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REPORT

ON THE

F O S S I L P L A N T S

OF THE AURIFEROUS GRAVEL DEPOSITS OF  
THE SIERRA NEVADA.

BY LEO LESQUEREUX.

WITH TEN PLATES.

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CAMBRIDGE:  
JOHN WILSON AND SON.

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## INTRODUCTORY NOTE.

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DURING the first three years of the existence of the Geological Survey of California, large collections of specimens were made in various parts of the State, and especially in the mining districts of the Sierra Nevada. Unfortunately these were in part destroyed by fire, and among the material thus lost was a fine suite of fossil leaves from the beds underlying the volcanic deposits of the west slope of the Sierra, and associated with the auriferous gravels so extensively worked by the hydraulic process. The loss thus incurred was in part made good by a collection of fossil plants placed at my disposal by Mr. C. D. Voy of Oakland, the specimens thus furnished forming a portion of the large collection purchased afterwards from Mr. Voy, and presented to the State University of California by the liberality of Mr. D. O. Mills of San Francisco. The specimens in question were subsequently placed in the hands of Mr. Lesquereux for description, and to these were added some other materials of value, chiefly obtained by Mr. Gorham Blake and myself, at the prolific locality of Chalk Bluffs.

A full account of the formation in which these fossil plants occur will be found in the writer's "Memoir on the Auriferous Gravel Deposits of the Sierra Nevada," which will shortly be published as Part I. of the volume to which the paper herewith presented belongs. It has been thought best, however, not to delay the issue of the paper of Mr. Lesquereux, as it forms a nearly independent contribution to the geological history of the Sierra Nevada, and marks an important addition to our knowledge of the epoch immediately preceding the present one, giving as it does a clew to the vegetation, in later Tertiary times, of an exten-

sive region of the western edge of our continent. This paper also offers a worthy and most desirable supplement to the "Botany of California," of which one volume has been already published, while the other and concluding one is now in the press. All the volumes and memoirs above mentioned are to be received as a continuation, in part, of the work of the Geological Survey, stopped by the Legislature in 1874. Permission has been given to the late State Geologist by the Board of Regents of the University of California, in whose hands the matter was left, to continue the publication of the Survey so far as it was in his power to do so; and in this somewhat arduous undertaking he has received valuable assistance from some of the liberal-minded citizens of San Francisco, to whom he takes this opportunity of tendering his best thanks.

J. D. WHITNEY.

DEAR SIR:—

You will please find herewith the report on the specimens of fossil plants which you have intrusted to me for examination.

These vegetable remains represent merely leaves which, embedded in a fine-grained whitish clay or soapstone, are generally, for their outlines at least, in a very good state of preservation. The areolation of those from the Chalk Bluffs of Nevada County is, however, generally rendered obsolete by a coat of varnish, which also gives to them an apparent thickness which may not represent their natural character. The words "coriaceous" and "subcoriaceous," used in the description of these leaves, might therefore be taken with some degree of uncertainty. However, in comparing the leaves of Mr. Voy's collection which have been varnished with those of the same locality belonging to yourself, and those also of Tuolumne County which have been left in their original state of preservation, the texture of all appears of the same consistence.

Except the specimens which are your own property, all the others, under the name of the Voy Collection, belong to the University of California, and have been returned to that institution.

Very respectfully yours,

L. LESQUEREUX.

To PROF. J. D. WHITNEY,  
Cambridge, Mass.





# DESCRIPTION OF SPECIES.

## MONOCOTYLEDONES.

### PALMÆ.

#### SABALITES, STERNB.

#### **Sabalites Californicus**, sp. nov.

*Pl. I. Fig. 1.*

*Fragment of a frond with rays of large size, carinate in the lower part, flattened upwards; primary nerves broad and obtuse, secondary veins four to five, nearly at equal distance, with three or four obsolete intermediate veinlets.*

The fragment represents the middle part of a large palmate leaf, whose rachis is unknown. Its relation, therefore, to *Sabal* or to *Flabellaria* is uncertain. The rays, distinctly carinate in the lower part of the specimen, where they measure twelve to fourteen millimeters, both sides taken altogether, gradually widen upwards and become flattened, measuring twenty-two millimeters at the top of the specimen, which is about twelve centimeters both ways. The lower part, therefore, has the appearance of a fragment of *Sabal*, while the rays flattened upward resemble those of *Flabellaria*. The rays are in their whole length distinctly separated into equal parts by the primary nerves, somewhat thicker than the secondary ones, convex at the top of the ridges and concave at the bottom of the carinae. The secondary veins, a little more than one millimeter distant, are also somewhat broad when seen through the thin, smooth epidermis, and separated by three or four indistinct veinlets. The absence of the rachis with this specimen prevents any comparison with fossil species of Palms.

*Habitat.* — Chalk Bluffs, Nevada County. Professor J. D. Whitney.

## DICOTYLEDONES.

## AMENTACEÆ.

## BETULA, L.

**Betula æqualis**, sp. nov.*Pl. I. Figs. 2-4.*

*Leaves elliptical-ovate, equally narrowed up to a sharp point and downward to a short petiole; borders equally dentate; secondary veins mostly simple, craspedodrome.*

The form of the leaves is the same in all the specimens, differing only by their size, from five to eight centimeters long, and from two to three and a half centimeters broad. The secondary veins are mostly simple, either slightly curving in passing up to the borders in an acute angle of divergence of  $30^\circ$  or straight, entering the alternate teeth and sometimes the intermediate ones by short branches, as in Fig. 2. The lower pair of lateral veins join the middle nerve a little above the base of the leaves, which is generally bordered, at least on one side, by a thin marginal veinlet; they are parallel, equidistant, opposite in the lower part of the leaves, alternate in the upper part, generally separated by a thin tertiary vein dissolved below the middle of the areas; the teeth, nearly equal, are sharp, and slightly turned upwards.

The relation of this species to the present *Betula occidentalis*, Hook., commonly found along the streams of the Rocky Mountains, is very close indeed. The nervation is the same; the nearly equal teeth are, in some leaves at least, of the same form and size; the difference is only in the shape of the leaves, which in the fossil species are longer, wedge-form to the base, and also proportionally narrow. A fine representation of this *Betula* is given in Watson's "Botany of the Fortieth Parallel," Pl. XXXV. Among the fossil species, ours is comparable to *B. Brongniarti*, Ett. Fos. Fl. v. Bilin. I., p. 46. Pl. XIV. Figs. 9-13, which is common in the Miocene of Europe, and has been described also by Heer, Gaudin, Saporta, and other palæontologists. The affinity, however, is more marked with the living American *B. occidentalis* than with any fossil forms known as yet of this genus.

*Habitat.* — Chalk Bluffs, Nevada County, California. Voy's Collection.

## FAGUS. TOURNEF.

**Fagus Antipofi**, HEER.*Pl. II. Fig. 13.*

*Leaves somewhat thick, coarsely nerved, oblong-lanceolate, gradually narrowed to the short petiole; borders distantly dentate; secondary veins close, parallel, straight to the teeth; nervilles distinct, in right angle to the veins.*

*Fagus Antipofi*, HEER, Flor. Foss. Alask., p. 39, Pl. V. Fig. 4 a; Pl. VII. Figs. 4-8; Pl. VIII. Fig. 1. Abich., Mem. Acad. d. sc. de St. Pétersb., Tom. VII. Vth ser., p. 572, Pl. VIII. Fig. 2.

*Fagus lanceifolia*, HEER, Overs. K. Vetensk.-Acad. Verhandl. Kjobenh., 1868, I. p. 64.

We have of this species only the fragmentary specimen figured. The leaf is slightly coriaceous, deeply marked by the secondary nerves and their nervilles, and has the borders either regularly undulate or cut by short teeth entered by the secondary veins, which pass nearly straight from the middle nerve at an angle of divergence of 40°. The nervilles divided in the middle of the areas by cross veinlets are close, and in right angles to the veins. The leaf is, in all its characters, similar to Fig. 4 of Pl. VII., of the Fossil Flora of Alaska, where all the forms described by Professor Heer have been found. In his description the author recognizes five different varieties of his species, (*b*) being the one to which this leaf is referable.

*Habitat.*—Table Mountain, Tuolumne County, California. Voy's Collection, Museum of the University of California.

**Fagus pseudo-ferruginea**, sp. nov.*Pl. II. Fig. 14.*

*Leaf obovate, lanceolate-pointed, narrowed to the short petiole; borders undulate; middle nerve thin; secondary veins craspedodromic, nearly straight in passing obliquely to the borders.*

At first I considered this leaf as referable to *Fagus Antipofi*, var. *a*, as described by Abich; but it presents some marked differences. The middle nerve is much narrower; the secondary veins more distant, less distinct, dissolved quite near the borders, slightly curved, and also more open. The substance of the leaf is not as coarse, rather thin, and the base is more acutely embeate. But for the entire merely undulate borders, this leaf should be identified with the living *Fagus ferruginea*, Ait., of the present North American flora. By this character it resembles the Euro-

pean *F. sylvatica*, Linn., to which it is related in an equal degree, differing by its more acute base, and by more numerous less straight secondary veins.

*Habitat*.—Chalk Bluffs, California. Voy's Collection.

## QUERCUS, LINN.

### § I.—LEAVES ENTIRE.

#### **Quercus elænoides**, sp. nov.

*Pl. I. Figs. 9–12.*

*Leaves coriaceous, oval or oblong, lanceolate, nearly equally narrowed upward to a point, or a short obtuse acumens, and downward to a short petiole; lateral veins at an open angle of divergence; parallel camptodrome.*

These leaves vary in size from five to ten centimeters long, and from two to three centimeters broad; either oval-pointed or oblong, lanceolate acuminate, gradually narrowed to the petiole. The midrib is narrow; the lateral veins open, diverging about 50°, curving, camptodrome, and generally branching near the borders. The areas are more generally simple, as in Fig. 11, but sometimes divided in the middle by tertiary veins, anastomosing with nervilles at a distance from the middle nerve, and passing by divisions into the areolation; nervilles distinct in right angle to the secondary veins, forming, by multiplied branches in opposite directions, small quadrate meshes, as seen in Figs. 11 and 12. The species is closely related to *Quercus chrysa*, Ung., especially to the figures in Heer (Flor. Tert. Helv., III., Pl. CLI. Fig. 3.) and in Saporta (Étud., III., Pl. V. Fig. 2). Like the following species, it is of the type of *Quercus virens*, Ait., and *Q. cinerea*, Muhx., of the Southern United States flora.

*Habitat*.—Table Mountain. Voy's Collection.

#### **Quercus convexa**, sp. nov.

*Pl. I. Figs. 13–17.*

*Leaves of a thick coriaceous consistence, small, oblong, obtuse, rounded, and narrowed to a short petiole; borders reflexed, very entire; surface convex; nervation camptodrome.*

The collection has a large number of finely preserved specimens of this species, easily identified by their small oblong, obtuse, always convex leaves.

They vary in size from two and one half to five centimeters long, and from one to two centimeters broad. The secondary veins are in a very open angle of divergence from the narrow midrib, often, especially in the small leaves, in right angle to it, curved toward the borders, camptodrome, with primary areas generally divided to the middle by thin tertiary veins. As in the former species, to which it is related by its areolation, the nervilles in right angle to the secondary veins are divided by cross branches, generally oblique, passing by multiple ramifications into very small areolæ, not as distinctly quadrangular as in the former species, but rather irregularly polygonal.

This species is also related to *Quercus elæna*, Ung., but essentially differs by the form of its shorter leaves. It is more closely allied to the Live Oak, *Q. virens*; to the var. *nana* by its nervation, and to the var. *maritima* by the form and size of the coriaceous leaves. I have mentioned as *Quercus virens*, from the Pliocene chalk bluffs of the Mississippi, Amer. Journ. of Sci. and Arts, 1859, Vol. XXVII. p. 364, leaves which appear identical with those described here.

*Habitat.*—Same locality as the former. Voy's Collection.

#### § II.—LEAVES SERRATE OR DENTATE.

##### **Quercus Nevadensis**, sp. nov.

*Pl. II. Figs. 3, 4.*

*Leaves obovate, rounded to an obtuse point, gradually narrowed from the middle to the base; borders distantly dentate; nervation subcamptodrome.*

We have of this species only the two specimens figured. The length of the leaves is nine to eleven centimeters, and their width from three to five; their shape is obovate or oblanceolate, as they gradually enlarge upwards from a narrowed base, and are rounded to an obtuse point. The teeth of the borders are distant and short, generally turned outside, separated by shallow sinuses, and descend to below the middle of the leaves, even, in the small specimen, to near the base. The secondary veins are close, sixteen pairs in each leaf, parallel, mostly simple, passing from the middle nerve, at an angle of divergence of 50°, nearly straight to the borders, where they abruptly curve, entering the teeth by a short branch, a nervation of the same type as that of the dentate leaves of *Dryophyllum*. The nervilles are very distinct, somewhat distant, mostly simple and de-

current; the areolation obsolete, the surface coarse, the substance not thick, rather membranaceous.

This species has not any marked relation with any fossil one. By the nervation, and somewhat also by the form of the leaves, it is allied to *Q. castanea*, Willd., of the present flora of North America, but still more to a section of Mexican Oaks, whose coriaceous leaves are bordered with short distant teeth: *Q. Humboldli*, *Q. glaucescens*, Humb. and Bonpl., *Q. spicata*, Kunth., etc.

*Habitat.* — Chalk Bluffs. Voy's Collection.

**Quercus Boweniana**, sp. nov.

*Pl. II. Figs. 5, 6.*

*Leaves coriaceous, rather small, oblong, lanceolate, pointed or acuminate, gradually curving to a short petiole; borders obscurely and distantly dentate; secondary veins parallel, simple, craspedodrome.*

The smallest of the two leaves which represent this species is five centimeters long, comprising the short petiole, and one and a half centimeters broad; the other is about twice as large; their form is elliptical oblong, narrowed in the same degree toward the point or short acumen (broken), and to the petiole, which is scarcely two millimeters long, and slightly inflated. The borders, distantly and obscurely dentate, are entered by the points of the secondary veins, which are simple, equidistant, parallel, more or less open, according to the size of the leaves, straight or curving very little in passing to the borders. The areolation, observable only upon the fragment of the larger leaf, is formed by subdivisions, generally in right angle of the fibrille, and composed of very small quadrangular meshes.

These leaves have a distant relation to those of the following species, but none known as yet to any from the European Tertiary.

*Habitat.* — Bowen's Claim. Voy's Collection.

**Quercus distincta**, sp. nov.

*Pl. II. Figs. 7-9.*

*Leaves somewhat thick, or subcoriaceous, of larger size than those of the former species, long petioled, ovate, rounded to the petiole and entire toward the base, distantly obscurely dentate above, gradually narrowed to an obtuse point; secondary veins distant, subcamptodrome.*

These leaves are of the same section as those of the two former species. Their form is ovate, rounded at the base to a comparatively long petiole, obtusely pointed, the borders marked by short distant teeth, scarcely discernible in some of the specimens, like that of Fig. 7 for example. The nervation is subcamptodrome, the lower secondary nerves curving to the borders and following them in festoons, the upper ones entering the teeth while their upper branches follow the borders, and pass to the intermediate teeth by veinlets. The secondary veins are distant, the lower ones at a more open angle of divergence, and curved, the upper ones nearly straight, generally forking once, or simple, or sparingly branching in the middle of the areas.

To this species, also, the fossil leaves published by European authors offer scarcely any analogy. The peculiar nervation is comparable to that of the leaves of *Quercus attenuata*, Goep. Tert. fl. v. Schossnitz, p. 17, Pl. VIII. Figs. 4, 5, which have a different type of denticulation of the borders, and their base narrowed to the petiole. A more marked relation is found with the living species *Q. crassifolia*, Humb. and Bonpl., of Mexico, and *Q. agrifolia*, Nee, of California.

*Habitat.* — Chalk Bluffs, Nevada County, California. Voy's Collection.

**Quercus Goepperti**, sp. nov.

*Pl. II. Fig. 11.*

*Leaf small, oblong, narrowed in equal degree upward to an obtuse point, and downward to a short petiole; borders doubly serrate or denticulate; secondary veins parallel, subcamptodrome.*

The species is known by a single oblong, lanceolate obtusely pointed leaf, four centimeters long, a little more than one centimeter broad, narrowed in curving to a short slender petiole; borders denticulate, the teeth entered by the points of the secondary veins, being a little larger or more prominent; secondary veins parallel, either entering the teeth by the points, or curving quite near the borders, and passing to them by branchlets, a nervation of the same type as that of *Quercus Nevadaensis*. By the border divisions only, this leaf is related to *Q. attenuata*, Goep. loc. cit., Fig. 5; but it greatly differs from it by its more numerous secondary veins, its oblong linear shape, etc.

*Habitat.* — Same as the former. Voy's Collection.

**Quercus Voyana**, sp. nov.*Pl. II. Fig. 12.*

*Leaf small, subcoriaceous, nearly round in outline, crenulate from the middle to the base, undulate and truncate at the top; midrib thick; secondary nerves curved, subcamptodrome, deeply marked, as also the precurrent nerves in right angle to the veins.*

This small leaf, nearly round or enlarged truncate at the top, and rounded to the petiole, has the same character of nervation as the former species; the lower veins distinctly camptodrome, the upper ones entering the borders, either directly or by branching veinlets. The lower part is by its form similar to the leaves described above as *Quercus distincta*, and indeed, but for its truncate top, it would be considered as a variety of the same species. Its size is only about three centimeters across, and both ways. Its relation is to *Q. agrifolia*, Nec.

*Habitat.*—Chalk Bluffs, Nevada County, California. Voy's Collection.

## § III.—LEAVES DEEPLY LOBATE.

**Quercus pseudo-lyrata**, sp. nov.*Pl. II. Figs. 1, 2.*

*Leaves of large size, oblong obovate in outline, cuneate to the petiole, divided into deep linear obtusely pointed or acuminate lobes, either simple or marked toward the point by one or two large teeth; secondary veins few and distant, passing up in an acute angle of divergence to the points of the lobes.*

The consistence of these two fine leaves is not very thick, only subcoriaceous; they are narrowed at the base, and wedge-form to the petiole, four lobate on each side, the two lower pairs of lobes short, entire, obtuse, the third longer, with the lobes either entire obtusely pointed, or cut near the point in two or three acute or acuminate teeth; the lobes have the same declination as the secondary veins, which diverge from the midrib on an angle of 40–50°. The secondary veins pass up to the point of the lobes, and are more generally simple, sometimes branching, the divisions either curving along the borders, or the upper ones entering the teeth of the lobes. The intermediate tertiary veins are short, and generally on a more open angle of divergence.

These fine leaves represent the section of our American lyrate Oaks in



a remarkably distinct likeness. Indeed, they are so similar to those of *Quercus lyrata*, Valt., a common species of the flora of the Southern States, that it is scarcely possible to doubt their identity. The fossil leaves are merely slightly smaller, their lobes less inclined backwards, and the tertiary veins less deeply marked. As the leaves of Oaks are so variable that the identification of species is rarely ascertainable from their characters only, I did not think advisable to apply to the fossil ones the name of the living species, notwithstanding the impossibility of remarking any difference between them.

*Habitat?* — The locality is unknown, or at least not marked in the catalogue of the labels. The matrix of the specimens is a white soft clay, like that of the Chalk Bluffs of Nevada County, California, and no other species is preserved upon them, except a fragment of a leaf apparently referable to *Castanea intermedia*, Lesq. These specimens are evidently from the same formation and age as those of the Chalk Bluffs.

#### CASTANEOPSIS, SPACH.

##### **Castaneopsis chrysophylloides**, sp. nov.

*Pl. II. Fig. 10.*

*Leaves coriaceous, entire, with undulate apparently recurved borders, oblong-lanceolate, narrowed upwards to a slightly obtuse acumen, and more gradually from the middle downward to a short petiole; nervation camptolome.*

By the form of the leaf, narrowed into a short acumen, by their size, by the glabrous surface, and by the characters of nervation as far as they can be recognized, this leaf has a remarkable likeness to those of *C. chrysophylla*, Hook., of the present flora of California. The lateral veins are slightly more curved, and also in a somewhat more acute angle of divergence from the midrib, at least in a general point of comparison. Many leaves, however, of the living species, of which I have numerous finely preserved specimens, do not show any difference whatever, either in the directions or in the curve of the secondary veins. So great is the affinity that if a fruit like that of the chestnut had been found in connection with this leaf, I should have admitted it as positively identified to *C. chrysophylla*. Its type is also that of some species of Oaks, either fossil, like *Quercus Lyellii*, Heer., *Q. alana*, Ung., or living, like *Q. virans*, var. *naviliana*, all species from

which it differs by the acuminate point. Nothing more of the nervation can be observed upon the specimen than what is seen on the figure.

*Habitat.*—Chalk Bluffs, Nevada County, California. Voy's Collection.

### SALIX. L.

**Salix Californica**, sp. nov.

*Pl. I. Figs. 18–21.*

*Leaves subcoriaceous, entire, oval-obtuse, or oblong, obtusely pointed, or lanceolate, tapering to a long acumens, rounded in narrowing to the base, short petioled; secondary nerves in an acute angle of divergence; venation obsolete.*

The four leaves figured of this species show a great diversity of shape. They vary in size from four to six centimeters long, and from one and a half to two centimeters broad, the broadest part being generally a little below the middle, and hence, either gradually decreasing into a long acumens, as in Fig. 19, or to a short slightly obtuse point, as in Fig. 21, or rounded and more obtuse at the top; the consistence is subcoriaceous, and the surface smooth; the midrib is narrow, and the secondary veins are only discernible, with some parallel nervilles in right angle, as in Fig. 18. They have generally one pair of basilar veinlets, derived from the midrib near the base of the lamina, and following the borders to their connection with an upper vein by nervilles.

This species is intimately related to *S. integra*, Goeppl., Schoss. Fl., p. 25. Pl. IX. Figs. 1–16, differing by more distant lateral veins, more obtuse or obtusely pointed leaves, generally broader, and of larger size. Goepplert compares his species to *Salix repens*, L., which has in the shape of some of its leaves some relation to this species also, but is very distinct by the salient nervation. Ours is rather comparable to the leaves of *S. Coulteri*, Anders., or to *S. sessilifolia*, Nutt., both species of the Western slope of North America.

*Habitat.*—Table Mountain, Tuolumne County, California. Voy's Collection.

**Salix elliptica**, sp. nov.

*Pl. I. Fig. 22.*

*Leaves elliptical, equally narrowed, and rounded to an obtuse point and to the petiole, borders minutely unequally serrate; lateral veins curving to and along the borders; tertiary veins short and thin, nervilles numerous and distinct.*

The only leaf seen of this species is four and a half centimeters long, two and a half centimeters broad in the middle, exactly elliptical-oval, with borders minutely but distinctly crenato-serrulate. The divergence of the lateral veins is about  $60^\circ$  in joining the deep narrow midrib; but they soon curve toward the borders in simple festoons, narrowing the angle of divergence from the middle upwards. These lateral veins are close, twelve pairs, parallel, thin, but deeply and distinctly marked like the nervilles which unite them in right angle, and also the short intermediate tertiary veins. This leaf has distinctly the characters of the section *Cinerascentes* or *Caprea*, of the living Willows, and is closely related to *S. capreoides*, Anders., of the California flora

*Habitat.* — Chalk Bluffs, California. Voy's Collection.

## POPULUS, LINN.

### **Populus Zaddachi**, HEER.

#### *Pl. VIII. Figs. 1–8.*

*Leaves very variable in size, ovate, more or less acutely and gradually pointed, round or cordate at the base; borders crenate; venation five to seven palmate, generally from the top of a long slender petiole; lower lateral nerves at an open angle of divergence; the inner ones more acutely oblique, and ascending to near the upper part of the leaves, sometimes to near the point.*

*Populus Zaddachi*, HEER, *Floe. Foss. Arct.*, I, p. 98, Pl. VI. Figs. 1–4; XV. Fig. 1*b*; II, p. 468, Pl. XLIII. Fig. 15*a*; XLIV. Fig. 6. *Fl. Foss. Alask.*, p. 26, Pl. II. Fig. 5*a*. *Mioc. Fl. Spitz.*, p. 55, Pl. II. Fig. 13*c*; X. Fig. 1; XI. Fig. 8*d*. *Mioc. Balt. Fl.*, p. 30, Pls. V., VI., XII. Fig. 1*c*.

This species is very distinct, though variable in the form and size of its leaves. Our specimens represent these leaves from four to fifteen centimeters long, and from two to nine and a half centimeters broad. They are generally gradually enlarged from the point to near the base, where they become rounded or cordate to the petiole; but sometimes in narrower leaves, as in Fig. 6, they are attenuated to the base. The borders are more or less deeply serrato-crenate, the teeth being either acute, as in Figs. 2 and 8, or very obtuse, as in Figs. 1 and 5. The petiole is slender, and of medium length. In Fig. 8 it seems very long; if, however, the plicature at the base of the specimen is really from a part of the petiole of the same leaf, this would indicate a length of fourteen to fifteen centimeters, equal to that of the leaf itself. The petiole of

the lower part of Fig. 5 is only half the length of that of the leaf, as it is also in the specimens figured by Heer. The larger leaves are seven, palmately nerved, the lowest veins open and thin, mere marginal veinlets; the middle ones of an intermediate size and divergence, the upper ones ascending in an acute angle of divergence to at least the three fourths of the laminae, either inclining toward the borders, or toward the midrib, which they nearly equal in size, and always branching outside; the secondary veins are few, and at a distance from the primary ones. As marked in Fig. 2, the areolation is formed by division of the nervilles in right angle, forming large subquadrate meshes, which, subdivided in the same direction by thinner veinlets, result in a very small ultimate irregularly quadrate reticulation. The various forms represented upon our plate are identical with those of the Baltic Mioc. Fl., Pls. V. and VI., agreeing equally well with those of the specimens from Greenland, Spitzbergen, and Alaska.

This species seems especially a representative of the Upper Miocene. We have it from the Green River group of the Rocky Mountains, but it has not been seen at Carbon, or in any other station of the American Lignitic.

*Habitat.* — Chalk Bluffs, California. Professor J. D. Whitney's, and Voy's Collections. Fig. 6 is marked Roach Hill, Oregon.

## PLATANUS, LINN.

### **Platanus appendiculata**, sp. nov.

*Pl. III. Figs. 1-6. Pl. VI. Fig. 7 b.*

*Leaves membranaceous or subcoriaceous, variable in size, either very large, widening upwards, fan-like, abruptly curving and decurrent to the petiole; or smaller, broadly obovate, rounded or subtruncate to a short point, wedge-form to the base, distantly dentate by short flat teeth; stipules double, leaf-like at the base of the short petiole.*

These remarkably fine leaves seem at first to represent two species, the one, Fig. 1, with very large, fan-like leaves, rapidly narrowed downward, and decurrent to the petiole, truncate or rounded at the top, with the borders marked by distant short teeth, separated by nearly flat or concave sinuses. This leaf, the only one seen of this size, is at least twenty-three centimeters long, twenty-four centimeters broad in its upper part, with a very long thick midrib, four millimeters broad at the base,

All the other specimens, and they are numerous, represent comparatively small leaves, seven to twelve centimeters long, six to eleven centimeters broad, all broadly obovate, either gradually or abruptly narrowed to the petiole, with the same character of nervation and of border divisions as the large one. The nervation is more or less regularly tripalmate, the primary lateral veins at an open angle of divergence from a distance above the borders, branching outside, and joined to the secondary nerves by thick veinlets, mostly simple or crossed at right angles in the middle of the areas. By a slight prolongation of the primary lateral nerves the leaves are obscurely trilobate. The petiole, as seen from Fig. 3, the only specimen upon which it is preserved, is short, bearing at its inflated base two leaf-like obovate, obtusely pointed stipules, having in a reduced degree the same characters as the leaves. As there is no other reason for considering these leaves as referable to two species than the great difference in size, and as the same diversity is observable in the leaves of the living *Platanus occidentalis*, Linn., to which this fossil one is closely related, a separation seems unjustifiable. By the form of its bifid and deciduous stipules, the species is related to *P. Lindeniana*, Mart., of Mexico.

*Habitat.* — Chalk Bluffs, California. Voy's Collection. All the specimens are from the same locality, and upon the same kind of whitish soft clay.

**Platanus dissecta**, sp. nov.

*Pl. VII. Fig. 12. Pl. X. Figs. 4, 5.*

*Leaves large, subcoriaceous, truncate or subcordate at the base, deeply three or five lobed; lobes narrow, lanceolate-acuminate, sharply toothed.*

This species is, like the former, closely allied by some of its characters to *P. occidentalis*, Linn., being, however, evidently distinct by its narrower, more acutely pointed lobes, in an acute angle of divergence to the middle, and by its sharply pointed teeth all turned upwards. As far as can be seen by the branching of the lateral primary nerves in two nearly equal divisions and the acute teeth, Fig. 12 of Pl. VII. is referable to the same species as Figs. 4 and 5 of Pl. X., though the direction of the lateral lobes differs. Among the specimens from Table Mountain are many fragments, showing the lobes still more inclined toward the middle one, and more acutely dentate. Fig. 5 of Pl. X. seems to represent an

undeveloped leaf with reflexed borders, scarcely dentate, a mere variety of the normal form. The essential difference of this species from *P. occidentalis* is in the narrower shape of the leaves, longer than broad, and in the deeper, acute divisions. As is generally the case in leaves of *Platanus*, some are five palmately nerved, and accordingly five-lobed, while others have the nerves and divisions only in three. The leaves are not as large as in the former species; the largest one figured here being only fifteen centimeters long, and about twelve centimeters broad between the points of the lobes.

*Habitat.*—Chalk Bluffs, California. Professor J. D. Whitney. More common in the same formation at Table Mountain, Tuolumne County. Voy's Collection.

