A REVISION OF THE FLORA OF THE LATAH FORMATION

By Edward Wilber Berry

INTRODUCTION

A preliminary account of the flora of the Latah formation by F. H. Knowlton was published in January, 1926, in connection with an account of the geology by J. T. Pardee and Kirk Bryan.[1] The materials were largely contributed by local students. During the summer of 1926 Knowlton visited the area and made large additional collections, which had not been unpacked at the time of his death. It is much to be regretted that he did not live to work up this collection, for it contained many novelties, and its excellent preservation was a constant source of pleasure to him. It became my duty to identify this material in order to prepare a collection of duplicates for the Spokane Museum, and in this task I encountered so much that was new and important that it has seemed desirable to prepare the present report. During the course of the work I have received valuable additional material from Prof. T. A. Bonser and Messrs E. E. Alexander and C. O. Fernquist, of Spokane.

The region from which the Latah flora was collected has a present altitude in the neighborhood of 2,000 feet. The Spokane Weather Bureau station shows an average annual precipitation (for a 24-year period) of 18.23 inches. This drops to less than 10 inches a short distance to the southwest, but rises to around 75 inches on the Pacific-facing slopes of the mountains west of the Spokane area and to 90 inches on the Pacific coast. The Latah area is characterized by summer droughts. The normal annual mean temperature is 45.9° F., which is not low relatively, but the climate is marked by extremes of temperature, both in winter and summer. Consequently the nights are cool, and both late and early frosts result in a relatively short growing season.

It is beyond the scope of the present paper to discuss these climatic factors in their bearing on the existing flora of the region, and this has already been done in a general way by more competent botanists. My purpose is merely to hint at the present conditions as a background for discussing the conditions in Miocene time.

Floristically the Spokane region is in the transition zone between the northern extension of the Great Basin arid region (Sonoran) and the (in general) evergreen mesophytic forests of the Columbian region to the west and the Rocky Mountain ranges to the north and east—what is usually termed the Canadian zone. These forests consist largely of needle-leaved conifers, and the assemblage becomes more hygrophilous on the Pacific slopes of the mountains west of Spokane and on the corresponding slopes of the mountains of Montana and Idaho. There is a considerable admixture of broad-leaved deciduous trees, especially along streams. In the heavier stands of evergreens there is a relative scarcity of undershrubs and herbaceous species.

This transition zone is both forested and treeless in the immediate vicinity of Spokane. The somewhat less arid forested portion includes such arborescent and shrubby genera as *Abies, Acer, Pinus, Populus, Pseudotsuga, Rhamnus, Salix, Taxus, Thuya, Tsuga, Alnus, Amelanchier, Ceanothus, Chimaphila, Linnaea, Lonicera, Menziesia, Opulaster, Pachystima, Ribes, Rosa, Rubus, Salix,* and *Vaccinium.* Of these the genera *Acer, Pinus, Populus, Salix, Alnus, Amelanchier, Ceanothus, Menziesia,* and *Vaccinium* were present in the region in upper or middle Miocene (Latah) time.

The present account of the Latah flora contains 152 species, as against 95 in Knowlton's preliminary account. Of this number 6 are referred to *Phyllites,* 6 to *Carpites,* and 1 to *Carpolithus,* all but the *Carpolithus* under names proposed in Knowlton's paper. I have not named a considerable number of new forms represented by poor material in the present collection.

The notable additions to the flora comprise a characteristic new fern of the genus *Asplenium;* a large and diversified representation of seeds and leaves of *Pinus;* two species of sweet fern, *Comptonia;* the leaves of several hardwoods hitherto unknown in the Latah flora, such as the hickory (*Hicoria*), beech (*Fagopsis*), sycamore (*Platanus*), horse chestnut (*Aesculus*), and linden (*Tilia*); or tree genera hitherto unknown in the western Miocene, such as the tulip tree (*Liriodendron*) and sassafras (*Sassafras*).

There is of course some duplication involved in giving separate names to leaves and fruits, especially in the genera *Pinus, Alnus, Acer, Ulmus, Liquidambar,* and *Quercus.* There are also undoubtedly too many species recognized among the poplars, birches, and

[1] U. S. Geol. Survey Prof. Paper 140, pp. 1-81, 1926.

oaks. These have been retained for the most part, out of respect for Knowlton's opinion and partly because of the impossibility of drawing satisfactory specific lines among the leaves of these trees, although I have indicated my opinions on these points in the systematic discussion.

