ARALIA IN AMERICAN PALEOBOTANY.

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IN a study of the mid-Cretaceous floras of the Atlantic coastal plain, the difficulty of determining by what characters certain leaves were allied to Aralia, Sassafras, or Sterculia led to a somewhat extended review of these genera, more particularly the former, which is so abundantly represented throughout the American Cretaceous and Tertiary.

As to the relationship of these leaves with modern species of Aralia, we are not here especially concerned. Leaves of this type, however, are such a constant feature of these ancient floras, both in this country and abroad, that they possess an unusual degree of interest, and I have endeavored in the following notes to define more precisely the characters which serve to distinguish these leaves from leaves of other genera with which they are often confused.

The existing species of Araliaceae number about 450, which Harms, in *Die natürlichen Pflanzenfamilien*, distributes among 51 genera. They are widely distributed in the temperate and tropical regions throughout the world, and include herbs, shrubs, and trees with simple, lobed, or compound leaves. The genus Aralia, as restricted, includes some 27 species of North America and Asia with ternately and pinnately decompound leaves. The only fossil form which seems to stand in this ancestral line is *Aralia triloba* Newb. from the Fort Union Tertiary.

In North America north of Mexico we have six existing species of Aralia, four eastern and two western (besides three varieties). Of these *Aralia spinosa* L. is the only arborescent form. Beside Aralia two other genera occur with us: Panax, with two eastern North American species and five species of central and eastern Asia; and Echinopanax, with one species on the Pacific coast of America, which reappears in Japan. Many other genera occur in the West Indies, Mexico, Central and South America.

The fossil species throughout the world have mostly been referred to Aralia or Hedera, and are comparable for the most part with the existing species of the Araliaceae as a whole, rather than with these respective genera. Beside these two genera, various fruits from the Atane and Patoot beds of Greenland, and from the Miocene of Europe, have been referred to Panax; Unger identifies a species of Cussonia from the Miocene (Kumi) of Greece, Velenvosky another from the Cenomanian of Bohemia, and Nathorst a species of Acanthopanax from the Pliocene of Japan. Some 44 species of Aralia leaves have been identified from American strata, ranging from the Potomac formation upward through the Miocene. Numerous analogues of these American species have been described in Europe, as well as five species which are identical. Thus *Aralia coriacea* Velen., occurs in the Cenomanian of Bohemia and at Marthas Vineyard; *Aralia transversinervia* Sap. & Mar. occurs at Gelinden and has been reported from Long Island; *Aralia formosa* Heer occurs at Moletein and in the Bohemian Cretaceous as well as in the Dakota group and Raritan formation; *Aralia Zaddachi* Heer of the Baltic Oligocene occurs in the Californian Miocene; and *Aralia Looziana* Sap. & Mar. of the Gelinden flora reappears in the Fort Union group.

The genus is well represented both in the Cretaceous and Tertiary of Europe, Schimper in his *Paléontologie Végétale* (1874) listing 34 species, mostly, from European localities.

Heer describes two species from the Tertiary of Siberia, a simple leaflet and a lobed leaf of the *A. Saportana* type; while Ettingshausen notes the occurrence of Aralia in the Tertiary of Australasia. Many of these fossil species have merely a paleobotanical value. Thus Newberry identifies seven species at the single Raritan horizon of Woodbridge, N. J., four of which are described for the first time by him.[1] Still another Raritan species is Heer's *Aralia formosa*, which occurs in the upper layers at South Amboy, N. J. It is quite possible that Newberry's *A. polymorpha, groenlandica, patens, palmata,* and *rotundiloba* are all the varied leaves of a single species. In the Matawan formation,

[1] Flora of the Amboy clays. 1896.

which overlies the Raritan and with which it is closely related both geologically and botanically, there occur numerous Aralia-like leaves. I have identified[2] five species from this horizon, and the protean character of all of these mid-Cretaceous forms is emphasized when we find but two of these Matawan leaves referable to Raritan forms and these not entirely identical, while two others are entirely new.

Saporta would consider all the forms referred to Sassafras (Araliopsis) as included in the Araliaceae, but it seems to me that most of these leaves have stronger affinities in other directions. Ward would consider these Aralia-like leaves as referable to Platanus or its ancestral prototype. I have provisionally referred *Sassafras acutilobum* L. to Aralia.[3] Among the remainder of the American species of Sassafras, those which are not true species of Sassafras are related to Cissites or Platanus (Protoplatanus).

Three types of leaves have been referred to Aralia: (1) palmately three to seven-lobed leaves; (2) pinnately or ternately parted leaves; (3) simple leaves or leaflets.

