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(Continuation of Contributions from the Museum of Geology)
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OBSERVATIONS ON THE FOSSIL FLORA OF EASTERN AND SOUTHEASTERN OREGON. PART I

BY
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OBSERVATIONS ON THE FOSSIL FLORA OF EASTERN AND SOUTHEASTERN OREGON. PART I

By CHESTER A. ARNOLD

THE purpose of this account is to describe a part of the fossil flora secured by Mr. Percy Train from the Trout Creek diatomite in Harney County, Oregon, and from several localities in Malheur County in the same state. The writer assisted Mr. Train at Trout Creek in 1932, when a total thickness of forty-three feet of diatomite was quarried and ten thousand specimens were secured. During 1933 Mr. Train removed several hundred additional specimens from the same place, and in 1935 he secured more than fifteen hundred specimens from Malheur County.

The material from Malheur County came from thirteen localities to the north of Sheaville and mostly within the Succor Creek and Carter Creek valleys. These localities are distributed through four general regions: (1) on the Fenwick ranch and west of Succor Creek, about midway between Sheaville and Rockville, (2) north and west of the Strode ranch, about two miles east of Rockville, (3) from one to one and one-half miles west of Rockville, and (4) along Carter Creek south of the Finley McKenzie ranch and about four miles west and southwest of Rockville. There are also a few other scattered localities of minor importance.

The fossiliferous strata in the Malheur County localities consist of very fine grained silts having varying degrees of hardness and ranging in color from chalky white to several shades of gray and buff. The material is of volcanic origin and was deposited in fresh-water lakes. As a rule, the preservation of the plant

parts is exceptionally good, since the fine texture of the silts is ideal for retention of the details of venation, and in many instances there is retained a dark carbonaceous film which shows the plant part in strong contrast to the matrix.

The Trout Creek diatomite occurs as layers ranging from a few inches to six feet or more in thickness and separated by zones of weathered volcanic ash. Altogether twenty-one layers of diatomite were recognized, and a careful record was kept of the fossil content of each.

Because of the size of the collections it has been found impractical to attempt treatment of the entire flora in a single account. The present paper deals with some of the more obvious forms, and the others, which constitute the greater bulk of the material, are reserved for subsequent contributions. Among some of the genera saved for future discussion are *Acer* (of which a large number of species are present), *Populus*, *Quercus*, *Castanopsis*, and numerous others. Several conifers and a few ferns and mosses are also represented.

In this paper the author has little to add to what has been said by previous writers concerning climatic and other environmental conditions indicated by the fossil flora. However, some interesting data are provided concerning the Miocene distribution of two genera, *Cedrela* and *Oreopanax*. Neither of these has been recognized as yet at Trout Creek, but at several localities in Malheur County the leaves and seeds of *Cedrela* are among the most abundant fossil types. LaMotte (1936) has recently figured the seeds of *Cedrela* from 49 Camp under the names of *Pseudotsuga Masoni* and *Pinus monticolensis*. *Oreopanax* is also reported from 49 Camp, but it is specifically different from the form in Malheur County.

Since the author does not have ready access to many of the types of the previously described species of the Miocene of the western states no attempt is made to criticize or add to the array, already confusing, of existing data pertaining to many of the fossil forms. It should be stated that the so-called simple-leaved oaks, which are included by most authors in *Quercus* but by some in *Castanopsis* and designated by such specific names as *con-*

similis, simulata, simplex, Trainii, etc., constitute a major element in both the Trout Creek and the Malheur County floras. These are purposely omitted from this paper, but may be treated in future communications. Recent literature shows that, even when types are available for examination, considerable difficulty is often encountered in identifying newly discovered material, and the content of papers in which these highly variable forms are discussed consists essentially of agreement or disagreement with previous authors.

The difficulties attending accurate identification of such highly variable fossil forms are real, not merely apparent. Just how great a range of variation may be permitted to enter into a diagnosis of a fossil species often depends upon the point of view and the outlook of the author. There are those who (usually because of a lack of familiarity with living species) consider almost every nontypical leaf a new species. At the other extreme is the individual who becomes impatient with quibbling over small details and proposes short cuts by throwing numerous diversified and atypical forms into a single large assemblage which he calls a species. Usually a middle course between these extremes is chosen by the well-informed individual, but there are times when either of the other alternatives may be desirable.

List of Families and Species

EQUISETACEAE
Equisetum sp.

GINKGOACEAE
Ginkgo adiantoides (Unger) Heer

SALICACEAE
Salix inquirenda Knowlton

BETULACEAE
Ostrya oregoniana Chaney

NYMPHACEAE
Nymphaeites rotundus Arnold, sp. nov.
N. diatoma (MacGinitie) Arnold, comb. nov.

MAGNOLIACEAE
Magnolia sp.

LAURACEAE
Sassafras hesperia Berry
Persea miocenica Arnold, sp. nov.

SAXIFRAGACEAE
Hydrangea Bendirei (Ward) Knowlton
Philadelphus Bendirei (Knowlton) Chaney

PLATANACEAE
Platanus aceroides Goeppert
P. dissecta Lesquereux

ROSACEAE
Amelanchier magnifolia Arnold, sp. nov.
Cercocarpus harneyensis Arnold, sp. nov.
Crataegus microcarpifolia Arnold, sp. nov.
Pyrus McKenziei Arnold, sp. nov.

ANACARDIACEAE
Rhus diluvialis Arnold, sp. nov.

TILIACEAE
Tilia sp.

SIMARUBACEAE
Ailanthus Lesquereuxi Cockerell

MELIACEAE
Cedrela Browniana Arnold
C. Trainii Arnold
C. pteraformis (Berry) Brown

NYSSACEAE
Nyssa Knowltoni Berry

OLEACEAE
Fraxinus succorensis Arnold, sp. nov.

ARALIACEAE
Oreopanax precoccinea (Brooks) Arnold, comb. nov.
O. gigantea (Knowlton) Arnold, comb. nov.

INCERTAE SEDIS
Phyllites mascallensis (Knowlton) Arnold, nom. nov.
P. cladrastifolia Arnold, sp. nov.

EQUISETACEAE

Equisetum sp. Pl. I, Fig. 1.

Remains of *Equisetum* are not common in the fossiliferous rocks of eastern Oregon and only a few fragments have been recovered. The largest specimen (Pl. I, Fig. 1) came from Trout Creek and consists of the lower portion of a rather large stem 13 mm. in diameter and showing seven nodes. Specific determination cannot be made in the absence of leaf sheaths or strobili, but *E. hyemale* var. *robustum* is suggested. Portions of rhizomes have been collected at several places in Malheur County.

Occurrence. — Trout Creek and Succor Creek, west of Fenwick ranch.

Nos. 17232, 18400 U.M.

GINKGOACEAE

Ginkgo adiantoides (Unger) Heer. Pl. II, Fig. 4.

Remains of the Ginkgoales are not so abundant in the Tertiary of North America as in the Jurassic and some other Mesozoic strata. Apparently the order was on the decline by Tertiary times, but still existed in North America.

A single well-preserved leaf, slightly smaller than the average leaf of *G. biloba* and lacking the terminal notch, is the only specimen in the present collections.

G. adiantoides has been reported a few times from other Miocene localities in Oregon and Nevada.

Occurrence. — Fenwick ranch, west of Succor Creek.

No. 18370 U.M.

SALICACEAE

Salix inquirenda Knowlton. Pl. I, Fig. 4.

The specimen illustrated appears to be so similar to *S. inquirenda* (Knowlton, 1926, Pl. 11) that there is little doubt that it represents the same species. The apical portion is lacking, but if the specimen is compared with Knowlton's figure of a leaf showing the tip it is apparent that the blade was originally about 14 cm. long. The petiole is 1 cm. long. The size and the shape of the two specimens are practically identical, as are also the character of the marginal serrations and the length and the curvature of the secondaries. Knowlton states that the base of *S. inquirenda* is obtuse (1926, p. 32), but it may be noted that on none of the leaves figured is the petiole or the extreme basal portion shown. Of the parts illustrated there is no difference between Knowlton's material and that described here.

The leaf has a pair of very small secondaries at the extreme base which Knowlton's material does not show. This may, however, be due to lack of preservation, since in all Knowlton's

figures the secondaries have been retouched. These basal secondaries commonly appear in leaves of the present species of *Salix*.

Occurrence. — Succor Creek at Strode ranch.

No. 18371 U.M.

BETULACEAE

Ostrya oregoniana Chaney. Pl. I, Figs. 2–3.