### LIQUIDAMBAR, LINN.

**Liquidambar Californicum**, sp. nov.

*Pl. VI. Fig. 7 c. Pl. VII. Figs. 3, 6.*

*Leaves coriaceous or subcoriaceous, comparatively small, three, rarely five lobed, denticulate, lobes short, ovate, pointed, or acuminate.*

*Acer denticulatum*, LESQX., Mss.

The species is represented by many more or less fragmentary leaves, the more complete of which have been figured. The largest of all (Fig. 3) is the only one divided in five lobes. It is about twelve centimeters long, and fourteen centimeters broad between the points of the upper lateral lobes, deeply cordate at the base, with the borders minutely and equally denticulate all around. The size of the other leaves varies from five to eight centimeters, both ways; they are all trilobate, generally truncate or rounded to the petiole; minutely denticulate. The long slender petiole of some of the leaves induced me to refer them to *Acer*, in my first note on these fossil plants. Count Saporta, to whom I owe valuable information on the relation of some of the species described here, is, however, of the opinion that they represent a new *Liquidambar*, closely allied to *L. Europæum* Al. Br. of the Miocene, and still more to two living species recently discovered; *L. acerifolium*, Maxim., of Japan, and *L. jauranensis*, OL. of China, both with coriaceous, minutely denticulate, three or five lobed leaves. We might also consider the Californian fossil species as a mere variety of *L. Europæum*, which, though generally

represented by larger, five-lobed, minutely denticulate leaves, is described by Unger, Iconog., p. 44, Pl. XX. Fig. 28, under the name of *L. acerifolium*, as a small trilobate, more deeply lobate, and long petioled leaf. In any case the presence of a *Liquidambar* in the upper tertiary of California is explainable either by the present geographical distribution of the genus, which has representatives in Japan and China, or by geological relation or derivation, as *L. Europeanum*. One of the most widely distributed species of the Miocene of Europe, especially abundant at Eningen, even recognized in the Miocene of Italy, has been described by Heer from specimens from Alaska.

*Habitat.* — Chalk Bluffs, Nevada County, California. Vey's Collection.

## URTICINEÆ.

### ULMUS.

#### *Ulmus Californica*, sp. nov.

*Pl. IV. Figs. 1, 2. Pl. VI. Fig. 7 a.*

*Leaves small, subcoriaceous, narrowly ovate-lanceolate, acuminate, rounded to the slightly unequal base; borders irregularly denticulate; secondary nerves parallel, numerous, more open towards the base, crasp. dodrome.*

The collection has numerous leaves of the same species from two localities, those from Table Mountain representing leaves generally smaller than those of the Chalk Bluffs. Fig. 2 is one of them, varying in size from three and a half to seven centimeters long, and proportionally broad. The essential characters are, however, identical. The border teeth are smaller, but irregular, those entered by the secondary nerves being a little stronger, all, however, generally turned outside. The secondary veins, thin at their points, are at a more or less open angle of divergence, according to the width of the leaves, and these, slightly unequal at the base and rounded to the petiole, are gradually narrowed from the middle upward into a long acumen. The characters of the leaves of *Ulmus* are easily recognized in their generic relation; but the species are less satisfactorily separated. In this form, however, they seem distinct from those of all the fossil species described, especially by the constantly narrow shape, the somewhat thick consistence of the laminae, and the small teeth turned outside. Except for this peculiar denticula-

tion, and for the longer acumens of the leaves, they are similar to those of the living *Ulmus alata*, Michx., a species frequently found along the streams, especially in the South, its range being from Middle Ohio to Florida.

*Habitat*. — Chalk Bluffs and Table Mountain, California. Voy's Collection.

***Ulmus pseudo-fulva*, sp. nov.**

*Pl. IV. Fig. 3.*

*Leaves large, ovate-lanceolate, taper-pointed, doubly dentate on the borders, cordate and equilateral at the base; lateral nerves open, especially near the base, distant, comparatively thin, like the nervilles, but distinct.*

Comparing this leaf to those of the former species, the essential differences remarked are, the larger size, the larger teeth of the borders, dentate on the back, and the thinner nervation. The leaves are also merely pointed, even obtusely so, and cordate at the base. The likeness of this leaf to those of the present *U. fulva*, Michx., the slippery elm, is so great, that but for the less acuminate point, the cordate base, and an apparently less coarse texture, identity of species should be acknowledged. If there were many specimens for comparison, these differences might be recognized as merely individual. As it is, I consider this species as the original slightly deviating form of *U. fulva*.

*Habitat*. — Chalk Bluffs, California. Professor J. D. Whitney's Collection.

***Ulmus affinis*, sp. nov.**

*Pl. IV. Figs. 4, 5.*

*Leaves of medium size, long-petioled, cuneate or rounded to the base, ovate, lanceolate-acuminate; borders doubly serrate; lateral nerves very close.*

The long petiole, the sharp serrature of the borders, with primary teeth turned upwards, and only a short intermediate one, especially the close, numerous secondary nerves, scarcely curving in passing up to the teeth, separate the leaf (Fig. 4) as a distinct species. Though the fragment (Fig. 5) is from the same locality, its characters are not equally definite, the borders being slightly more obtusely and irregularly doubly serrate. The unequal base is of no account as character of a leaf of *Ulmus*, and as the lateral veins are close, the areolation and the nervation the



same, — for in both leaves the midrib is comparatively thin, — it appears referable rather to this than to the former species, to which its affinity is also marked. This type is Miocene, the species being very closely related to *Ulmus tenuinervis*, Lesqx., of South Park, which itself is allied to *U. Braunii*, Heer, of the Upper Miocene of Oeningen.

*Habitat.* — Table Mountain, Tuolumne County, California. Voy's Collection.

### FICUS, TOURNEF.

**Ficus sordida**, sp. nov.

*Pl. IV. Figs. 6, 7.*

*Leaves large, coriaceous, entire, broadly ovate or nearly round, obtuse or pointed, truncate or slightly cordate at the nearly equilateral base, palmately five nerved from the top of an enlarged thick petiole; nervation coarse, camptodrome.*

Of the two leaves which represent this fine species, one, nearly round, is twelve centimeters broad, ten and a half centimeters long, slightly contracted toward the very obtuse point. The other, thirteen and a half centimeters long, is more enlarged toward the subcordate base, where it measures eleven and a half centimeters, rapidly narrowing upwards to an acute point. The lateral nerves curve in passing to the borders, the inner pair ascending to near the top, there parallel with the secondary nerves, three pairs of them, the lower one at a greater distance from the base, and thinner than the middle. The surface of these leaves is black, somewhat crumpled or rather smooth, but deeply cut by the nervation, and irregularly wrinkled. The nervilles, in right angle to the veins, obliquely divide in anastomosing, and by subdivisions constitute an irregularly comparatively large polygonal areolation.

This species, though of the same type as the following, is evidently different from it. It is comparable, even apparently closely allied, to the fragment of leaf described by Heer as *Ficus? granulatica*, Flor. Arct., II. p. 472, Pl. LIV. Fig. 2. Another fragment, less complete, is figured in the same work, I. Pl. XIII. Fig. 6. The nervation is about of the same character. In the Greenland leaves, however, the primary veins are more slender, the leaves smaller, and the areolation more compact.

*Habitat.* — Chalk Bluffs, Nevada County, California. Voy's Collection.

**Ficus tiliæfolia**, Al. Br.*Pl. IV. Figs. 8, 9.*

*Leaves large, subcoriaceous, entire, unequilateral, palmately three or five nerved, ovate, rounded or subcordate at the base, pointed or acuminate; petiole thick.*

This species differs from the former by its thinner primary nerves, and their divisions ascending nearly straight to the borders, where they abruptly curve in bows, often touching the margins; by the distinctly unequilateral base of the more narrowly pointed leaves, and the square primary areolation. This species is well known, its characters definite, and its distribution very wide. The leaves greatly vary in size, Fig. 9 representing its small forms, Fig. 8 the middle ones, for there are leaves of this species twice as large. It has been described by European authors from most of the stages of the Miocene. On this continent we find it already in the lowest strata of the Eocene Lignitic, as at Point of Rocks, for example, quite near the top of the Cretaceous measures. It abounds at Golden, Colorado, Black Buttes, Wyoming, etc., and is therefore represented in the whole Tertiary. No species has been seen in the Cretaceous Dakota group, however, which could indicate any relation to it. The type is represented at the present time by *Ficus sycomorus*, Linn., an analogous species.

*Habitat.*—Chalk Bluffs, California. Voy's Collection.

**Ficus microphylla**, sp. nov.*Pl. IV. Figs. 10, 11.*

*Leaves small, coriaceous, very entire, broadly oval or rhomboidal in outline, rounded upwards to a short obtuse point, and downwards to a thick petiole; palmately three-nerved from the slightly unequilateral base; nervation camptodrome.*

The species is represented in the collection by three leaves, all about of the same size, the largest three centimeters long, and a little more than two centimeters broad. The nervation is of the same character as that of the two former species; but the primary nerves are very thin, in three only, and on a more acute angle of divergence than that of the secondary ones. The lateral nerves ascend to above the middle of the leaves, where they curve near the borders, anastomosing by simple flexure with the secondary veins, which are scarcely branched, merely

joined by very thin nervilles. The petiole seems to become inflated a little below the base of the leaves, as seen in Fig. 11, the only specimen where the petiole is preserved.

There is no fossil species to which these leaves may be compared, for a close relation, at least. They have the same nervation as *Ficus plumicostata* of Golden, whose young leaves, of about the same size, have also somewhat thin primary and secondary nerves. But the form of the leaves is different, and the distinct veinlets, mostly parallel, simple, and thin, are of another character.

*Habitat.*—Table Mountain, Tuolumne County, California. Voy's Collection.

## LAURINEÆ.

### PERSEA, GÆRT.

#### *Persea pseudo-Carolinensis*, sp. nov.

#### *Pl. VII. Figs. 1, 2.*

*Leaves coriaceous, comparatively large, oblanceolate, obtusely pointed, gradually narrowed to the petiole: lateral nerves on an acute angle of divergence, curving to and following the borders in long series of anastomosing bows.*

The two fragments representing this fine species present quite distinctly the details of nervation and of areolation. The lateral nerves, on a very acute angle of divergence at the base, become by and by more open toward the top of the leaves, gradually curve upwards, and follow the borders high above in a long series of simple festoons. The thick fibrillæ, branching in the middle of the areas, or anastomosing with short tertiary veins, compose, by the first divisions, large, irregularly square or equilateral areolæ, and by subdivisions mostly in right angle, constitute an ultimate reticulation of very small round polygonal meshes. This kind of nervation refers these leaves to *Persea*, and indeed, by comparison with those of *P. Carolinensis*, Nees, of the present North American flora, the analogy of form and of all the characters is seen to be very close. Generally the lower veins of *P. Carolinensis* are at a more open angle of divergence, and the size of the leaves is smaller. They vary considerably, however, even upon the same branch, and leaves are not uncommonly seen with the basilar nervation precisely similar to that of Fig. 1, while others are found as large, still larger than the fossil one.

The var. *palustris*, Chap., has leaves still more obtusely pointed than that of Fig. 1, the only one preserved nearly in its integrity. If not identical with the living species, the fossil one may be considered as its ancestor. Its analogy to fossil species is marked with *P. Bramii*, Heer, Fl. Tert. Helv., p. 80, Pl. LXXXIX. Figs. 9, 10, of the Miocene of Ceningen.

*Habitat.*—Table Mountain, California. Voy's Collection.

## DISCANTHEÆ.

### ARALIA, L.

#### **Aralia Whitneyi**, sp. nov.

*Pl. V. Fig. 1.*

*Leaves of very large size, subcoriaceous, surface polished, fan-like in outline, broadly cuneate or subtruncate to a thick, apparently short petiole; three palmately nerved, and seven-lobed by subdivision of the lateral nerves; lobes entire, cut down to about one third of the lamina, broadly lanceolate-acuminate; secondary venation camptodrome.*

The figure represents one of the smallest and better preserved leaves of this species, from its numerous specimens in the collection. It is twenty centimeters broad, and eighteen long from the top of the petiole. Another of these leaves, well preserved also, is twenty-seven centimeters long, and fragments less complete indicate a size of thirty-six centimeters wide, and thirty centimeters broad for the leaves which they represent. The shape or general outline of the leaves is very graceful. They are like large open fans cut around in seven nearly equal lobes, all joined by obtuse sinuses, and separating in the same degree, according to the angle of divergence of  $20^{\circ}$  to  $25^{\circ}$  of the primary nerves, which run straight to the point of the lobes. The primary nerves are properly in three; but the lateral ones fork twice at a short distance from the base, and thus compose the seven-lobed divisions of the leaves. These primary veins and their branches are thick; the secondary ones, on the contrary, originating a little lower than the base of the lobes, are thin, but distinct, close, parallel, curving in passing up to the borders, camptodrome; the nervilles are distinct, and in right angle to the nerves, those of the lower part turned up from the primary nerves, and arched in the middle. The areolation is obsolete.

This species seems to have been extensively distributed in this flora, for it is represented by numerous specimens from divers localities, presenting always, as far as that may be recognized by the fragments, the same characters and the same large size of leaves. The genus *Aralia* has its origin in the Cretaceous; numerous species of *Aralia* and *Araliopsis* have been described from the Dakota group, one of which, *A. Towneri*, has, like this, entire lobes, and a nervation of the same character. The relation of our species, however, is more definite with *A. affinis* and its closely allied congener *A. notata*, of the Eocene, which is locally as widely distributed as that of the Chalk Bluffs, for in some localities specimens of this species only have been found in abundance.

The same type is represented in the European Miocene by *Aralia* (*Platanus*) *Hercules*, Ung. Chlor. Prot., p. 138, Pl. XLVI., and at the present time by some species of the section of the *Oreopanax*, especially by the beautiful *Aralia papirifera* of China and Japan, whose leaves are of the same form, and generally still larger than those of the fossil species.

*Habitat.* — Chalk Bluffs, Nevada County, California. Voy's Collection. Represented also by more than one half of the specimens of the collection of Professor J. D. Whitney.

#### ***Aralia Zaddachi?* HEER.**

*Pl. V. Figs. 2, 3.*

*Leaves comparatively small, subcoriaceous, five-lobed, rounded to and cordate at the base, distantly obtusely dentate secondary nerves at an acute angle of divergence.*

The consistence of these leaves is somewhat thick; the primary tri-palmate nervation, from the base of the petiole, gives a five-lobed division of the lamina by the forking of the lateral primary nerves in branches of equal thickness. Contrary to what is remarked in the former species, the middle nerve is thicker than the lateral ones. The lower secondary veins, at an acute angle of divergence, either follow the borders and curve along them when they are entire, or enter the obtuse, distant teeth, distinct from near the cordate base of the leaves in Fig. 2. The upper secondary nerves are somewhat more open and more curved in passing to the borders. The lobes which reach to the middle of the lamina are oblong, slightly enlarged in the middle, lanceolate-acuminate, and distantly dentate below the point which is apparently entire, as seen

in Fig. 3. The areolation is distinct, composed, by subdivisions of the nervilles, of very small, round, polygonal meshes. The figure given of this species by Heer, in his *Mioc. Balt. Fl.*, p. 89, Pl. XV. Fig. 1 *b*, represents merely one lobe, whose point is broken, and a narrow obtuse sinus. The characters of nervation, that is, the lower secondary nerves in an acute angle of divergence, somewhat more open for the upper ones, as also the border divisions of the leaves, are exactly the same; the fragment is, however, too small for warranting a claim of identification, which, however, receives a degree of evidence from the presence in this flora of a large number of leaves of *Populus Zadduchi*, a species, as remarked formerly, also abundant in the Miocene Baltic flora. This type of *Aralia* differs from all the Cretaceous congeners by the cordate base of the leaves.

*Habitat.*—Table Mountain, Tuolumne County, California. Voy's Collection.

***Aralia angustiloba*, sp. nov.**

*Pl. V. Figs. 4, 5.*

*Leaves of medium size, coriaceous, very entire, broadly cuneate to a short petiole, enlarged upwards, and deeply cut in five linear narrow entire lobes; primary nervation in three from the base, in five by the forking of the lateral nerves, all slender and of equal thickness; secondary veins open, close, equidistant, parallel, and camptodrome.*

The leaves, of a coarse, rugose, coriaceous texture, are deeply cut in five narrow linear lanceolate? lobes, whose point (broken) seems to be obtuse. They differ from those of the former described species and of other fossil congeners, not merely by the characters of their divisions, but by the close, numerous secondary nerves on a broad angle of divergence,  $70^\circ$ . The only species offering some points of analogy to this are both *Aralia (Platanus) digitata* and *A. jatropaefolia*, Ung. Flor. Prot.; but the first has the lobes much enlarged in the middle, and acuminate; the second has them dentate; and in both species the five palmately primary nerves are from the top of the petiole.

*Habitat.*—Chalk Bluffs, California. Voy's Collection.

## CORNUS, LINN.

**Cornus ovalis**, sp. nov.*Pl. VI. Figs. 1, 2.*

*Leaves small, entire, oval, obtuse, rounded to a short petiole, penninerve; secondary nerves closer toward the base, the upper ones distant, simple, acrodome.*

We have only the two fragments figured, representing leaves five to six centimeters long, and three centimeters broad in the middle. They are nearly exactly oval, the base joining the short petiole by an inward curve. The three lower pairs of secondary veins are close to each other, half a centimeter distant, while the fourth pair is more than double that distance from the third. They are all simple or without branches, either alternate or opposite on the same angle of divergence of 40°, joined by thin nervilles in right angle, and following the borders in simple curves.

The characters of nervation are the same as in the species of *Cornus* of the North American flora. By considering them only, we could refer these leaves to *C. alternifolia*, L., common over the eastern slope of the United States. Its leaves, generally acuminate, are sometimes rounded at the summit, like that of Fig. 1, by the splitting of the lamina and the incurving of the sides. There is, however, a difference in the base of the leaves which in the living species is generally narrowed and slightly tapering to the petiole. The rounded base is observable upon the leaves of *C. Mas*, L., of Europe, and *C. sessilis*, Torr., of California, both of the same section as the fossil ones.

*Habitat*.—Table Mountain, Tuolumne County, California. Voy's Collection.

**Cornus Kelloggii**, sp. nov.*Pl. VI. Fig. 3.*

*Leaves large, entire, broadly oval or nearly round, contracted upwards into a short acumina, narrowed by a cupre to the base; secondary veins few, opposite, compton-drom; nervilles strong, simple, distant, continuous.*

This fine leaf, about fourteen centimeters long (the lower part is broken), ten and a half centimeters broad, has characters very similar to those of *Cornus Nuttallii*, Audub., of California. In the living species the lateral

nerves are more numerous, generally five pairs; but some leaves have only four, the three lower pairs equidistant, the fourth somewhat further removed, as in the fossil leaf. The more marked difference is in the narrower, oval-lanceolate form of the leaves of the California species, and in the direction of the nervilles, which often turn upwards, and pass into branches or to secondary nerves. From the description of another species, *C. macrophylla*, Walt., whose leaves are fifteen centimeters long and ten centimeters broad, broadly ovate, acuminate, rounded to the base, there is apparently a still more intimate relation between the fossil leaf and those of that species of China. I have, however, not been able to obtain specimens for comparison. This type is not distinctly represented in any fossil flora. *C. platiphylla*, Sap. Séz. Fl., p. 391, Pl. XI. Figs. 8, 9, has a distant affinity to it by the form of the leaves, but greatly differs by its numerous lateral nerves and comparatively narrower and smaller leaves. It seems of recent origin, like the fine *C. florida* and *C. Nuttallii* of the North American flora.

*Habitat.* — Chalk Bluffs, Nevada County, California. Voy's Collection.

## POLYCARPEÆ.

### MAGNOLIA, LIN.

#### **Magnolia lanceolata**, sp. nov.

*Pl. VI. Fig. 4.*

*Leaves oblong-lanceolate, gradually narrowed to the base, more rapidly curving to a point or short acumens; lateral veins numerous, subequidistant, camptodrome.*

This leaf is not coriaceous, rather of a thin substance; its borders are slightly undulate, and its veins, scarcely more open toward the base, at a broad angle of divergence of about 70°, are slightly curved in passing toward the borders, where they branch and anastomose in bows. The veins are strong, distinct, but the details of areolation are obsolete. Its relation to *M. acuminata*, L., the cucumber-tree of the present North American flora, is very close. Indeed, but for the smaller size of the fossil leaf and its secondary veins, slightly more curved in passing to the borders, the identity of this form to the living species could not be denied. The secondary nerves are equally strong, equally distant, and under the same angle of divergence; the slight undulation of the borders



is also remarked in both the fossil and the living leaves. The obliteration of the areolation prevents an accurate comparison. This leaf is about twenty-three centimeters long, and six centimeters broad above the middle. The average size of those of *M. acuminata* is twenty-eight centimeters long, and nine to ten broad.

*Habitat.* — Chalk Bluffs, Nevada County, California. Voy's Collection.

**Magnolia Californica**, sp. nov.

*Pl. VI. Figs. 5–7.*

*Leaves broadly oval, with entire, slightly undulate borders, rounded upwards to a short acumens, and more gradually narrowed downwards to a short petiole; secondary veins open, parallel, camptodrome, anastomosing along and quite near the borders in simple or double bows.*

The fragment (Fig. 5) has the lateral nerves somewhat more distant, and apparently thicker; but, considering the leaves of living species of *Magnolia*, these same differences are remarked. The relation of this species to *M. cordata*, Mich., common in the present flora of the Southern States, is quite as marked as that of the former species to *M. acuminata*. The base is equal and embeate to the petiole, while in the living species it is generally unequilateral, and more or less cordate. Leaves narrowed to the petiole, however, are frequently found in *M. cordata*; indeed, young leaves are generally of this character, and though the base of the fossil leaves are equilateral the lamina is divided by the midrib in two unequal sides, as in the living species. All the details of nervation, as far as they can be seen and have been carefully represented (Fig. 5), are the same, even the basilar veinlets, as in Fig. 7. In the fossil floras of the Miocene of Europe, *M. Diana*, Ung. Sillog., p. 28. Pl. XI. Figs. 1–4, is the more analogous species, differing especially by narrower leaves and the winged petiole. Fig. 6 of our plate represents the cone-like receptacle of a *Magnolia* with seeds still attached to it, and some loose ones upon the same fragment. It is referable, very probably at least, to one of these two species, whose specimens are all from the same locality.

*Habitat.* — Chalk Bluffs, with the former. Voy's Collection.

**ACERINEÆ.**

ACER. LINN.

**Acer æquidentatum**, sp. nov.<sup>1</sup>*Pl. VII. Figs. 4, 5.*

*Leaves small, tripalmately lobed; lateral lobes short, placed above the middle of the leaves, abruptly pointed; borders acutely dentate, rounded at the base, or truncate to a long slender petiole.*

The substance of these leaves is rather thick, and their size apparently small, the largest one seen from all the specimens being about eight centimeters both ways. The borders are cut all around by acute equal teeth turned upwards somewhat like those of *Platanus*, and all are entered by the primary and secondary nerves; the fibrillæ are comparatively thick, continuous; the middle lobe is twice as long as the lateral ones, lanceolate-pointed. The relation of this species is distinctly marked with *A. vilifolium*, Al. Br., represented in *Flor. Tert. Helv.*, III. Pl. CXVII. Fig. 14, which, by its outline, short lobes, and long slender petiole, is of the same characters as those figured here, merely differing by shorter teeth, and still shorter, more obtuse lobes. It is still, by its form and denticulation, more like the leaf of Weber, Palæont. (separ. abd.), p. 83. Pl. V. Fig. 4 *b*, referred to *A. vilifolium* by the author, and by Heer to his *A. brachyphyllum*, which has a five palmate nervation, and is therefore of a different type. The borders of the leaf of *A. vilifolium* have not been observed by Heer, and the characters of the teeth are not yet positively recognized. Professors Al. Braun and Ettingshausen, the last in his *Bilin flora*, have described the species without figures, the teeth being indicated as obsolete. The type is that of our present *Acer spicatum*, Lam., whose leaves, some of them, at least, have the general outline of the fossil ones, the truncate base, and the long slender petiole. Its teeth, however, are longer, mostly double and irregular, and the lobes acuminate.

*Habitat.*—Chalk Bluffs, Nevada County, California. Voy's Collection.

<sup>1</sup> *Acer vilifolium* is written upon the plate by mistake.

**Acer Bolanderi**, sp. nov.*Pl. VII. Figs. 7-11.*

*Leaves of small size, subcoriaceous, palmately three-lobed; lateral lobes shorter than the middle one, entire or distantly obtusely dentate; base broadly cuneate and subcordate to the slender petiole.*

All the specimens representing this fine species have the same characters, the leaves trilobate, with borders either entire or cut along the sides of the lobes into a few obtuse teeth. The largest of these (Fig. 7) is only five and a half centimeters between the points of the lateral lobes; the smallest are not half as large. The lobes are in an angle of divergence of  $30^{\circ}$ – $45^{\circ}$ , with obtuse broad sinuses. Two species of the present flora of California have relation to this fossil one: *Acer tripartitum*, Nutt., by the form of the leaves, which are, however, of larger size and acutely dentate; and *Acer grandidentatum*, whose leaves are generally five-lobed, but which are of the same size and of the same consistence, with lobes obtusely distantly dentate, as in this fossil species. It is also comparable to *Acer subcampestre*, described by Gœppert, from the Miocene of Schossnitz, and to *Acer Italicum*, Mass., of the same formation of Italy. The affinity is, however, distant.

*Habitat.*—Table Mountain, Tuolumne County, California. Voy's Collection.

**FRANGULACEÆ.**

ILEX, LINN.

**Ilex prunifolia**, sp. nov.*Pl. IX. Fig. 7.*

*Leaves small, oval, obtusely pointed, rounded in narrowing to the base; middle nerve thin; secondary nerves parallel, equidistant, curved, and camptodrome; borders distantly obtusely dentate.*

The reference of this leaf, the only one representing the species, is not positively ascertainable. By the camptodrome direction of its secondary nerves it resembles the living *I. decidua*, Walt., which has the same border divisions, and in some of its leaves the same form. The base of the fossil leaf is, however, less narrowed and tapering.

*Habitat.*—Table Mountain, California. Voy's Collection.

## ZIZYPHUS, MILL.

**Zizyphus microphyllus**, sp. nov.*Pl. VIII. Fig. 9.*

*Leaves small, subcoriaceous, oblong, rounded to the base; primary lateral veins from above the base, subacrodome; borders minutely serrulate.*

By its form, size, and the minutely serrate borders, this leaf has an analogy to species of *Ceanothus*, especially to the small form of *C. velutinus*, Dougl., whose basilar lateral nerves, however, come out from the base of the leaves. I do not know any fossil species to which this fragment might be compared. Like that of the former, the specimen should perhaps have been left undescribed. These leaves may be, however, useful for future comparison.

*Habitat.* — Chalk Bluffs, California. Professor J. D. Whitney.

**Zizyphus piperoides**, sp. nov.*Pl. VIII. Figs. 10, 11.*

*Leaves subcoriaceous, entire, lanceolate, acuminate, rounded to the petiole; lateral primary nerves subacrodome, joined to the midrib in an acute angle of divergence, and slightly decurving to it.*

The characters of nervation of these leaves are the same as in the former species. The lateral primary veins from above the base of the leaves ascend at a distance from the borders to near the point, anastomosing with the secondary veins, as seen in Fig. 11, and more or less branching outside; under them there is a pair of basilar veinlets following up, parallel to the borders. Rounded at the base, these leaves are gradually narrowed into an apparently long acumen. They vary in size from six to ten centimeters long, and from two to three centimeters broad a little above the base, where they are broader. The midrib, which is strong, is in its lower part joined to the lateral nerves by indistinct, irregular veinlets, and divided upwards in alternate distant branches, which curve and anastomose in bows at a distance from the borders. The details of nervation and of areolation are obsolete. The forms and nervation are like those of the leaves of many species of *Piper*.

*Habitat.* — Chalk Bluffs, California. Voy's Collection.

**TEREBINTHINEÆ.**

RHUS, LINN.

**Rhus typhinoides**, sp. nov.*Pl. IX. Figs. 1-6.*

*Leaves pinnate, leaflets opposite, distant, small, short-petioled, lanceolate, acutely taper-pointed or acuminate; borders serrate; secondary veins numerous, parallel, at an open angle of divergence, camptodrome.*

It seems at first as if these leaves, which are represented by numerous specimens, might be referable to two different species, one with unequal-lateral leaflets, the other with more equal ones gradually narrowed to the petiole, as Figs. 1 and 5. The difference is evidently the result of the lateral or terminal position of the leaflets, as distinctly seen from the lower fragment of Fig. 1. The nervation is the same, and the denticulation of the borders is merely more or less enlarged, according to the size of the leaflets. It is easy to recognize the close affinity of the fossil species to *Rhus typhina*, Linn., the staghorn Sumach, so frequently seen on the eastern slope of North America. There is a difference, however, in the generally longer linear leaflets of the living species, in the more marked or larger denticulations of the borders, and in the more open angle of divergence of the lateral veins, which are less regularly camptodrome, more generally entering the teeth by their points than by branching veinlets. I find, however, among the specimens of *R. typhina* some leaflets where these deviations or differences are scarcely noticeable. The consistence of the fossil leaflets, though not coriaceous, is firm, somewhat thick. In the fossil species of *Rhus* this one is comparable to *R. obliqua*, Sap., and *R. derelicta*, Sap., both of the Miocene of France, compared by the author to *Rhus typhina*, to which, however, they are less intimately allied than ours.

*Habitat.*—Table Mountain, Tuolumne County, California. Voy's Collection.