The Latah flora now contains 75 genera in 51 families and 29 orders. The largest order is the Fagales, with 25 nominal species; next come the Sapindales, with 14; the Pinales and Salicales, with 13 each; the Ericales, with 8; and the Laurales, with 7.

Similarly the largest family is the Fagaceae, with 16 nominal species; next in specific representation is the family Salicaceae, with 13; followed by the Betulaceae, with 9; the Lauraceae, with 7; the Pinaceae, Cupressinaceae, and Papilionaceae, with 6 each; and the Aceraceae, with 5. The largest genus is *Quercus*, with 13 nominal species; next come *Phyllites* and *Carpites*, with 6 each; and *Pinus*, *Salix*, *Acer*, and *Vaccinium*, with 5 each. Most numerous individually are the leaves of the oaks, poplars, *Sequoia*, and bald cypress.

As probably the largest and best-preserved western Miocene flora except that from Florissant, Colo., the Latah flora is of especial interest. In addition to the plants the scales, rays, and vertebrae of a small cyprinoid fish are not uncommon in these deposits. These remains are not sufficiently complete for precise identification, but they probably represent the genus *Leuciscus* and may be identical with *Leuciscus turneri* Lucas, of the Esmeralda formation of western Nevada. I have illustrated two of the characteristic scales in the present paper. (See pl. 49, figs. 1, 2.)

In Knowlton's account of the Latah flora he remarks on the rarity of insect remains, an anomalous feature because of the fine-grained texture and lacustrine character of the sediments. Only one species, a carabid beetle, *Calosoma fernquisti* Cockerell, was recorded. The more recent collections bid fair to remedy this situation, containing several other beetles, flies, dragon flies, etc. These will be described in a separate contribution.

Flora of the Latah formation

Bryophyta:
- Musci—
  - Mniaceae—
    - Archaeomnium patens E. G. Britton.
  - Polytrichaceae—
    - Polytrichites spokanensis E. G. Britton.
    - Moss, unnamed.

Lepidophyta:
- Lycopodiales—
  - Lycopodiaceae—
    - Lycopodium hesperium Knowlton (fertile spike).

Arthrophyta:
- Equisetales—
  - Equisetaceae—
    - Equisetum, rhizome with tubers.

Pteridophyta:
- Polypodiales—
  - Polypodiaceae—
    - Asplenium occidentale Berry.
    - Woodwardia praeradicans Berry.
    - Woodsia bonseri Berry.
    - Pteris sp. Berry.

Coniferophyta:
- Ginkgoales—
  - Ginkgoaceae—
    - Ginkgo adiantoides (Unger) Heer.
- Pinales—
  - Taxaceae—
    - Tumion bonseri Knowlton.
  - Cupressinaceae—
    - Sequoia langsdorfii (Brongniart) Heer.
    - Sequoia sp. Knowlton, wood.
    - Taxodium dubium (Sternberg) Heer.
    - Taxodium, staminate ament.
    - Libocedrus praedecurrens Knowlton.
    - Glyptostrobus?, staminate aments.
  - Pinaceae—
    - Pinus latahensis Berry.
    - Pinus macrophylla Berry.
    - Pinus monticolensis Berry.
    - Pinus tetrafolia Berry
    - Pinus sp. Knowlton.
    - Tsuga latahensis Berry.

Spermatophyta:
- Angiospermae—
  - Monocotyledonae—
    - Pandanales—
      - Typhaceae—
        - Typha? sp. Knowlton.
    - Naiadales—
      - Naiadaceae—
        - Potamogeton heterophylloides Berry.
        - Palaeopotamogeton florissanti Knowlton.
    - Arales—
      - Araceae—
        - Arisaema hesperia Knowlton.
    - Graminales—
      - Poaceae—
        - Grass, unnamed.
    - Liliales—
      - Smilaceae—
        - Smilax lamarensis Knowlton.
      - Juncaceae?—
        - Juncus? crassulus Cockerell.
  - Dicotyledonae—
    - Choripetalae—
      - Juglandales—
        - Juglandaceae—
          - Hicoria juglandiformis (Sternberg) Knowlton.
      - Myricales—
        - Myricaceae—
          - Comptonia hesperia Berry.
          - Comptonia insignis (Lesquereux) Cockerell.
      - Salicales—
        - Salicaceae—
          - Salix florissanti Knowlton and Cockerell.
          - Salix inquirenda Knowlton.
          - Salix perplexa Knowlton.
          - Salix remotidens Knowlton.
          - Salix? sp. Knowlton.
          - Salix, pistillate flower.
          - Salix, stipule.