Both leaves and involucral fruit sacs of *Ostrya* are present at Trout Creek and Succor Creek, but the former are not so readily recognized as the latter. At neither place are any of these remains abundant. *Ostrya oregoniana* was first described from the Crooked River basin (Chaney, 1927, p. 106) and has since been recognized at 49 Camp.

Occurrence. — Trout Creek and Fenwick ranch.

Nos. 17229, 18372 U.M.

NYMPHACEAE

Nymphaeites rotundus, sp. nov. Text figure 1.

Leaf large, with deep sinus; basal lobes rounded; venation coarse, dichotomously branching; main veins interconnected by

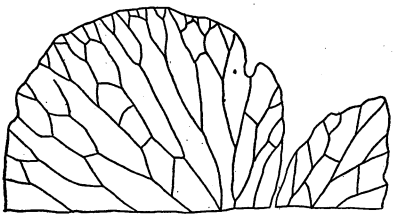

FIG. 1. *Nymphaeites rotundus*, sp. nov. Basal portion of large leaf showing rounded lobes and narrow sinus. Trout Creek. No. 18373 U.M. × ½

cross veins, producing a network; vein islets large, rather regular in shape, radially elongated but becoming smaller and shorter toward the margin; margin entire.

Since it is impossible to distinguish between the leaves of *Nymphaea* and *Castalia* in the fossil state, it is the opinion of the present writer that the form genus *Nymphaeites* is the proper one for the reception of the material described here. Knowlton (1919, p. 148) has named several species of *Castalia*, but other authors have assigned similar material to *Nymphaea*. The speci-

men described here is the basal region of a large leaf which shows the sinus portion, but not the area where the petiole was attached. The sinus is narrow toward the center of the leaf, but broadens toward the outside. The lobes are rounded. Apparently the leaf was about 20 cm. broad.

The venation compares well with that of *Castalia ampla*, but there are no marginal indentations. The vein pattern and the width of the sinus simulate those of *C. odorata*, and the rounding of the lobes is quite like that of *Nymphaea advena*.

Occurrence. — Trout Creek.

No. 18373 U.M.

Nymphaeites diatoma (MacGinitie), comb. nov.

Nymphaea diatoma MacGinitie, 1933, p. 55, Pl. 8, Fig. 1.

This species from the Trout Creek diatomite appears to belong to the same leaf category as *N. rotundus* described above, although it seems specifically distinct. It differs in having a broad sinus and very pronounced veins, which extend nearly to the margin without forming a regular network with the elongated islets. MacGinitie (1933, Pl. 7, Fig. 6) assigns a portion of rootstock to the same species as the leaf. This rootstock could, with equal propriety, be referred to either *N. diatoma* or *N. rotundus*.

Occurrence. — Trout Creek.

MAGNOLIACEAE

Magnolia sp.

The only material positively recognizable as belonging to *Magnolia* is the terminal portion of a seed-bearing receptacle.

Occurrence. — Carter Creek, south of Finley McKenzie ranch.

No. 18374 U.M.

LAURACEAE

Sassafras hesperia Berry. Pl. II, Fig. 3.

A nearly complete leaf of *Sassafras* was recovered from the light-colored lake deposits near the Fenwick ranch along Succor Creek.

Although *Sassafras* is known from four or five localities in the Miocene of Oregon and Washington it is not nearly so abundant at this level in North America as in older strata. All the known forms of *Sassafras* from the western Miocene probably belong to a single species closely comparable to the living species.[1]

Occurrence. — Fenwick ranch, west of Succor Creek.

No. 18375 U.M.

Persea miocenica, sp. nov. Pl. II, Fig. 2.

Leaf blade oval, 5 cm. broad by 12.5 cm. long, broadest at the middle, base and apex equally tapering and acute, margin entire; midrib straight, prominent at the base but becoming less so toward the apex; secondaries subopposite, 7 or 8 pairs, camptodrome, unequally spaced, lowermost ones short and spreading at an angle of 50 degrees from the midrib, next higher pair spreading at a more acute angle and curving upward to the broadest portion of the leaf, those in the upper half spreading similarly to the lowermost ones; tertiaries percurrent, innermost ones connected to midrib; petiole 1.3 cm. long, stout.

The single but well-preserved leaf described here bears a close resemblance to the living *P. Borbonia.* It is slightly larger than an average leaf of the living species. Both show the same venation pattern, especially with respect to the angle of departure and the spacing of the secondaries and the percurrency of the tertiaries. In fully half the leaves of *P. Borbonia* examined a similar pair of wide-spreading short basal veins and the same type of acute base are shown.

The angle of spread of the uppermost and the lowermost secondaries appears to distinguish *P. miocenica* from a leaf described by Lesquereux (1878, p. 19, Pl. 7, Figs. 1–2) as *P. pseudo-Carolinensis* from the Auriferous gravels. This leaf, also, according to Lesquereux, resembles the living species cited above. He remarks, too, upon the spreading of the lowermost veins in the living species and notes how his material differed from it in this respect. This feature is quite variable in *P. Borbonia.*

[1] According to Fernald ("The Nomenclature of Sassafras," *Rhodora,* Vol. 38, pp. 178, 179. 1936), the correct name for the living species is *Sassafras albidum* (Nutt.) Nees.

Some of the leaves of *Diospyros virginiana* appear similar to the leaf described here, but when a large number of leaves are compared it becomes apparent that the affinities of the fossil are with *Persea* instead. Most of the leaves of *Diospyros virginiana* have a rounded base, and the blade is broadest below the middle. The basal secondaries are usually strong and show the same curvature as those higher up. Furthermore, in the lower half of the blade the secondaries are closer. In all these respects the fossil leaf is quite unlike the leaves of *Disopyros.*

Occurrence. — Trout Creek.

No. 18376 U.M.

SAXIFRAGACEAE

Hydrangea Bendirei (Ward) Knowlton. Pl. II, Fig. 1.

MacGinitie (1933, p. 59) makes brief reference to *Hydrangea Bendirei*, but figures no material, and he states that there is some doubt concerning its generic reference.

A single well-preserved sterile flower from Trout Creek removes all doubt as to the correctness of the reference. The central portion is distinctly shown, and there is no indication of the attachment of smaller flowers, as there is in *Cornus.* It has four broadly ovate calyx lobes, which appear to be completely separate. All the lobes are of about the same size, and each is provided with a midvein from which lateral veins depart near the base. A network is produced by the smaller veins.

The fossil remains of *Hydrangea*, *Porana*, and *Viburnum* are sometimes confused, but Brown (1935, p. 583) has shown that *Hydrangea* and *Porana* are clearly distinct. The flower of *Porana* is a connate structure, usually with five fused lobes and parallel venation. In *Viburnum* the venation is similar to that of *Hydrangea*, but it has five delicate lobes, which are somewhat unequal in size. Also, when a *Viburnum* flower is pressed flat the lobes usually fold somewhat and do not spread out evenly, as do those of *Hydrangea.*

Occurrence. — Trout Creek.

No. 17231 U.M.

Philadelphus Bendirei (Knowlton) Chaney. Pl. III, Fig. 4.

A single leaf from Succor Creek, from which the apex and one side of the basal portion are missing, appears identical in every respect with the material described by Knowlton (1902, Pl. 10, Fig. 4) from the John Day Basin as *Cinnamomum Bendirei*, but transferred by Chaney (1927, p. 118) to *Philadelphus*. That portion of the margin which is preserved is entire, but near the tip there is a pronounced undulation, which may represent an abnormality. It is unknown whether the apex is acute or rounded, but to judge from the appearance of the veins the leaf probably terminated shortly beyond where the break occurred. The second pair of basal veins, which is frequently present in *Philadelphus*, is lacking in the specimen.

Occurrence. — Fenwick ranch, west of Succor Creek.

No. 18380 U.M.

PLATANACEAE

Platanus aceroides Goepp. Pl. III, Fig. 1.

At certain localities in Malheur County the leaves of *Platanus* are among the commonest fossils. *P. dissecta* is most abundant, but certain leaves, because of their smaller size and relatively shallower indentations, appear similar to figures of *P. aceroides* by Goeppert, Lesquereux, Schimper, and others.

Acer aequidentatum Lesq. (1878, Pl. 7, Figs 4–5) from the Auriferous gravels also closely resembles figures of *P. aceroides*.

Occurrence. — Fenwick ranch west of Succor Creek. (Material possibly belonging to this species has been collected at Trout Creek.)

No. 18376 U.M.

Platanus dissecta Lesq. Pl. IX, Figs. 1–3.

Platanus dissecta is one of the most common species at certain localities, where leaves of large size occur. Very few leaves are found complete, but fragments 17 cm. in diameter are common. Some leaves were probably larger.