Leaves of the first style, which concern us more particularly, may be briefly characterized as follows: Palmately 3–7 lobed, thick or coriaceous; petiole usually present and stout; margins entire or dentate; primaries 3–5 (7 in *A. dissecta*) generally rather stout, basal in ten species, sub-basal in ten species, and supra-basilar in fifteen species, doubtful in a few cases; lateral primaries when forked usually above their base, often present as basal sub-primaries; secondaries camptodrome in the entire-margined forms and craspedodrome in those which have dentate margins, both characters combined in some species; areolation obsolete, or square, or polygonal; base decurrent or cuneate in twenty species, rounded or truncate in fourteen species, doubtful in the balance, of which one is cordate and two or three are lobate. Young leaves may be entire-margined and three-lobed, while older leaves are dentate and five-lobed, which has caused a further duplication of species.

We may distinguish Sassafras, Sterculia, and Platanus,

[2] Flora Matawan formation. 1903. [3] BOT. GAZ. 34: 438. 1902.

which are oftenest confounded with Aralia, by the following characters:

In *Sassafras* the primaries branch from the midrib, usually a considerable distance above the base, which is decurrent and never lobate; the margins are entire; the texture is not coriaceous; sinuses margined, or secondaries at least showing some evidence of disarrangement in the region of the sinuses; secondaries camptodrome; the decurrent base usually margined.

Sterculia has usually petiolate coriaceous leaves with obsolete venation and conically pointed lobes; is palmately lobed, usually from below the middle; primaries usually three from the top of the petiole; base cuneate; margins always entire; secondaries becoming effaced near the margin, or bowed close to the margin.

In *Platanus* the leaves are large, thick, and palmately lobed, not deeply so, however, and the sinus always open; coarse leaves three-nerved from near the base; primaries and secondaries straight and stout; secondaries numerous, parallel, usually craspedodrome; margin never entire; lobes always broad; base sometimes lobate.

The American species of palmately lobed Aralias may be separated into five groups.

SECTION 1.

Thick leaves fan-shaped in outline with long thick petioles; young leaves three-lobed; old leaves five-lobed; lobes narrow and pointed; base decurrent (except *A. Zaddachi*); sinuses narrow, extending more than half way to the base; margins dentate above with craspedrome secondaries, entire below with camptodrome secondaries; primaries three, stout, supra-basilar (except *A. Zaddachi*); lateral primaries forking some distance from the midrib; secondaries numerous and parallel. *Aralia digitata* Ward leads the way to the Green River species, *A. macrophylla* Newb., and by its lobate basal expansion shows its close relation to *Platanus basilobata* Ward.

This section includes: A. Saportana Lx., Dakota group; A. Saportana deformata Lx., Dakota group; Aralia sp., Dawson, Mill Creek; A. Welling-

toniana Lx., Dakota Tuscaloosa, and Raritan; A. digitata Ward, Fort Union group; A. Zaddachi ? Heer, Miocene.

SECTION 2.

Thick leaves rather orbicular in outline, with a long petiole (so far as it is known), lobes 3 to 5, broad and obtusely pointed, showing a tendency to become sub-lobate; base but slightly decurrent, generally rounded or truncate; sinuses open, extending about half way to the base; margins entire; secondaries camptodrome; primaries three, basal or sub-basal; lateral primaries unbranched, usually with sub-primaries below; areolation usually obsolete; smaller leaves than in section 1. A common type of mid-Cretaceous leaf is that which has been referred to *Aralia groenlandica* Heer and which has been recorded from the more or less synchronous strata of the Atane schists, the Dakota group, the New Jersey Raritan and Matawan formations, and the Island Raritan. I take as typical leaves of this species Heer's *f. 3. pl. 38* Fl. Foss. Arct. **6**, abth. 2 and Lesquereux's *f. 1, pl. 54*, Fl. Dak. Gr.; and it may be noted that Heer includes leaves which are considerably removed from this type, while Lesquereux includes Dakota leaves (*fig. 2, loc. cit.*) which approach on the one hand his *Aralia subemarginata* and on the other (*fig. 3, loc. cit.*) leaves which approach the synthetic group of Aralias which Newberry describes from the Raritan formation of New Jersey. This *groenlandica* type of leaf seems to be a rather primitive one, a leaf from which numerous rather closely related species have been derived.

This section includes: Aralia groenlandica Heer, Atane, Dakota, Raritan, Matawan, Island; A. gracilis Lx., Laramie ?; A. notata Lx., Denver and Fort Union; A. patens, Newb., Raritan, Island; A. rotundiloba Newb., Raritan and Island; A. polymorpha Newb., Raritan; A. palmata Newb., Raritan and Matawan; A. subemarginata Lx., Dakota; A. Brittonianum Berry, Matawan; A. acerifolia Lx., Ft. Union and Miocene.