Spermatophyta—Continued.
Angiospermae—Continued.
Dicotyledonae—Continued.
Choripetalae—Continued.
Salicales—Continued.
Salicaceae—Continued.
Populus heteromorpha Knowlton.
Populus lindgreni Knowlton.
Populus washingtonensis Knowlton.
Populus, amentiferous bract.
Populus, bud scales.
Populus, pistillate ament.
Fagales—
Betulaceae—
Betula fairii Knowlton.
Betula heteromorpha Knowlton.
Betula largei Knowlton.
Betula, winged fruit.
Alnus elliptica Berry.
Alnus prerhombifolia Berry.
Alnus sp. Knowlton, cones.
Alnus or Betula, staminate catkin.
Carpinus sp. Knowlton.
Fagaceae—
Castanea castaneaefolia (Unger) Knowlton.
Castanea orientalis Chaney.
Fagopsis longifolia (Lesquereux) Hollick.
Quercus bonseri Knowlton.
Quercus cognatus Knowlton.
Quercus merriami Knowlton.
Quercus obtusa Knowlton.
Quercus payettensis Knowlton.
Quercus rustii Knowlton.
Quercus simulata Knowlton.
Quercus spokanensis Knowlton.
Quercus treleasii Berry.
Quercus ursina Knowlton?
Quercus cf. Q. pseudolyrata Lesquereux.
Quercus, acorn.
Quercus, cupule.
Urticales—
Ulmaceae—
Ulmus fernquisti Knowlton.
Ulmus speciosa Newberry.
Ulmus, fruit.
Moraceae—
Ficus? washingtonensis Knowlton.
Platanales—
Platanaceae—
Platanus aspera Newberry.
Platanus dissecta Lesquereux.
Platanus appendiculata Lesquereux?
Ranales—
Menispermaceae—
Menispermites latahensis Berry.
Magnoliaceae—
Liriodendron hesperia Berry.
Magnolia californica Lesquereux.
Magnolia dayana Cockerell.
Magnolia sp. Knowlton.
Rosales—
Grossulariaceae—
Ribes fernquisti Berry.
Hamamelidaceae—
Liquidambar californicum Lesquereux.
Liquidambar, fruit.
Saxifragaceae—
Hydrangea bendirei (Ward) Knowlton.

Spermatophyta—Continued.
Angiospermae—Continued.
Dicotyledonae—Continued.
Choripetalae—Continued.
Rosales—Continued.
Drupaceae—
Prunus rustii Knowlton.
Rosaceae—
Amelanchier scudderi Cockerell.
Cercocarpus praeledifolius Berry.
Caesalpiniaceae—
Cassia idahoensis Knowlton
Cassia spokanensis Berry.
Cassia sophoroides (Knowlton) Berry.
Cercis? spokanensis Knowlton.
Papilionaceae—
Sophora alexanderi Knowlton.
Sophora spokanensis Knowlton.
Meibomites knowltoni Berry.
Meibomites lucens Knowlton.
Leguminosites bonseri Berry.
Leguminosites alexanderi Berry.
Sapindales—
Sapindaceae—
Sapindus spokanensis Berry.
Sapindus armstrongi Berry.
Celastraceae—
Celastrus lacoei Lesquereux.
Celastrus fernquisti Knowlton.
Celastrus spokanensis Berry.
Euonymus knowltoni Berry.
Anacardiaceae—
Rhus typhinoides Lesquereux.
Rhus merrilli Chaney.
Hippocastanaceae—
Aesculus hesperia Berry.
Aceraceae—
Acer bendirei Lesquereux.
Acer chaneyi Knowlton.
Acer merriami Knowlton.
Acer minor Knowlton.
Acer oregonianum Knowlton.
Rhamnales—
Rhamnaceae—
Rhamnus spokanensis Berry.
Paliurus hesperius Berry.
Malvales—
Tiliaceae—
Tilia hesperia Berry.
Malvaceae?—
Malva? hesperia Knowlton.
Hibiscus? occidentalis Berry
Parietales—
Ternstroemiaceae—
Ternstroemites idahoensis (Knowlton) Berry.
Laurales—
Lauraceae—
Laurus californica Lesquereux.
Laurus grandis Lesquereux.
Laurus princeps Heer.
Laurus similis Knowlton.
Sassafras hesperia Berry.
Umbellularia dayana (Knowlton) Berry.
Umbellularia lanceolata Berry.
Umbellales—
Araliaceae—
Aralia whitneyi Lesquereux.

