (1841).

the coast of Alaska, the islands of Behring Sea, and adjacent Kamtschatka this depressed form with small orbicular or reniform leaves retains its characteristics in a marked degree, and were the plant known only from that district it would stand as an undoubted species.

Mr. Coville has called the attention of the writer to a shrub four to six feet high which is associated with the depressed *Betula glandulosa*, var. *rotundifolia*, and the Cook's Inlet tree which is identified with *B. pendula*, var. *japonica*. This intermediate shrub is well represented in the National Herbarium, and it is possible, as Mr. Coville suggests, that it is of hybrid origin, since similar hybrids of trees and dwarf shrubs have before been noted.* The material presents a strong superficial resemblance to Greenland specimens of *B. alba*, var. *minor*, although the strongly resiniferous branchlets hardly place it with that shrub.

In conclusion, it should be emphasized that the specific lines in *Betula*, as in *Alnus*, *Quercus* and *Salix*, are often too vague. It is quite possible to trace by a series of specimens a direct connection between the dwarf *Betula nana* or *B. glandulosa* and the tall *B. alba*. Thus *B. nana* in its larger development is separated with difficulty from the Scandinavian *B. alpestris*. This shrub, in turn, is quite like glabrate states of the American *B. pumila*, which, through its var. *glandulifera*, passes to *B. glandulosa*, the larger developments of which pass in the Cascade Mts. to *B. microphylla*, and in the Saskatchewan region to *B. alba*, var. *minor*. The latter shrub is often inseparable on the New England mountains from *B. alba*, var. *cordifolia*, which on the lower slopes becomes a large tree and passes gradually to the broad-leaved form figured by Michaux as *B. papyracea*. A very similar series is readily made to include *B. pendula* and *B. humilis*. But since it is obviously impracticable to regard all these forms as one species, it seems wiser to recognize the more marked centers of variation as species which are admitted to pass by exceptional tendencies to other forms ordinarily distinguished by marked characteristics.

The American representatives of § *Costatae*, *Betula nigra*, *B. lenta*, and *B. lutea*, are represented by related species in Asia, but none of these trees are of very boreal range, and they appear well distinguished as endemic species.

* *B. pubescens* [*alba*] × *humilis*, Warnst. Verh. Bot. Ver. Brandenb. xi, 129 (1870).

B. nana × *verrucosa* [*pendula*], Sael. Medd. Soc. Faun. et. Fl. Fenn. xiii, 256 (1886).

B. nana × *pubescens* [*alba*], Koehne, Deutsche Dendr. 112 (1893).

B. pumila × *lenta*, Jack, Gard. and For. viii, 243, fig. 36 (1895).

The American forms of §§ *Albae* and *Nanae* now recognized by the writer and discussed in the preceding notes may be briefly enumerated as follows:

B. ALBA, L. Sp. ii, 982 (1753); Roth, Fl. Germ. i, 404. *B. papyrifera*, Marshall, Arbust. Am. 19 (1785). *B. papyracea*, Ait. Hort. Kew. iii, 337 (1789). *B. pubescens*, Ehrh. Beitr. v, 160, vi, 98 (1790–91). *B. odorata*, Bechst. Diana, i, 74 (1797).—NEWFOUNDLAND to ALASKA, south to PENNSYLVANIA, INDIANA, NEBRASKA, WYOMING, IDAHO and WASHINGTON; passing on the Pacific coast to the dark-barked forma *occidentalis* (*B. occidentalis*, Hook. Fl. Bor.-Am. ii, 155 (1839)); ICELAND, northern EUROPE and ASIA, south in the mountains to northern SPAIN, ITALY, etc. (Pl. V, figs. 1–6.)

B. ALBA, var. GLUTINOSA, Trautv. ex Regel, Mon. Bet. 20 (1861). *B. glutinosa*, Wallr. Sched. Crit. 497 (1822). *B. pendula*, Reichenb. Ic. Fl. Germ. xii, t. 625, not Roth.—Valley of Wassataquoik River, MAINE; SWEDEN, FINLAND, GERMANY, SWITZERLAND, AUSTRIA.