Certain very small leaves which show characters indicative of *Platanus* are referred to *P. dissecta* by Brooks (1935, p. 295).

Several such leaves are present in the material at hand (Pl. X, Fig. 3) and, though their identity may remain in some doubt, they show the coarse marginal crenulations prominent in *P. dissecta.*

Occurrence. — Present at most localities along Succor Creek and Carter Creek.

Nos. 18377, 18378, 18379 U.M.

ROSACEAE

Amelanchier magnifolia, sp. nov. Pl. IV, Figs. 1, 4. Text figures 2–3.

Leaves resembling those of various genera of the Rosaceae are abundant at Trout Creek, but the variation in size, marginal

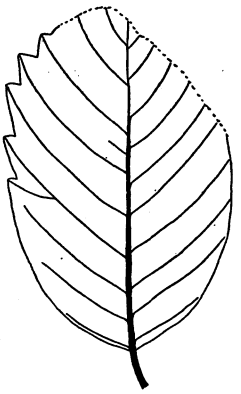

FIG. 2

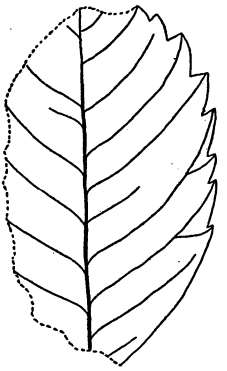

FIG. 3

FIGS. 2–3. *Amelanchier magnifolia* Arnold, sp. nov. Outline sketches showing shape of leaf, marginal teeth, and secondaries. Trout Creek. No. 18404 U.M. Paratypes. × ¾

characters, and venation, together with frequent poor preservation, renders positive identification of such genera as *Prunus, Pyrus,* and *Amelanchier* almost impossible in the greater number of instances. There are a few fairly large leaves which, although they intergrade with the smaller ones that are more of the type

of *A. dignatus* as recently defined by Brown (1935, p. 577), cannot be definitely assigned to any species heretofore described, and which seem to deserve specific rank.

Leaf blade oval, up to 10 cm. long and 6 cm. broad; petiole 1 cm. long; margin coarsely serrate along upper half with five to twelve broad pointed teeth, lower margin entire; midrib distinct, persistent to the apex; nine to twelve pairs of subopposite secondaries depart from the midrib at a steep angle but immediately bend outward at an angle of 55 to 60 degrees, then curve upward slightly toward the margin; some of the secondaries extend to the tips of the marginal teeth, but others fork at some distance back, with each branch passing to a tooth; tertiaries percurrent, at right angles to midrib in lower part (indistinct above).

The dimensions given for this species are based upon some half-dozen specimens which appear identical. No attempt is made here to indicate the minimum size of the species, although some smaller specimens measuring about 4 by 6 cm. appear indistinguishable in all essential respects from the larger ones. Beyond this it is impossible to distinguish this species sharply from *A. dignatus* or from certain living species of *Pyrus*.

In shape and marginal characters *A. magnifolia* resembles the living *A. alnifolia*, although the latter has a much smaller leaf. *A. florida* and *A. sanguinea* are also similar.

MacGinitie (1933, p. 58) mentions *A. Grayi* (= *A. dignatus*) from Trout Creek, but does not figure it. Whether his material was different from small specimens of *A. magnifolia* is unknown.

Occurrence. — Trout Creek.

Nos. 18381, 18404 U.M.

Cercocarpus harneyensis, sp. nov. Pl. IV, Fig. 3.

Leaves oval, ranging from 1.5 to 3 cm. in breadth and 3 to 5.5 cm. in length; petiole 0.5 to 1 cm. long, stout; base cuneate; margin entire below the middle, coarsely crenate in upper portion; midrib distinct and straight, extending to tip; secondaries distinct, equal to number of marginal teeth and with one vein passing undivided to the apex of each tooth, the lowermost pair lying parallel to the basal margin; angle of divergence of lower-

most secondaries about 35 degrees from midrib, with the higher ones becoming successively steeper.

Several *Cercocarpus* leaves have been recovered from the lower part of the Trout Creek diatomite. The smaller specimens bear considerable resemblance to *C. parvifolius* Nutt., which at present is rather widely distributed over the arid portions of western North America and the Pacific Coast.

Although at first suspected of belonging to *Crataegus*, these leaves are assigned to *Cercocarpus* because of the simple, coarse crenations along the margin, each of which has a distinct secondary vein passing directly to the tip. The leaves of *Crataegus* are usually doubly or finely serrate and the veins branch considerably before reaching the apices of the teeth.

C. harneyensis is similar in many respects to *C. antiquus* Lesq. from the Auriferous gravels, and the two might come within the range of variation of a single species were the fossil forms more completely known. To judge from the published figures of *C. antiquus*, it differs from *C. harneyensis* in being more slender and in having smaller and more numerous teeth, which are pointed instead of rounded.

C. harneyensis is also quite similar to *C. cuneatus* Dorf, but has larger crenulation.

Occurrence. — Trout Creek.

No. 18382 U.M.

Crataegus microcarpifolia, sp. nov. Pl. V, Figs. 2–3.

Leaves variable in size, blade up to 8.5 cm. long and 6 cm. broad, oval to nearly round, base truncate to acute, petiole 1.5 to 4 cm. long; blade deeply cut into seven (or fewer) major lobes; sinuses extending almost to midrib in basal portion, but becoming successively shallower toward apex; lowermost lobes slender, standing well apart from upper portion and connected to it by a very narrow lamina, broadest at the middle and constricted basally, with a small secondary lobe on the lower margin, sometimes having two sets of secondary veins, the lowermost of which supplies the inferior secondary lobe (or the single vein may branch to supply it); lobes of the upper margin acute,

pointed forward, variously indented; a secondary vein passing to the base of each sinus, where it divides and follows both margins; divergence of secondaries acute except in the basal lobes, where they spread at a wide angle.

The description given above is based upon several leaves which are very similar to some which have been assigned to *C. Newberryi*, but careful comparisons with figures of the latter have led to the conclusion that sufficient differences exist to justify specific separation.

The first difference to be noted is that the leaves of *C. microcarpifolia* are larger. According to Chaney (1927, p. 121), the largest leaves of *C. Newberryi* are 5.3 cm. long (apparently the petiole is excluded from this measurement), whereas those described above are larger. Furthermore, all published figures of leaves representing *C. Newberryi* show forms which are definitely smaller (Lesquereux, 1883, Pl. 50, Fig. 10; Newberry, 1898, Pl. 48, Fig. 1; Chaney, 1927, Pl. 14, Figs. 6, 10). Other important differences are seen in the shape of the lobes and the sinuses. In *C. microcarpifolia* the lowermost sinuses are deeper than in *C. Newberryi* and thereby separate the lowermost lobes more completely from the upper portion of the leaf. In some instances the connecting lamina is so narrow as to be almost nonexistent; and corresponding to the deeper sinuses are the more slender basal lobes which are sometimes slightly constricted near the midrib. Illustrations of *C. Newberryi* show unconstricted basal lobes set off by a sinus which narrows to a point with a considerable width of lamina remaining to connect with the upper portion. In these respects the leaves of *C. microcarpifolia* resemble the larger leaves of the living species, *C. oxycantha* and *C. monogyna*.

The incomplete specimen figured by Knowlton (1902, Pl. 10, Fig. 1) as *C. flavescens* bears considerable resemblance to *C. microcarpifolia* and may be of the same species. It has the deep basal sinus which nearly cuts off the basal lobes from the upper portion.

The presence in *C. Newberryi* and *C. microcarpifolia* of a secondary vein which divides at the point of the sinus indicates that both belong to the section Microcarpae of the genus *Crataegus* as defined by Sargent (1921, p. 400).

A conservative course of procedure would be to group together as one species all the western Miocene forms of *Crataegus* with deeply incised leaves, on the assumption that the intergrades make a satisfactory separation impossible. This, however, would hardly provide an adequate picture of the Miocene representatives of *Crataegus,* because it is entirely reasonable to assume that there were then several species with dissected leaves, just as there are today, and when characters appear constant in a number of specimens one is justified in supposing that distinct species are indicated.

C. microcarpifolia may be compared with the living species, *C. monogyna, C. apiifolia, C. oxycantha,* and *C. pinnatifida. C. monogyna* and *C. apiifolia* occur in North America; the remainder are European or Asiatic. The closest resemblance appears to be to *C. pinnatifida,* which has larger leaves than either *C. oxycantha* or *C. monogyna.*

Occurrence. — Trout Creek.

Nos. 18383, 18405 U.M.

Pyrus McKenziei, sp. nov. Pl. IV, Fig. 2.