Spermatophyta—Continued.
Angiospermae—Continued.
Dicotyledonae—Continued.
Choripetalae—Continued.
Umbellales—Continued.
Cornaceae—
Cornus acuminata Berry.
Nyssa knowltoni Berry.
Nyssa magnifica (Knowlton) Berry.
Umbelliferae—
Umbelliferospermum latahense Berry.
Gamopetalae—
Ericales—
Ericaceae—
Menziesia knowltoni Berry.
Arctostaphylos spatulata Berry.
Arctostaphylos knowltoni Berry.
Vacciniaceae—
Vaccinium americanum (Lesquereux) Berry.
Vaccinium bonseri Berry.
Vaccinium bonseri serrulatum Berry.
Vaccinium salicoides Knowlton.
Vaccinium spokanense Berry.
Ebenales—
Ebenaceae—
Diospyros princetoniana Cockerell.
Diospyros andersonae Knowlton.
Gentianales—
Apocynaceae—
Apocynophyllum latahense Berry.
Polemoniales—
Convolvulaceae—
Porana microcalyx (Knowlton) Berry.
Rubiales—
Caprifoliaceae—
Viburnum lantanafolium Berry.
Viburnum fernquisti Berry.
Position uncertain—
Phyllites amplexicaulis Knowlton.
Phyllites crustacea Knowlton.
Phyllites pardeei Knowlton.
Phyllites peculiaris Knowlton.
Phyllites relatus Knowlton.
Phyllites sp. Knowlton.
Carpolithus pteraformis Berry.
Carpites boraginoides Knowlton.
Carpites ginkgoides Knowlton.
Carpites menthoides Knowlton.
Carpites paulownia Knowlton.
Carpites polygonoides Knowlton.
Carpites spokanensis Knowlton.

LOCAL DISTRIBUTION

Anyone taking the trouble to tabulate the local occurrences of the members of the Latah flora will find the same facies and much the same species at each fossiliferous outcrop. The species recorded from only a single locality are usually represented by a single or but a few specimens.

All but one of the plant localities are within a few miles of one another in the vicinity of Spokane; the only remote locality is that at Stanley Hill, 2 miles northeast of Coeur d'Alene, Idaho, and this is only 25 miles distant.

Such contrasts between localities as appeared in the collections studied by Knowlton have tended to disappear when the later collections were studied. Twenty-two species were named from the Coeur d'Alene district by Knowlton, and but six of these were common to the Spokane area. The subsequent collections show quite as many oaks, poplars, and sequoias around Spokane as at Coeur d'Alene. The following 16 species, representing over 72 per cent of the identified species from Coeur d'Alene, are now represented in the collections from Spokane, so the plants from the two areas can not be said to differ appreciably, either botanically or in the indicated environmental conditions:

Sequoia langsdorfii.	Quercus simulata.
Taxodium dubium.	Betula fairii.
Populus lindgreni.	Betula heteromorpha.
Alnus, pistillate cones.	Ficus washingtonensis.
Quercus cognatus.	Prunus rustii.
Quercus merriami.	Sophora alexanderi.
Quercus payettensis.	Cassia sophoroides.
Quercus rustii.	Umbellularia dayana.

RELATIONSHIPS

The following 39 genera out of a total of 75 in the Latah flora are not represented in the existing flora of the State of Washington as described by Piper:[2]

Archaeomnium.	Carpinus.	Sapindus.
Polytrichites.	Ficus	Celastrus.
Ginkgo.	Platanus.	Aesculus.
Tumion.	Menispermites.	Paliurus.
Sequoia.	Liriodendron.	Tilia.
Taxodium.	Magnolia.	Ternstroemites.
Libocedrus.	Liquidambar.	Laurus.
Arisaema.	Hydrangea.	Sassafras.
Hicoria.	Cassia.	Umbellularia.
Comptonia.	Cercis.	Nyssa.
Castanea.	Sophora.	Diospyros.
Fagopsis (Fagus).	Meibomites.	Apocynophyllum.
Ulmus.	Leguminosites.	Porana.