B. ALBA, var. CORDIFOLIA. *B. cordifolia*, Regel, Mon. Bet. 28, t. 12, figs. 29–36 (1861). *B. alba*, subsp. *papyrifera*, β, *cordifolia*, Regel in DC. Prodr., xvi, pt. i, 166 (1864). *B. papyrifera*, var. *minor*, Wats. and Coult. in Gray, Man. ed. 6, 472 (1889), in part, not *B. papyracea* var. *minor*, Tuck.—LABRADOR and NEWFOUNDLAND to NEW BRUNSWICK, MAINE, NEW HAMPSHIRE, LAKE SUPERIOR, IOWA, ALBERTA, BRITISH COLUMBIA, IDAHO, and WASHINGTON.

B. ALBA, var. MINOR. *B. davurica*, Ledeb., Fl. Alt. iv, 245 (1833), not Pallas. *B. papyracea*, var. *minor*, Tuckerman, this Journal, xlv, 31 (1843). *B. tortuosa*, Ledeb., Fl. Ross. iii, 652 (1849). *B. odorata*, var. *alpigena*, Blytt, Norg. Fl. 402 (1861). *B. alba*, subsp. *tortuosa*, Regel, in DC., l. c. 168 (1864). *B. davurica*, β, *americana*, Regel, l. c. 175 (1864). *B. odorata*, var. *tortuosa*, Lange, Fl. Dan. xvii, 10, t. 2918 (1877). *B. papyrifera*, var. *minor*, Wats. and Coult. l. c., in part. *B. pubescens*, var. *tortuosa*, Koehne, Deutsche Dendr. 109 (1893).—LABRADOR to the mountains of MAINE, NEW HAMPSHIRE and VERMONT; mountains of SASKATCHEWAN, ASSINIBOIA, and ALBERTA; GREENLAND, ICELAND, LAPLAND, FINLAND, northern GERMANY, ALTAI MTS.; dwarf forms from ALASKA resemble this variety, but have the strongly resiniferous branchlets of *B. glandulosa* and *B. pendula*. (Pl. V, figs. 7–12.)

BETULA ALBA, var. CARPATICA. *B. carpatica*, Wald. and Kit. in Willd. Sp. iv, 464 (1805). *B. borealis*, Spach, Ann. Sci. Nat., ser. 2, xv, 196 (1841). *B. glutinosa*, Fries, Summ. Veg. Scand., 212 (1846), not Wallr. *B. pumila*, γ, *borealis*, Regel, Mon. Bet. 55, t. 13, figs. 38, 39 (1861). *B. alba*, subsp.

pubescens, ζ *carpatica*, Regel in DC., l. c. 168 (1864). *B. odorata*, var. *carpatica*, Lange, Haandb., ed. 3, 708 (1864). *B. odorata*, var. *rhombifolia*, Lange, Fl. Dan., xvi, t. 2851 (1871).—Anticosti, QUEBEC; ALBERTA; and northward; SCANDINAVIA to GERMANY, AUSTRIA and RUSSIA. (Pl. V, figs. 13–14.)

B. PENDULA, Roth, Fl. Germ. i, 405 (1788). *B. verrucosa*, Ehrh., Beitr. vi, 98 (1791). *B. alba*, var. *verrucosa*, Wallr., Sched. Crit., 495 (1822). *B. alba*, var. *vulgaris*, Spach, l. c. 186 (1841). *B. odorata*, Reichenb., Ic. Fl. Germ., xii, fig. 1288 (1850), not Bechst. *B. gummifera*, Bertol., Fl. It., x, 229 (1854). *B. alba*, subsp. *verrucosa*, α, *vulgaris* and δ, *resinifera* (in part), Regel in DC., l. c. 163, 164 (1864). *B. kenaica*, W. H. Evans, Bot. Gaz., xxvii, 481 (1899), in part. *B. alaskana*, Sargent, Bot. Gaz., xxxi, 236 (1901), mostly.—QUEBEC to ILLINOIS, ALBERTA, MACKENZIE and ALASKA; Europe and Asia, widely distributed. (Pl. V, figs. 15–18; Pl. VI, figs. 19–22.)