Leaf blade oval, 4 by 7 cm., broadest slightly above the middle, rounded at apex and base, tip abruptly acuminate; margin finely serrate almost to base; petiole 2 cm. long; midrib straight, extending to tip; secondaries depart from midrib at an angle of about 40 degrees, straight except near tip, where they become slightly curved, seven or eight pairs, subopposite below but becoming alternate above, extending nearly to margin but not entering directly into the marginal serrations; tertiaries percurrent, nearly at right angles to the secondaries.

Occurrence. — Carter Creek, southwest of Finley McKenzie ranch.

No. 18384 U.M.

ANACARDIACEAE

Rhus diluvialis, sp. nov. Pl. V, Fig. 4.

Leaflet oval, 3.5 cm. broad by 6 cm. long; blade cut into five lobes, the basal pair being largest; each lateral lobe supplied

by a distinct secondary vein; midrib extending to apex; basal lobes separated from upper portion by deep sinuses which become shallower in upper part; secondary veins departing at an angle of 45 degrees and branching on lower sides to supply smaller inferior lobes; several small veins depart at right angles from midrib between, below, and above the secondaries; base cuneate; margin irregularly and coarsely serrate.

The specimen described here closely resembles the living *R. trilobata*, although it is somewhat larger than are the leaflets commonly seen among western representatives of this species. It is more like material grown at the Arnold Arboretum. The author is unaware of any *Rhus* similar to this having been described from the Miocene of the Great Basin; hence the justification for assigning it specific rank.

Among fossil forms referred to *Rhus* there is some general resemblance to *R. Hilliae* Lesq., from Florissant, but there are obvious differences. The apex of *R. Hilliae* is rather acute, and the marginal teeth are sharper than in *R. diluvialis*. It shows less pronounced lobing in the upper portion, and the basal secondary veins are less distinct.

Mention might also be made of the European form, *R. Pyrrhae* Unger, from the Middle Miocene. This shows a cuneate base and an oval outline similar to that of *R. diluvialis*, but is not so strongly lobed.

Occurrence. — Carter Creek, southwest of Finley McKenzie ranch.

No. 18385 U.M.

TILIACEAE

Tilia sp. Pl. V, Fig. 1.

So far the foliage of *Tilia* has not been recognized at either Trout Creek or Succor Creek, but the presence at one locality of a portion of a pedunculate bract of *Tilia* attests its presence in the Miocene flora of that region.

The fragment shows clearly the doubling of the midvein near the apical portion of the bract, a feature quite pronounced in the living *Tilia americana*. Chaney refers to similar material of

Tilia from Eagle Creek and Gray's ranch (1927, p. 130), and LaMotte reports *T. aspera* from 49 Camp (1936, p. 138).

The comparative rarity of *Tilia* in the Oregon Miocene deposits indicates that it was probably not abundant in the vicinity of deposition but represents an upland form.

Occurrence. — Carter Creek, southwest of Finley McKenzie ranch.

No. 18386 U.M.

SIMARUBACEAE

Ailanthus Lesquereuxi Cockerell. Pl. VIII, Figs. 3–4.

Two samaras, one from Trout Creek and the other from Succor Creek, appear indistinguishable from Lesquereux's figure, and also from fruits of the living species, *A. glandulosa.* This appears to be the first noted occurrence of *Ailanthus* in the Miocene of Oregon comparable to the living species. *A. ovata,* which has been described from Bridge Creek, is notably different and may not even be an *Ailanthus.*

A. Lesquereuxi is an additional example of a genus which during Miocene times ranged far from its present native habitats.

Occurrence. — Trout Creek and Succor Creek, west of Fenwick ranch.

Nos. 18387, 18388 U.M.

MELIACEAE

Cedrela Browniana Arnold. Plate VII, Figs. 1–2.
Cedrela Trainii Arnold. Plate VI, Figs. 1–3, 6.
Cedrela pteraformis (Berry) Brown. Plate VI, Figs. 4, 7–10.

Pseudotsuga Masoni LaMotte, 1936, p. 111, Plate 3, Figs. 6, 7.
Pinus monticolensis LaMotte, 1936, p. 110, Plate 5, Figs. 1, 4.

Cedrela Browniana and *C. Trainii* were recently described elsewhere (Arnold, 1936) and, since nothing is to be added to the descriptions, the three forms listed above will be treated together.

The occurrence of *Cedrela* in the Miocene of western America

was recently demonstrated when Brown (1935, p. 579) showed that certain winged seeds earlier assigned to *Gordonia* belong to the former genus. In Malheur County these seeds occur in abundance, and at some localities they are among the predominant plant types. The slender, asymmetrical leaflets are also abundant, but are not so readily recognized as are the seeds because of their similarity to other leaves. If they had occurred alone, without the supporting evidence of the seeds, it is doubtful whether the presence of *Cedrela* in the Carter Creek and Succor Creek beds would have been even suspected. The seeds also occur at Spokane in the Latah formation and at 49 Camp, Nevada. It is probable that the genus will soon be recognized in other Miocene localities of the West.

Objects resembling the capsules of *Cedrela* also occur (Pl. VI, Fig. 5). On the specimen figured three valves with two sutures and the perianth scars below are shown.

Two species of leaves, *C. Browniana* and *C. Trainii*, are recognizable. The former has the larger leaflets, which are more rounded at the base. It is comparable in many respects to the living species, *C. mexicana*. The nearest living relative of *C. Trainii* is undetermined.

The seeds (*C. pteraformis*) differ considerably in size and shape and may belong to either or both of the leaf species described above, or to other species as yet unrecognized. One might attempt to separate them into form species were it not for the fact that within a single capsule of *C. mexicana* as great a variation in size and shape can be observed as among the entire assemblage of fossil specimens. For this reason it is necessary to keep a separate generic designation for them.

Cedrela is at present a tropical genus with several species in Central and South America. It is closely related to *Toona*, the Indian mahogany, of southeastern Asia.

Occurrence. — At all localities along Succor Creek and Carter Creek, the leaves being more abundant at the latter sites. Not recognized at Trout Creek.

Nos. 17749, 17750, 17751, 17752, 17753, 17754, 17755, 17758, 17759, 18401, 18402, 18403 U.M.

NYSSACEAE

Nyssa Knowltoni Berry. Pl. VIII, Figs. 1, 5.

A well-preserved leaf from the Trout Creek diatomite and a similar but smaller one from Rockville appear to belong to the species described by Berry (1929, p. 261) from the Latah at Spokane. The only apparent difference is that in the two Oregon specimens the uppermost secondaries have a steeper upward curve than the lower ones, whereas in the Latah specimen figured by Berry the curvature is about the same for all except those at the very base. In this respect the material from Oregon is more suggestive of certain living species of *Cornus* — *C. asperifolia*, for example.

The two specimens under consideration here are retained in *Nyssa* because the percurrent tertiaries are arranged at right angles to the secondaries, whereas in Cornus they are at right angles to the midrib. Aside from this rather clearly diagnostic feature the material might be compared to *Cornus ovalis* Lesq.

Occurrence. — Trout Creek and Rockville.

Nos. 18389, 18390 U.M.

OLEACEAE

Fraxinus succorensis, sp. nov. Pl. III, Fig. 2.

Leaflet oval, blade 3.6 by 7.5 cm., petiole 15 mm. long, broadest at middle; base rounded; apex pointed; marginal serrations distant and confined to the upper half; secondaries in seven pairs, alternate, departing from the midrib at an angle of about 80 degrees but curving upward as the margin is approached; marginal teeth supplied by inferior branches from the secondaries; tertiaries percurrent, at right angles to secondaries; midrib distinct.

Fruits (Pl. III, Fig. 3) and leaf fragments resembling those of *F. americana* are fairly common in the Trout Creek diatomite and at several localities in Malheur County, so no attempt is made to assign the fruits to any particular species.

Occurrence. — Fenwick ranch, west of Succor Creek.

No. 18391 (fruits, Nos. 18392, 18393) U.M.

ARALIACEAE

Oreopanax precoccinea (Brooks), comb. nov. Pl. X, Figs. 1–5.

Quercus precoccinea Brooks, 1935, p. 292, Pl. 16, Fig. 1.

Fragments of a large digitately compound leaf have been recovered at several localities in Malheur County. Among the material are one complete leaflet (Pl. X, Fig. 3) and another specimen showing the basal portions of three leaflets in place as they were attached to the base of the petiole (Pl. X, Fig. 1). The latter specimen furnishes the necessary clue to its generic identity.