Disregarding the form genera *Archaeomnium*, *Polytrichites*, *Meibomites*, *Leguminosites*, *Laurus*, and *Apocynophyllum*, we may note that of the 39 genera found in the Latah flora which are not present in the existing flora of the State of Washington the following 26 are no longer represented in the existing flora of western America:

Ginkgo.	Ficus.	Celastrus.
Taxodium.	Menispermites.	Aesculus.
Arisaema.	Liriodendron.	Tilia.
Hicoria.	Magnolia.	Ternstroemites.
Comptonia.	Liquidambar.	Sassafras.
Castanea.	Hydrangea.	Nyssa.
Fagus (Fagopsis).	Sophora.	Diospyros.
Ulmus.	Sapindus.	Porana.
Carpinus.	Paliurus.	

[2] Piper, C. V., Flora of the State of Washington: Contr. U. S. Nat. Herbarium, vol. 11, 1906.

The majority of these are well-known arborescent genera of the mixed hardwood forests of the mesophytic region of southeastern North America, although many are not confined to that region.

The following genera of the Latah flora are still represented in western North America: *Tumion*, *Libocedrus*, *Platanus*, and *Cercis* in California; *Sequoia* and *Umbellularia* in Oregon and California. These all represent genera of once general distribution in western North America, which because of changing climatic conditions, chief of which was the progressive increase in aridity due to the geologically recent elevation of the Sierra Nevada and Cascade Range, became extinct in the region east of the mountains and now survive only in favored situations west of them.

The following genera of the Latah flora no longer represented in western North America occur in the existing flora of eastern Asia:

Ginkgo.	Carpinus.	Aesculus.
Glyptostrobus.	Menispermites.	Paliurus.
Arisaema.	Liriodendron.	Tilia.
Hicoria.	Magnolia.	Ternstroemites.
Castanea.	Liquidambar.	Sassafras.
Fagus (Fagopsis).	Hydrangea.	Nyssa.
Ulmus.	Celastrus.	Porana.

Several of these, such as *Liriodendron*, *Hicoria*, and *Sassafras*, are relatively recent discoveries in the flora of China, whose presence in that region is not generally known. All the genera in the foregoing list of Asiatic occurrences except *Ginkgo*, *Paliurus*, and *Porana* are common to the mesophytic region of southeastern North America.

It is of great interest to comment in somewhat more detail on the features above set forth.

The genus *Ginkgo*, whose single existing species was aptly termed a living fossil by Darwin and which survived to modern times only in eastern Asia and is now a prized ornamental tree in all temperate countries, has an ancestral history that goes back to remote geologic time. It was present over practically all of North America, as well as on all the other continents except Africa and South America, during the Mesozoic era. The Tertiary found it still present in the floras of Europe, Asia, the Arctic region, and western North America. To-day, through the care of man—temple gardeners in eastern Asia and arboriculturists elsewhere—this unique tree has been preserved from total extinction, greatly to our enjoyment and profit.

The genus *Taxodium*, the bald cypress of the southeastern United States, has an ancestral history quite as romantic though shorter than that of the maidenhair tree (*Ginkgo*). It grew on all three of the continents of the Northern Hemisphere, commencing with the Eocene, and maintained its holarctic distribution well into Miocene time, contributing to the brown-coal deposits of both America and Europe. Its restriction of range began in the late Tertiary, and its existing species are three—two slightly differentiated forms in the southeastern United States and the third or Mexican cypress, separated from the other two by the arid country of our Southwestern States and northern Mexico, furnishing some of the historic trees associated with Cortez's conquest of Mexico, and as old as the big trees of California, if not older.

The genus *Sequoia*, represented by the familiar redwood and the still more restricted big trees of California, has been the subject of so much comment that the theme is well-nigh threadbare. Its ancestry goes back to the Mesozoic, and it was present throughout the whole Northern Hemisphere well into Tertiary time. Large standing silicified trunks may be seen in the upper Miocene deposits at Florissant, Colo., and in the celebrated fossil forests of Yellowstone Park, and its wood is found with the foliage in the Latah formation, in which its twigs are so abundant. The main facts of its history have long been well known, but it has not been realized how recently was the great elevation of the mountains, which was the main factor in the ecologic rearrangement and extinctions among the Miocene forests of our Pacific States.

The genus *Tumion* (or *Torreya*, as it is more generally called) is another example of an old line of trees, practically cosmopolitan in Cretaceous time, which has single existing survivors in such geographically remote regions as Florida, California, and eastern Asia, standing, as it were, on the brink of extinction.

The so-called incense cedar, *Libocedrus*, represents another Latah type, quite as rare as *Tumion*, although its history is not so completely known, which was evidently widely distributed in former times, as it survives in such remote regions as California, eastern Asia, Chile, New Zealand, and New Caledonia.