B. PENDULA, var. JAPONICA, Rehder in Bailey, Cyc. Am. Hort., i, 159 (1900). *B. japonica*, Siebold, Verh. Batav. Gen. xii, 25 (1830). *B. latifolia*, Tausch, Fl. Ratisb., 751 (1838). *B. alba*, subsp. *verrucosa*, δ *resinifera*, Regel in DC., l. c. 164, in part; subsp. *mandshurica* and *latifolia*, Regel, l. c. 165 (1864). *B. kenaica*, W. H. Evans, l. c. (1899), mostly. *B. alaskana*, Sargent, l. c. (1901), in part.—SUNGARIA to JAPAN, north to the Yenisei River, SIBERIA, and KAMTSCHATKA; east to Peel River and Fort Simpson, MACKENZIE, and along the ALASKA coast; and apparently on the coast of Washington Co., MAINE (trees sterile). (Pl. VI, figs. 23, 24.)

B. POPULIFOLIA, Marshall, Arbust. Am., 19 (1785). *B. alba*, var. *populifolia*, Spach, Ann. Sci. Nat., ser. 2, xv, 187 (1841). *B. alba*, subsp. *populifolia*, Regel, in DC., l. c. 164 (1864).—PRINCE EDWARD ISLAND to central MAINE, southwestern QUEBEC, and western NEW YORK, south mostly on the coastal plain to DELAWARE.

B. MICROPHYLLA, Bunge, St. Pétersb. Mém. Savans Étrang., ii (1835), 606—reprint, Fl. Alt. Suppl. 84. *B. occidentalis*, Nutt., Sylva, i, 22, t. 7 (1842), not Hook. *B. rhombifolia*, Nutt., l. c. 24, t. 8, not Tausch. *B. fruticosa*, var. *cuneifolia*, Regel, Mon. Bet. (1861) 35, t. 7, figs. 16–23. *B. alba*, subsp. *soongorica*, Regel, Bull. Soc. Imp. Nat. Mosc., vi, (1868)—reprint, Enum. Pl. Semenow (1869) 99. *B. fontinalis*, Sargent, Bot. Gaz. xxxi, 23 (1901).—In the mountains from ALASKA to northern CALIFORNIA, SASKATCHEWAN, SOUTH DAKOTA, and NEW MEXICO; ALTAI and TYAN SHAN MTS., central Asia. (Pl. VI, figs. 25–32.)

B. NANA, L., var. MICHAUXII, Regel, Mon. Bet. (1861), 45. *B. Michauxii*, Spach, l. c. 195 (1841). *Apterocaryon Michauxii*, Opiz, Lotos, v (1855), 258.—HUDSON BAY, LABRADOR and NEWFOUNDLAND. (Pl. VI, figs. 47, 48.)

B. PUMILA, L., Mant. 124 (1767). *B. alpestris*, Fries, Summ. Veg. Scand., i, 212 (1846). *B. fruticosa*, var. *humilis*, Reichenb. Ic. Fl. Germ., xii, fig. 1280 (1850). *B. nana* var. *alpestris*, Regel, Mon. Bet. 45 (1861). *B. Grayi*, Regel, Bull. Soc. Imp. Nat. Mosc., xxxviii, 406, t. 6, figs. 9–13 (1865).—LABRADOR and NEWFOUNDLAND to ONTARIO, south to Morris Co., NEW JERSEY, Champaign Co., OHIO, Lake Co., INDIANA, and McHenry Co., ILLINOIS; GREENLAND, SCANDINAVIA, northern GERMANY, FINLAND, LAPLAND, RUSSIA, SIBERIA. (Pl. VI, figs. 33–38.)

B. PUMILA, var. GLANDULIFERA, Regel in DC., l. c. 173 (1864).—ONTARIO and MICHIGAN to MINNESOTA, SASKATCHEWAN and BRITISH COLUMBIA, south in the mountains to IDAHO and OREGON.