**Rhus Boweniana**, sp. nov.*Pl. IX. Figs. 8, 9.*

*Leaves pinnate; leaflets unequal-lateral, oblong-oval, obtusely pointed; secondary veins numerous, parallel; borders distinctly obscurely denticulate.*

These two leaflets seem at first like a variable form of *R. typhinoïdes*. They have, however, all the secondary veins percurrent to the point of the distant more obtuse teeth, and this difference is marked enough to authorize a distinct specification. The specimens are too obscure (the details of the areolation being obsolete on account of a coating of varnish) to offer precise indication of their relation. They may even represent leaflets of a trilobate species, as by their outlines and nervation they have a degree of likeness to the leaves of *R. diversifolia*, Torr. and Gr., of Oregon. This one, however, has the leaflets comparatively broader, and still more indistinctly denticulate; they are intermediate in characters between the former and the following species.

*Habitat*.—The specimens do not bear any reference number. They seem to be from the same locality as that of the former species. Voy's Collection.

***Rhus mixta***, sp. nov.

*Pl. IX. Fig. 13.*

*Leaves pinnate; leaflets linear or ovate-lanceolate, obtusely pointed, more or less unequalateral at the round-cuneate base; borders distinctly and distantly serrate; nervation subcamptodrome.*

The leaflets exposed upon the specimen appear to belong to the same odd-pinnate leaf, the short oval ones being the terminal, and the long, narrower, and linear representing the lateral ones. Though by their facies they seem referable to a *Carya*, their nervation is that of a *Rhus*, the secondary veins either curving under the teeth and entering them by nervilles, or passing up directly to their points. These lateral nerves are close, parallel, generally at an open angle of divergence, from  $60^{\circ}$ – $70^{\circ}$ , thick, deeply impressed, joined by fibrillæ about in right angle. All the details of areolation are obsolete. I do not know of any more marked relation to this species than that of *Rhus typhina*, Linn., which it resembles by the linear form of the lateral leaves, and the close numerous secondary veins of an equal angle of divergence. The fossil species differs, however, by the broader shorter terminal leaflets being merely obtusely pointed, and by the more distant teeth of the borders.

*Habitat*.—Chalk Bluffs, California. Professor J. D. Whitney.

**Rhus myricæfolia**, sp. nov.*Pl. I. Figs. 5-8.*

*Leaves large pinnate; leaflets oblong, lanceolate-pointed or acuminate, short-petioled; borders undulate and denticulate; nervation mixed.*

The consistence of the leaflets is hard, apparently coriaceous, the surface undulate and smooth; their size is comparatively large, from eight to thirteen and a half centimeters long, and one and a half to two and a half centimeters broad. The form, embeate to the base, is ovate lanceolate acute or oblong-lanceolate, gradually passing up to a prolonged acumen. As seen in the comparison of Figs. 5 and 6, the borders are more or less distinctly dentate, according to the size of the leaves; the dentations, however, being irregular in all; they are also undulate like the surface. The secondary nerves, as marked in Figs. 6 and 7, are at a right angle of divergence near the base, gradually becoming more oblique upwards, all curved in passing to the borders, where they either enter the teeth or curve in passing under them, as in the former species. By their shape, their consistence and nervation, these leaves are similar to those of *Myrica*, to which they should have been referred but for the fragment (Fig. 5) which shows distinctly part of a compound leaf. We do not have in our flora any species of *Rhus* of the same characters as those of this species. It, however, belongs to the section of the *Rhus* with smooth or naked petioled pinnate leaves and serrate leaflets, like *R. viridiflora*, Poir., *R. glabra*, Linn., especially represented at our time in the North American flora. Fig. 8 is apparently a small crushed cone, or a seed surrounded by an involucre. Its reference is not ascertained.

*Habitat.* — Chalk Bluffs, Nevada County, California. Voy's Collection.

**Rhus metopioides**, sp. nov.*Pl. VIII. Figs. 12, 13.*

*Leaves pinnate; leaflets coriaceous, very entire, unequilateral, broadly ovate, abruptly pointed, rounded to a short petiole; secondary nerves in right angle to the midrib, subcamptodrome, separated by tertiary thinner veins anastomosing by veinlets at various angles to the secondary ones.*

This form bears to the present *Rhus metopium*, Linn., of Cuba (found also in cultivation at Key West and South Florida), the same degree of

relation as *R. typhioides* bears to *R. typhina*. The shape of the leaves is like that of the specimens from Cuba, whose nervation is, however, more oblique to the midrib. The specimens of the cultivated plants of the species which I have obtained in great number and finely preserved from Key West, show in the direction of the secondary nerves in the intermediate veins, in their anastomoses by veinlets of different direction, in the multiple bows along the borders, the same characters as in these fossil leaves, whose nervation is equally very varied. Sometimes the secondary nerves pass to the borders, and enter them mostly by branchlets, and the tertiary parallel veins always irregular, variously distant, join them by nervilles, either oblique or in right angle, composing a series of simple secondary bows, distant from the borders, to which they are united also by nervilles. Sometimes the secondary nerves curve in large bows at a greater distance from the borders, as in Fig. 13, and with nervilles in right angle upon their backs compose a second row of festoons which follow close to the margins. In Fig. 12 the details of nervation are less varied, and more closely resemble those of the living species. The leaflets from Cuban specimens are quite as unequilateral as those of this fossil species. Those of Florida are more regular, generally round truncate, and equilateral. The leaves are indifferently three palmately divided or imparipinnate. By the nervation, *Celastrus Zacchariensis*, Sap., of the Miocene of France (St. Zaccharie), is related to this. Its leaves, however, are dentate or crenate.

*Habitat*.—Table Mountain, Tuolumne County, California. Voy's Collection.

***Rhus dispersa*, sp. nov.**

*Pl. I. Fig. 23.*

*Leaflet small, subcoriaceous, lingulate, cuneate to an obtuse point, rounded, subcordate at the base; borders denticulate from the middle upwards; nervation subcamptodrome.*

This leaflet, of a very small size, one and a half centimeters long, and scarcely seven millimeters broad, is evidently detached from a compound leaf. Slightly and gradually enlarged upwards from the base, it is rapidly narrowed at the top into an obtuse point, and distinctly though distantly denticulate in its upper part. The secondary veins, mostly opposite, irregular in distance, but parallel, go out from the narrow midrib in an open angle of divergence,  $50^{\circ}$  to  $60^{\circ}$ , pass straight to very near the



borders, where they abruptly curve, joined to the teeth by branchlets, or sometimes passing directly to their points. The intermediate areas are divided by short tertiary veins, connected to nervilles at right angles, or traversed by distinct veinlets also in right angle to the nerves. The ultimate areolation is obsolete.

By the characters of its nervation this leaflet is equally referable to *Rhus* or to *Zanthoxylon*. In the species of this last genus the leaflets are generally narrowed to the base, or to the petiole; in some species of *Rhus* they are sessile, and more generally rounded, truncate, or subcordate to the base.

*Habitat*.—Table Mountain, California. Mixed with the numerous small leaves of *Quercus convexa*. This was the only specimen found. Voy's Collection.

## ZANTHOXYLON, LINN.

### **Zanthoxylon diversifolium**, sp. nov.

*Pl. VIII. Figs. 14, 15.*

*Leaves pinnate or trifoliolate; leaflets very variable in size, subcoriaceous, entire, oblong-oval, unequilateral, cuneiform at the base; nervation camptodrome.*

At first sight it would seem that these two leaves belong to two different species, the largest one being at least seven centimeters long, and nearly four wide, while the other is not half as large, though of the same form. The characters of nervation are identical. The lateral nerves on a broad angle of divergence, variable in distance, the upper ones nearly parallel, curve in the same degree in traversing the areas toward the borders, which they follow in simple bows prolonged by anastomosis of veinlets. In both leaves the lowest secondary vein on the narrowed side passes up in a very acute angle of divergence, joining the nerves above by anastomoses, either with tertiary veins, or by thick veinlets at right-angles to the midrib. In both the ultimate areolation of equilateral or subquadrate small meshes is formed by subdivision of the veinlets at right-angles. It thus appears that we have two leaflets probably separated from the same leaf, pinnately divided, like most of those of this genus. I find no species in the present flora to which these leaves are related, except *Z. triphyllum*, a trifoliolate species from Brazil communicated to me

under this name, but not described in the Prodrömus. The relation is rather in the size and form of the leaflets than in the nervation, which in the Brazilian plant is analogous to that of *Rhus metopium*, but with a punctate areolation. In the fossil floras our species is distantly comparable to *Z. integrifolium*, Heer, Fl. Tert. Helv., III. p. 86, Pl. CXXVII. Figs. 27-30.

*Habitat.*—Bowen's Claim, Oregon, in connection with *Quercus Boweniana*, and fragments of *Acer vitifolium*. Voy's Collection.

### JUGLANS. LINN.

#### *Juglans Californica*, sp. nov.

*Pl. IX. Fig. 14. Pl. X. Figs. 2, 3.*

*Leaves large, entire, oblong-oval, obtuse, narrowed or rounded to the base; secondary veins numerous, inequidistant, on an open angle of divergence, camptodrome.*

Nothing more can be observed of these leaves than is represented by the figures. They are referable to the *Juglans* of the type of *J. regia*, Linn., so widely known in cultivation, and spontaneous only in Asia. We do not have it in America, where even by cultivation it fails to give evidence of prosperity. As the type is extremely common in the Miocene of Europe, where it is represented by numerous species, some of them varieties of the most common one, *J. acuminata*, Al. Br., and as we have the same species also common in the North American Tertiary, the fossil form of the California Chalk Bluffs may be considered as probably the last representative of this type upon the North American Continent. In the different appearances of its leaves, their form, their open nervation, their shape, this species is related to *J. acuminata* var. *latifolia*, Heer, Flor. Tert. Helv., III. p. 88, Pl. CXXIX. Figs. 2-8. They are generally narrower, more evidently broadly obtuse or taper pointed, rather than abruptly acuminate. It is the only difference. The great variety of the leaflets of the same species of *Juglans* may render advisable the reference of these of the Californian Pliocene to Heer's species.

*Habitat.*—Chalk Bluffs, Nevada County, California. Voy's Collection.

**Juglans Oregoniana**, sp. nov.

Pl. IX. Fig. 10.

*Leaflet large, linear-oblong, slightly enlarged upwards; borders minutely crenate; nervation camptodrome.*

This fine leaf is apparently very long, and probably abruptly pointed (the point is broken). Its borders are minutely crenate, its secondary nerves close, open, at a right angle of divergence toward the base, curved in traversing the areas, following close to the borders in simple festoons, and mostly simple or without branches, connected only by strong nervilles in right angle. The affinity of this species to *Juglans nigella*, Heer, of the Alaska Flora (p. 38, Pl. IX. Figs. 2-4), is very close, the difference being merely in the more open lateral nerves toward the base of the leaves, and in the minute obtuse denticulation of the borders, the leaves from Alaska being sharply more coarsely serrate. The nervation, especially the distribution of the basilar nerves, is that of the present *J. nigra*, Linn., which, however, has always some of its veins branching, and the border teeth larger and more distant. The linear form of the leaves is comparable to that of *Juglans rupestris*, Engelm.

*Habitat.*—On soft laminated clay with *Aralia Whitneyi*, evidently of the same age as the Chalk Bluffs of California, without definite locality but Oregon. Voy's Collection.

**Juglans laurinea**, sp. nov.

Pl. IX. Fig. 11.

*Leaflet oval, narrowed upwards to a blunt point, gradually narrowed in a curve to the unguilateral base; borders sharply distinctly serrate; nervation camptodrome.*

The borders of this leaf are more distinctly serrate than in the former species; the nervation is also of a different and peculiar type, the basilar veins at an acute angle of divergence, about 30°, ascending from the thick midrib high up, at a distance from the borders, and anastomosing in curves to the first pair of secondary nerves above, which are open, more than 50°, and parallel to the following pairs up to the top. This nervation, which resembles that of some leaves of the *Laurineæ*; *Laurus*, *Tetranthera*, is also remarked in *Juglans Bullia*, Heer, a Miocene species which, however, greatly differs by entire borders, and the disposition of the upper veins of the

leaflets. No species of *Juglans*, either fossil or living, is distinctly related to this leaf. It has in its shape some likeness to *J. Bilinica*, Ung., whose leaves are very variable in form and size, and sometimes as sharply serrate as this one; but the characters of nervation are quite different.

*Habitat*. — Chalk Bluffs, Nevada County, California. Voy's Collection.

***Juglans egregia*, sp. nov.**

*Pl. IX. Fig. 12; Pl. X. Fig. 1.*

*Leaflets large, firm, but not quite coriaceous, oblong-lanceolate, rapidly narrowed to an obtuse point; more gradually attenuated to the petiole; borders sharply, minutely, distantly serrate; nervation camptodrome.*

Though the leaflets represented upon our plates are different, especially in their size, they seem referable to the same species, all the characters, except the rounded base of the leaves of Fig. 1, Pl. X., being alike. Differences of the same kind are generally remarked upon species of *Juglans* of the present flora. The leaflets, eighteen to twenty centimeters long, four to eight centimeters broad, are either oblanceolate, gradually narrowed to the petiole, and obtusely pointed, or oblong, rounded to the base, and rapidly attenuated or cuneiform to the point; the borders are more or less distantly serrate from near the base, and the lateral nerves, slightly more open toward the base, are generally equidistant, and on the same angle of divergence, averaging  $50^\circ$ . They are, when distant, separated by intermediate tertiary veins traversing to the middle of the areas, where, joined by nervilles in right angle, they enter into the areolation mostly composed of subdivisions of the nervilles, forming irregularly square or equilateral large meshes. The veins following the borders in simple bows are joined to the teeth by veinlets only, and do not enter the borders by their ends. This character refers these fine leaves to *Juglans* rather than to *Carya*, to which they have some likeness of shape. No fossil species is comparable to this one, except, in a very distant way, *J. Bilinica*, Ung., whose leaflets, as remarked above, are very variable in shape.

*Habitat*. — Chalk Bluffs, California, with numerous fragments of *Aralia Whitneyi*. Professor J. D. Whitney.

**ROSIFLORÆ.****CERCOCARPUS, H. B. K.****Cercocarpus antiquus, sp. nov.***Pl. X. Figs. 6–11.*

*Leaves obovate, cuneiform to the base and to the point, dentate from the middle upwards : lateral veins close, parallel, craspedodrome.*

The leaves, of a thick consistence, varying in size from two to six centimeters long, and comparatively broad, are gradually narrowed downward from the middle, slightly decurrent at the base to a short petiole, and somewhat more obtusely cuneate to the point. The lateral veins thick, but indefinite, close, parallel, on an acute angle of divergence of  $40^\circ$ , enter each one of the obtuse teeth which border the leaves from the middle upwards, the lower part being entire. The surface seems covered with a villous coating; for in Figs. 6, 7, and 10 the space between the veins is indistinctly and irregularly lineate, as if the nervation was obscured by hairs. These leaves are evidently referable to this genus; they are, however, of an average size, somewhat larger than that of the species now inhabiting the Rocky Mountains, and intermediate between them and *C. Fothergilloides*, H. B. and Kunth., of Mexico. No species of this genus has been found in a fossil state until now.

*Habitat.*—Table Mountain, Tuolumne County, California. Represented by numerous specimens in Voy's Collection.

## GENERAL CONCLUSIONS.

IN the first volume of the Geological Report of California, Professor J. D. Whitney, considering the age of the auriferous gravel and clay beds where the fossil leaves described above have been obtained, says that, from the determination of a quantity of bones and teeth found in this formation, it appears referable to the Pliocene. "Among them, remains of the rhinoceros, of an animal allied to the hippopotamus, an extinct species of horse, and a species allied to the camel had been recognized."<sup>1</sup> He also adds, as a confirmation of his conclusions, "that the works of man have been so frequently found among the recent deposits of the auriferous gravel, and in such connection with the bones of the mastodon and elephant, that it is hardly possible to escape the inference that the human race existed before the disappearance of these animals from the region which was once thickly inhabited by them."

Professor Whitney remarks on the same question, that a few specimens of the leaves of Buckeye-Tunnel, Tuolumne County, were forwarded to Professor Newberry, who made a preliminary investigation of them and furnished some notes of its results, authorizing the conclusions that these stratified deposits under the lava of Table Mountain are of Tertiary age, and that in all probability they belong to the later Pliocene epoch. Professor Newberry writes that "the leaves submitted to him are quite different from those of any trees now living in California, and that they are specifically distinct from those of the Miocene Tertiaries of Oregon, Nebraska, or of any other part of the continent. They include Tertiary and recent genera, such as *Acer* and *Carpinus*, and are therefore not older than the Miocene."

In 1872 Professor Whitney sent me from California a large number of specimens of fossil plants, part of which — those from the auriferous deposits of Tuolumne and Nevada counties — represent the species described above. The other half of the collection consists of specimens mostly from

<sup>1</sup> Geological Survey of California. Geology, Vol. I, pp. 250 - 252.

Miocene formations of Oregon, and a few also from California; they are reserved for a later publication. The relation of these plants is, however, casually considered in this memoir.

In 1873 I delivered to Professor Whitney a preliminary report on these plants, with descriptions of the species, remarking, as a conclusion, that the flora of the auriferous gravel of California had a predominance of species either identical or closely allied to some of the present North American flora, but had still some representatives of Miocene types, which imprinted on it a character of antiquity more marked than is generally expected in the vegetation of a Pliocene period. I therefore considered this group of plants as referable to the oldest Pliocene, or to a formation intermediate between the Miocene and the Pliocene.

These conclusions were neither positive nor definitive, for we had then for comparison, outside of the plants of our time preserved in the herbariums, merely palaeontological works on the Miocene species of Europe, and from this it was irrational to draw conclusions on the characters or the relations, either antecedent or subsequent, of a flora so closely allied to that of the present epoch of North America, whose types, especially for the arborescent species, are far different from those of Europe.

Now the circumstances are greatly changed in this country, and have become far more favorable to the studies of the palaeophytologists. The collections of specimens have been enriched in a remarkable degree by the discoveries of later years, and what has been published until now on the vegetable remains of the Mesozoic and Cænozoic formations of this continent may be used with a degree of reliance for the determination of the geological age of some deposits, or at least for defining the relation of the groups of plants pertaining to them.

The Cretaceous flora of the Dakota group deserves first to be mentioned, not merely on account of its precedence in the order of the discoveries, but especially on account of the remarkable characters of its dicotyledonous leaves, which already represent some types reproduced in species living at our time, and, as may be reliably inferred, in those of the intermediate formations. Our first acquaintance with those plants is derived from the discovery made by Dr. F. V. Hayden in Nebraska of a few leaves apparently referable to *Sassafras*, *Liriodendron*, *Platanus*, etc., and from the discussions on their characters and their true relation, as recorded in the American Journal of Sciences and Arts of 1859, especially. This

was a mere beginning of a scientific exposition of general interest. For the presence of highly developed vegetable types in the Cretaceous was a fact as surprising to European palaeontologists as to those of this continent, and of course induced more extensive and careful researches in the same field.

In 1866 Heer published the *Phyllites Crétacées du Nebraska*, from specimens collected by Professors Marcou and Capellini in a tour of exploration especially undertaken for the purpose of ascertaining the accuracy of the geological determination of the deposits where the so-called Cretaceous leaves had been found. Seventeen species or vegetable forms are described and figured in this memoir. Later, in 1868, two other papers were prepared from specimens of Cretaceous leaves collected by Professor F. V. Hayden, — one by Professor Newberry, the other by myself. Both are without figures, intended merely as an exposition of specific characters of plants which had to be more fully described in monographs. The plates of eighteen species prepared by Professor Newberry for his work have been engraved, but not yet published.

The number of specimens of Cretaceous plants having been considerably increased by the explorations of Professor Hayden and myself in Nebraska and Kansas, I was requested to prepare for publication all the vegetable Cretaceous forms which were then under examination; and these were described and figured in the sixth volume of the Report of the United States Geological Survey of the Territories, 1874. This work represents one hundred and thirty Cretaceous species, figured in thirty plates. In the following year I made a revision of this volume in the Annual Report of Dr. F. V. Hayden, with description and figures of twenty-six new species, from specimens received after the publication of the Cretaceous flora. Thus, from the different works mentioned above, the Cretaceous flora of this continent is represented by about two hundred specified forms.

Our acquaintance with the vegetable palaeontology of the North American Tertiary has been also widely advanced of late, especially by the United States geological explorations of the Western Territories under the direction of Dr. F. V. Hayden. In 1860 this Tertiary flora was represented merely by six species, described and figured by Professor J. D. Dana in the Report of the United States Exploring Expedition under the command of Lieutenant Charles Wilkes, from materials found on the



northwest of Washington Territory near Frazer River; and by short preliminary descriptions of my own, in the American Journal of Sciences and Arts, of three small groups of fossil plants from far distant localities and different geological ages. The materials of the first had been obtained by Dr. John Evans from Vancouver and Bellingham Bay;<sup>1</sup> they represent fourteen species. Those of the second came from Southern Tennessee, sent by Professor James Safford, who published in his Report descriptions and figures of the eleven species determined from his specimens. The specimens of the third were obtained by myself from the Chalk Bluffs of the Mississippi, near Columbus, Kentucky. They represent only seven species which have not been figured. In 1861 Professor Heer published in a separate pamphlet, with two plates of illustrations, seven species from a lot of materials sent to him as collected by Dr. C. B. Wood at Nanaimo, Vancouver Island, and Burrard Inlet. In 1863 Professor Newberry recorded in the Boston Journal of Natural History the characters of seven species procured by the geologists of the Boundary Commission. And the same year I published in the Transactions of the American Philosophical Society of Philadelphia thirty species from important materials communicated by Professor Eugene W. Hilgard, then State Geologist of Mississippi. The species are figured in nine plates. In 1868 Professor Newberry described and reviewed in a valuable memoir, "The Ancient Floras of North America," forty Tertiary species from the Fort Union group, all from specimens procured by Dr. F. V. Hayden in his explorations of the Western Territories;<sup>2</sup> and the same year I prepared a preliminary report on the characters of twenty-two vegetable Tertiary forms, from materials procured by Dr. John L. Leconte in his geological survey for the Union Pacific Railroad, and from specimens sent by Dr. F. V. Hayden. To this we have to add, for this decade of years, as an important work on the Tertiary plants of North America, the "Fossil Flora of Alaska" (*Flora Fossilis Alaskana*), by Heer, with an introduction and general remarks in German, and the descriptions in Latin of fifty-six species, illustrated by ten plates. The plants are all referred to the Miocene.

Since 1870, and from the specimens collected by the United States

<sup>1</sup> The species were described in detail and figured for a Report in preparation by Dr. Evans, then United States Geologist. But, so far as I know, this Report has not been published.

<sup>2</sup> These species have been figured and engraved later with those of the Cretaceous mentioned above.

explorations of the Western Territories for the Department of the Interior, I have prepared each year for the annual reports of Dr. F. V. Hayden, the director of the explorations, a review of the progress of the discoveries in vegetable palaeontology, and given preliminary descriptions of the species (1870-1875). And then a revision of all the materials has been made for the preparation of the seventh volume of the monographs of the survey, the "Fossil Flora of the Tertiary Formations of the Western Territories," which is now published. It describes three hundred and thirty vegetable forms, represented in sixty-five plates of illustrations. If to this be added the species described by Professors Heer and Newberry, and those from Oregon, already described and figured, the number of North American Tertiary plants known up to this time is not far from five hundred. With the Cretaceous species, they constitute already an important amount of palaeontological data, which may be used with advantage in botanical pursuits.

Of course I have profited by these documents as far as it was possible in preparing the present Report, which, however, may be received by practical botanists with some misgiving; for the determinations of fossil vegetable remains are extremely difficult, and generally somewhat uncertain; and therefore the conclusions derived from their characters are generally considered as more or less unsatisfactory. In this case, however, as the essential types of the plants of the auriferous gravel are very distinct, and clearly represented by specimens in a good state of preservation, I believe that they will be easily recognized even by botanists unacquainted with palaeontology.

In the table on pages 56, 57, will be found a synopsis of the essential points to be considered in regard to the deductions and conclusions derivable from the relations of characters and of distribution of species.

I have to explain, first, why the number of the so-called new species is so large for a list of a mere group of fifty plants.

Until now the Pliocene floras of Europe have been scarcely considered, though evidently they only can afford a key to the secret history of the distribution of the present vegetation, in some countries at least, by exposing the prefigurement of its characters. On this subject there is, to this time, no work of importance, except the "Flora of Maximieux," by Saporta and Marion. It is a splendid, remarkable work, indeed, which

describes thirty-two species, and quotes, in the comparative examination, most of those known in Europe from the same formation. Not one of them, however, offers a close affinity to the plants of the Chalk Bluffs. This difference is explainable by the likeness of the characters of the Pliocene species to those of the present time,—a relation which reduces the affinities to local or geographical limits, as they are now. The circumscriptions are wider, or the geographical areas less distinctly fixed in older geological divisions, and thus the flora of the Chalk Bluffs has some Miocene species identifiable in Europe, but none of its Pliocene as yet.

On another side, in coming nearer to the present period the vegetable forms become more and more similar to those of our time, some being apparently identical. But it is very difficult to make out positive identity from the characters of leaves only. The identity is probable, evident to the eyes of the observer; but it cannot be proved. For species of this kind a derivative appellation, indicating supposed identity, like *pseudo* or the terminative *ites*, seems more appropriate. The authors of the "Flora of Maximicux" append to the specific name the epithet *pliocene*, and thus have *Populus alba (pliocenica)*, etc.

The Miocene relation of the flora of the Chalk Bluffs is indicated by a few identical species: *Fagus Antipoffi*, Heer, described from the Miocene of Alaska, of France, and of Arctic Russia; *Populus Zuddachi*, Heer, predominant in the Upper Miocene of the Baltic, and found also in the same formation of Alaska, Greenland, and Spitzbergen; *Ficus liliifolia*, Al. Br., present in the whole Miocene of Europe as far north as Cöningen, and in the North American from the Lower Lignitic measures, which I consider as Lower Eocene, through the different stages of the Tertiary; *Aralia Zuddachi?* Heer, whose identification is as certain as it can be made in the comparison of our specimens with the mere fragment which represents this species from the Baltic Miocene. Besides this, we find a marked affinity between *Quercus clunoides* and *Q. cluna*, Ung., a common Miocene species of Europe; *Salix elliptica*, related to *S. varians*, Goepf.; *Ficus sordida*, closely allied to, if not identical with, *F. Greenlandica*, Heer, of Greenland; *F. microphylla*, which seems a mere diminutive form of *F. planicostata*, a common species of the Lower Lignitic of the Rocky Mountains; *Aralia Whitneyi*, related to *A. affinis* of the group of Evanston, Middle or Upper Eocene; *Acer aquidodatum*, related to *Acer vilifolium* of Cöningen in a

degree which cannot be fixed on account of the deficiency of the specimens by which this last form is represented; *Juglans Californica*, comparable to *J. acuminata*, var. *lulifolia*, Heer, a species of wide distribution in the Tertiary, mostly Miocene, of Europe and of this country; and *J. Oregoniana*, which bears the same degree of affinity to *J. nigella*, Heer, of Alaska. Thus the Miocene or Tertiary facies of the flora of the Chalk Bluffs is manifested by four identical species, and by eight more or less intimately related to Tertiary species of this country or of Europe. It must be remarked, however, that, except the two species of *Ficus*, these last-named forms are truly intermediate in their relation, which, as seen here below, is quite as close with types of the present flora as it is with Tertiary ones. The comparison of these species, taken all together, gives a proportion of less than twenty-five per cent, as indicative of the Miocene character in the flora of the auriferous gravel. As the table shows, the more evident relation of the above species is with those recognized in the Tertiary of Alaska, and in the Lignitic of the Rocky Mountains by identity, more or less distinct, with *Fagus Antiprifi*, *Populus Zudlachi*, *Ficus lilacifolia*, *F. microphylla*, *F. Greenlandica*, this one only from Greenland; and that, therefore, the oldest types of the flora of the Chalk Bluffs are mostly American. Indeed, some of these types, as will be seen hereafter, may be clearly traced up to the Cretaceous of the Dakota group.

The degree of relation of the plants of the above table with species of the present flora is much higher. As identical, as far as leaves may show identity, we find *Betula aequalis* with *B. occidentalis*; *Fagus pseudo-ferruginea* intermediate between *F. ferruginea* and *F. sylvatica*; *Quercus Whitneyi* with *Q. lyrata*; *Castanea chrysophylloides* with *C. chrysophylla*; *Ulmus Californica* with *U. alata*; *U. pseudo-fulva* with *U. fulva*; *Persca pseudo-Carolinensis* with *P. Carolinensis*; *Cornus ovalis* with *C. sessilis* or *C. Mas*; *Magnolia lanceolata* and *M. Californica* with *M. acuminata* and *M. cordata*; *Rhus typhinoïdes* and *R. melopioides* with *R. typhina* and *R. melopium*. *Juglans Californica* is referable to the old type *J. acuminata*, now represented only by the Asiatic *J. regia*, widely distributed by cultivation. Besides, there is an evident, though less distinct relation between *Quercus chenoïdes* and *Q. convexa* with *Q. virens* and its variety; *Q. Nevadaensis* with *Q. castanea*; *Q. Boeckiana*, *Q. distincta*, *Q. Goepperli*, and *Q. Vogana* with *Q. agrifolia* of California, and a group of Mexican Oaks, *Q. crassifolia*, *Q. Hum-*

*boldii*, etc.; *Salix Californica* with *S. sessilifolia* of Oregon; *S. elliptica* with *S. capreoides* of California; two species of *Platanus* with *P. occidentalis*, the form of the stipules of *P. appendiculata*, referring it more particularly to *P. lindeniana*, which, however, is considered a Southern or Mexican variety of *P. occidentalis*; *Liquidambar Californicum* with *L. acerifolium* of Japan; *Cornus Kelloggii* with *C. Nuttallii* of California; *Acer aquidentatum* with *A. spicatum*; *A. Bolanderi* with *A. tripartitum* and *grandidentatum* of the Rocky Mountains; *Juglans Oregoniana* with *J. rupestris* of the mountains of New Mexico and California, and *Cercocarpus antiquus*, intermediate in the size of its leaves between *C. fothersgilloides* of Mexico and *C. ledifolius*, now inhabiting the slopes of the mountains from Colorado to California. Therefore types of the present flora are represented in that of the Chalk Bluffs by fourteen probably identical species, counting *Cercocarpus* and *Juglans Californica*, and by sixteen more or less intimately related ones, or in a relation more than double in degree of what it is in the Miocene. On the species of this list also, the same remark can be made as on those of the former; they represent most of all true American types. Indeed, of the fifty species of the table, there are none strange to the present North American flora, except the two species of *Ficus* pertaining to a peculiar division of the genus, predominant in the Tertiary of both continents, but now disappeared, it seems, or merely represented by *F. carica*, everywhere cultivated in an infinity of varieties, and *Juglans Californica*, the offspring of *J. acuminata*, apparently the ancestor of *J. regia*, which is as generally known and cultivated, in Europe at least, as the Fig. I have compared *Zanthoxylon diversifolium* to *Z. triphyllum* on account of the peculiar similarity of its leaves to those of the Brazilian species; but the Pliocene form is as closely related by some of its characters to *Z. integrifolium* of the Miocene of Oeningen, to which, according to Heer, *Z. Americanum* bears the nearest affinity. Hence it is evident that the general character of the Pliocene flora of the auriferous gravel deposits is truly North American, or that it is most nearly related to that of the present epoch.