The complete leaflet mentioned above is 15 cm. long and 4 cm. broad. Other incomplete leaflets are larger. The leaflets are straight with a strong midrib which diminishes gradually toward the apex, where it terminates in a short attenuate spine. The margin is cut into lobes of different lengths which are separated by rounded sinuses somewhat after the manner of the scarlet oak (*Quercus coccinea*) and which were responsible for its being originally compared to that genus and species (Brooks, 1935, p. 292). The longest lobes are slightly above the middle of the leaflet and their length diminishes gradually toward both the base and the apex. The shorter lobes are simple and terminate in minute attenuate spines which are merely prolongations of the secondaries, which pass into the lobes at a wide angle from the midrib. The longer lobes are not so simple. They often show secondary indentations (Pl. X, Fig. 2) quite similar to the simple primary ones. Some of the lobes intermediate between the longest and the shortest bear three spinous tips which are separated by very shallow sinuses. The basal portion of each leaflet tapers gradually to the point of attachment.

Each lobe is supplied with a secondary vein which departs from the midrib at an angle of 60 or 70 degrees and which passes directly to the tip, if the lobe is of the simple type. If subdivided, the secondary may branch several times, with a branch passing to the tip of each secondary lobe. The tertiaries form a network, and a distinct peripheral vein follows the margin.

The complete leaf was approximately circular in outline, quite

large, and apparently coriaceous. The largest leaflets indicate that some of the leaves probably attained a diameter of 30 or 40 cm. The number of leaflets present in a single leaf is conjectural, but to judge from the arc indicated by the three attached leaflets (Pl. X, Fig. 1) there could have been nine or more.

Among the living species of *Oreopanax*, *O. coriareifolius* [2] from the Department of Cuzco, Peru, resembles *O. precoccinea* with respect to type of leaf and shape and arrangement of the leaflets. This species occurs at an altitude of more than 2,000 meters. The leaf has nine leaflets similar in size and lobing to those already described, and the longer lobes which occur above the middle of the leaflet are cut in a similar manner. The likeness between the fossil and the living species is sufficient to indicate close relationship, although specific identity is improbable. Differences of minor importance may be noted, such as the shape of the lobes, which in the living species are longer, more slender, and more forward-pointing.

As stated above, fragments of the foliage of *O. precoccinea* may bear a superficial resemblance to the leaves of certain living oaks, but the digitately compound leaf, together with certain differences in details of the finer venation, are indicative of *Oreopanax*.

A large leaf from Florissant, described by Lesquereux as *Aralia dissecta* (1883, Pl. 35), shows lobing similar to that of *O. precoccinea*, but it has seven digitately arranged primary veins connected basally by a continuous lamina. Nevertheless, a relationship is possible since within some living species of the Araliaceae the compound type of leaf is known to intergrade with the simple palmately lobed type.

Berry (1916, pp. 329–331) describes two species of *Oreopanax* from the Eocene of Tennessee, Mississippi, and Arkansas. Both of these show the digitately compound leaf of *O. precoccinea*, but have different lobing. The same comparison applies to *O. Conditi* from 49 Camp, Nevada.

[2] *Oreopanax coriareifolius* appears to be but a *nomen nudum* since no description of it can be found. The specimen examined is Sheet No. 1422439 in the United States National Herbarium.

Berberis? gigantea, described by Knowlton from Bridge Creek (1902, Pl. 11, Fig. 1), appears also to be an *Oreopanax*, but it is distinct from *O. precoccinea*. It probably represents a simple leaf with large, nearly opposite, lobes, but it might be the central portion of a very large, deeply indented leaflet such as occurs in the living Peruvian species mentioned above, in which the lateral lobes of the leaflets are nearly opposite. Dr. A. C. Smith and Dr. W. H. Camp, who have recently reëxamined the type specimen of *B.? gigantea*, express the opinion that it bears certain resemblances to *O. Jaliscana* from Mexico. Since this form apparently belongs to *Oreopanax* rather than to *Berberis*, it may appropriately be designated as **Oreopanax gigantea** (Knowlton), comb. nov.

Occurrence. — Succor Creek north of the Strode ranch, Rockville, and at three localities along Carter Creek southwest of the Finley McKenzie ranch; Ballantyne ranch about thirteen miles southwest of Honesdale, Idaho.

Nos. 18394, 18395, 18396, 18397, 18398 U.M.

INCERTAE SEDIS

Phyllites mascallensis, nom. nov.

Phyllites oregonianus Knowlton, 1902, p. 85, Pl. 16, Fig. 1.
Phyllites oregonianus MacGinitie, 1933, p. 68, Pl. 7, Fig. 2.

Knowlton used *Phyllites oregonianus* for two new species, so the second one, described in 1902 from the John Day Basin and later recognized by MacGinitie at Trout Creek, requires a new name. *Phyllites mascallensis* is proposed. *P. oregonianus* was first applied to a specimen from the lavas of the Cascade Range (Knowlton, 1900, p. 49), but the two forms described under that name are entirely different.

The leaf from the Cascade Range, to which the name rightly belongs, is large, with secondaries that depart nearly at right angles from the midrib. *P. mascallensis* is a small leaf in which the secondaries branch from the midrib at an acute angle and then curve up toward the margin.

It appears that Knowlton's account of the fossil plants from

the Cascade Range has been generally overlooked. The paper is not even listed in his *Catalog of Mesozoic and Cenozoic Plants of North America*, nor are the new species referred to.

Occurrence. — John Day Basin and Trout Creek.

Phyllites cladrastifolia, sp. nov. Pl. VIII, Fig. 2.

Leaf (or leaflet) ovate, width 3.5 cm., length 5.5 cm.; petiole 1.5 cm. long; base rounded; apical portion forming a right angle; margin entire below but apparently shallowly crenulate along upper portion; midrib distinct and extending to apex; nine pairs of equally spaced camptodrome subopposite secondaries which depart at an obtuse angle below but become more acute above; veinlets obscure.

As implied by the specific name chosen for this species, it shows considerable resemblance to a normal leaflet of the living *Cladrastis lutea.* In size, shape, and venation it is so like the living species that one could refer it to *Cladrastis* without hesitation were it not for the apparent shallow crenulations along the upper margin. These appear to be natural, not wrinkles produced by drying. The leaflets of *Cladrastis lutea* are entire.

Cladrastis is a tree of limited distribution which occurs immediately west of the southern Appalachians and in southwestern Missouri. Apparently it has never been recognized in the fossil state.

Occurrence. — Trout Creek.

No. 18339 U.M.

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EXPLANATION OF PLATE I

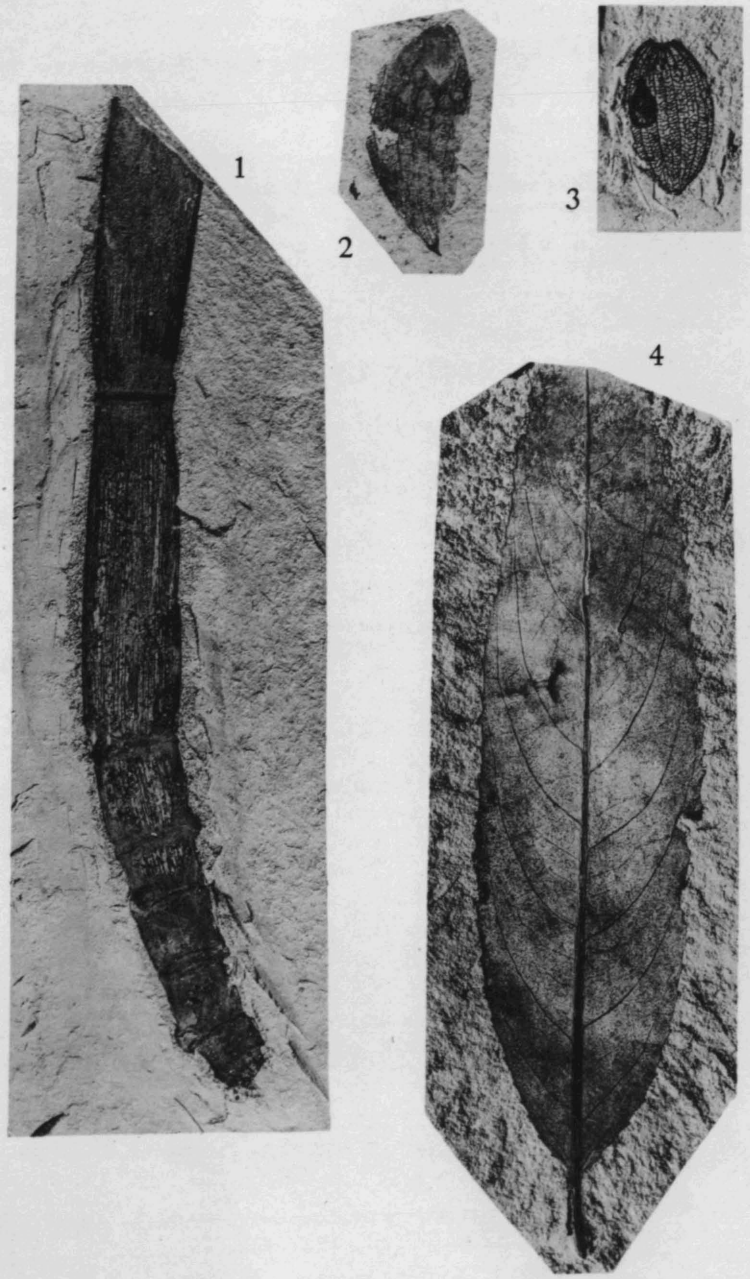
FIG. 1. *Equisetum sp.* Trout Creek. No. 17232 U.M.