B. GLANDULOSA, Michx., Fl. Bor.-Am., ii, 180 (1803). *B. nana* of various American authors, not L. *B. Littelliana*, Tuckerman, this Journal, xlv, 30 (1843).—GREENLAND and HUDSON STRAITS to KAMTSCHATKA, and the Altai Mts. of SIBERIA; south in eastern America to the higher mountains of MAINE and NEW HAMPSHIRE; in the interior to LAKE SUPERIOR and MANITOBA; and in the western mountains to SOUTH DAKOTA, COLORADO, UTAH, and northern CALIFORNIA. (Pl. VI, figs. 39, 40.)

B. GLANDULOSA, var. ROTUNDIFOLIA, Regel in DC., l. c. 172 (1864). *B. rotundifolia*, Spach, l. c. 194 (1841). *B. nana*, var. *sibirica*, Ledeb., Fl. Ross., iii, 654 (1849).—GREENLAND and northern LABRADOR to KAMTSCHATKA, and the Altai Mts. of SIBERIA, south to the higher mountains of MAINE and NEW HAMPSHIRE, and along the coast of ALASKA. Perhaps hybridizing with *B. pendula*. (Pl. VI, figs. 41–44.)

EXPLANATION OF PLATES.*

PLATE V, figs. 1–6, BETULA ALBA.

FIGURE 1.—Leaf of young flowering branch of *B. pubescens*, Ehrh., from the Vosges Mts., near Rambervilles, France (*Joad*).
FIGURE 2.—Leaf of fruiting branch of *B. papyrifera*, Marsh., from Lake Winnipeg, Manitoba (*Bourgeau*).
FIGURE 3.—Leaf of fruiting branch of *B. occidentalis*, Hook., from Pend d'Oreille River, British Columbia (*Lyall*).
FIGURE 4.—Leaf of young branch of *B. pubescens*, Ehrh., from Bohemia (Tausch).
FIGURE 5.—Leaf of fruiting branch of *B. papyrifera*, Marsh., from Southport, Maine (*Fernald*).
FIGURE 6.—Leaf of fruiting branch from Austria—after Ettingshausen and Pokorny, Phys. Pl. Aust. iii, t. 201.

PLATE V, figs. 7 to 12, B. ALBA, var. MINOR.

FIGURE 7.—Leaf of fruiting branch of *B. tortuosa*, Ledeb., from the Altai Mts., Siberia (ex. herb. St. Petersb.).
FIGURE 8.—Leaf of fruiting branch of *B. odorata*, var. *tortuosa*, Lange, from the Dovre Mts., Norway—after Lange, Fl. Dan. xvii, t. 2918.
FIGURES 9, 10.—Leaves of original fruiting branches of *B. papyracea*, var. *minor*, Tuck., from Mt. Washington, New Hampshire.
FIGURE 11.—Leaf of dwarf form of *B. papyracea*, var. *minor*, Tuck., from Mt. Washington, New Hampshire (*Faxon*).
FIGURE 12.—Leaf of fruiting branch of *B. odorata*, var. *minor*, Rosenvinge in herb., from Greenland (*Hartz*).

PLATE V, figs. 13, 14, B. ALBA var. CARPATICA.

FIGURE 13.—Leaf of fruiting branch of *B. borealis*, Spach, from Anticosti, Quebec (*Macoun*).
FIGURE 14.—Leaf of *B. alba*, subsp. *pubescens*, ζ *carpatica*, Regel, from Lapland (*Regel*).

PLATE V, figs. 15 to 18, PLATE VI, figs. 19 to 22, B. PENDULA.

FIGURES 15, 17.—Leaves of young flowering branch of *B. alba*, subsp. *verrucosa*, δ *resinifera*, Regel (type of *B. alaskana*, Sargent) from Saskatchewan (*Bourgeau*).
FIGURES 16, 18.—Leaves of fruiting branch of *B. verrucosa*, Ehrh., from Christiania, Norway (*Blytt*).
FIGURE 19.—Leaf of fruiting branch of *B. pendula*, from Warren, Illinois (*L. M. Umbach*, sheet No. 351,017 U. S. Nat. Herb.).
FIGURE 20.—Leaf of fruiting branch from Gotland, Sweden (*Blomberg*).
FIGURE 21.—Leaf of *B. alba*, subsp. *mandshurica*, Regel, from Mandschuria—after the original illustration (Regel, Bull. Soc. Imp. Nat. Mosc., 1865, t. 7, fig. 15).
FIGURE 22.—Leaf of fruiting branch of *B. verrucosa*, δ *resinifera*, Regel, from Nushagak River, Yukon District, Alaska (*McKay*).