Arisaema, a herbaceous genus with an unknown history, survives in the mesophytic regions of eastern Asia and southeastern North America.

The hickories, long supposed to have survived only in southeastern North America, have recently been discovered in that great natural floral preserve of central China. Their range was holarctic during the early Tertiary, and they survived until late Tertiary time in both the western United States and Europe.

The sweet fern (*Comptonia*) has a single modern species in southeastern North America. There were numerous fossil species on all the northern continents, and some survived until the late Tertiary in Eurasia and western America. *Comptonia* was especially abundant around the Miocene Lake Florissant in Colorado, and one of the Florissant species occurs in the Latah flora. Late Eocene species are found northward through the present Rocky Mountain region to Alaska.

The chestnut (*Castanea*), no longer found in western North America, has three existing species in southeastern North America, a Mediterranean species

ranging from Spain eastward to southwestern Asia, and a fifth species in China and Japan. Its geologic history goes back to the Eocene, and it was not uncommon in the West and in Alaska during most of the Tertiary.

As I have pointed out in the systematic descriptions, the genus *Fagopsis* is believed to be referable to *Fagus*, which comprises the beeches found to-day in Europe, eastern Asia, and southeastern North America. Their cousins, the evergreen beeches of Chile, Australia, and New Zealand, are now segregated in the separate genus *Nothofagus*. The oldest known fossil beeches are found in the Upper Cretaceous of Europe and North America. They were certainly holarctic in their range during the Tertiary period, about 30 species from the Miocene having been described, as compared with but 4 in existing floras.

The elm is widely distributed over the North Temperate Zone except in western North America. Although there are six species of elms in our present forests, none occur west of the Rocky Mountains, where they were so abundant before the rising Sierra Nevada and Coast Ranges interrupted the moisture-laden winds from the Pacific. The elms, like the beeches, probably reached the maximum of variety and distribution during the Miocene epoch.

The hornbeam (*Carpinus*), doubtfully represented in the Latah flora, occurs to-day, like so many other of the Latah hardwoods, in Europe, southeastern Asia, and southeastern North America. Its ancestors are not certainly known at horizons earlier than the "Paleocene," but there are more fossil than recent species, especially in the later Tertiary.

What appears to be an undoubted fig leaf is rather common in the Latah formation. The genus *Ficus* is an exceedingly large one, with hundreds of living and fossil species of a great variety of habitats, though confined in the existing flora to warm temperate and tropical regions. Its ancestry goes back to the Cretaceous, and it was particularly abundant in western North America during Upper Cretaceous and Eocene time. It was not out of place in the strictly temperate humid environment that prevailed in Washington in Latah time, because many modern species live under comparable climatic conditions, the cultivated fig normally ripening its fruit in Maryland and at altitudes of 8,000 feet in Bolivia.

The genus *Platanus*, which has three nominal species in the Latah flora contains the existing sycamore, buttonball, or plane tree, with six or seven species of southwestern Asia, southeastern and western North America, Mexico, and Central America. With its numerous fossil species and several extinct genera it constitutes a separate order of flowering plants related to the order Urticales, which includes the elm and fig families. *Platanus* was exceedingly abundant in the Upper Cretaceous and Eocene in western North America, as well as throughout Eurasia, became more restricted but was still abundant during the Miocene, and survived in that region in a single species—*Platanus racemosa* Nuttall—which finally has become restricted to stream valleys in California as the climate of the region became drier.

Although the genus *Menispermites* is a form genus of the family Menispermaceae, as I have explained in the systematic descriptions, the Latah species probably represents the genus *Cebatha* or *Menispermum*—the latter with but two existing species of climbers, one in eastern Asia and the other in eastern North America. *Menispermites* is common in the Upper Cretaceous of the West, and a species of *Cebatha* is present in the latest Tertiary of British Columbia.

The genus *Liriodendron*, the familiar tulip tree of southeastern North America, has one of the most interesting geologic histories of all our forest trees. Exceedingly varied and wide ranging during the Upper Cretaceous, its ancestors have been found in the Arctic, in eastern and western North America, and in Europe. The Eocene records include British Columbia, Greenland, Iceland, and Europe. Well-marked forms grew in Europe through the Miocene and late Pliocene, but no certainly identified Miocene form has been found in western North America prior to the discovery of characteristic fruits in the Latah formation. The existing species are but two in number—the common southeastern American *Liriodendron tulipifera* and an almost identical form in China, separated by half the circumference of the globe—the sole survivors of this ancient and once holarctic line.