The assertion, however, does not apply to the present flora of California, where none of the more predominant genera recognized in the Pliocene plants are represented. *Fagus*, *Quercus* (of the subdivision of *Q. virans*, *Q. castanea*, and *Q. lyrata*), *Liquidambar*, *Ulmus*, *Persca*, *Magnolia*, *Acer* (the section of *A. spicatum* and *A. rubrum*), *Ilex*, *Rhus* (with pinnately divided leaves), *Zanthoxylum*, are all generic divisions amply represented in the

Pliocene flora of California, and in the present flora of the Atlantic slope of this continent, but not at all in that of the Pacific.

This remarkable dislocation of the flora of the Pliocene from that of California may be explained in two ways: either by modifications in the physical circumstances of the Pacific slope of the United States after the Pliocene epoch, or by the old hypothesis of a case of spontaneous production of new vegetable types, which were supposed to be generated for every new geological formation.

To set aside this last hypothesis, we have only to refer briefly to the essential characters of the ancient floras of North America from the appearance of the dicotyledonous plants in the Cretaceous, and to see if the essential types of the Atlantic flora and of the Pliocene of California are there already distinctly recognized. To do this I will merely consider the more marked groups of arborescent vegetables in the order in which they are described in Gray's "Botany of the Northern United States."

Beginning with the *Magnoliaceæ*, this family of plants is positively Cretaceous. Species of *Magnolia* first described from the Dakota group of Nebraska and Kansas (also from the Cretaceous of Moletin, Germany) are found, more and more related to those of the present time, in the Eocene Lignite of the Mississippi and that of the Rocky Mountains, especially of New Mexico; in the Miocene of Carbon and in the Pliocene of California, where the specific forms become apparently identical with some of those known now and described by Gray. *Liriodendron* is one of the best defined genera of the same Cretaceous formation, the Dakota group, where its numerous leaves have been referred to three species, one of them scarcely different by the character of its leaves from those of the living Tulip-tree. There is also an *Asimina* known by its leaves in the Miocene of Carbon, and another by its fruits in the Eocene of the Mississippi. The *Menispermaceæ* have, in the American Cretaceous, leaves of characters quite similar to those of *Menispermum Canadense* and *Cocculus Carolinus*. To represent the *Nymphæaceæ*, there are two species of *Nelumbium* in the Eocene of Colorado. The *Anacardiaceæ* have a *Zanthoxylum* and a number of species of *Rhus* in the Pliocene of California, and still more of a similar type in the Upper Miocene of Colorado. This last order seems to be of recent origin, while the *Ulmaceæ*, Cretaceous by different leaves described under the generic name of *Ampelophyllum*, appear more

distinctly in the Eocene by a number of species of *Cissus* and *Vitis*, one of which is recognized in the Lower Miocene of Carbon, and by a fine *Ampelopsis* scarcely distinct from *A. quinquefolia*, in the Upper Miocene of Colorado. The *Rhamnaceæ*, already in the Cretaceous in one species, become predominant in the Eocene of the Territories with *Berehemia* leaves, which, though described under a proper specific name, cannot be positively distinguished from *B. volubilis*. Of the following orders in the vegetable series, the Tertiary has especially species of *Celastrus*, *Ceanothus*, and *Sapindus*, this last in abundance mostly from the Miocene, with *Acer*, *Negundo*, and *Staphylea*. The Miocene species of the last genus is hardly separable from *S. trifoliata*. The *Leguminosæ* and the *Rosaceæ* are little known, and the few forms described are not as yet comparable to those of the present time. The first order has in our present vegetation mostly herbaceous plants. In the second we have a *Spiræa* in the flora of Alaska and another in that of Florissant, Colorado. A *Crataegus* is also present in the Eocene of Golden. I have described as *Hammamelites* some Cretaceous leaves considered by Saporta as related to *Hammamelis*; we have, however, no leaves in the Tertiary which might by relation of types authorize this reference. But the *Araliaceæ* are positively Cretaceous. Species of *Aralia* described from the Dakota group are reproduced in close conformity of types in the Upper Eocene of Evanston, and especially in the Pliocene of California. Comparing, for instance, *Aralia quinquepartita* of the Cretaceous Flora (Pl. XV. Fig. 6), and *A. Torreri* (Pl. IV. Fig. 1) of Dr. F. V. Hayden's Annual Report of 1874, with Figs. 4 and 5, Pl. V., of this memoir, the likeness will certainly appear striking. The fine leaf of *A. Saportani*, also, with its shorter lobe and fan-like form, is comparable to *A. Whitwaji*, while the present forms of *Aralia* with serrate lobes have a more distant affinity to a new species with crenate lobes recently sent from the Cretaceous of Colorado. This one is quite near to *A. formosa*, Heer, of Moëtin, perhaps identical with it.<sup>1</sup> The *Cornaceæ* have numerous species of *Cornus* in the Eocene and two in the Pliocene of California, while *Nyssa* is by leaves and fruits at Evanston. *Viburnum* represents the *Caprifoliaceæ* by a large number of leaves of different species of the Eocene. Their characters refer them as intermediate to *V. dentatum* and *V. lantanoides*, and one of them to *V. ellipticum* of Oregon. Professor Newberry describes in his Ancient Floras two species from the Fort Union group. We have none as

<sup>1</sup> *Hedera*, also, the well-known Ivy introduced from Europe, is of Cretaceous origin on this continent

yet from more recent formations. The fossil *Ericaceæ* are few and scarcely defined by their leaves. *Ambrosia Grayana* is recognized by Heer in the Miocene of Burrard Inlet and in that of Alaska. I have it from Spring Cañon, and, as far as it may be identified from the incomplete specimens, it is in the Dakota group already. The *Aquifoliaceæ* have species of *Ilex* from the Upper Miocene of Florissant: one belongs to the section *Aquifolium*; the others, with the one described here from the Pliocene, to that of the *Prinosides*. In the *Ebenaceæ* we find in the Cretaceous one species of *Diospyros*. The genus then is represented by two others from Black Butte, one from British Columbia, and one from Evanston. These are related to some of the species of the European Miocene. Another of a different character is described from Florissant. The *Lauraceæ* are already in the Dakota Cretaceous by leaves and fruit, and continue in all our geological formations in leaves indifferently referable to *Laurus* and *Persea*. It is the same with *Cinnamomum*, a genus mostly Miocene in Europe, where it has a number of specific forms. One American species, *C. affine*, closely related to the beautiful *C. Mississippiense*, of the Southern Tertiary Lignitic, is in the Eocene of Colorado and in the Miocene of Carbon. A *Tetraolhera* with leaves and branches bearing fruits, found at Evanston, is seemingly identical with *T. laurifolia* of Cuba. With this there is in the Cretaceous a prodigious quantity of leaves apparently referable to *Sassafras*, a genus known also from the Miocene of Greenland. If, therefore, no remains of *Sassafras* have been found until now in the subsequent geological formations of North America, this is probably to be accounted for by our limited acquaintance with our fossil flora, especially with that of the Lower Miocene. Of the *Oleaceæ*, species of *Fraxinus* are in the Eocene and in both stages of the Miocene. Hitherto I have passed in review the botanical divisions where the arborecent forms are not the predominant ones, and where therefore the series of the fossil representatives are forcibly interrupted. But, coming to the *Urticaceæ*, the *Amentaceæ*, and the *Conifera*, we find in the old formations such an array of species analogous to those of the present floras of Eastern North America, that these only would suffice to force the reference of the arborecent types of our vegetation to those of the geological times. *Ulmus* and *Platanus*, of comparatively recent origin, abound in the Upper Miocene of the Territories, the first represented by forms so very similar to those of the Pliocene of California and of the Atlantic flora that the specific differences are



very difficult to fix. *Platanus* has a number of species in the Cretaceous one, especially related to *P. occidentalis*. The same type is then followed by *P. Hardenii* of the Eocene, where other and different species are found also; by *P. aceroides* and *P. Gullivnae* of the Miocene of Carbon; and by the species of the Pliocene of California. It is the same with *Juglans* and *Carya*, not positively recognized, however, in the Cretaceous, but already present by different species in the Eocene of Colorado and the Mississippi, and henceforth in the subsequent formations. No less than six species of fossil *Juglans* have been described (without counting those of the Pliocene, where all the types are represented), and a fine *Carya*, *C. antiquorum*; generally found in a profusion of specimens. Of *Quercus*, two of the types of the present North American flora are already in the Cretaceous,—that of the *Q. castanea*, also in the Miocene of Alaska, wherefrom Heer describes a *Q. pseudo-castanea*, and that of *Q. imbricaria*. In the Eocene of Golden, *Q. angustiloba* recalls our *Q. falcata*. Eighteen forms of *Quercus*, recognized in the Lignitic Tertiary flora, show to those of our time an analogy becoming still more distinct by the species of the Pliocene. *Castanea* is Miocene, or even perhaps Cretaceous, by the leaves referred to the genus *Dryophyllum* of the European authors. Of *Fagus*, the Cretaceous leaves are not distinguishable by any evident characters from those of the living *F. sylvatica* and *F. ferruginea*. *Corylus* is Eocene. Dr. Newberry has described from the Fort Union group leaves of this genus under the specific name of *C. Americana* and *C. rostrata*, while *C. Macquarrii*, Heer, a species intermediate between these two, is richly represented in the Alaska Miocene flora. There we have also *Liquidambar*, *Myrica*, *Alnus*, *Betula*, *Carpinus*, in specific forms, if not identical, at least closely allied to those of the Eastern North American flora. These genera are mostly Miocene; one, *Myrica*, is in the Eocene of Black Butte. Leaves described as *Populites* from the Cretaceous of the Dakota group may represent the first forms of *Populus*, a genus which becomes more distinctly and more abundantly represented. Like *Myrica*, in the Upper Miocene of Colorado, where the type of *Comptonia* has two or three species. If we add *Salix*, distinct in the Cretaceous, the Eocene, and the Miocene by species analogous to those of our time and to one of those of the Pliocene, we have passed, without scarcely omitting any genus of arborescent plants, the whole series of the generic divisions described in Gray's flora, except the Conifers, which, though absent at some localities, — in the Eocene of Golden, for example, in the

Pliocene of the auriferous gravel of California also, — show by their representatives at other stations an uninterrupted relation to those of the present times. In the Cretaceous we find four species of *Sequoia*, one *Glyptostrobus*, and one *Pinus*. From the Eocene of Point of Rocks and Black Butte, a formation still considered by some geologists as Cretaceous, five species of *Sequoia* and two *Abietes* are described. *S. brevifolia* is very closely related to *S. Lungsdorffii*; and this, found also in the Eocene, and more abundant still in the Upper Miocene of Florissant, is, by the remarkable affinity of characters, the ancestor of *S. sempervirens*, the Redwood of California, as *S. affinis*, also of the Upper Miocene, is that of *S. gigantea* (the big trees). At Carbon, and in the same Miocene formation near Fort Fetterman, *Taxodium distichum (miocenicum)* abounds. Its name indicates specific identity with the Bald Cypress of the Atlantic flora.

I am forcibly limited here to this short review, where I cannot take into account any specifications and enter into details which would render more evident the relation of the present North American Eastern flora to that of the geological times. But this is enough to prove that from the Cretaceous up there is no break in the chain which unites by links of successive modifications the types of the present vegetation with those of the geological times.

Professor Gray in his Memoir on the Botany of Japan,<sup>1</sup> considering a few data derived from unimportant materials which I had obtained in the Chalk Bluffs of the Mississippi, recognizes, by a remarkable prevision, the ancient relations of the vegetation of the eastern slope of the continent. He says on the subject:<sup>2</sup> “Here may be adduced the direct evidence, recently brought to light, of the presence of the Live Oak (*Quercus virens*), Pecan (*Carya oliviformis*), Chinquapin (*Castanea pumila*), Planer-tree (*Planera Gmelini*), Honey Locust (*Gleditsia triacanthos*), *Prinos coriariens*, and *Acorus calamus*, besides an Elm and a *Ceanothus*, doubtfully referable to existing species,— on the Mississippi, near Columbus, Kentucky, in beds of a formation anterior to the drift, and whose position is indicated by Professor D. D. Owen as about one hundred and twenty feet below the ferruginous sand, in which the bones of the *Megalonyx Jeffersoni* were found. All the vegetable remains which have been obtained in a

<sup>1</sup> Memoir on the Botany of Japan, and its Relation to that of North America, in Mem. of the Amer. Acad. of Arts and Sci., Vol. VI. p. 447.

<sup>2</sup> Amer. Journ. of Science and Arts, 2d Ser. No. 81, May, 1859.

determinable condition have been referred, either positively or probably, to existing species of the United States flora, most of them now inhabiting a few degrees farther south.”<sup>1</sup>

Professor Heer also, in his *Flora of Alaska*, admits that the essential types of the North American vegetation of our time are far more distinct there than they are in the Miocene of Europe. This, therefore, invalidates the old hypothesis of the migration of vegetable Miocene species from Europe to America, a supposition which was warranted at the time by the relation of our present Northeastern flora with that of the European Tertiary.

What is known of the disturbances which have followed the Pliocene epoch in California is sufficient to explain the destruction of its flora. Professor J. D. Whitney says of the auriferous deposits of Tuolumne County, from which were obtained a large number of the specimens described here, that the Table Mountain covering them has been formed by a flow of lava which filled the valley after running forty miles down the slopes of the Sierra, and forming a continuous ridge elevated more than two thousand feet. The lava covers detrital beds of gravelly materials which in the centre of the valley are fully two hundred feet thick; and from the data exposed in detail in his Report, Professor Whitney estimates the amount of denudation, during the period since the volcanic mass took its present position, at three or four thousand feet of perpendicular depth. And yet this was done during the most recent geological epoch, and these surprising changes have not been peculiar to this region, but the whole slope of the Sierras through the gold region has been the scene of similar volcanic overflows and subsequent remodellings of the surface into a new system of relief and depressions.<sup>2</sup>

This tells the whole story, and clearly accounts for the disappearance of a number of vegetable Pliocene types in California during the recent geological epochs by marine submersion, the all-destroying glacial agency, and volcanic cataclysms of long duration; and contrariwise it explains their preservation on the eastern part of the continent, where the destructive

<sup>1</sup> Some of the species of the Chalk Bluffs of California have a remarkable affinity to those of the Pliocene of the Mississippi, above referred to by Professor Gray. — *Quercus cirrus* and its varieties, for example. The lithological characters of the clay-beds, which at Columbus, Kentucky, are overlaid by a thick deposit of agglomerated gravel, are also the same, so that it might not be inconsistent to admit synchronism for the two formations.

<sup>2</sup> Geological Survey of California, by J. D. Whitney, State Geologist. — *Geology*, Vol. I, pp. 244, 245.

influences have left less irrefragable marks of their activity. The vestiges of glacial action — moraines, erosions, striated rocks — are seen everywhere in the valleys of California; while the glacial drift on the eastern slope of the United States scarcely passes south of the Ohio River. And as the immense plains extending from the Missouri River to the base of the Rocky Mountains have evidently been covered by water during the prevalence of the terrace epoch, or after the glacial period, this barrier, and also that of the chain of mountains still more impassable to plants than to water, forcibly prevented a western redistribution of the species destroyed in California by glacial agency.

Notwithstanding these destructive influences, the flora of California still preserves a few of the Pliocene types, and these, by their present habitat and the apparent modifications of their characters, seem to point to what have been the essential causes of the disappearance of the others. For instance, *Betula aquatica*, *Acer Bolanderi*, *Cercocarpus antiquus*, have now representatives which seem to have been gradually dwarfed or modified by the influence of the cold, and thus acclimatized gradually to the temperature of the subalpine zone which they now inhabit. Preserved during the glacial period in some sheltered nook, they have thus apparently wandered gradually to the mountains, following the disappearance of the ice. A few other species have remained with their typical characters and their habitat, — *Castanopsis chrysophylla* and *Cornus Kelloggii*, for instance, plants of hard texture and of great tenacity of life. According to the data kindly furnished by Professor Bolander, these species inhabit now near Oakland from an altitude of 1,800 feet to the Sierras, where *Castanopsis chrysophylla* is met with to an altitude of 8,000 feet. Very few, if any, arborescent species of the present time have such a vertical range of more than five thousand feet. *Cornus Kelloggii*, according to the same authority, occupies the base of densely wooded slopes of the Sierras, or is found in open places, where there is sufficient terrestrial moisture; even in boggy places of the Yosemite Valley, ascending to 5,000 feet. Another species, *Cornus ovalis*, which was probably very abundant in the Pliocene flora, has been about totally destroyed in California. It looks like an isolated remnant of a type mostly driven southward at the glacial period, and now inhabiting Mexico. The two species of *Sequoia* — one the more predominant, the other the more remarkable, of the flora of California — are evidently also remnants of the Pliocene, *S. gigantea*, which

in all probability covered the higher slopes of the mountains of that epoch, has been destroyed everywhere, except in some deep valleys surrounded with walls of high granitic peaks, where it stands as a wonder of the vegetation of this continent. The other, *S. sempervirens*, left here and there, has again taken the ascendancy under more favorable physical circumstances. Its present distribution explains its preservation until the present epoch. According to Professor Bolander, "the distribution of the Redwood depends upon sandstone and oceanic fogs. Where either one of these conditions is wanting there is no Redwood. The Redwoods begin in the northern part of Monterey County, in isolated groups, in deep, moist cañons. A short distance south of Monterey City, on the Monterey Bay, a white bituminous slate sets in, and extends nearly to Pajaro River. On this no Redwood is found but *Pinus insignis*. At Pajaro River, eight to ten miles from the ocean, they set in again, and extend to nearly twenty-eight miles south of this city (San Francisco), either in deep cañons, or in groves extending over several ridges eastward as far as the fog may reach. Thus they continue in similar localities to latitude 42°, the State boundary."

From these facts, as also from what is known of the general distribution of Conifers, generally depending on a high degree of atmospheric moisture, the character of the flora of the Chalk Bluffs indicates the geographical station of the localities where the Pliocene plants have been found, as that of a region sheltered by ranges of mountains against the influence of the Pacific fogs, and whose vegetation has been influenced by circumstances analogous to those governing it, as at the present time.

The plants described here from the Pliocene clearly expose the climate of the period which they represent. They record a temperature a few degrees higher, in the average, than that of Middle California, or, like the species of the Chalk Bluffs of the Mississippi, they represent a latitude of a few degrees farther south. The Palms were very rare in this flora; only a single specimen of a *Sabal* is found in the whole collection. Nevada County is on the 39th parallel of latitude, and a species of Palm still inhabits California under the 34th degree. For the Mississippi Valley, *Sabal* and *Chamærops* species have their northern limits also under this same latitude. The action of a warmer climate seems indicated by the Oaks of the Mexican type, and by species of *Ficus*; but this is counter-

balanced by species of *Betula*, *Fagus*, *Ulmus*, etc., whose range of distribution goes much farther north, and scarcely descends below the 36th parallel. Hence, a climate like that of the gulf shores, the zone of the Live Oak, is about the same as that represented by the fossil plants described from Nevada County.

As a conclusion to these remarks, the essential points of information derived from the examination of the groups of plants of the Chalk Bluffs of Nevada and Tuolumne Counties, California, may be briefly recalled as follows:—

1. This flora is, up to this time, limited to fifty species. These are related by some identical or closely allied forms to the Miocene, and still more intimately by others to the present flora of the North American continent.

2. The North American faëies is traced by some species to the Miocene, the Eocene, even the Cretaceous of the Western Territories. Hence it is not possible to persist in considering the essential types of the present North American flora as derived by migration from Europe or from Asia, either during the prevalence of the Miocene or after it. This flora is comatural and autochthonic.

3. The relation of the Pliocene plants of Nevada and Tuolumne Counties is with the flora of the Atlantic slope, and not with that of California at the present time. This fact is explained by the influence of glacial action during the prevalence of the ice period, and is even clearly exposed by the distribution of the few Pliocene species remaining in the flora of the Pacific coast. The modification of the characters of the present flora of California have, therefore, to be looked for in climatic or other phenomena subsequent to the glacial period. This remarkable fact, so clearly demonstrated by nature, may serve as an exemplification of the causes of the disconnection of some of the other groups of our geological floras.

4. This small group of Pliocene fossil plants from California denotes the importance of the study of the North American Pliocene in relation to that of the characters and of the distribution of the present flora of the continent. Professor A. Gray, as seen above, has already alluded to the probable evidence which might hereafter be obtained bearing on the

subject from an acquaintance with the vegetable remains preserved in abundance in the Pliocene and post-Pliocene deposits of the Mississippi and the lower Ohio River. An immense amount of material is there buried, awaiting future investigations. This will prove even more important to botanists and palaeontologists than those plants which I have had the opportunity of describing in this memoir.

A COMPARATIVE TABLE, EXPOSING THE RELATION OF THE PLANTS DESCRIBED ABOVE.<sup>1</sup>

Species described.	Miocene species, identical or closely related.	Species of the present Flora identical or closely allied.	Habitat of the Related Species.
1. <i>Salicites Californicus</i> , Lx.	Relation unknown.		
2. <i>Betula repalis</i> , Lx.		† <i>Betula occidentalis</i> , Hook.	Rocky Mountains, Utah, etc.
3. <i>Fagus Antipodi</i> , Heer.	<i>Fagus Antipodi</i> , Heer.	† <i>Fagus ferruginea</i> , Ait.	Miocene Alaska and Russia.
4. " <i>pseudo-ferruginea</i> , Lx.		† <i>Quercus virgens</i> , Ait., <i>Q. cinerea</i> , Michx.	Eastern United States.
5. <i>Quercus elaeoides</i> , Lx.	<i>Quercus elena</i> , Ung.	" <i>virgens</i> , var. <i>anaea</i> , Willd.	Southern U. S., European Miocene.
6. " <i>convexa</i> , Lx.		" <i>castanea</i> , Willd.	Southern United States.
7. " <i>Nevadensis</i> , Lx.		" <i>crassifolia</i> , H. & B.	Eastern United States.
8. " <i>Boweniana</i> , Lx.		" <i>agrifolia</i> , Nees.	Mexico.
9. " <i>distincta</i> , Lx.		" <i>Humboldtii</i> , H. & B.	California.
10. " <i>Goepferi</i> , Lx.		" <i>agrifolia</i> , Nees.	Mexico.
11. " <i>Voyana</i> , Lx.		† " <i>lyrata</i> , Walt.	California.
12. " <i>pseudo-lyrata</i> , Lx.		† <i>Castanopsis chrysophylloides</i> , Hook.	Southern United States.
13. <i>Castanopsis chrysophylloides</i> , Lx.		† <i>Salix sessilifolia</i> , Nutt.	California.
14. <i>Salix Californica</i> , Lx.		" <i>capricornis</i> , Aulder.	"
15. " <i>cliptica</i> , Lx.	<i>Salix varians</i> , Goepf.	" <i>capricornis</i> , Aulder.	" European Miocene.
16. <i>Populus Zaddachi</i> , Heer.	<i>Populus Zaddachi</i> , Heer.		Eur., N. Am., and Greenland Miocene.
17. <i>Platanus appendiculata</i> , Lx.			Mexico.
18. " <i>dissecta</i> , Lx.		<i>Platanus lindemiana</i> , Mart.	Eastern United States.
19. <i>Liquidambar Californicum</i> , Lx.	<i>Liquidambar Europaeum</i> , Al. Br.	" <i>occidentalis</i> , L.	Japan (Alaska, fossil).
20. <i>Ulmus Californica</i> , Lx.		<i>Liquidambar acerifolium</i> , Max.	Eastern and Southern United States.
21. " <i>pseudo-falva</i> , Lx.		† <i>Ulmus alata</i> , Michx.	"
22. " <i>affinis</i> , Lx.		† " <i>falva</i> , Michx.	" " " "
23. <i>Ficus sordida</i> , Lx.	<i>Ficus tenuinervis</i> , Lx.		Upper Miocene, Colorado.
24. " <i>tiliartolia</i> , Al. Br.	<i>Ficus Greenlandica</i> , Heer.		Greenland Miocene.
25. " <i>microphylla</i> , Lx.	" <i>tiliaefolia</i> , Al. Br.		Miocene, Europe and America.
26. <i>Persca pseudo-Carolinensis</i> , Lx.	" <i>planicostata</i> , Lx.		Eocene, Colorado and Wyoming.
		† <i>Persca Carolinensis</i> , Nees.	Southern United States.



27. <i>Aralia Whitneyi</i> , Lx.	<i>Aralia notata</i> , Lx.	<i>Aralia papirifera</i> of Japan.	Upper Eocene, Western Terr., U. S.
28. " <i>Zadlachi</i> , ? Heer.	" <i>Zadlachi</i> , Heer.		Baltic Miocene.
29. " <i>angustifolia</i> , Lx.	? " <i>digitata</i> , Ung.		Miocene, Europe. (Cretaceous, N. A.
30. <i>Cornus ovalis</i> , Lx.		† <i>Cornus mas</i> , Linn. <i>C. sessilis</i> , Tor.	Asia, California.
31. " <i>Kelloggii</i> , Lx.		† " <i>Nuttallii</i> , Audub.	California.
32. <i>Magnolia lanceolata</i> , Lx.		† <i>Magnolia acuminata</i> , Linn.	Southern United States.
33. " <i>Californica</i> , Lx.		† " <i>cordata</i> , Michx.	" " "
34. <i>Acer aquidentatum</i> , Al. Br.	<i>Acer vitifolium</i> , Al. Br.	<i>Acer spicatum</i> , Lam.	Eastern U. S. Fossil, Eur. Miocene.
35. " <i>Bolanderi</i> , Lx.		<i>Acer tripartitum</i> , Nutt., and <i>Acer grandidentatum</i> , Nutt.	Rocky Mountains and California.
36. <i>Ilex prunifolia</i> , Lx.		<i>Ilex decubita</i> , Walt.	Northern & Southern United States.
37. <i>Zizyphus microphyllus</i> , Lx.	Relation unknown.	? <i>Ceanothus velutinus</i> , Dougl.	California.
38. " <i>piperoides</i> , Lx.			
39. <i>Rhus typhina</i> oides, Lx.		† <i>Rhus typhina</i> , Linn.	Eastern United States.
40. " <i>Boweniana</i> , Lx.		" " "	" " "
41. " <i>mixta</i> , Lx.		" " "	" " "
42. " <i>myricaeifolia</i> , Lx.	Relation unknown.		
43. " <i>metopoides</i> , Lx.		† " <i>metopium</i> , Linn.	Florida and Cuba.
44. " <i>dispensa</i> , Lx.	Relation unknown.		
45. <i>Zanthoxylon diversifolium</i> , Lx.	? <i>Zanthoxylon integrifolium</i> , Heer.	? <i>Zanthoxylon triphyllum</i> .	Brazil, and fossil, Eur. Miocene.
46. <i>Juglans Californica</i> , Lx.	<i>Juglans acuminata</i> , var. <i>latifolia</i> , Heer.	† <i>Juglans regia</i> .	Asia. Fossil, Am. & Eur. Miocene.
47. " <i>Oregoniana</i> , Lx.	" <i>nigella</i> , Heer.	" <i>rupestris</i> , Engelm.	S'thern U. S. Fossil, Alaska Miocene.
48. " <i>kurinica</i> , Lx.	? " <i>bifurca</i> , Ung.		Miocene, Europe.
49. " <i>egregia</i> , Lx.	Relation unknown.		
50. <i>Cercocarpus anti-quius</i> , Lx.		† <i>Cercocarpus Fothergilloides</i> , H. B. & K.	Mexico.

† Very close affinity, or rather probable identity is marked by a †; distant relation by a ?; preceding the specific name.

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# APPENDIX.

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## DESCRIPTION OF FOSSIL LEAVES FROM THE TUNNEL OF THE NORTH FORK COMPANY, NEAR FOREST CITY.\*

### **Quercus transgressus**, sp. nov.

*Leaf coriaceous, short-petioled, oblong-orate, tapering to a short acumen, rounded at base to a short petiole; borders entire, recurved; lateral nerves open, parallel, numerous, 12-14, interlinked by distinct transverse nervilles.*

This leaf, five centimeters long, represents a species closely allied to *Quercus chrysolepis*, D. C., of California. From the statements of authors, this oak is abundantly distributed from the plains to the mountains. Among my specimens there is, sent by Dr. Kellogg from the Sierra Nevada, a branch bearing coriaceous, entire leaves, with the same characters as the fossil one. Considering merely this specimen, I should be authorized to refer the fossil leaf to this species; but the normal form has leaves more or less dentate. If this characteristic should be, after further discoveries, recognized upon other fossil leaves of the same formation, the identity of the Pliocene oak with *Q. chrysolepis* should be clearly established.