PLATE VI, figs. 23, 24, B. PENDULA, var. JAPONICA.

FIGURE 23.—Leaf of *B. alba*, subsp. *latifolia*, *a Tauschii*, Regel, from Eastern Asia—after Regel, Bull. Soc. Imp. Nat. Mosc., 1865, t. 7, fig. 11.
FIGURE 24.—Leaf of *B. kenaica*, W. H. Evans, from Cook Inlet, Alaska (*Coville and Kearney*, No. 2412).

*The plates illustrating this paper have been carefully prepared by Mr. F. Schuyler Mathews. Unless otherwise stated, the figures are life-sized.

PLATE VI, figs. 25 to 32, B. MICROPHYLLA.

FIGURE 25.—Leaf of young shoot of *B. microphylla* from the Altai Mts., Siberia (ex. herb. St. Petersberg).
FIGURE 26.—Leaf of *B. fruticosa*, var. *cuneifolia*, Regel (syn. *B. microphylla*, Bunge) from the Altai Mts., Siberia—after Regel, Mon. Bet. (1861) t. 7, fig. 18.
FIGURE 27.—Leaf of fruiting branch of *B. occidentalis*, Nutt. (*B. fontinalis*, Sargent) from Idaho Springs, Colorado (*Engelmann*).
FIGURE 28.—Small leaf from fruiting branch of *B. occidentalis*, Nutt. (*B. fontinalis*, Sargent) from Coulee City, Washington (*Lake and Hull*, No. 790).
FIGURE 29.—Leaf of young shoot of *B. occidentalis*, Nutt. (*B. fontinalis*, Sargent) from the Black Hills, South Dakota (*Rydberg*, No. 1006).
FIGURE 30.—Leaf of fruiting branch of original material of *B. alba*, subsp. *soongorica*, *β microphylla*, Regel, from the Tyan Shan Mts., Central Asia (Semenow).
FIGURES 31, 32.—Leaves of fruiting branch of *B. occidentalis*, Nutt. (*B. fontinalis*, Sargent) from Laramie Peak, Wyoming (*A. Nelson*, No. 1647).

PLATE VI, figs. 33 to 38, B. PUMILA.

FIGURE 33.—Leaf of sterile shoot of *B. pumila* from Anticosti, Quebec (*Macoun*).
FIGURE 34.—Leaf of sterile shoot of *B. alpestris*, Fries, from Lapland (*Laestadius*).
FIGURE 35.—Tip of branch from Bonne Espérance, Quebec (*Allen*, No. 70).
FIGURE 36.—Leaves of glabrate form from Bay of Islands, Newfoundland (*Waghorne*).
FIGURE 37.—Leaves of *B. alpestris*, Fries, from Norway—after Lange, Fl. Dan., Suppl. t. 37.
FIGURE 38.—Leaves of young branch of *B. alpestris*, Fries, from Lapland (*Andersson*, No. 186).

PLATE VI, figs. 39, 40, B. GLANDULOSA.

FIGURE 39.—Leaf of branch from Mt. Washington, New Hampshire (*J. A. Allen*).
FIGURE 40.—Leaves of branch from Hopedale, Labrador (*Sornborger*, No. 80).

PLATE VI, figs. 41 to 44, B. GLANDULOSA, var. ROTUNDIFOLIA.