The magnolias to-day have about a score of species, one-third of which occur in southeastern North America and the rest in the region from the Himalayas eastward to southeastern Asia. Their ancestral line goes back to the Upper Cretaceous, and they once had a continuous range over the lands of the Northern Hemisphere. They were abundant along the west coast as late as Miocene time and continued to flourish in Europe until the advent of the Pleistocene glaciation.

Another tree, common in western North America as late as the Miocene, is the *Liquidambar*, now represented in southeastern North America by the familiar red or sweet gum, also present in eastern Asia, Asia Minor, and Central America. It is not certainly known in deposits earlier than the Eocene, but during that epoch it grew in Greenland, Alaska, and Oregon; and it survived in Europe as late as the Pliocene.

Hydrangea, more familiar as a cultivated shrub than as a wild plant, is a genus with about 35 existing species of shrubs or small trees found in southeastern North America, South America, and eastern Asia. One of its peculiarities is the tendency for some of the small flowers of the flower cluster (corymb) to become sterile and consist merely of three, four, or five enlarged and showy sepals. The selection of this

feature by gardeners has resulted in the completely sterile large single or double clusters of the favorite cultivated forms. The geologic history of *Hydrangea* is unknown, but its discovery in this intermediate geographic position in the Miocene is interesting, as is also its representation in the Latah formation by large sterile flowers with four or five calyx lobes.

The genus *Cercis*, the redbud or Judas tree, contains five or six existing species. One of these is found in southeastern North America, a second in Texas, a third in the humid part of the Pacific coast region, and the others in Mediterranean Europe and southwestern, central, and eastern Asia. Its geologic history is imperfectly known, but characteristic forms have been discovered in the Eocene of North America and Europe and are rather common in the Miocene of Holarctica.

The genus *Sapindus*, including the soapberry, is no longer found in western America, although it was practically cosmopolitan in the Upper Cretaceous and throughout much of the Tertiary. It belongs to a large and mostly tropical family and in the existing flora is not found nearer Washington than southern Arizona. It is especially common in southeastern Asia.

Celastrus, whose sole living North American representative is the shrubby or climbing bittersweet of the eastern part of the continent, belongs to a genus with an extended geologic history, during which it attained a cosmopolitan range. There are about 30 other existing species in eastern Asia, Australia, and Madagascar. It was common in western North America in the late Cretaceous and Eocene, and three species are represented in the Latah flora, one of which is also found at Florissant, Colo.

The genus *Paliurus* of Jussieu contains two or three existing species of shrubs or small trees with cordate or ovate, palmately three-veined, and usually small leaves with stipular thorns. The fruits are coriaceous, peltate, and umbonate, with a horizontal marginal, radiately veined wing. In existing floras they are restricted to dry-soil habitats from Spain on the west to Japan on the east. *Paliurus aculeatus* Lamarck extends from Spain through southern Europe, Asia Minor, Crimea, the Caucasus, and Persia to China (Szechwan). *Paliurus ramosissimus* Poiret extends from about 27° north latitude in Kiangsi to Japan, and *Paliurus orientalis* Franchet, sometimes united with the preceding, reaches the stature of a thin tree sometimes 50 feet tall in eastern Szechwan and Shensi, China.

Whatever the taxonomic distinction of the three, their ranges overlap, and the geologic record is sufficiently complete to show that their present range is a restricted one and that they represent relict species.

Turning now to the geologic record we may note that a considerable number of fossil species have been described, based for the most part on leaves and therefore subject to the uncertainties attending the identification of this class of remains.

The oldest records embrace about a dozen species, so called, of leaves, from the Upper Cretaceous. These include four from the Dakota sandstone of Kansas, one from the Patoot beds of Greenland, two from the Mill Creek beds of western Canada, one from Vancouver Island, one from the Eutaw formation of Georgia, three from the Magothy formation of New Jersey, Staten Island, and Long Island, and one from the so-called Laramie of Yellowstone Park, which is of Montana age. Many of these are very similar to the leaves of the existing species but lack the corroboration of associated fruits or structural remains.

The Eocene has furnished at least 10 nominal species, including occurrences in western Greenland, Spitsbergen, Siberia, and Alaska on the north, and in British Columbia, Montana, Colorado, and Wyoming in the western part of North America. I have described three species from the Wilcox group (lower Eocene) of the Mississippi embayment, and one of these is represented by characteristic fruits. Seward has described a large fruit from the supposed Eocene of southeastern Nigeria which has the appearance of a *Paliurus* but is not certainly so assigned.