### **Quercus Steenstrupiana?** HEER, *Arct. Fl.* I. p. 109. Pl. XI. Fig. 5; XLVI. Figs. 8, 9.

*Leaf small, four to five centimeters long (the upper part is broken), acute-lanceolate, rounded in narrowing to the unequal base, obscurely dentate on the borders; lateral nerves close, parallel, entering the teeth, which in this specimen are scarcely distinct, the borders being mostly destroyed.*

\* The specimens here described were collected by Professor Pettee, in 1879, in a tunnel near the Bald Mountain tunnel on the North Fork of Oregon Creek (see Plate Q), about 4,500 feet above the sea-level, and twenty miles north of Chalk Bluffs. Localities in the hydraulic mining region where the leaves are sufficiently well-preserved for identification are not common; and, in view of the fact that as much light as possible is desired in regard to the nature and range of the Pliocene vegetation, it was considered best that these specimens should be referred to Mr. Lesquereux for examination, and the results published as an appendix to his previous communication on the subject of the fossil plants of the auriferous gravels. — J. D. W.

Of course no satisfactory comparison can be made from such an incomplete fragment. Heer describes the leaves of his species as doubly, sharply dentate, the intermediate teeth being entered by branches of the lateral veins. In the specimen from California the veins branch in the upper part and tend to the borders, as in the leaves represented by Heer from Greenland specimens, and this direction indicates a duplicate denticulation of the borders. This, however, is not positive evidence. Heer compares his species to the living *Quercus cuspidata*, Thunb. of Japan.

***Quercus pseudo-chrysophylla*, sp. nov.?**

*Leaf coriaceous, twelve centimeters long, oblong or ovate-lanceolate, rounded at base to a short thick petiole, gradually narrowed from the middle upwards, or tapering to a short acumen; borders distantly obscurely dentate; lateral nerves very oblique, curved in passing up, and tending toward the teeth, thick, abruptly forking in two branches of diminutive size just near the borders, one of the divisions entering a tooth, the other passing under it and joining tertiary branches in the middle of lateral areas.*

The leaf is finely preserved. Comparing it to some of the numerous varieties of *Quercus chrysophylla*, Humb. and Bonpl., it is scarcely possible to doubt its specific identity. It has the same shape, the same size, the same consistence, and the same nervation. The lateral nerves are slightly more oblique, the angle of divergence being  $80^\circ$ . But in the numerous specimens of *Q. chrysophylla* which I have for comparison, the leaves vary in length from four to twelve centimeters, and the angle of divergence of the lateral nerves is between  $40^\circ$  and  $80^\circ$ . The essential character of the nervation, the forking of the lateral nerves near the borders, distinct only in one species of the Miocene, *Quercus furcinervis*, is still more marked in the Pliocene leaf of California, as it is also in those of the living *Q. chrysophylla*.

*Habitat.* — This species now inhabits the Sierra Nevada, from Oregon to Monterey, to an altitude of 6,000 feet.

One of the specimens, No. 43, represents a fragment of a large leaf, apparently of *Ficus tiliifolia*, described on p. 18 (Pl. IV. Figs. 8, 9).

***Acer arcticum***, HEER, Arct. Fl. IV. p. 86. Pl. XXII. Figs. 4, 7; Pl. XXIII. Figs. 4, 5.

*Leaf of medium size, six and a half centimeters long and as broad in the middle, triangular in outline, truncate cordate at the base, obscurely palmately five-nerved and five-lobed, coarsely sinuate-dentate on the borders.*

As in some of the leaves (in Heer, l. c.) to which this is comparable, the palmate division of the lower lateral nerves is not very definite, the inferior

pair being thinner and more like marginal veins than like primary nerves. For this reason the lobes are not distinct, or scarcely more prominent than the obtuse large teeth of the borders. By this character this leaf corresponds partly to the first of the subdivisions established by Heer in this description, *leaves as broad as long, short-lobed, broadly obtusely dentate*, and partly to the fourth division, wherein he includes truncate or sub-truncate leaves. The identification of this finely preserved leaf is positive.

The relation of this species is with the present North American *Acer spicatum*, the mountain Maple, whose range in the Northern States is from the Atlantic to the Mississippi.

### **Acer, species.**

The specimen shows only the middle part of a leaf. It is *trilobed, the lobes separated by deep narrow obtuse sinuses; coarsely sinuate dentate on the borders*. As far as the characters are recognizable, the fragment represents a leaf equally referable to *Acer macrophyllum*, Pursh, and to *Acer grandidentatum*, Nutt. It is intermediate in size, but comes nearer the last of these species, especially similar to a large form of *A. grandidentatum*, which I collected in the Ogden Cañon of Utah.

It is to be regretted that the fragment is not in a better state of preservation, and that it cannot be ascertained if this leaf of the Pliocene does not positively represent a species intermediate between *A. macrophyllum* and *A. grandidentatum*, or an older type, modified by peculiar circumstances forcing it to migrations, partly to the mountains where it became dwarfed, partly to the south wherefrom it returned later and during the present period with an amplitude of foliage resulting from a habitat in a warmer climate.

Another specimen, No. 50, represents a large leaf, apparently referable to *Magnolia lanceolata*, p. 24, Pl. VI. Fig. 4.

The borders are erased, the nervation is obscure, the determination is not certain.

In a lot of specimens, sent for examination by Professor William Denton, I found a few fragments of leaves from the Chalk Bluffs, in Nevada County. They represent *Quercus conradii*, Lesq., *Aralia Zuddachi*, Heer, species already published from the same locality, and an *Acer*, new for this flora. It is *A. scottiana*, Sap., a species found in France by the author, in the Gypsies of Aix, therefore an old type, at least Miocene if not older.\* The leaf is three palmately nerved and palmate-trilobate; the medial lobe longer, and sparingly dentate or minute-lobed; but the lower part of the leaf is entire. In all its characters it seems

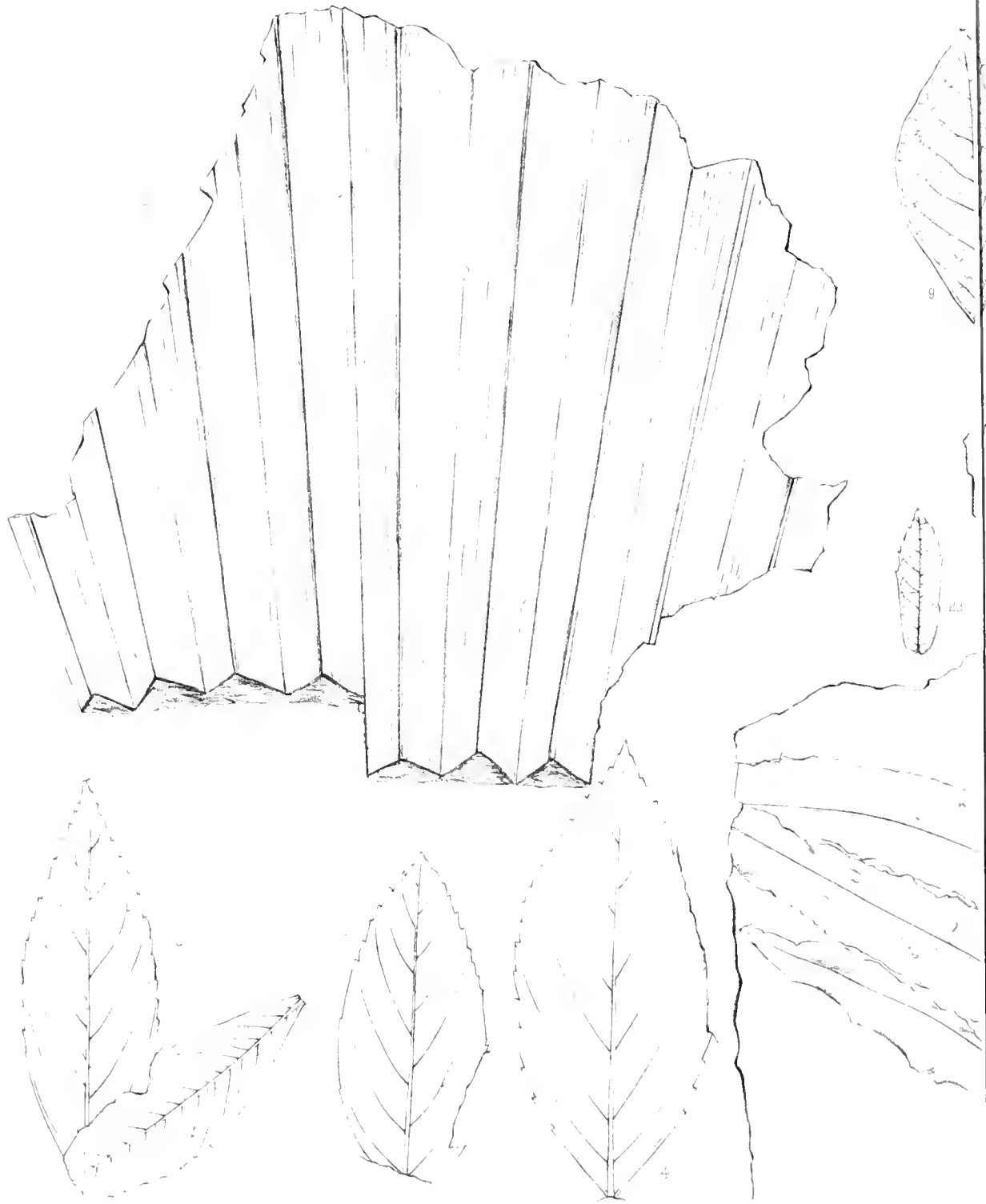
\* Saporta considers the formation as continuous from the upper Cretaceous to the lower Miocene. It has, however, a number of species identified in the Green River Group of the Rocky Mountains.

like a counterpart of the fragment figured by the French author, who refers it to a group of Maples, which includes among others *A. coccineum*, Michx.

The conclusions to be derived from the determination of these few fossil species fully coincide with what has been exposed by the table indicating the relation of the plants described in the report on the flora of the auriferous gravel deposits. The group is Miocene by one species of *Acer* and one of *Quercus*, while it has of each of these genera one species living at the present epoch. It has also an *Acer* positively identified with a species of the Gypses of Aix. Its relation therefore to the Miocene flora is more distinctly marked than to the flora of the present period. It has two Atlantic types, not present now in the Pacific slope, and two exclusively Californian ones, represented now by one species of wide distribution, *Quercus chrysolepis*, and by another probably modified by local influence, an *Acer*, intermediate between *Acer macrophyllum* and *A. grandidentatum*.

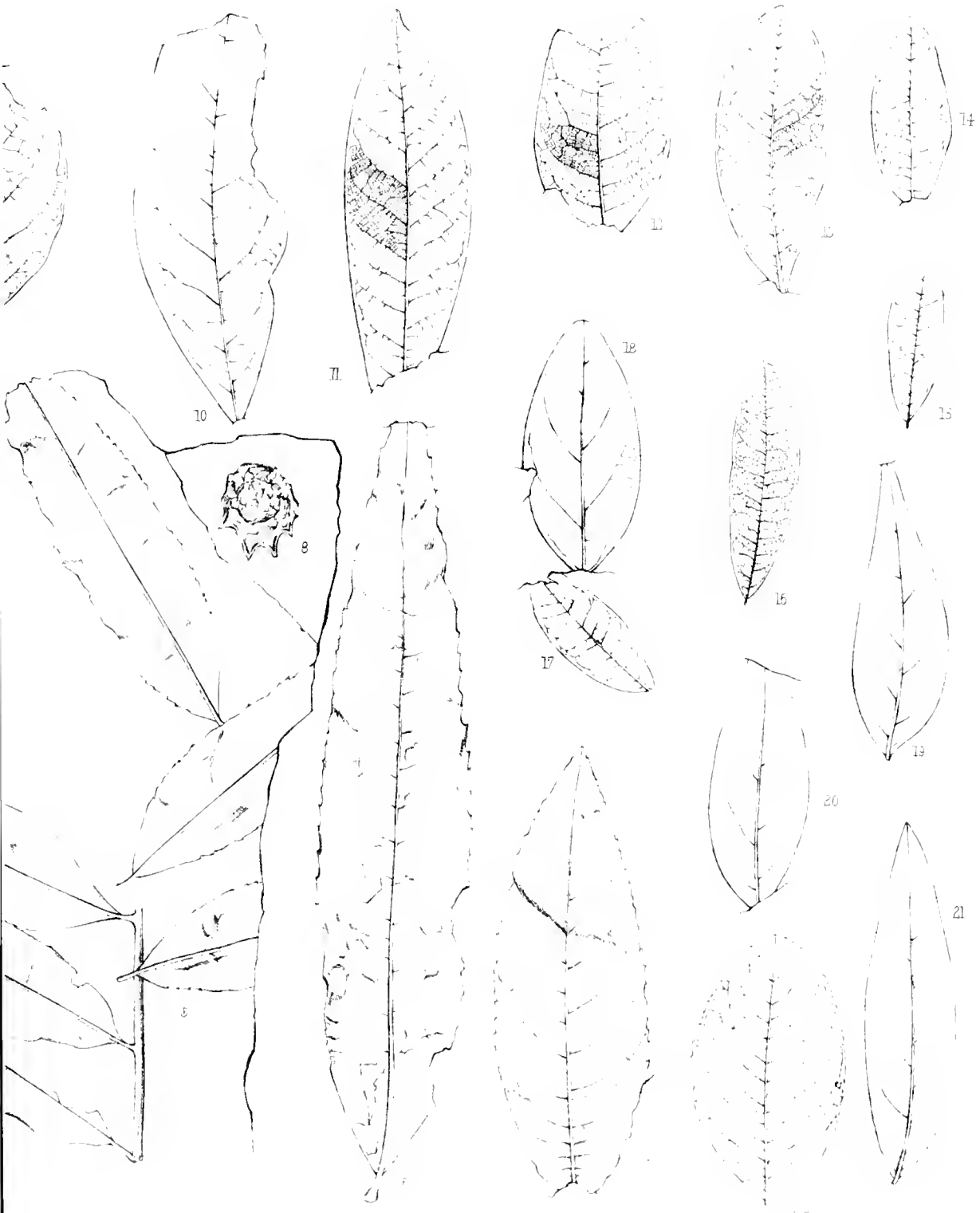
The relation to the Pliocene of Europe rests as it was formerly indicated, on the analogy, not identity of one species only.



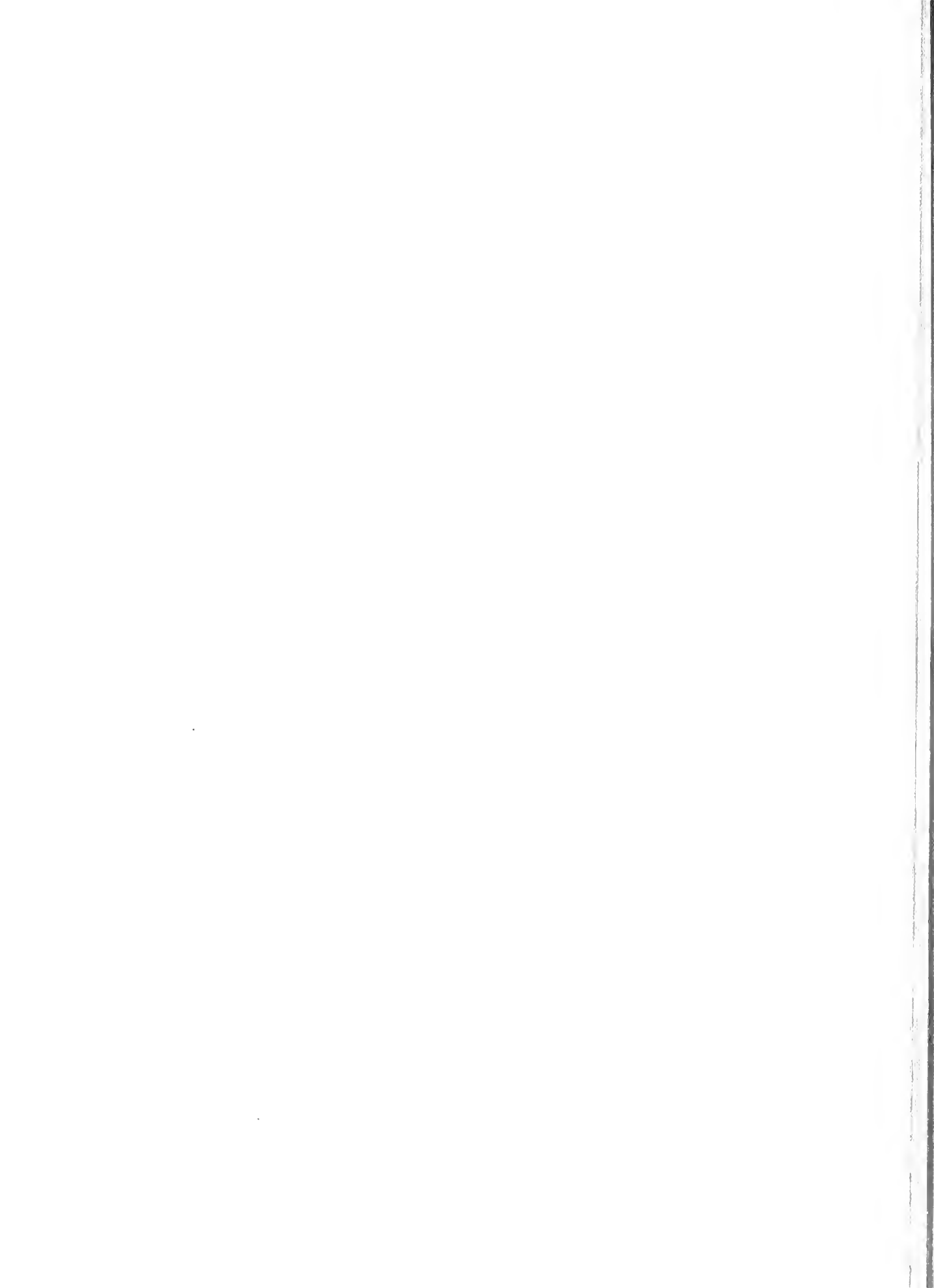


1.—*Salalite Californicus.*  
 2-4.—*Betula copulata.*  
 5-7.—*Rhus myricifolia.*  
 8.—*Ficus lucida.*  
 9-12.—*Quercus densata.*

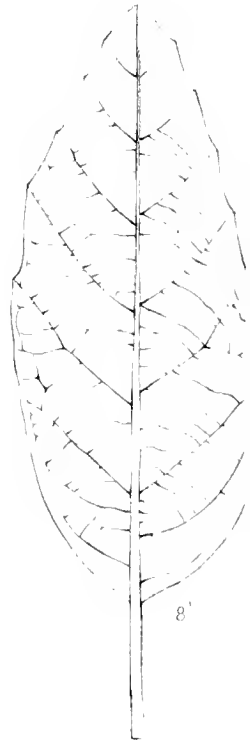
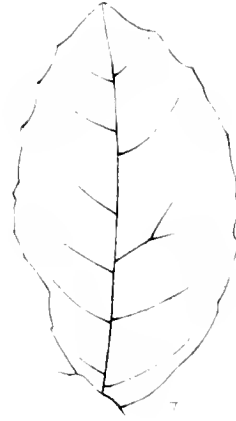
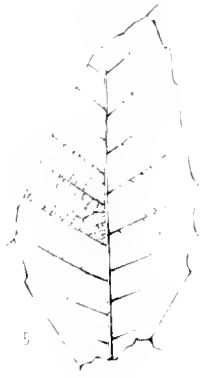




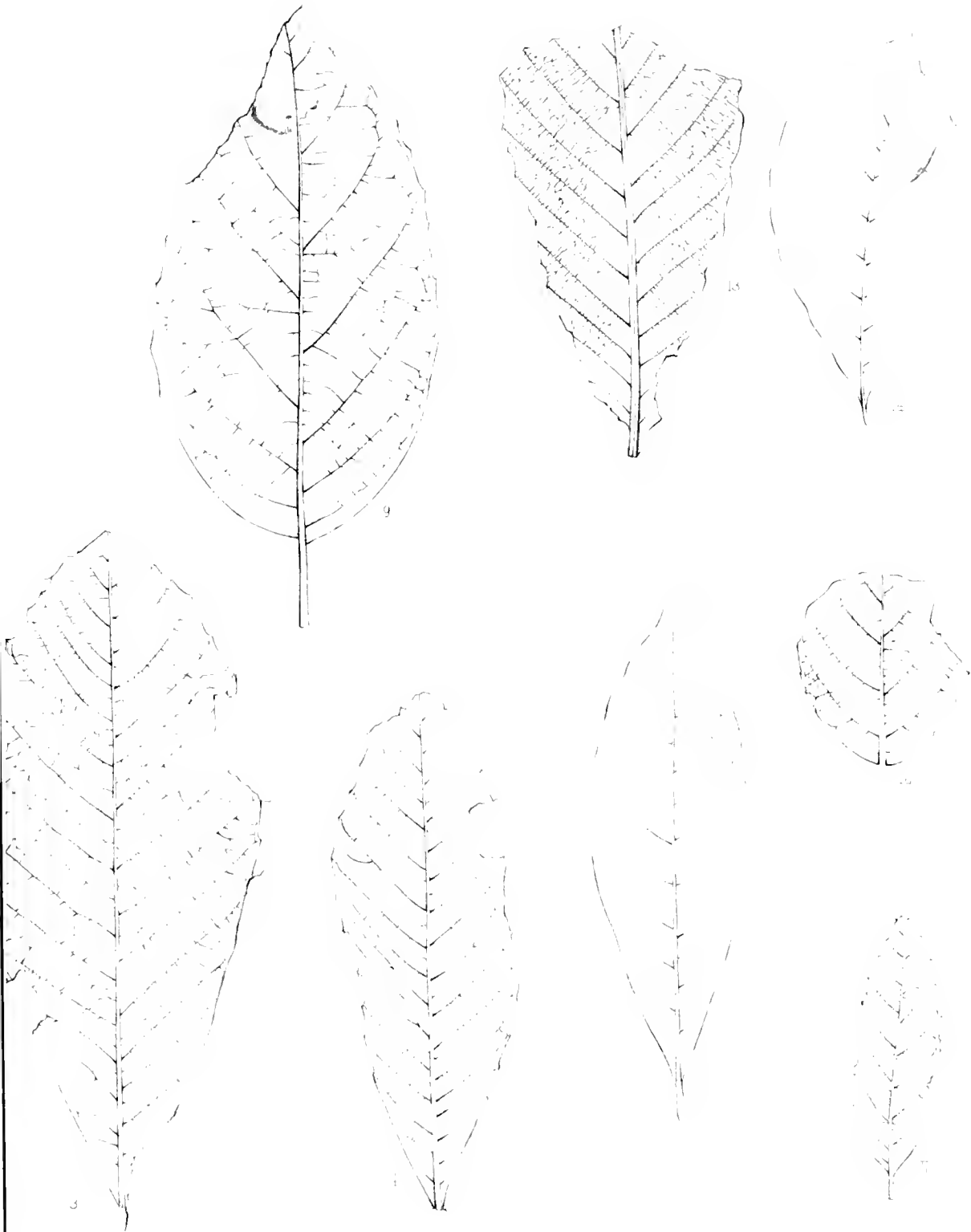
13-17.—*Quercus convexa*.  
18-21.—*Salix Californica*.  
22.—*Salix elliptica*.  
23.—*Rhus ilicifolia*.



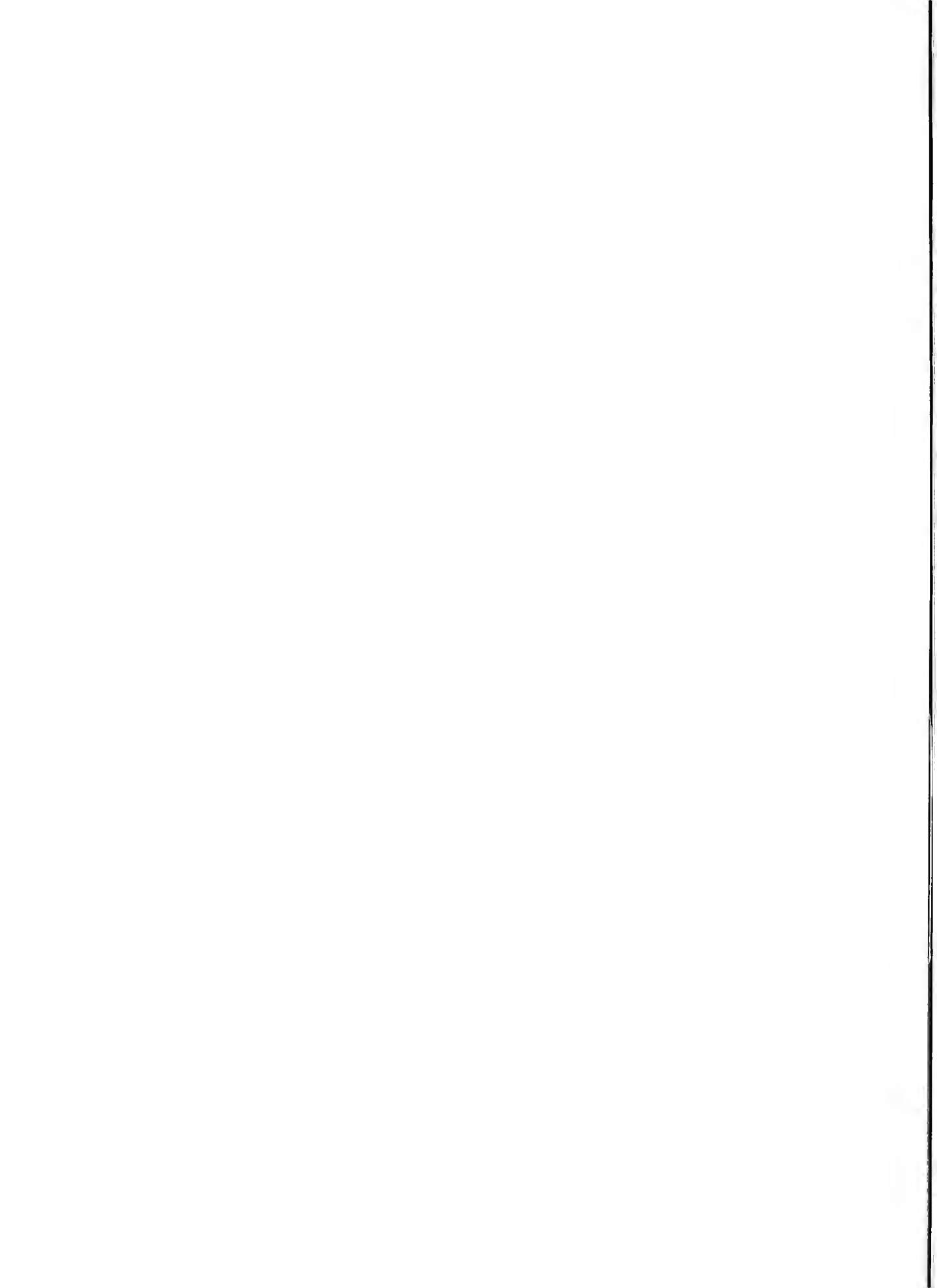




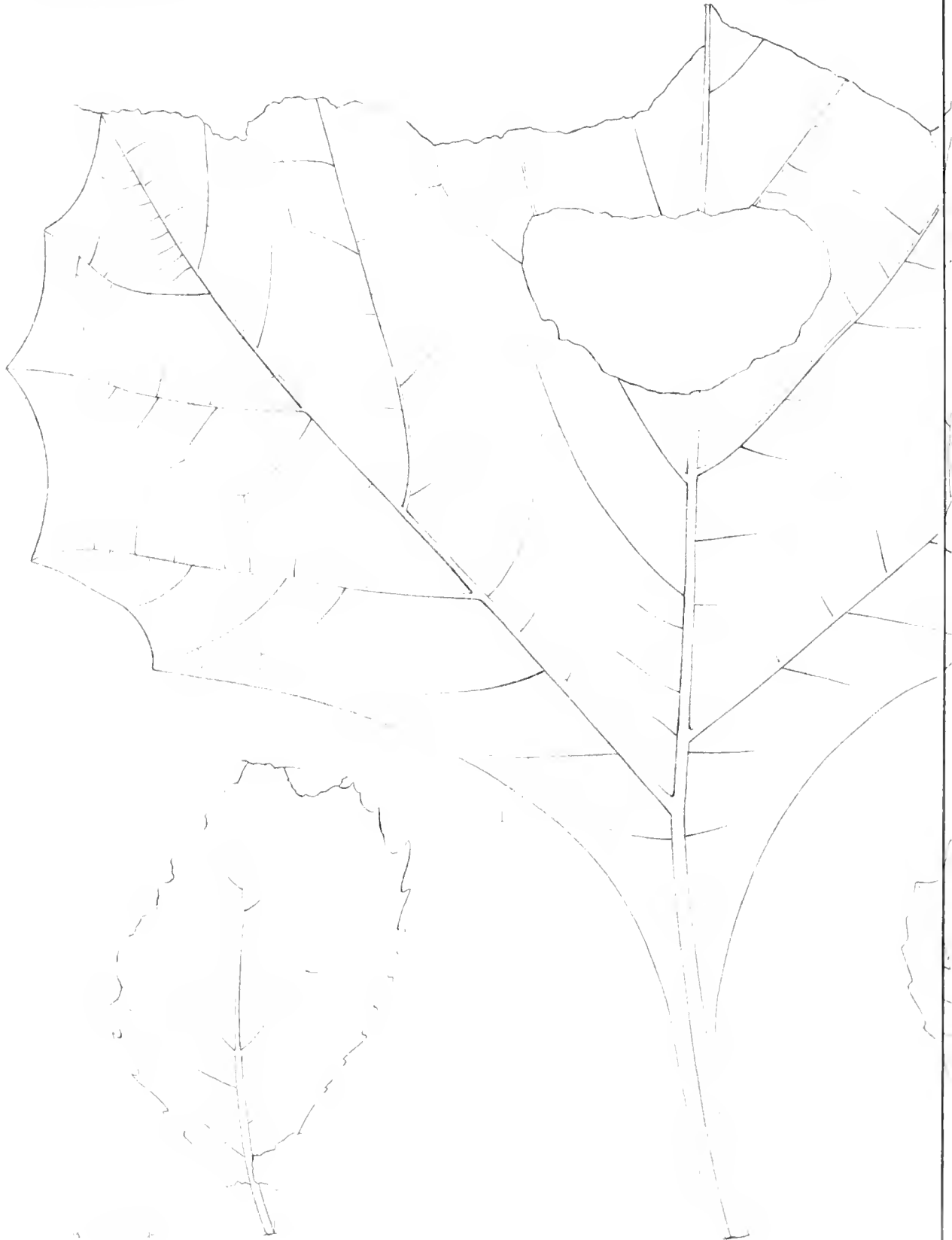
- 1, 2.—*Quercus pseudo-lyrata*.  
 3, 4.—*Quercus Nevadensis*.  
 5, 6.—*Quercus Boweniana*.  
 7, 9.—*Quercus distincta*.  
 10.—*Castanopsis chrysophyloides*.