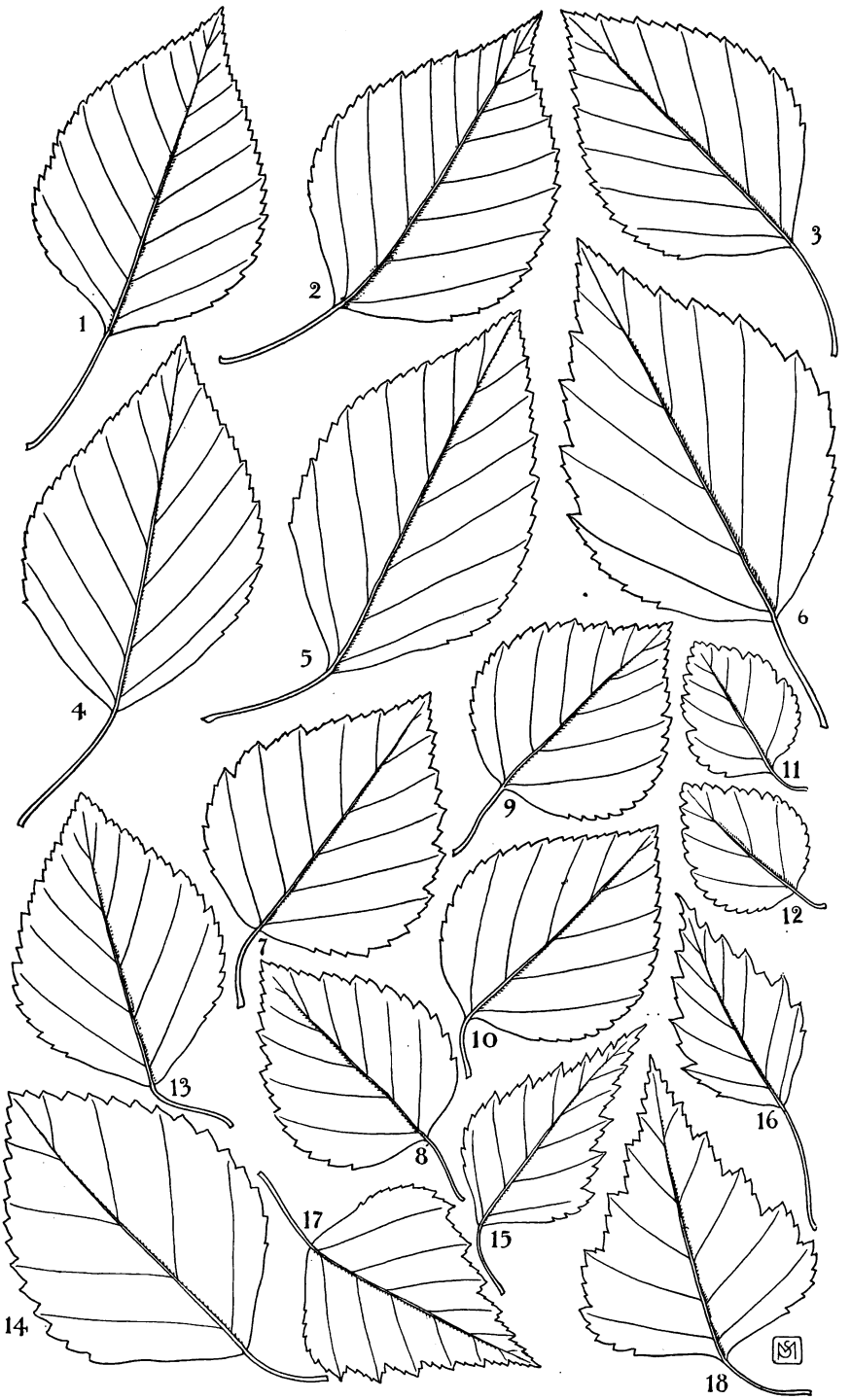
FIGURE 41.—Leaf from Mt. Washington, New Hampshire.
FIGURES 42, 43.—Leaves from Nunivak Island, Behring Sea (*J. M. Macoun*).
FIGURE 44.—Leaf from the Altai Mts., Siberia (ex. herb. St. Petersb.).

PLATE VI, figs. 45, 46, B. NANA.

FIGURE 45.—Fruiting branch from Grenjadastad, Iceland (*Elizabeth Taylor*).
FIGURE 46.—Scale from same, enlarged three times.

PLATE VI, figs. 47, 48, B. NANA, var. MICHAUXII.