SECTION 3.

Mostly large, very coriaceous, fan-like leaves, with very stout petioles and primaries; lobes 3 to 5 or more (?); the lobes long and rather slender (except *A. Ravniana*), obtusely pointed; sinuses narrow, primary ones deep, extending nearly to the base; base

decurrent; margins entire; secondaries (when preserved) numerous, parallel, and camptodrome; primaries three, basal or sub-basal; the lateral primaries forking some distance above their base; areolation generally obsolete; the small basal sub-primaries of section 2 wanting. The extreme of form in this section approach very close to the *Saportana* type of leaf of section 1.

The species included in this section are: Aralia Ravniana Heer, Atane and Matawan; A. Towneri Lx., Dakota and Matawan; A. quinquepartita Lx., Dakota and Raritan; A concreta Lx., Dakota; A. angustiloba Lx., Miocene; A. Wellingtoniana Vaughanii Kn., Woodbine, Dakota; A Jorgenseni Heer, Greenland Tertiary.

SECTION 4.

This and section 5 are residuary groups of species that require further study. This section includes a rather heterogeneous assemblage of fan-shaped leaves which agree in having entire margins; pointed lobes; usually stout primaries; petiole (where preserved) stout; primaries basal or sub-basal; texture coriaceous or sub-coriaceous; secondaries camptodrome (where known). Medium sized or small leaves except *A. Whitneyi*, which is very large and seems to be the Miocene ancestor of the existing Tetrapanax of eastern Asia.

The species included are: Aralia Masoni Lx., Dakota; A. Mattewanensis Berry, Matawan; A. Westoni Daws., Mill Creek; A. rotundata Daws., Mill Creek; A. radiata Lx., Dakota; A. tenuinervis Lx., Dakota; A. Whitneyi Lx., Miocene.

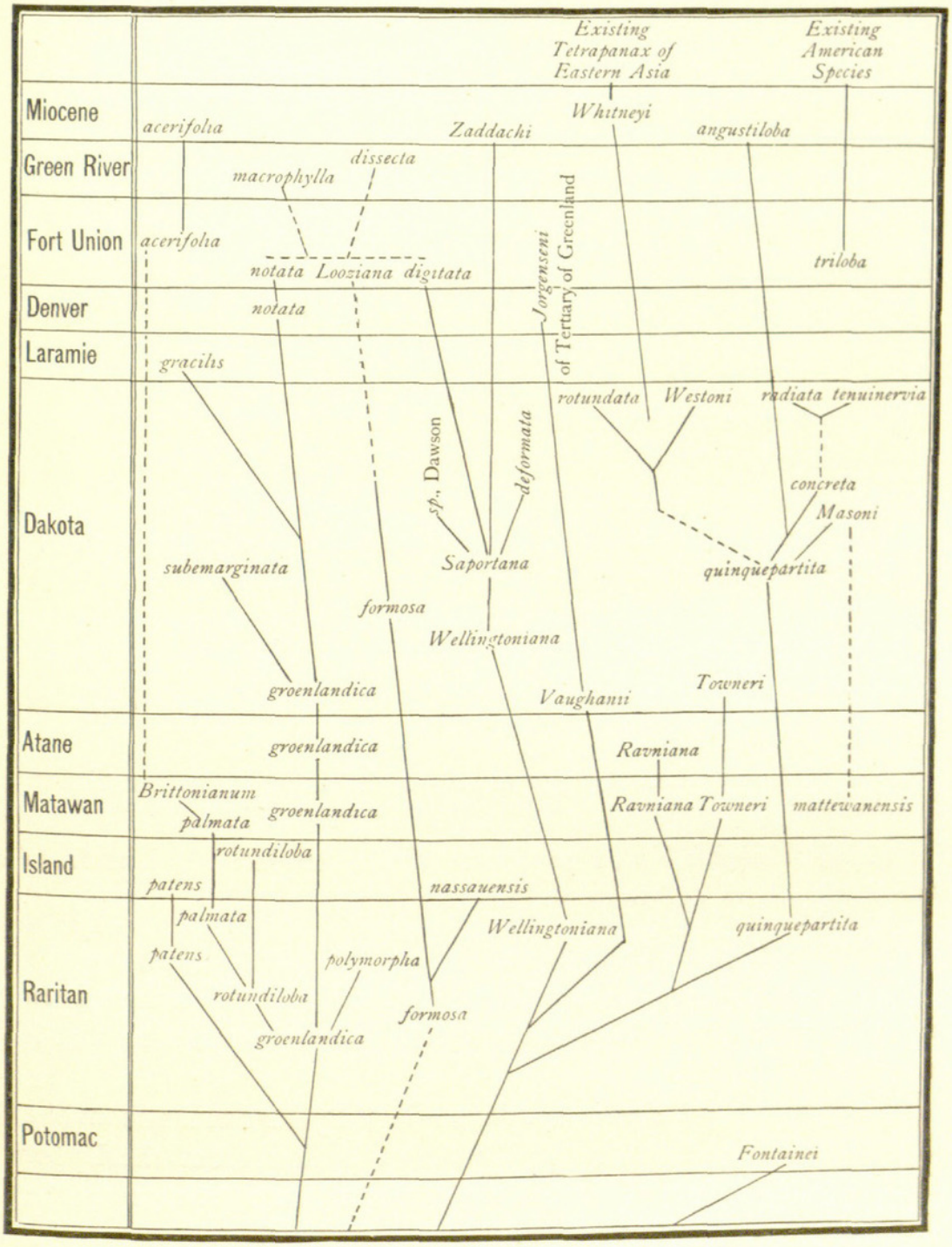
SECTION 5.