11.—*Quercus Goeperti*.  
12.—*Quercus Vovana*.  
13.—*Fagus Antipoffi*.  
14.—*Fagus pseudo-ferruginea*







1-6.—*Platonia*

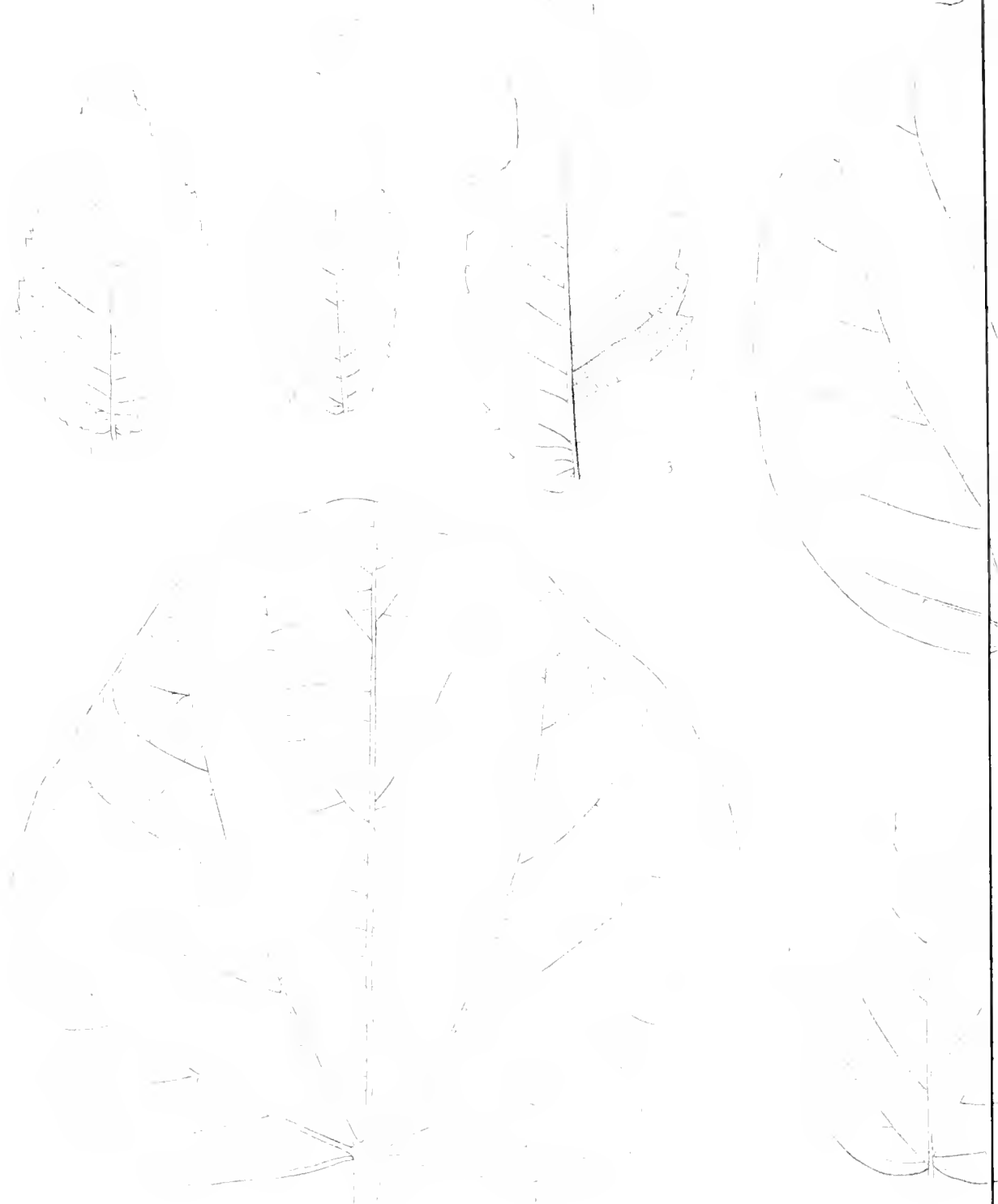




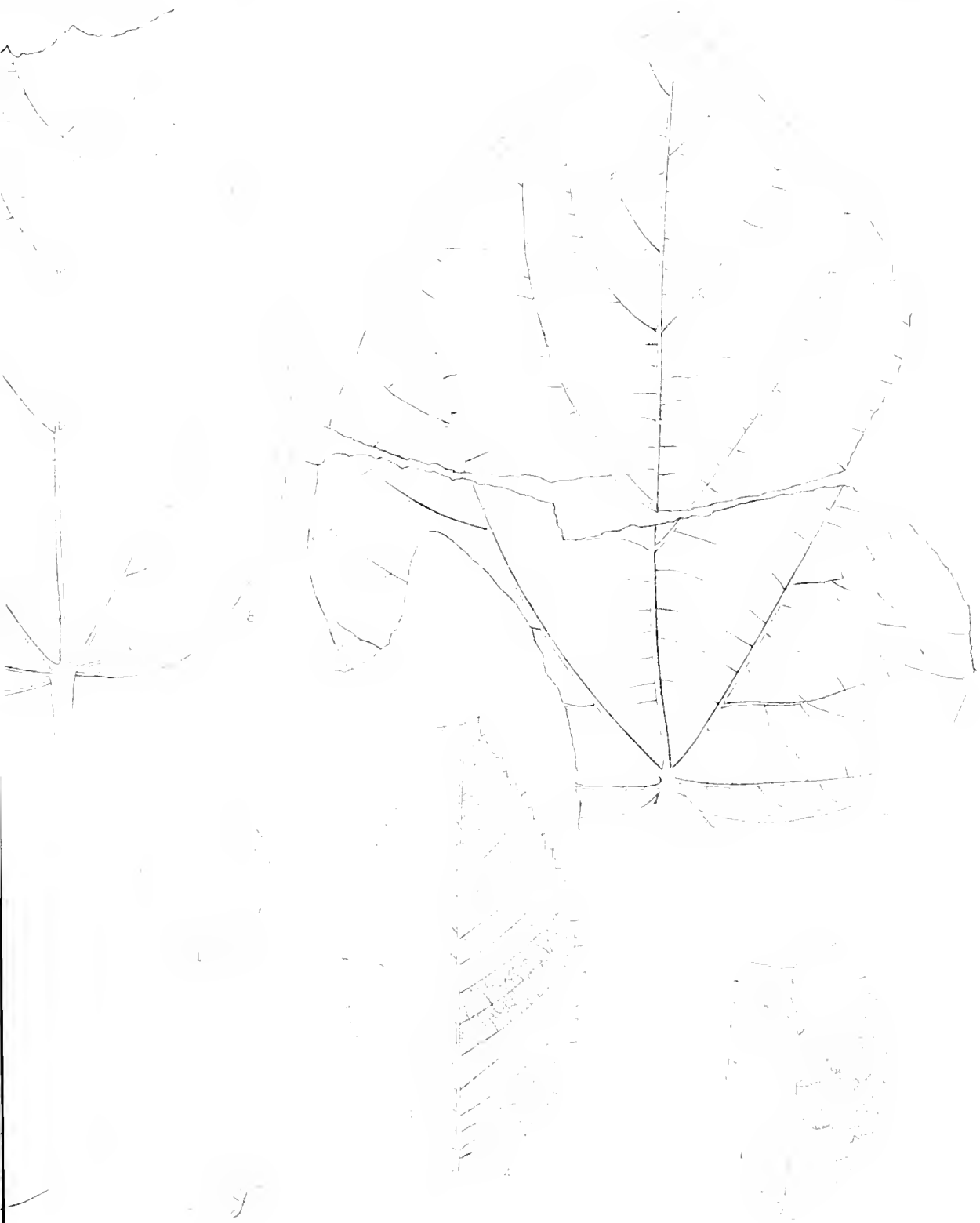
*s. appendiculata.*



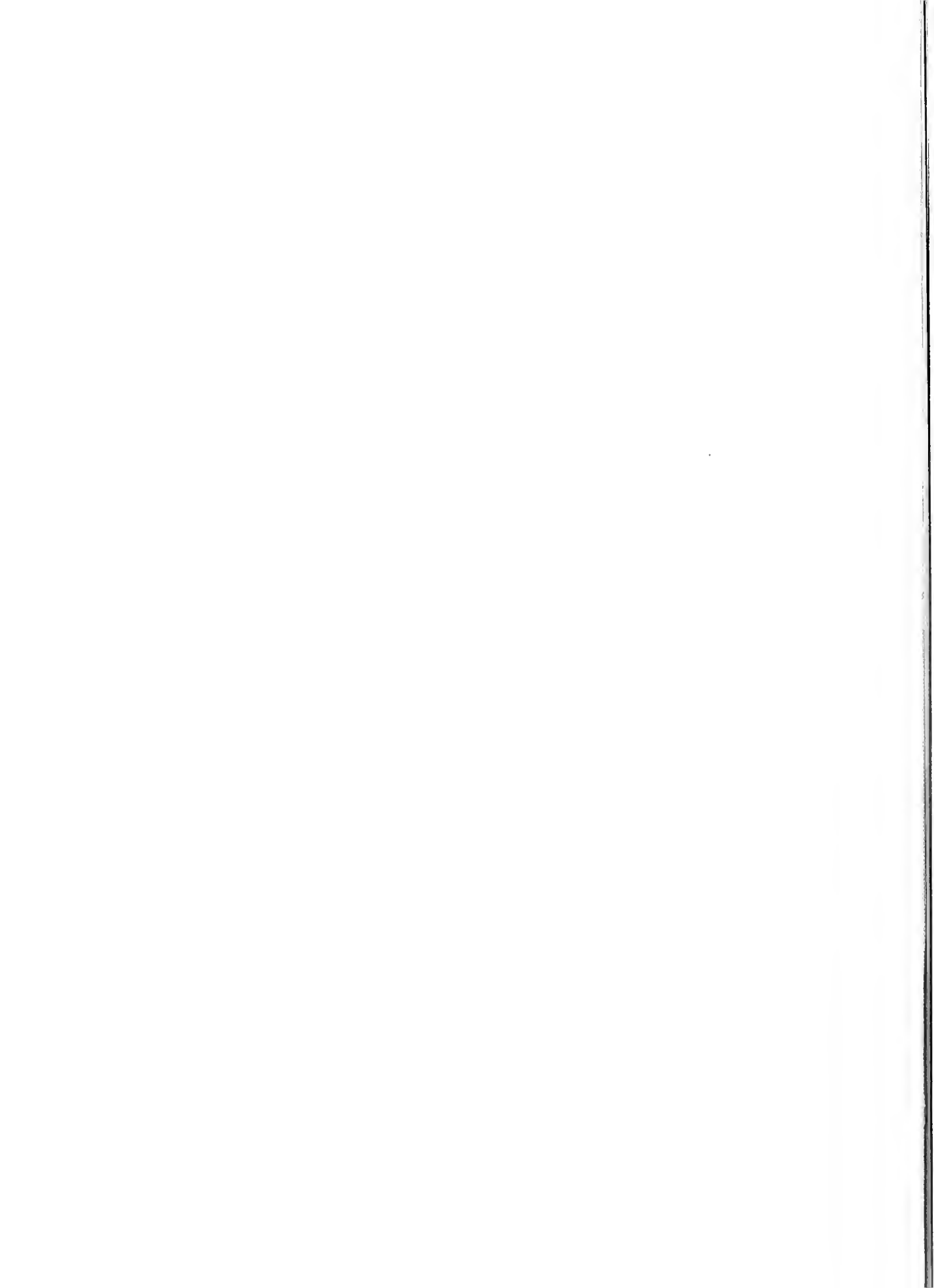




1, 2. - *Ulmus Californica*.  
3. - *Ulmus pseudo fulva*  
4, 5. - *Ulmus alpinus*.



6, 7.—*Ficus sordida*.  
8, 9.—*Ficus tiliifolia*.  
10, 11.—*Ficus microphylla*.

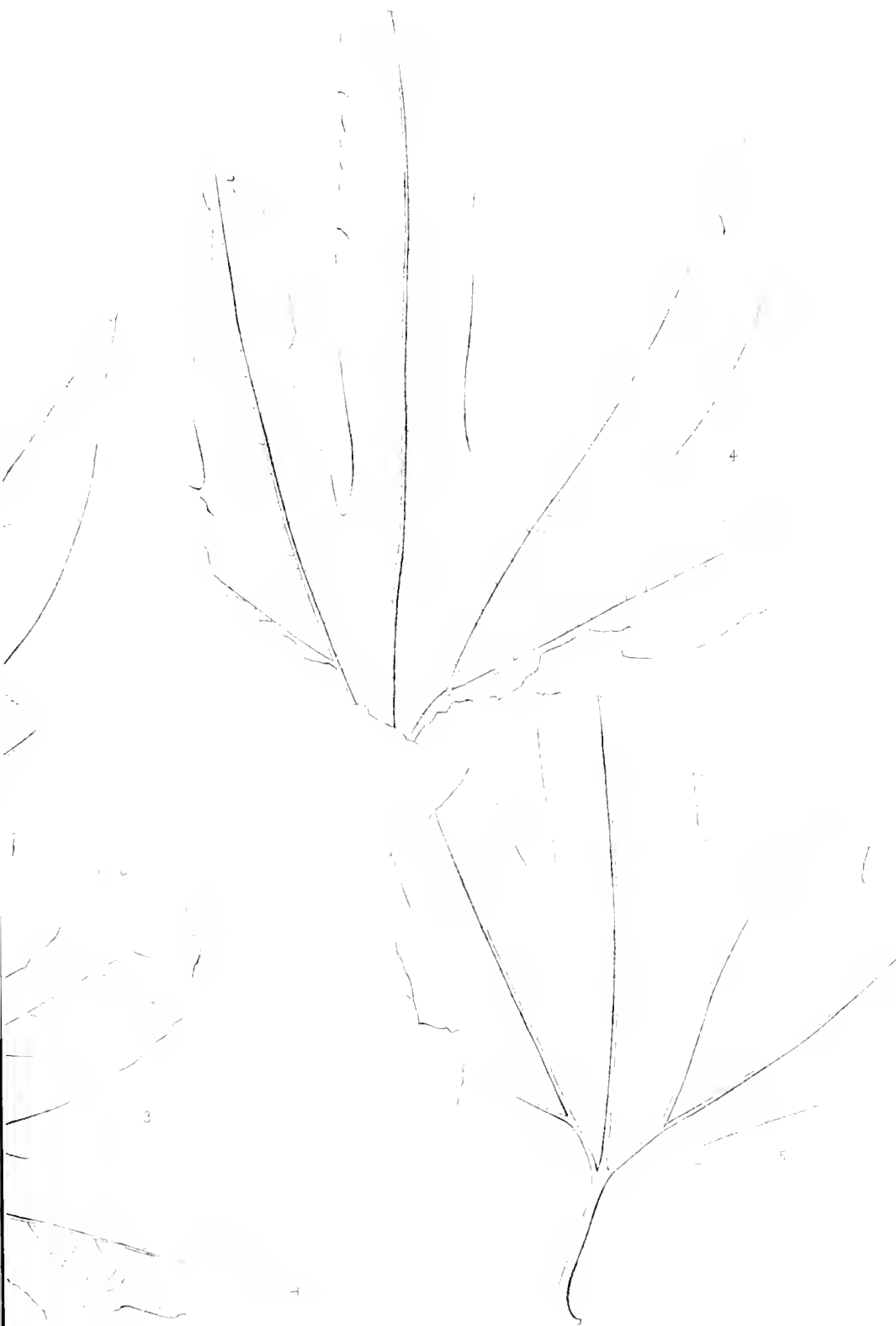




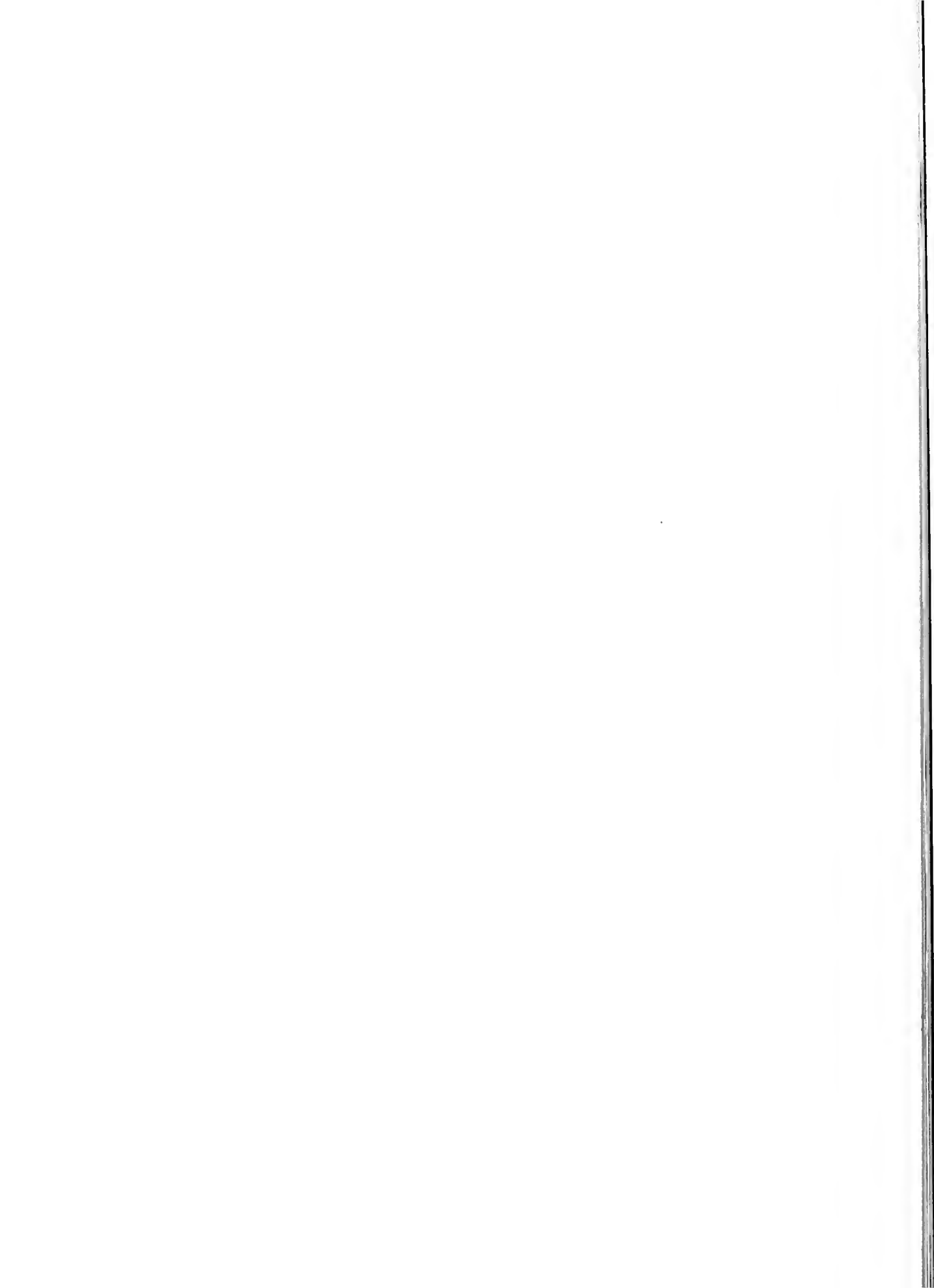


1.—*Aralia Whitneyi*.  
2, 3.—*Aralia Zaddachi* f





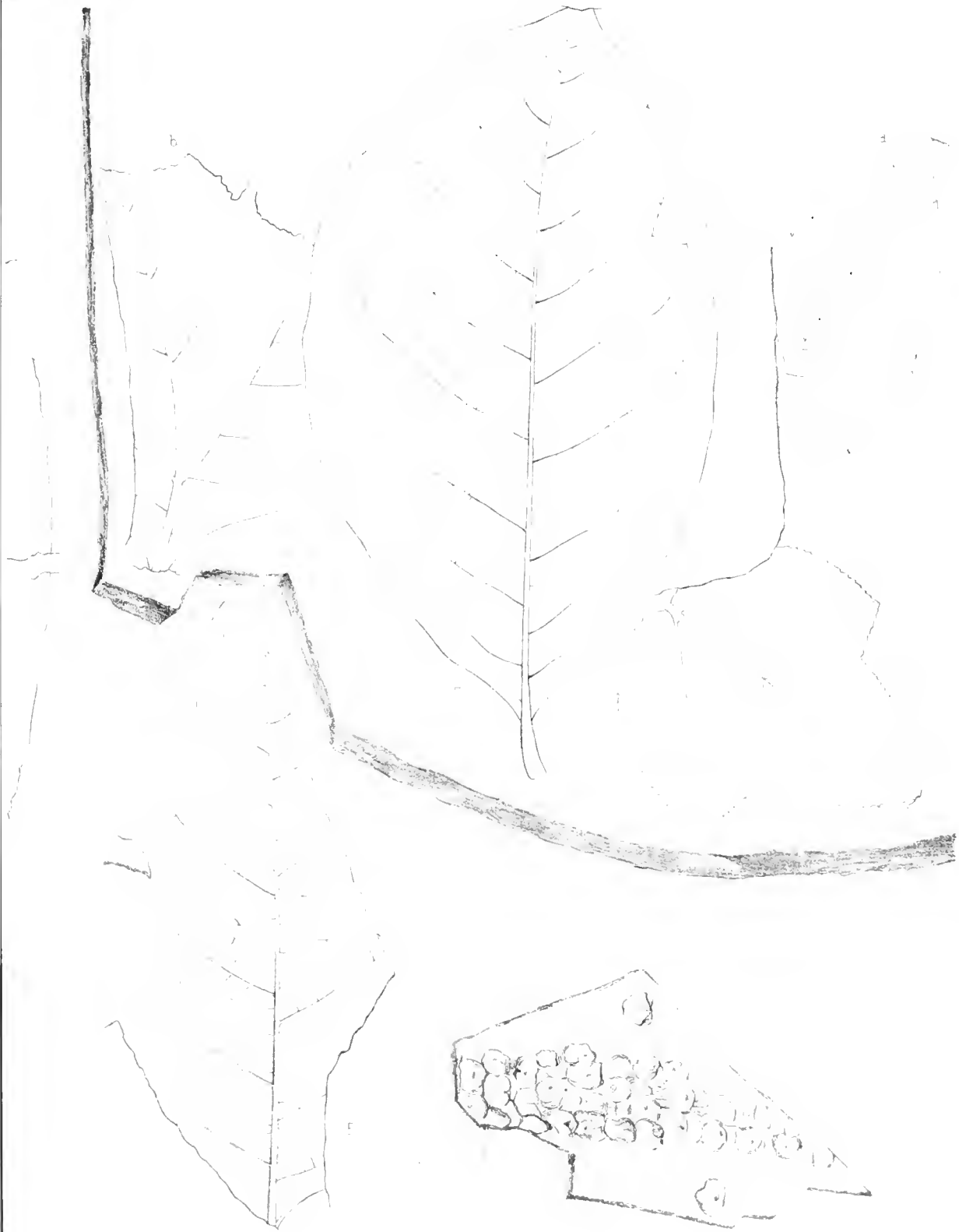
4, 5.—*Aralia angustiloba*.