FIGURE 47.—Fruiting branch from Grand Lake, Newfoundland (*Waghorne*).
FIGURE 48.—Scale from same, enlarged three times.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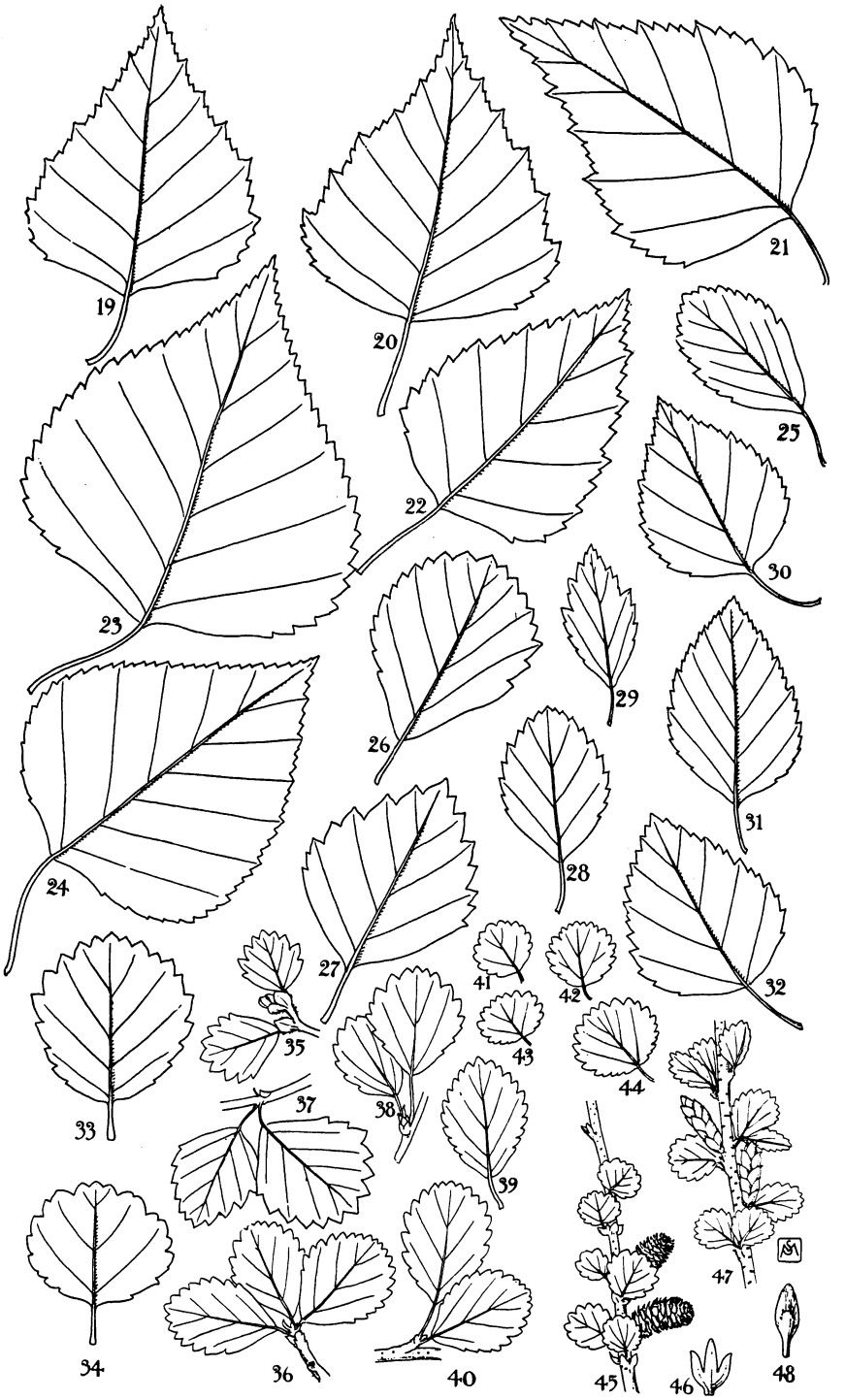
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