Rather small trilobate leaves with undulate or dentate margins; decurrent base; primaries three, stout, unbranched, sub-basal or supra-basilar; secondaries camptodrome and craspedodrome; lobes full, pointed. Includes leaves derived from the *Vaughanii-groenlandica* type and approaching the *notata-digitata* type of leaf very closely.

The species included are: Aralia formosa Heer, Dakota and Raritan (Europe); A. nassauensis Hollick, Island; A. Looziana Sap. & Marion, Fort Union (Europe); A. serrulata Kn., Fort Union.

SIMPLE LEAVES OR LEAFLETS.

The simple leaves referred to Aralia, following the precedent set by European paleobotanists, are four in number:


Existing Tetrapanax of Eastern Asia
Existing American Species
Miocene
Green River
Fort Union
Denver
Laramie
Dakota
Atane
Matawan
Island
Raritan
Potomac
acerifolia
Zaddachi
Whitneyi
angustiloba
macrophylla
dissecta
acerifolia
notata
Looziana
digitata
triloba
notata
Jorgensenii
of Tertiary of Greenland
gracilis
rotundata
Westoni
radiata
tenuinervia
sp. Dawson
deformata
concreta
Masoni
subemarginata
Saportana
quinquepartita
formosa
Wellingtoniana
groenlandica
Vaughanii
Towneri
groenlandica
Ravniana
Brittonianum
palmata
groenlandica
Ravniana
Towneri
mattewanensis
rotundiloba
patens
nassauensis
palmata
Wellingtoniana
quinquepartita
patens
polymorpha
rotundiloba
formosa
groenlandica
Fontainei

Aralia Browniana Heer from the Tertiary of Greenland, which may be compared with European leaves from the Oligocene of St. Zacharie and the Miocene of Armissan.

Aralia transversinervia Sap. & Marion, described by Hollick (who notes its resemblance to Ficus) from Long Island as identical with Saporta and Marion's Gelinden leaf.

Aralia lasseniana Lx., from the Eocene (?) and Miocene (?) of California, which may be compared with leaves from the Sezanne flora.

Aralia coriacea Velen., identified by Hollick from Marthas Vineyard, the type from the Cenomanian of Bohemia.

SPECIES NOT INCLUDED in the foregoing sections are:

Aralia Fontainei Kn., from the Potomac, the remains of which are too poor for accurate diagnosis.

Aralia triloba Newb., which represents a ternately or pinnately parted leaf from the Fort Union group, which is evidently ancestral to the modern North American Aralias.

Aralia ? Waigattensis Heer, which represents a probably pinnate leaf of uncertain affinities from the Patoot beds of Greenland.

Aralia dissecta Lx., a large much lobed leaf from the Green River group.

Aralia Wrightii Kn., represented by incomplete remains from the Miocene of Yellowstone Park.

DOUBTFUL REMAINS include:

Aralia sp. Dawson, from the Mill Creek, which has been included with *Aralia Saportana* because Dawson thought that it might be that leaf.

Two forms of *Aralia* sp. determined by Knowlton from the Laramie of Wyoming; two by the same author from the Upper Eocene of the John Day Basin, Oregon; and one from the Miocene of Yellowstone Park.

The foregoing table shows the relationship of these leaves as I conceive them.

PASSAIC, N. J.