FIG. 2. *Ostrya oregoniana* Chaney. Succor Creek, west of Fenwick ranch. No. 18372 U.M. Plesiotype

FIG. 3. *O. oregoniana.* Trout Creek. No. 17229 U.M. Plesiotype

FIG. 4. *Salix inquirenda* Knowlton. Succor Creek at Strode ranch. No. 18371 U.M. Plesiotype

PLATE I



EXPLANATION OF PLATE II

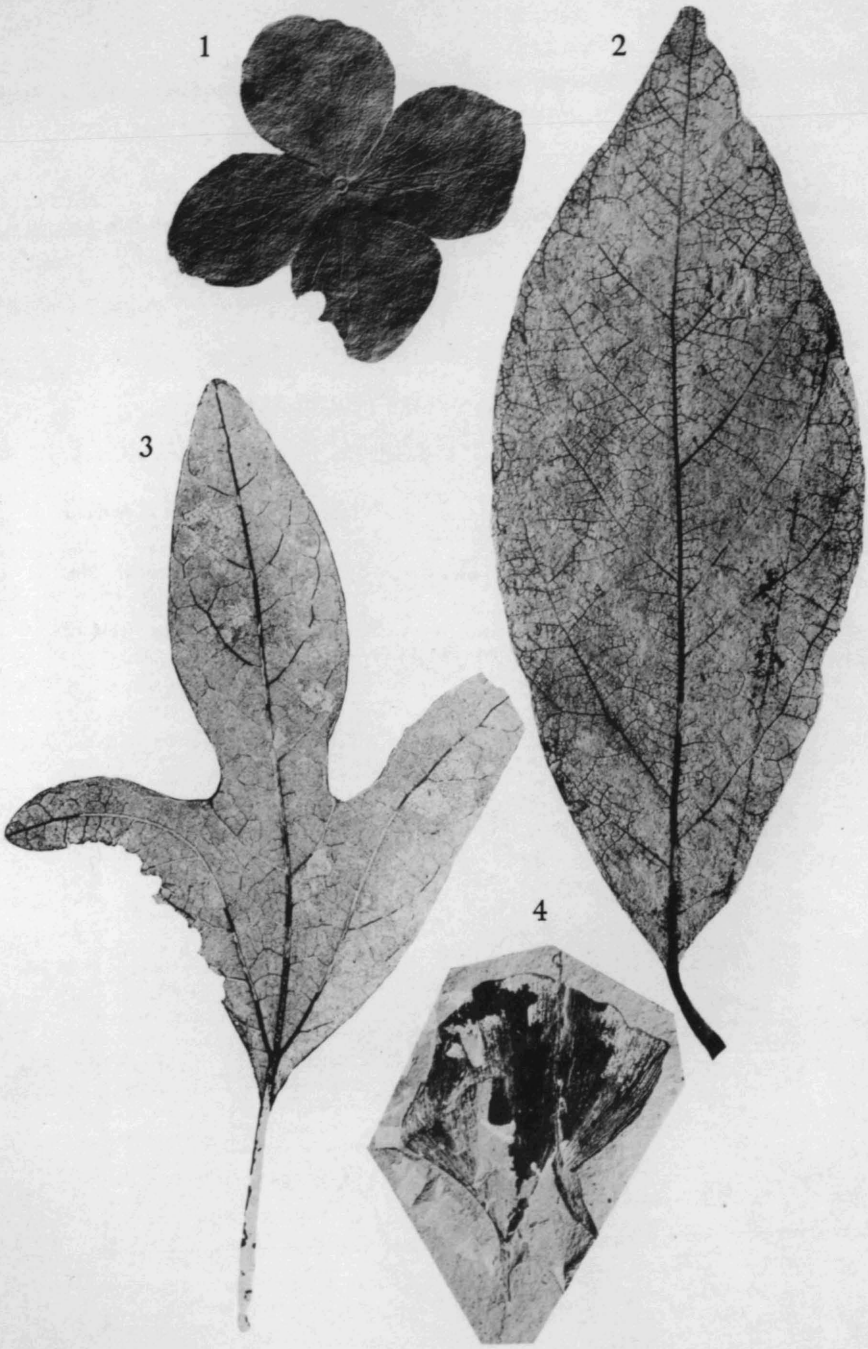
FIG. 1. *Hydrangea Bendirei* (Ward) Knowlton. Trout Creek. No. 17231 U.M. Plesiotype

FIG. 2. *Persea miocenica* Arnold, sp. nov. Trout Creek. No. 18376 U.M. Holotype

FIG. 3. *Sassafras hesperia* Berry. Fenwick ranch, west of Succor Creek. No. 18375 U.M. Plesiotype

FIG. 4. *Ginkgo adiantoides* (Unger) Heer. Fenwick ranch, west of Succor Creek. No. 18370 U.M. Plesiotype

PLATE II



EXPLANATION OF PLATE III

FIG. 1. *Platanus aceroides* Goepp. Fenwick ranch, west of Succor Creek. No. 18376 U.M. Plesiotype

FIG. 2. *Fraxinus succorensis* Arnold, sp. nov. Fenwick ranch, west of Succor Creek. No. 18391 U.M. Holotype

FIG. 3. *Fraxinus sp.* (fruits). Fenwick ranch, west of Succor Creek. No. 18392 U.M.

FIG. 4. *Philadelphus Bendirei* (Knowlton) Chaney. Fenwick ranch, west of Succor Creek. No. 18380 U.M. Plesiotype

PLATE III

EXPLANATION OF PLATE IV

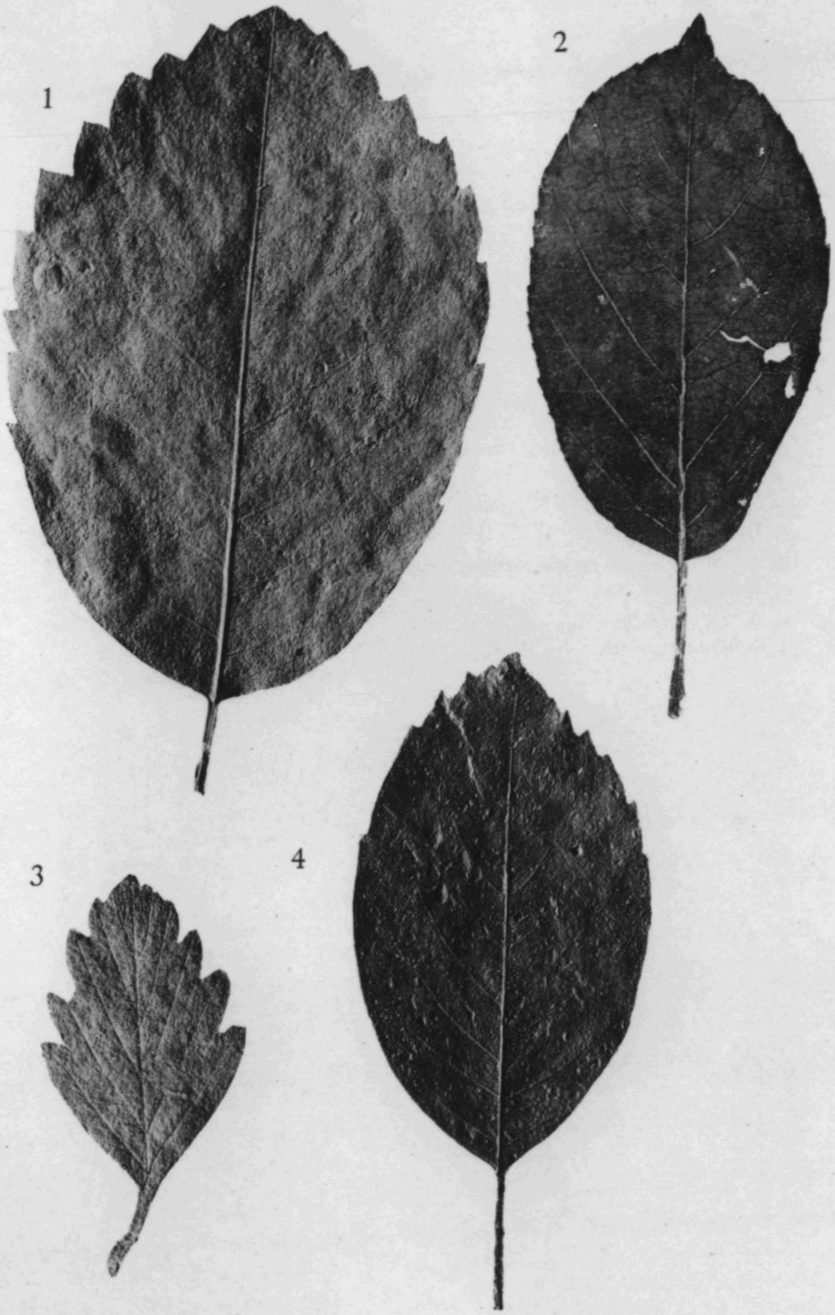
FIG. 1. *Amelanchier magnifolia* Arnold, sp. nov. Trout Creek. No. 18381 U.M. Holotype