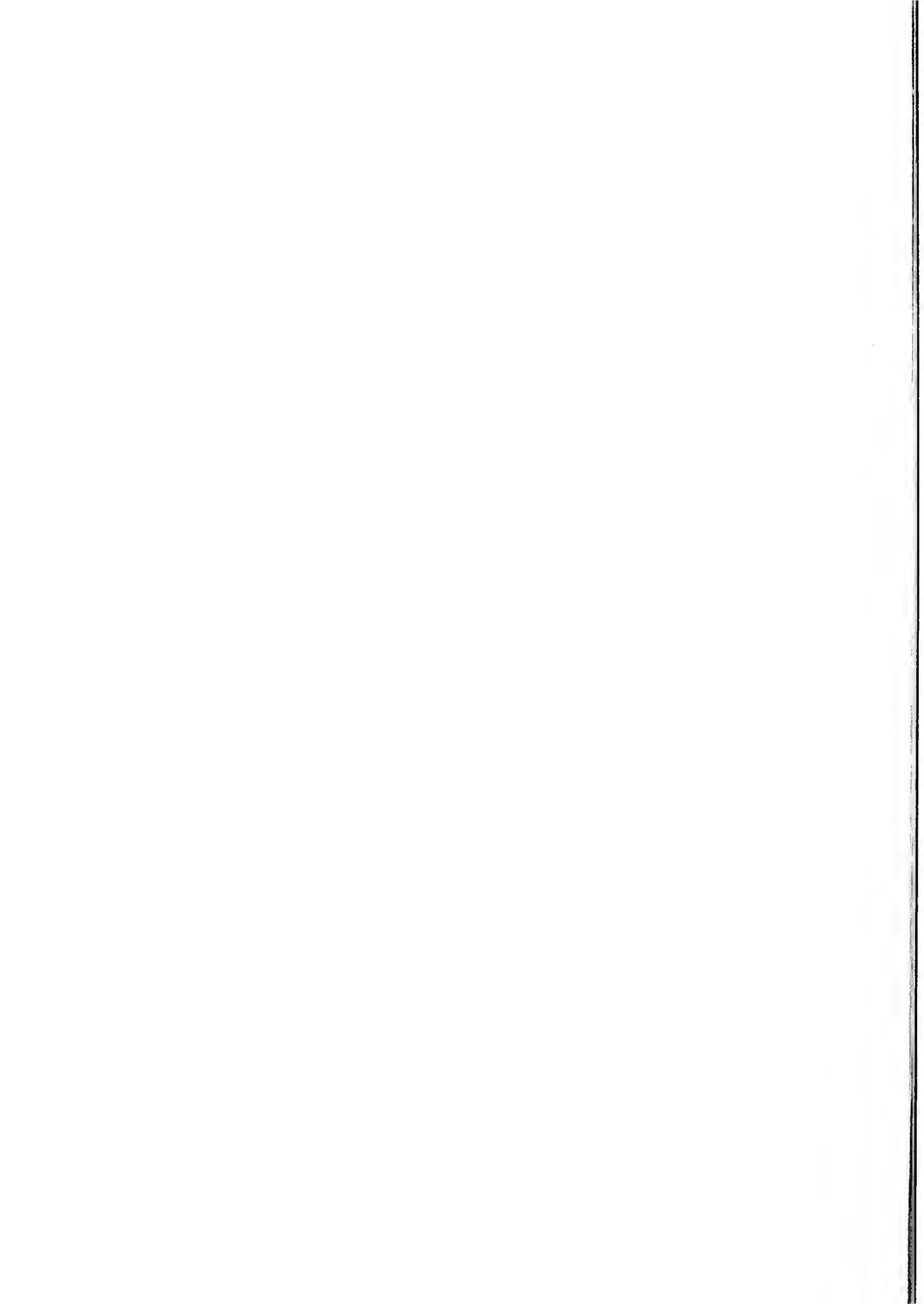


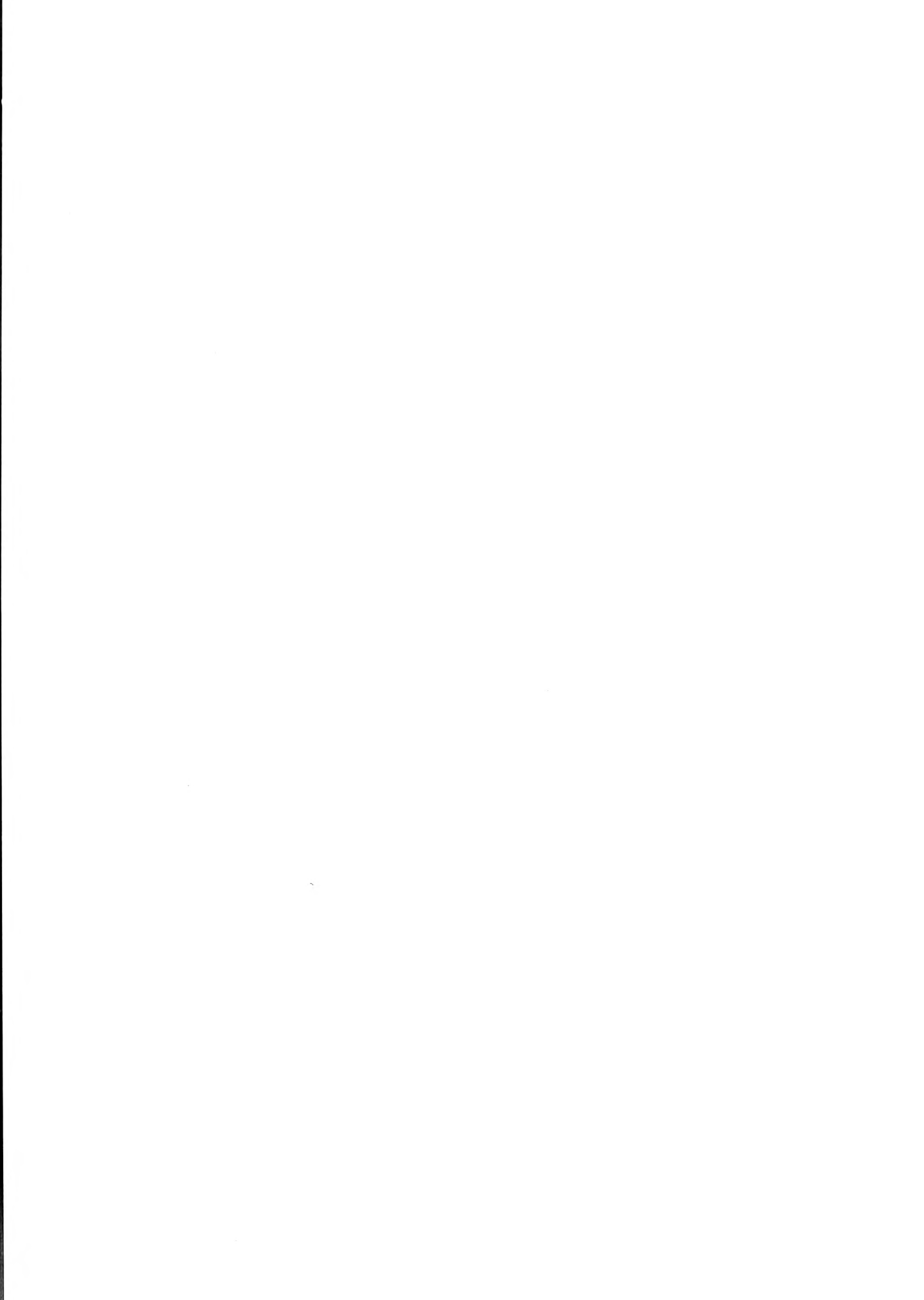


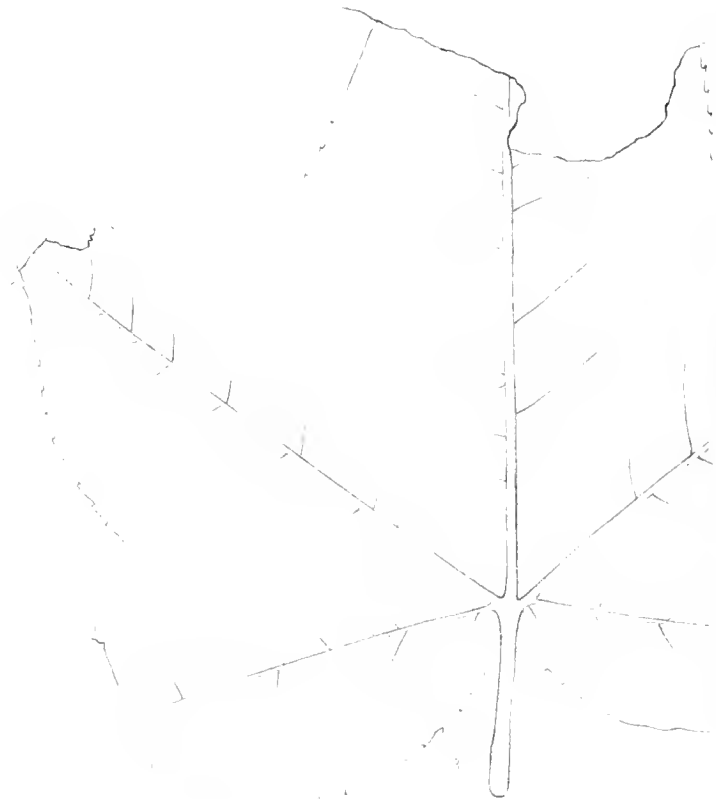
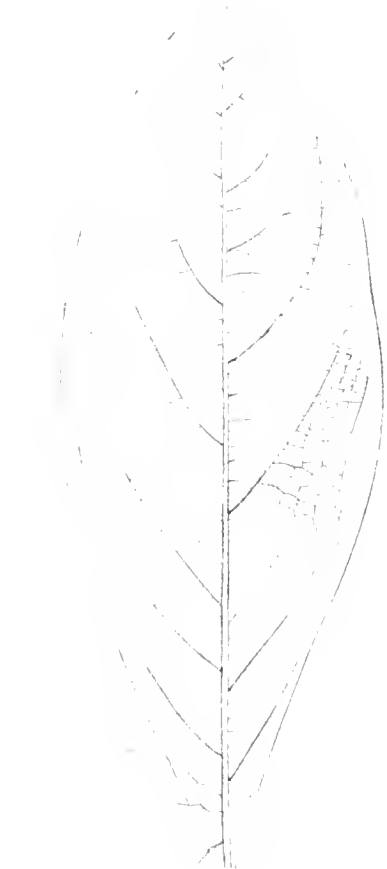
1, 2.—*Cornus ovalis*.  
3.—*Cornus Kelloggii*.  
4.—*Magnolia lanceolata*.  
5, 7.—*Magnolia Californica*.  
6.—*Magnolia fruit*.



7a.—*Ulmus Californica*.  
7b.—*Platanus appendiculata*.  
7c.—*Liquidambar Californicum*.





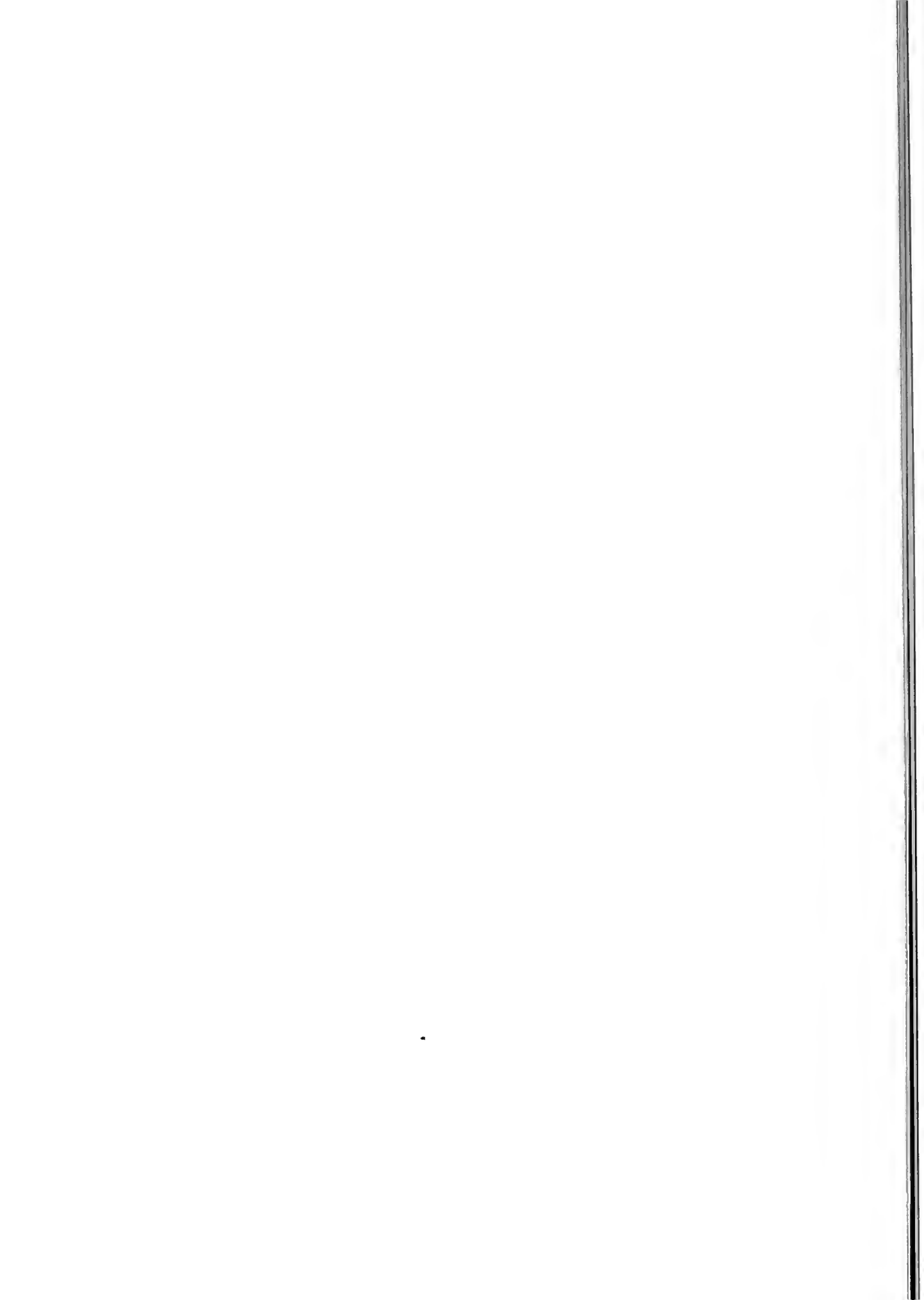


1, 2.—*Persea Pseudo-Carolinensis*.  
3, 4.—*Liquidambar Californicum*.

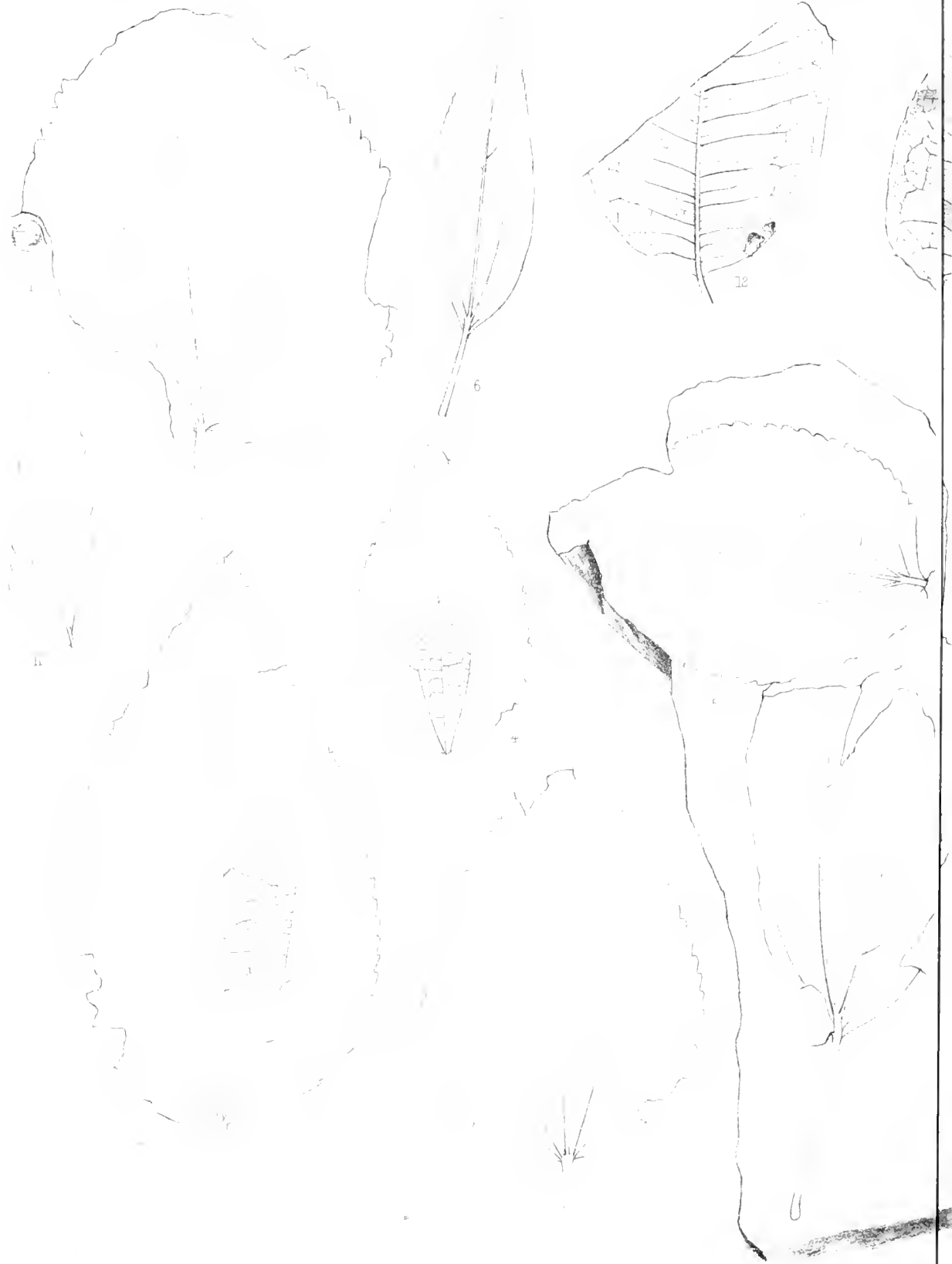




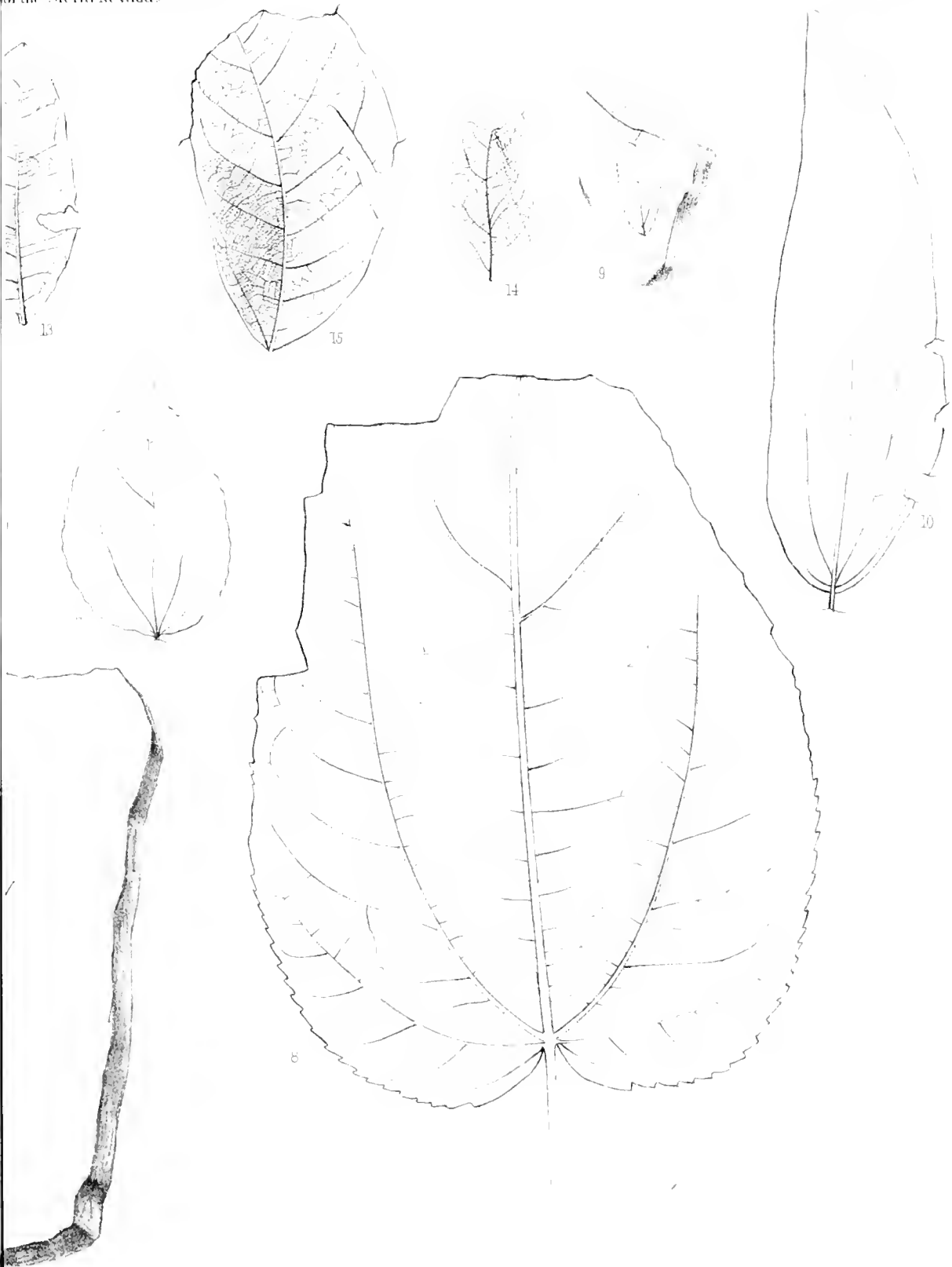
4, 5.—*Acer Vitifolium*.  
7-11.—*Acer Bolanderi*.  
12.—*Platanus Dissecta*.





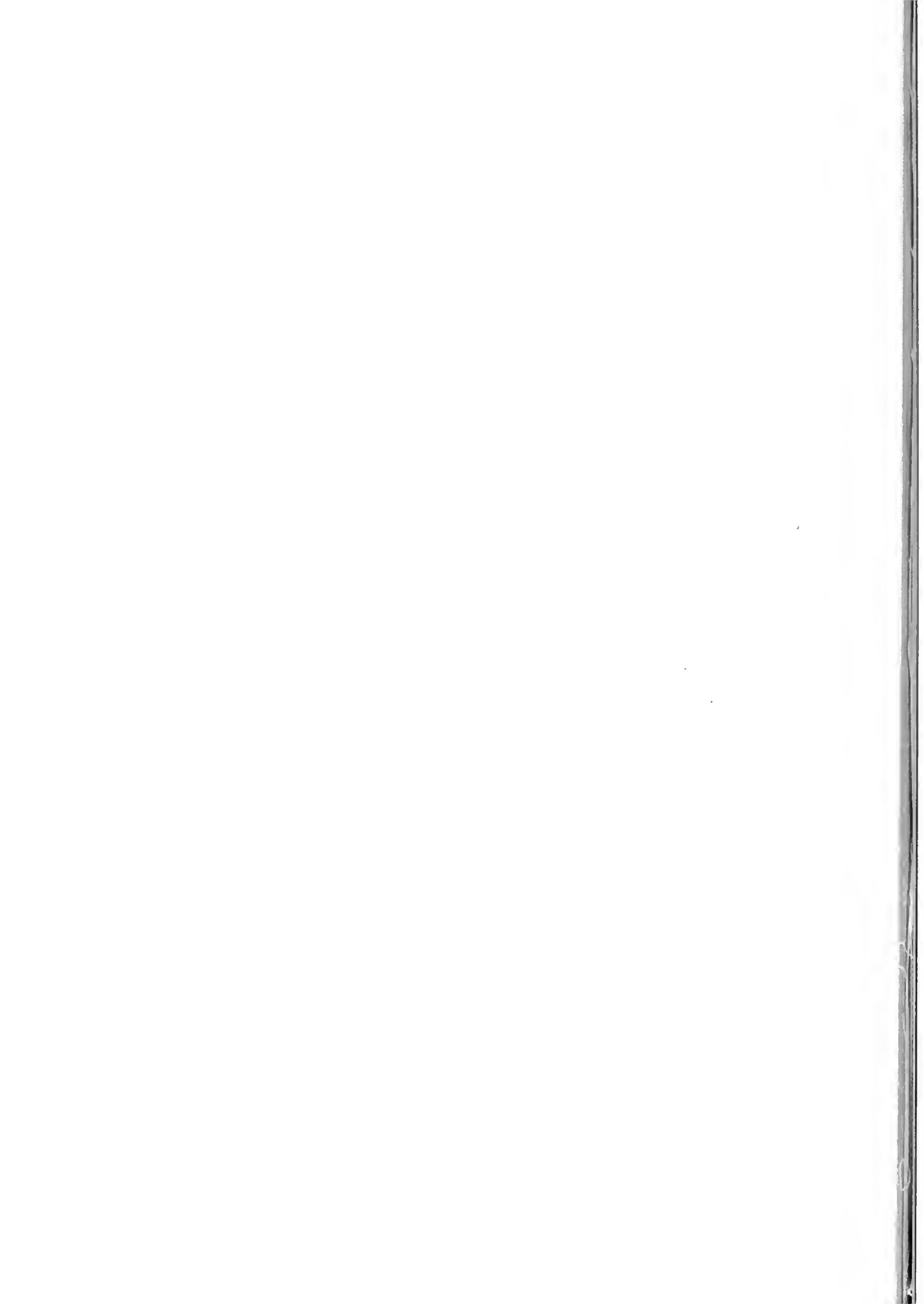


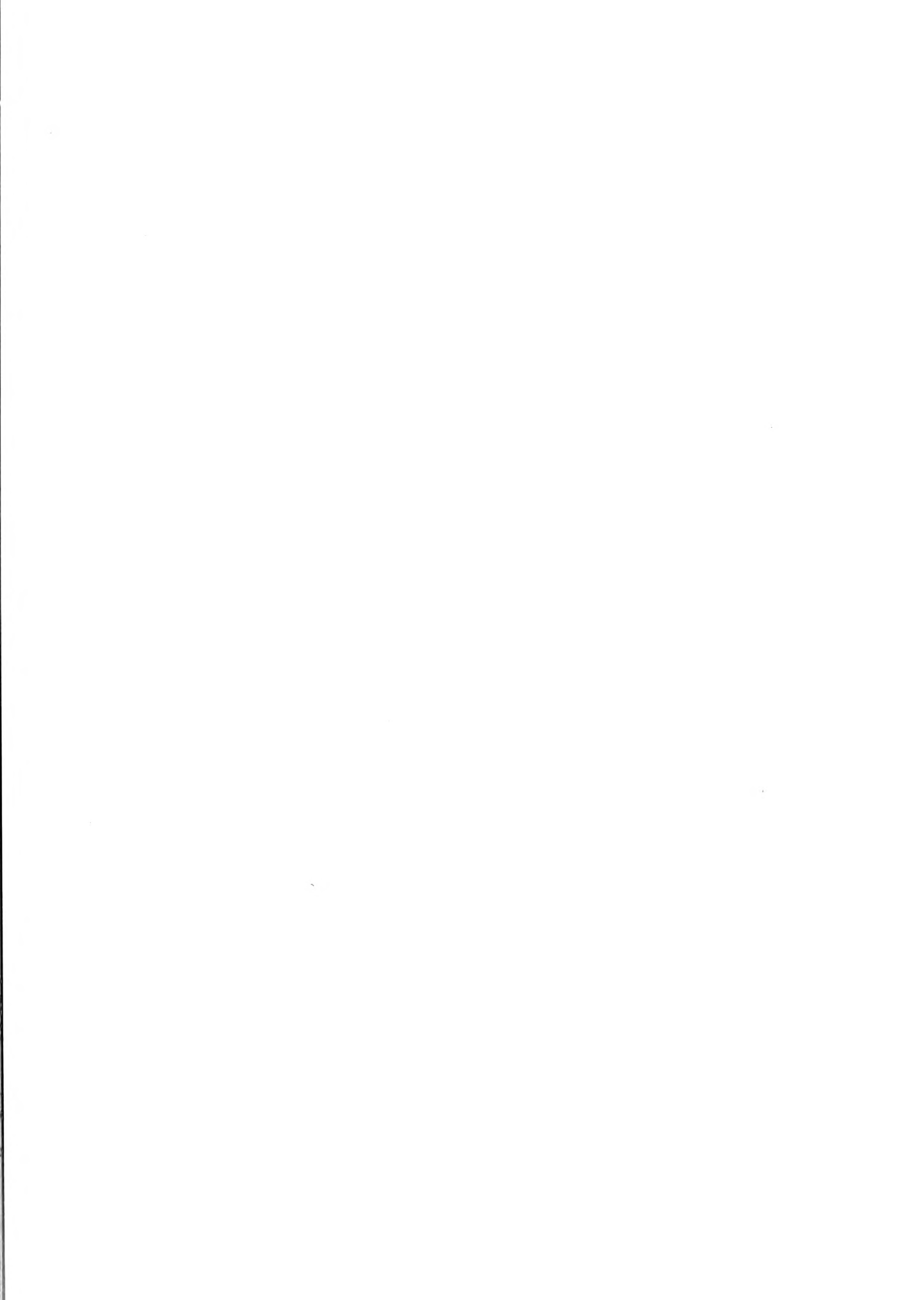
1-8.—*Populus Zaddachi*.  
 9.—*Zizyphus microphyllus*.  
 10, 11.—*Zizyphus piperoides*.

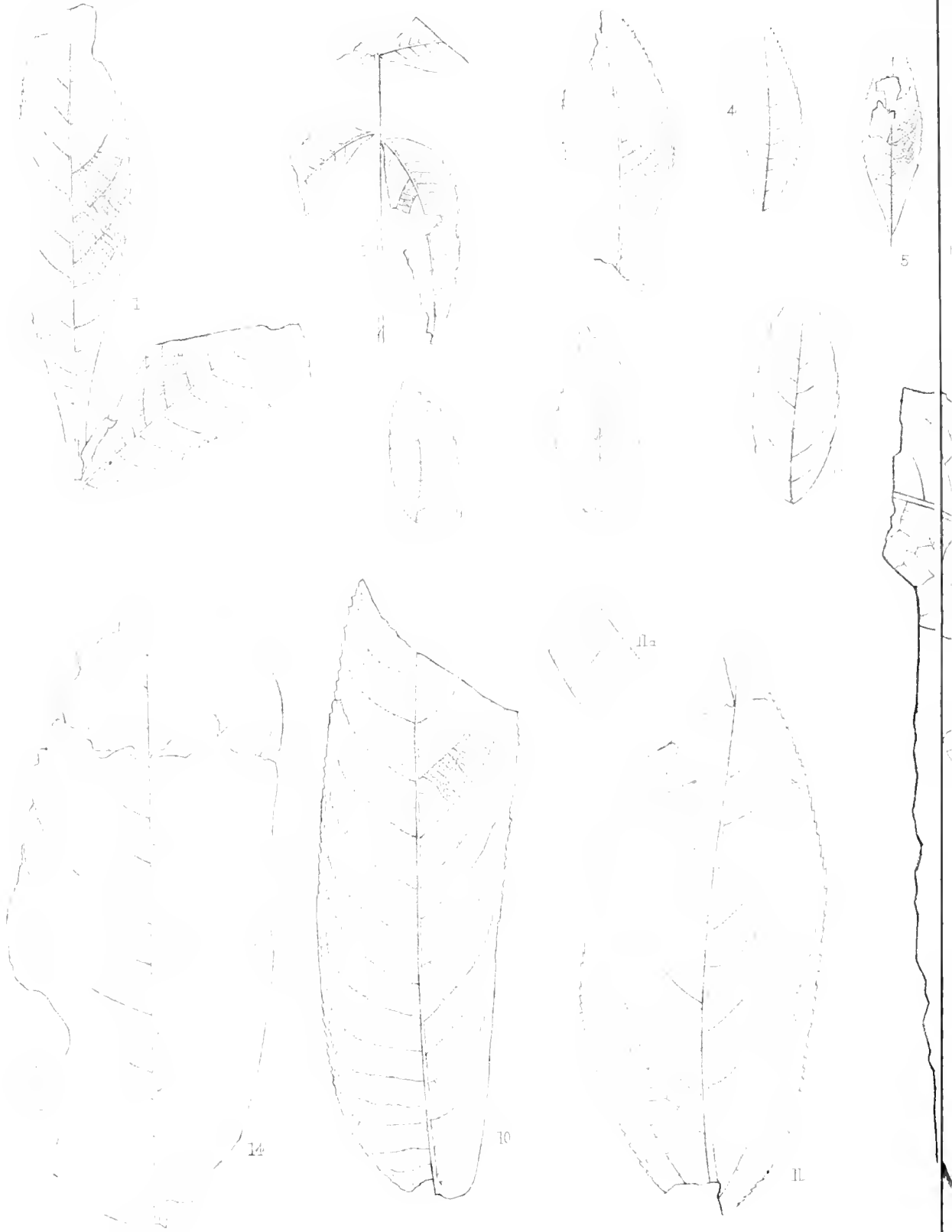


12, 13.—*Rhus metopioides*.

14, 15.—*Zanthoxylon diversifolium*.