FIG. 2. *Pyrus McKenziei* Arnold, sp. nov. Carter Creek, southwest of Finley McKenzie ranch. No. 18384 U.M. Holotype

FIG. 3. *Cercocarpus harneyensis* Arnold, sp. nov. Trout Creek. No. 18382 U.M. Holotype

FIG. 4. *Amelanchier magnifolia* Arnold, sp. nov. Trout Creek. No. 18404 U.M. Paratype

PLATE IV



EXPLANATION OF PLATE V

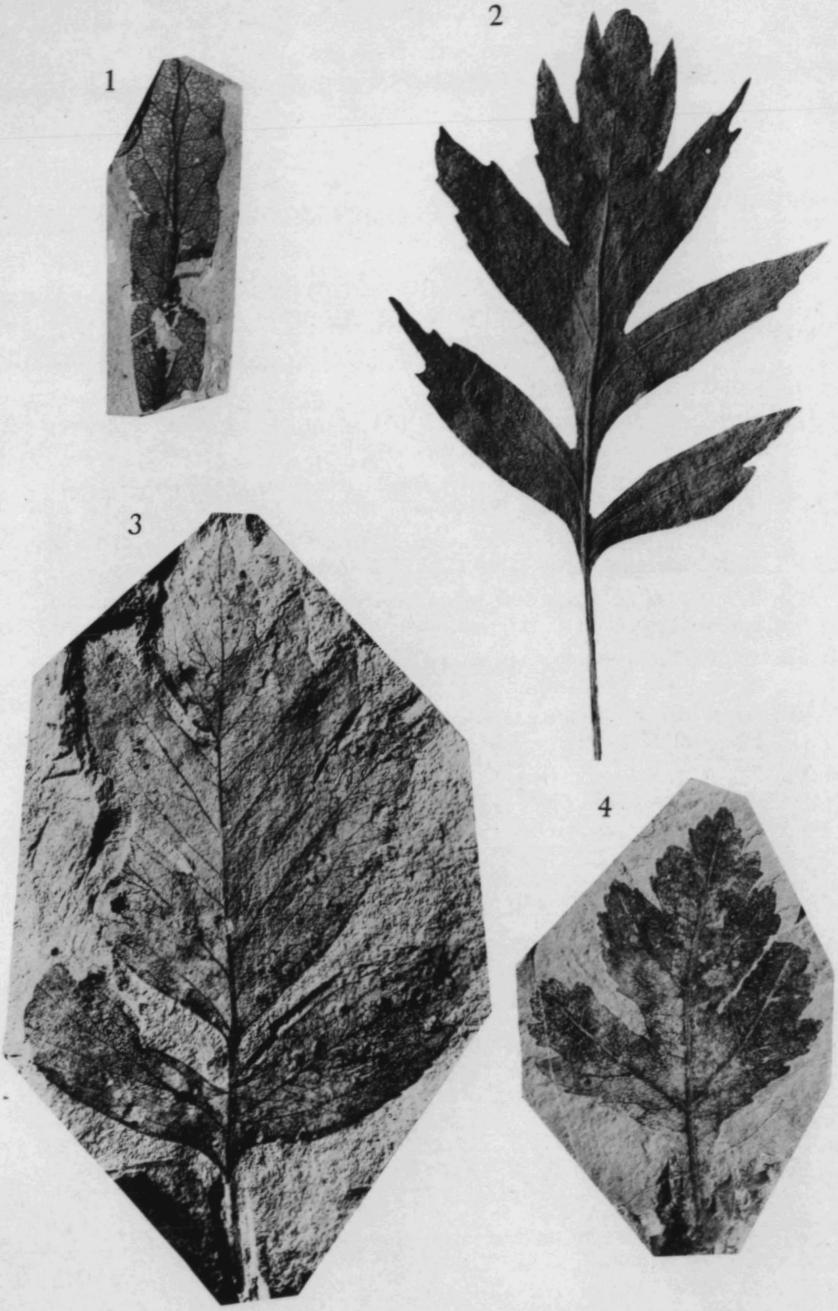
FIG. 1. *Tilia sp.* Carter Creek, southwest of Finley McKenzie ranch. No. 18386 U.M.

FIG. 2. *Crataegus microcarpifolia* Arnold, sp. nov. Trout Creek. No. 18405 U.M. Paratype

FIG. 3. *C. microcarpifolia* Arnold, sp. nov. Trout Creek. No. 18383 U.M. Holotype

FIG. 4. *Rhus diluvialis* Arnold, sp. nov. Carter Creek, southwest of Finley McKenzie ranch. No. 18385 U.M. Holotype

PLATE V



EXPLANATION OF PLATE VI

FIG. 1. *Cedrela Trainii* Arnold. Carter Creek, southwest of Finley McKenzie ranch. No. 17752 U.M. Holotype

FIG. 2. *C. Trainii* Arnold. Carter Creek, southwest of Finley McKenzie ranch. No. 18401 U.M. Paratype

FIG. 3. *C. Trainii* Arnold. Carter Creek, southwest of Finley McKenzie ranch. No. 18402 U.M. Paratype

FIG. 4. *C. pteraformis* (Berry) Brown. Carter Creek, southwest of Finley McKenzie ranch. No. 17759 U.M. Plesiotype

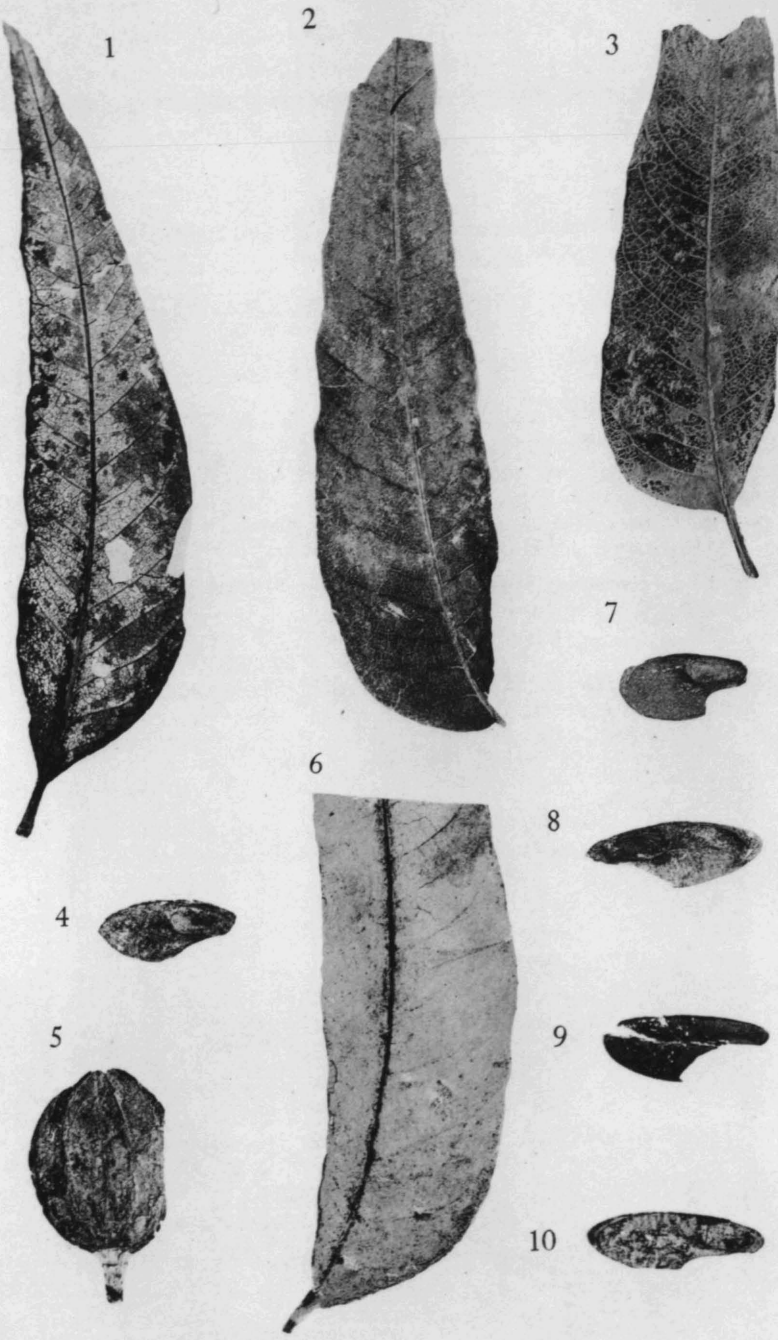
FIG. 5. *Cedrela sp.* Capsule showing three of the five valves and two sutures. Succor Creek, west of Fenwick ranch. No. 17749 U.M.