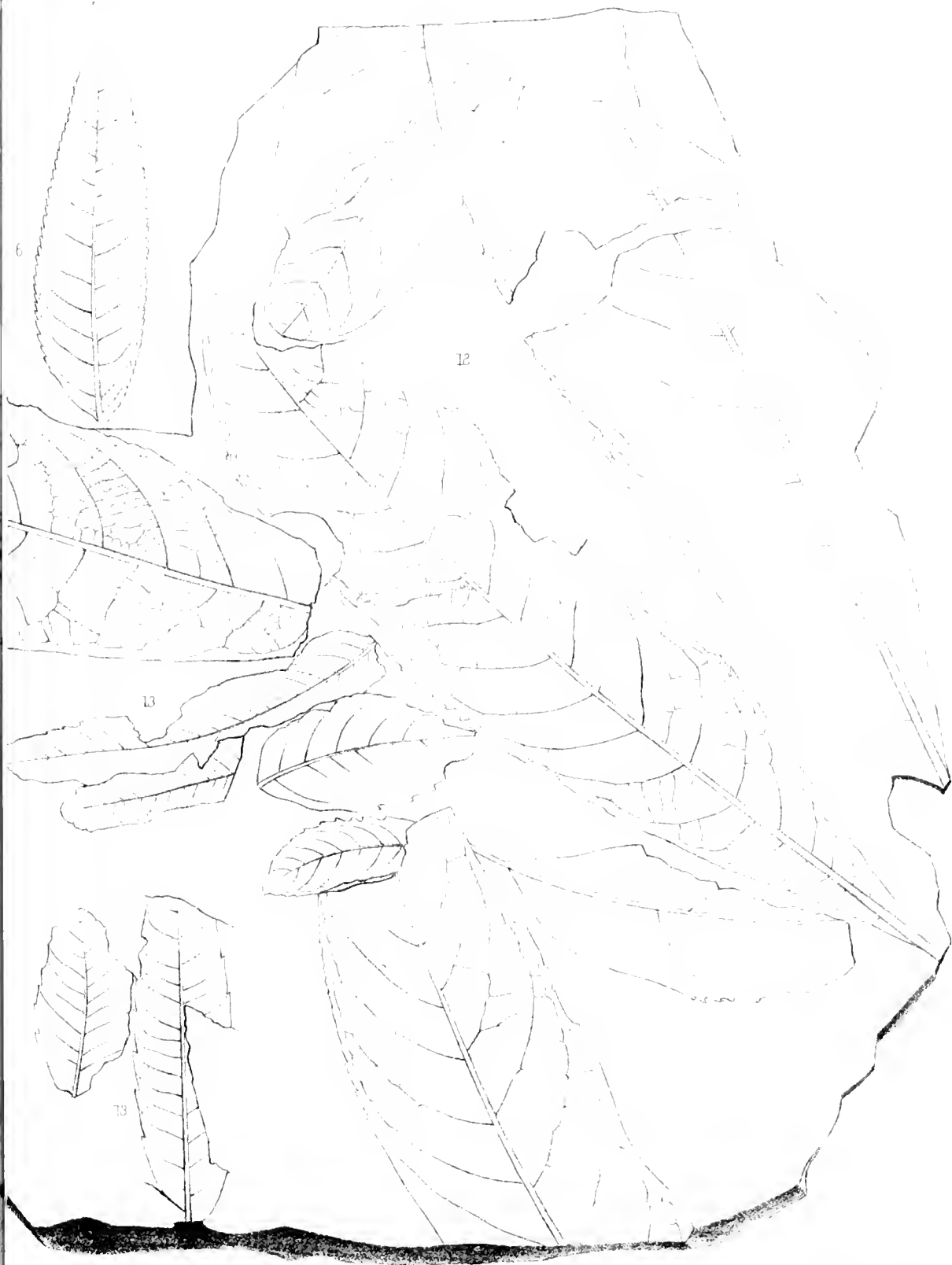




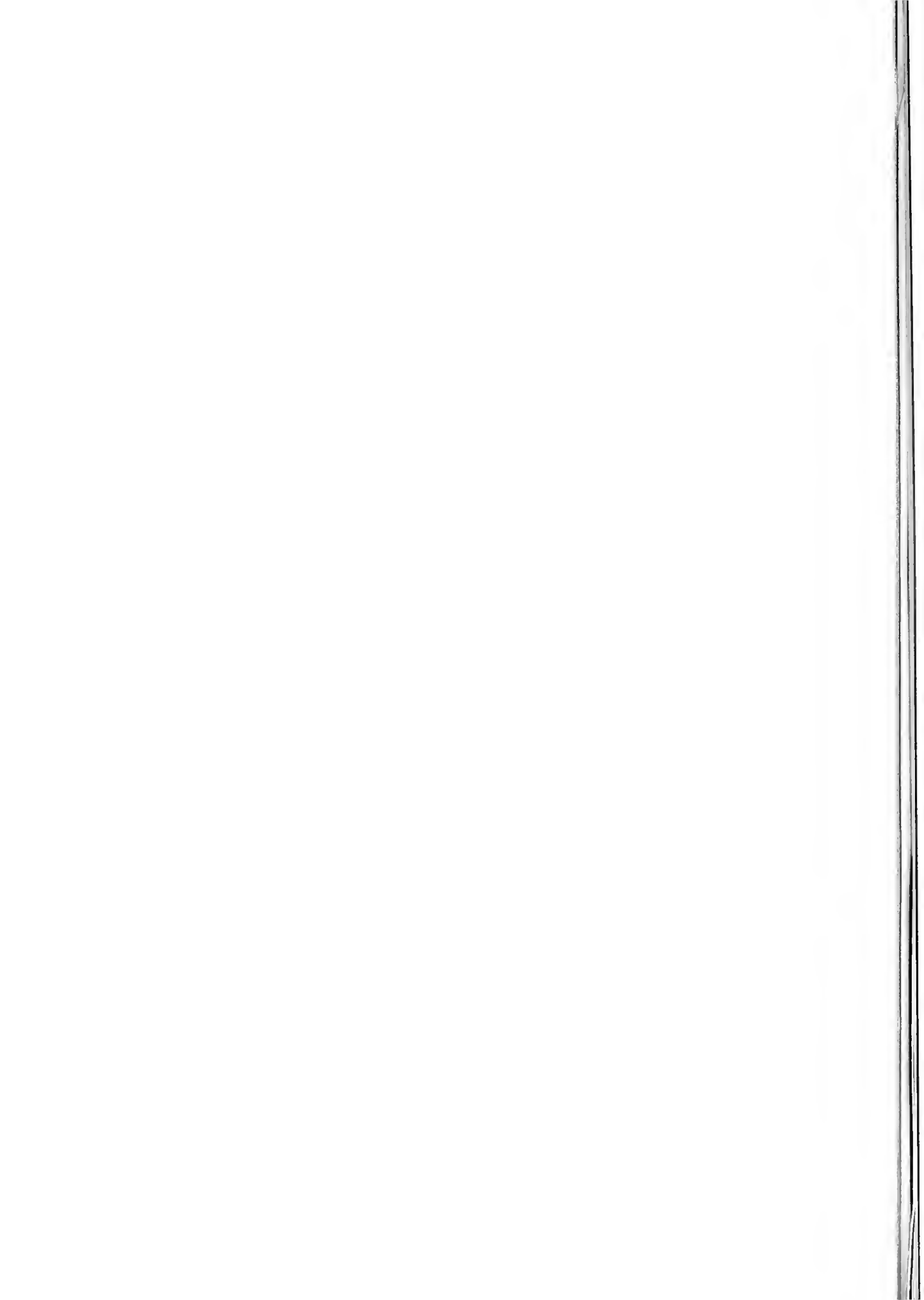


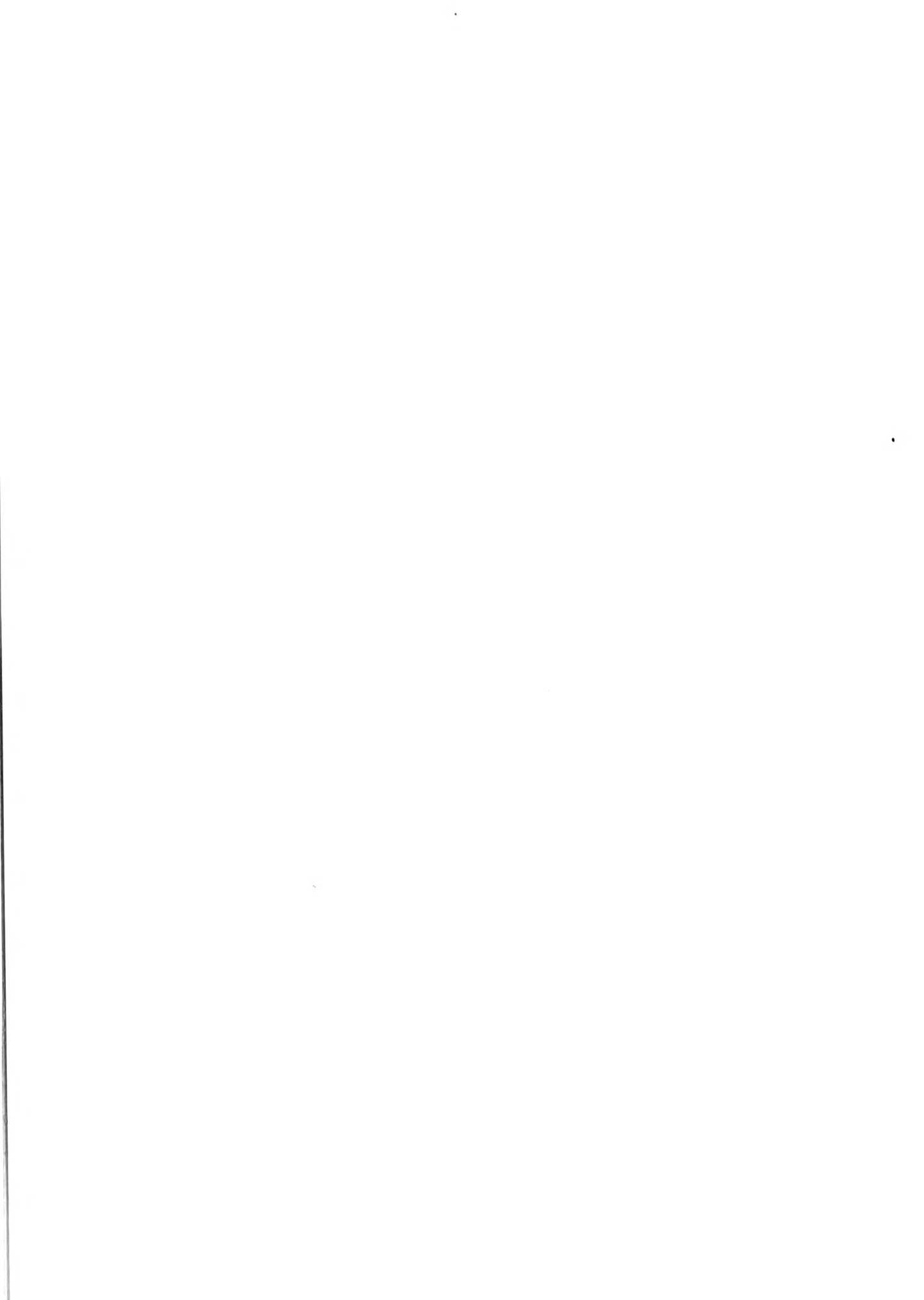
1-6.—*Rhus typhinoidea*.  
 7.—*Ilex prunifolia*.  
 8, 9.—*Rhus Boweniana*.  
 10.—*Juglans Oregoniana*.





11.—*Juglans laurinea*.  
12.—*Juglans egregia*  
13.—*Rhus mixta*.  
14.— *Juglans Californica*.



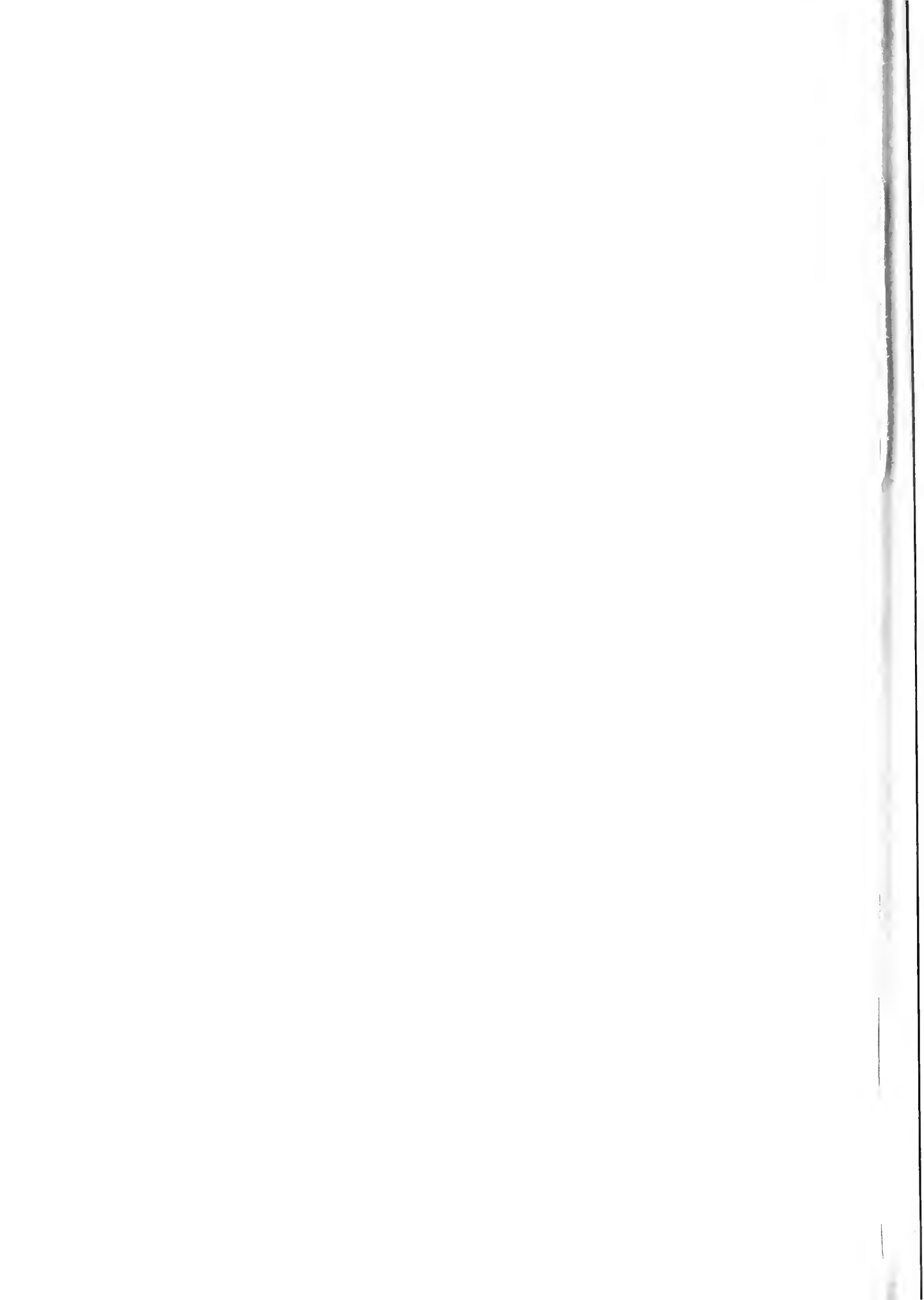


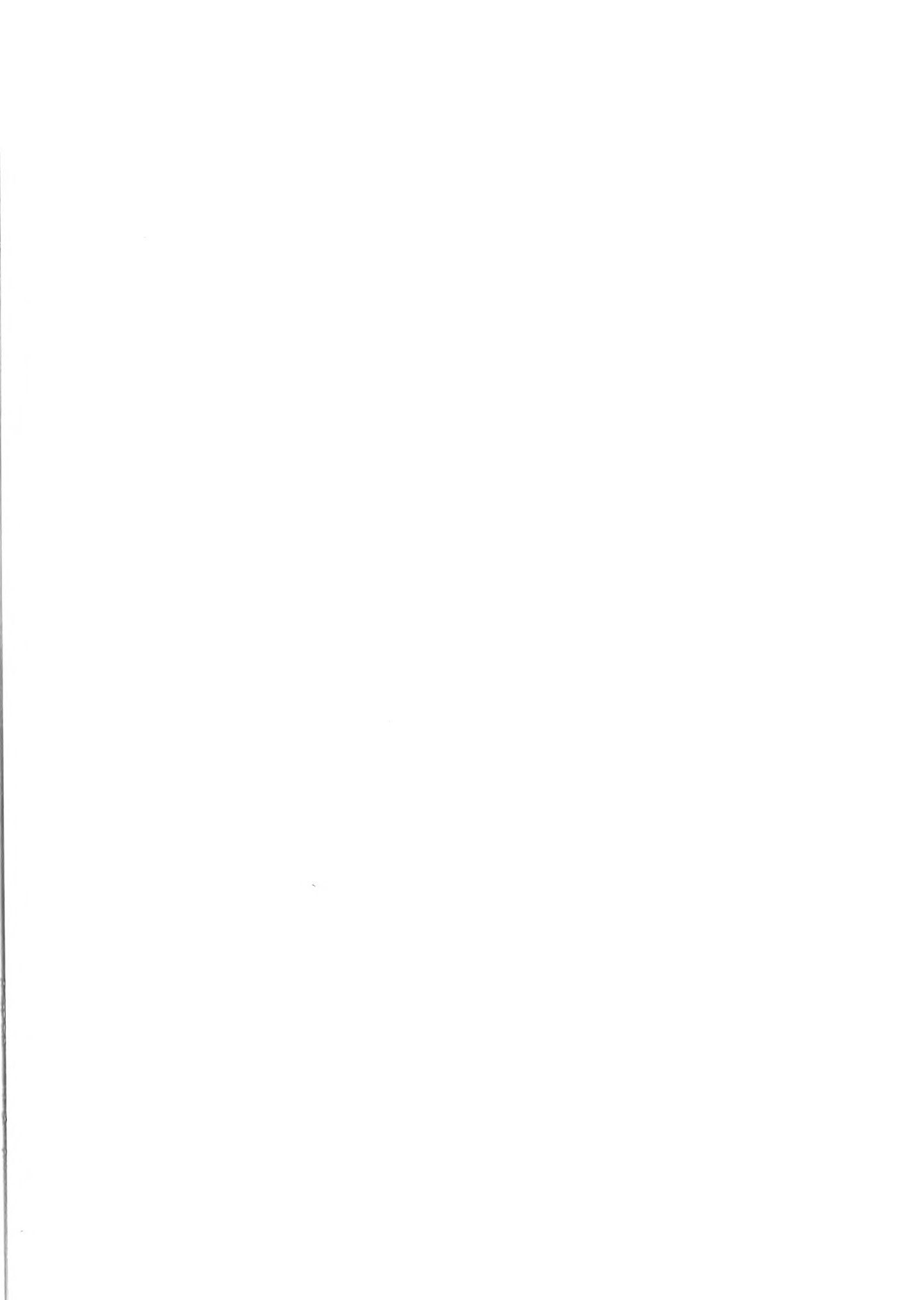


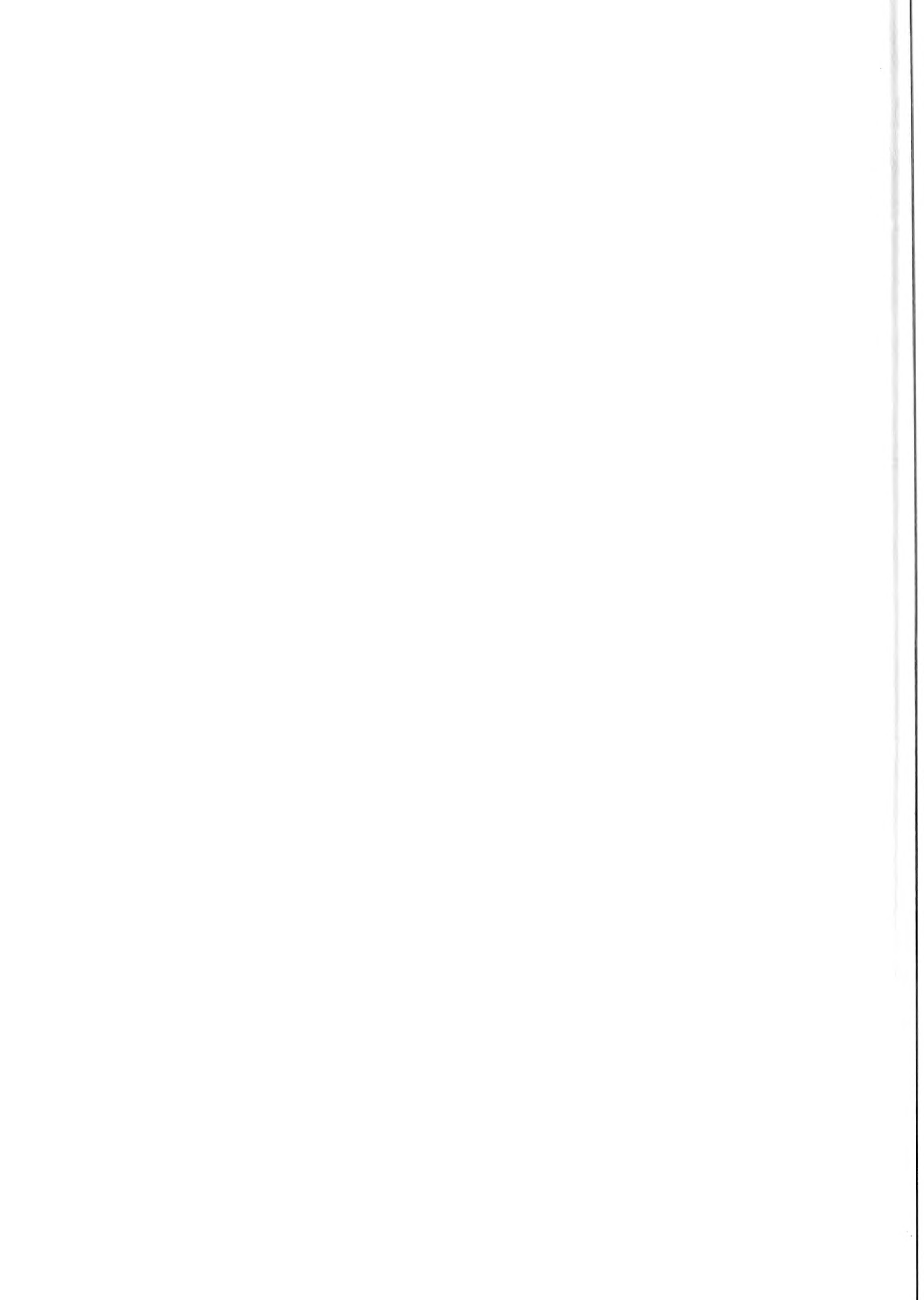
1.—*Juglans egregia*.  
2, 3.—*Juglans Californica*.



4, 5.— *Platanus dissecta*.  
6-11.— *Cercocarpus antiquus*,

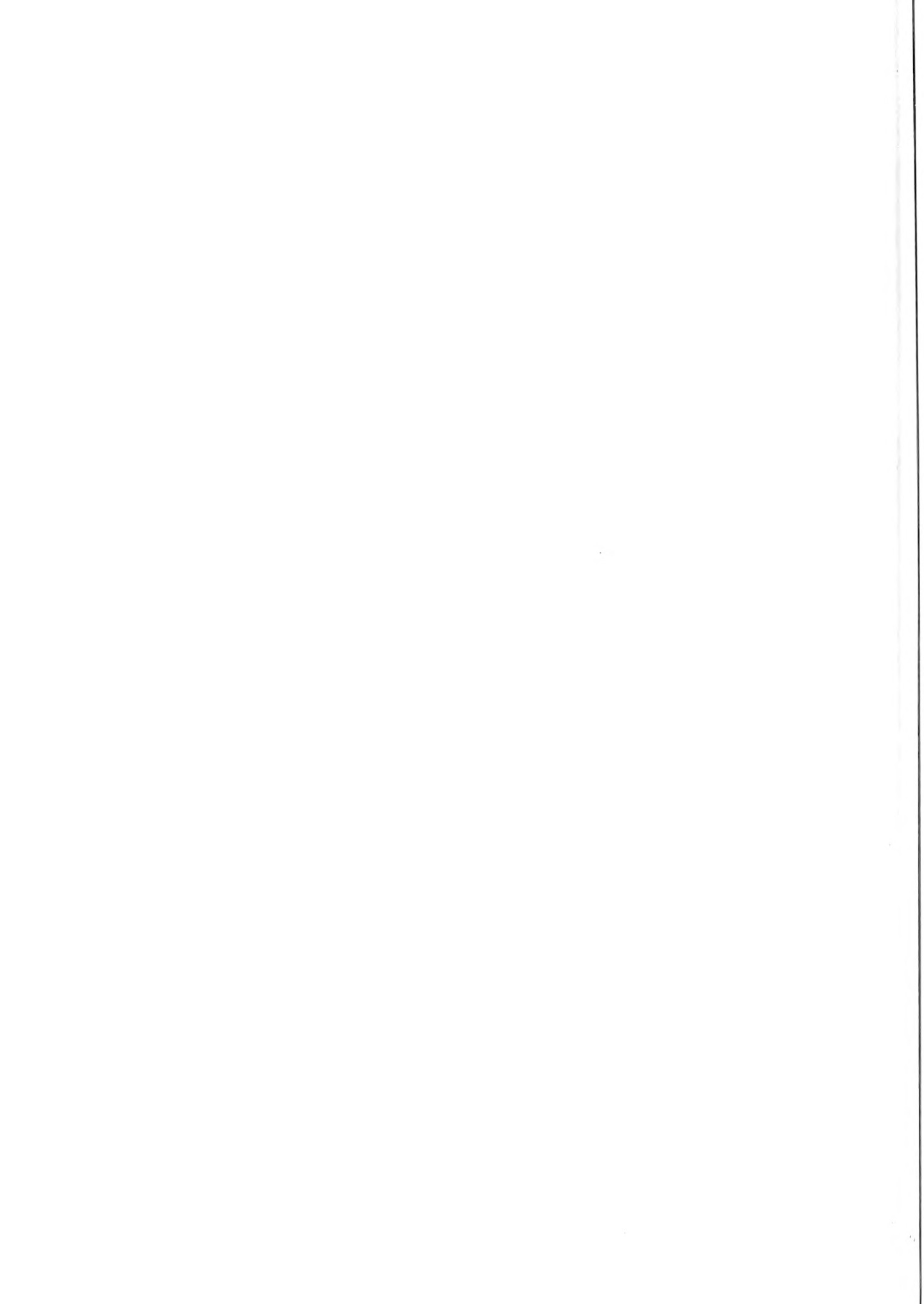




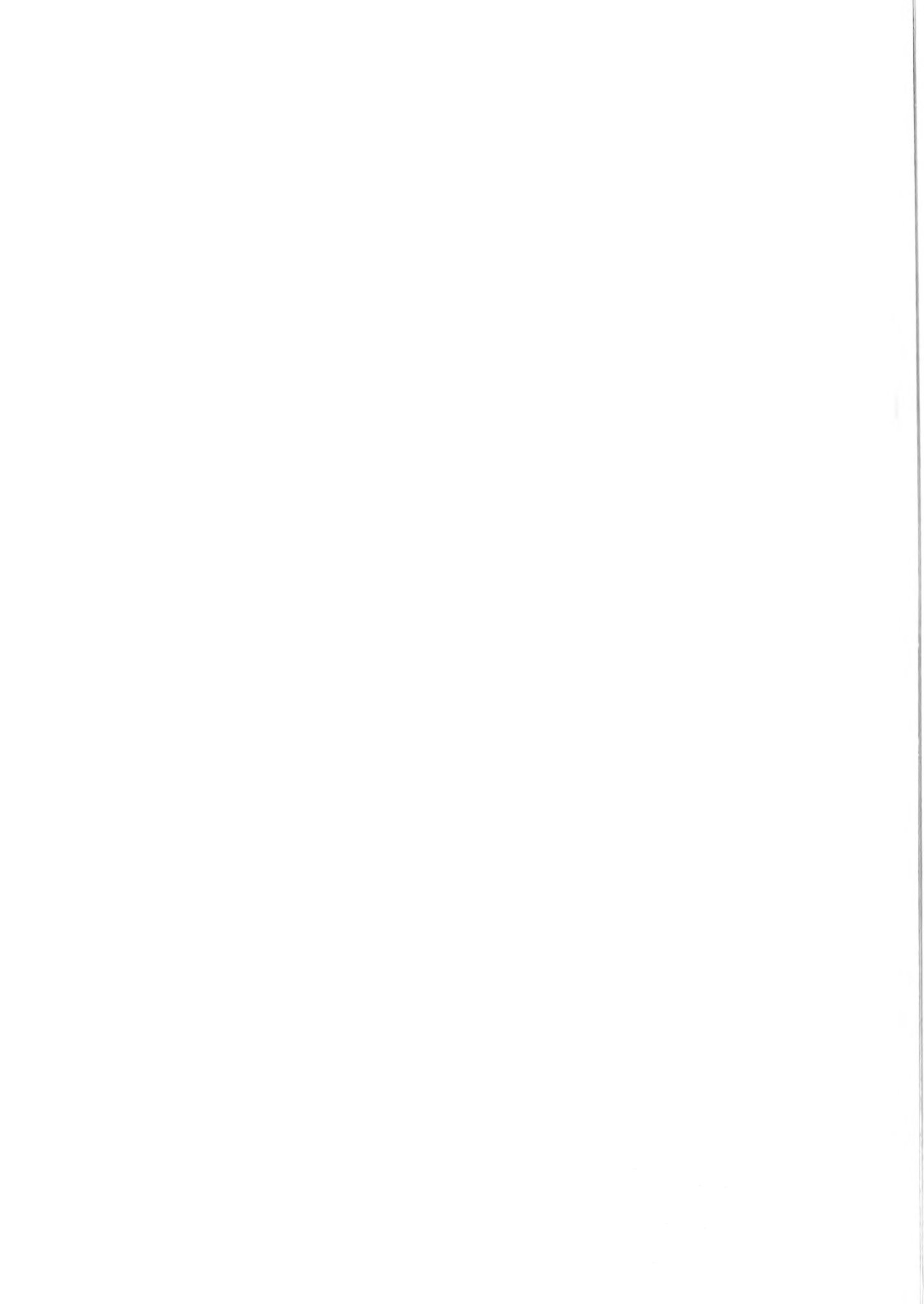












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