FIG. 6. *C. Trainii* Arnold. Carter Creek, southwest of Finley McKenzie ranch. No. 17751 U.M. Paratype

FIGS. 7, 8, 10. *C. pteraformis* (Berry) Brown. Carter Creek, southwest of Finley McKenzie ranch. Nos. 17755, 17754, 17758 U.M. Plesiotypes

FIG. 9. *C. pteraformis* (Berry) Brown. Strode ranch, in vicinity of Succor Creek. No. 17753 U.M. Plesiotype

PLATE VI



EXPLANATION OF PLATE VII

FIG. 1. *Cedrela Browniana* Arnold. Carter Creek, southwest of Finley McKenzie ranch. No. 17750 U.M. Holotype

FIG. 2. *C. Browniana* Arnold. Carter Creek, southwest of Finley McKenzie ranch. No. 18403 U.M. Paratype

PLATE VII

1

2

EXPLANATION OF PLATE VIII

FIG. 1. *Nyssa Knowltoni* Berry. Trout Creek. No. 18389 U.M. Plesiotype

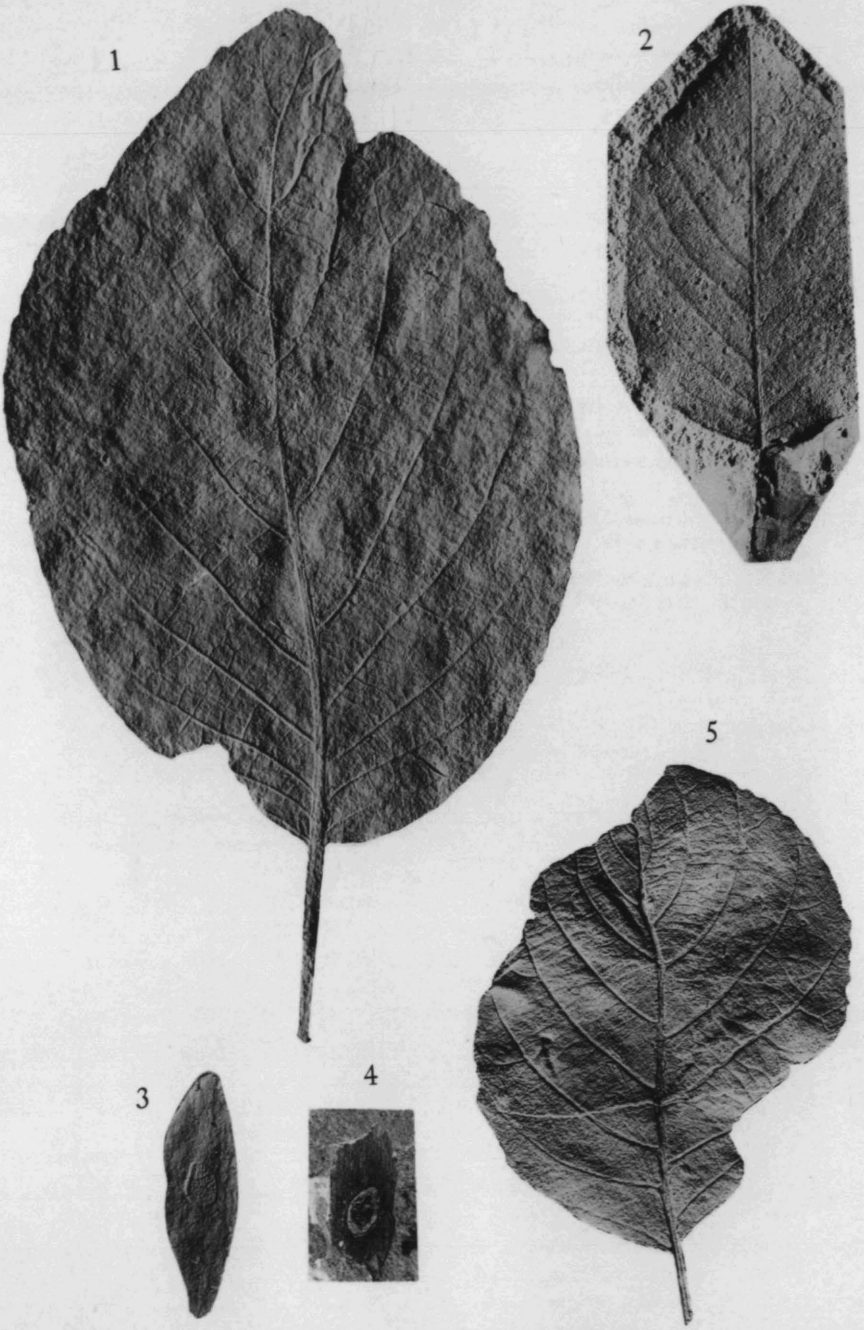
FIG. 2. *Phyllites cladrastifolia* Arnold, sp. nov. Trout Creek. No. 18399 U.M. Holotype

FIG. 3. *Ailanthus Lesquereuxi* Cockerell. Trout Creek. No. 18388 U.M. Plesiotype

FIG. 4. *A. Lesquereuxi* Cockerell. Succor Creek, west of Fenwick ranch. No. 18387 U.M. Plesiotype

FIG. 5. *Nyssa Knowltoni* Berry. West of Rockville. No. 18390 U.M. Plesiotype

PLATE VIII



EXPLANATION OF PLATE IX

FIG. 1. *Platanus dissecta* Lesq. West of Rockville. No. 18377 U.M. Plesiotype

FIG. 2. *P. dissecta* Lesq. Succor Creek, west of Fenwick ranch. No. 18378 U.M. Plesiotype

FIG. 3. *P. dissecta* Lesq. Carter Creek, southwest of Finley McKenzie ranch. No. 18379 U.M. Plesiotype

PLATE IX

EXPLANATION OF PLATE X

FIG. 1. *Oreopanax precoccinea* (Brooks) Arnold, comb. nov. Carter Creek, southwest of Finley McKenzie ranch. No. 18395 U.M. Plesiotype

FIG. 2. *O. precoccinea* (Brooks) Arnold, comb. nov. Carter Creek, southwest of Finley McKenzie ranch. No. 18398 U.M. Plesiotype

FIG. 3. *O. precoccinea* (Brooks) Arnold, comb. nov. Carter Creek, southwest of Finley McKenzie ranch. No. 18397 U.M. Plesiotype

FIG. 4. *O. precoccinea* (Brooks) Arnold, comb. nov. Carter Creek, southwest of Finley McKenzie ranch. No. 18394 U.M. Plesiotype

FIG. 5. *O. precoccinea* (Brooks) Arnold, comb. nov. Carter Creek, southwest of Finley McKenzie ranch. No. 18396 U.M. Small form. Plesiotype

FIG. 6. *O. coriareifolius* (nom. nud.). Living species from Department of Cuzco, Peru, introduced for comparison. From sheet No. 1422439, U. S. Nat. Herbarium. Collected by F. L. Herrera. × about $\frac{1}{3}$

PLATE X

(*Continued from inside of front cover*)