The Oligocene contains at least three species—one from Louisiana represented by very characteristic leaves and thorny stems, and two from southeastern France represented by both leaves and fruit.

There are at least 13 nominal species recorded from the Miocene. These include identifications based upon leaves in Alsace, Switzerland, Bohemia, Italy, France, Silesia, and two from Florissant, Colo., the last not conclusive in themselves but highly probable in view of the occurrence of typical fruits at the same Miocene horizon in the State of Washington. Miocene species based upon fruits include occurrences in Bohemia, Styria, Switzerland, and southern Russia. The last, which comes from the Sarmatian stage, is scarcely if at all distinguished from the existing *Paliurus aculeatus*. The Pliocene record consists of a typical fruit from central France (Cantal), which is also indistinguishable from the existing *Paliurus aculeatus*.

In view of what we know of the plant history of the Tertiary it is surely of interest that the Miocene species from Washington should be most similar to the restricted species of south-central China (*P. orientalis*), as are also the leaves associated with the fruit, and that there should be earlier (late Eocene) species in the intervening region in Alaska and Siberia.

The horse-chestnuts or buckeyes, highly ornamental small trees or shrubs, constitute the genus *Aesculus*, with about a dozen existing species in Europe, Asia, and North America. Four of these are found in North America, all eastern except *Aesculus californica* Nuttall, a small tree surviving along stream borders in California. It is not without significance that the handsome Latah species is more like the existing widely cultivated *Aesculus hippocastanum* Linné than it is like any of the surviving American species. The geologic history of the genus is very imperfectly known.

The genus *Tilia*, comprising the lindens, basswood, and limes, is the north temperate representative of a prevailingly tropical family of trees, and its score of existing species range over the north temperate zone except western North America and Central Asia. A considerable number of fossil species are known, extending back to Eocene time, when it grew in western America, Alaska, and eastern Asia. It is exceedingly common in the Miocene of Europe but in western American is known from only Washington, Colorado, and Yellowstone Park.

Ternstroemites is a form genus for members of the tea family (Ternstroemiaceae or Theaceae) of the warmer parts of America and southern and eastern Asia. The geologic history goes back to the Upper Cretaceous, when *Ternstroemites* was represented on all the northern continents. The characteristic Latah species, the only known Miocene form in western North America, is probably closely related to the genus *Gordonia*, which has two species of showy-flowered shrubs or trees in our South Atlantic States and eight or nine species in southeastern Asia and the Malay Archipelago.

The genus *Sassafras*, whose single existing species was until recently the unique possession of southeastern North America, as almost the sole temperate representative of the large and chiefly tropical family Lauraceae, has two additional species in central China, thus paralleling the distribution of the tulip tree and hickory. No ancestral tree history is more interesting. It occurred in both eastern North America and western Europe toward the end of the Lower Cretaceous and became varied and wide ranging during the Upper Cretaceous. The Eocene American records are confined to Greenland and British Columbia. It continued to be abundant in Europe as late as the Pliocene, but until the discovery of characteristic leaves in the Latah deposits its occurrence in North America during the long interval represented by the Oligocene, Miocene, Pliocene, and Pleistocene epochs had been entirely unknown.

The genus *Umbellularia*, with a single existing species—the California laurel or spice tree, *Umbellularia californica* Nuttall of low, moist valleys in Oregon and northern California west of the Sierra Nevada—evidently had a wider and more varied existence in the Miocene and is not uncommon in the Latah flora.

The sour, cotton, or tupelo gums of the genus *Nyssa* were given the Latin name of a water nymph because of their marked preference for a palustrine or at least wet environment. There are six or seven existing species, all confined to southeastern North America except a single species of southeastern Asia. There are numerous fossil species, many of them based upon the characteristic stones of their drupaceous fruits. They occur in Europe, Asia, North America, and the Arctic in either the Upper Cretaceous or Tertiary deposits, and the existing forms are evidently relics of a once holarctic distribution. They disappear from the European record at the end of the Miocene, and the Latah species, comprising both leaves and stones, represents their latest known appearance in western North America.

The genus *Diospyros* represents the mostly tropical family Ebenaceae and includes very many species, both fossil and recent—the former going back to the Upper Cretaceous. In the modern flora of North America it is represented by the well-known persimmon of the southeastern United States and a smaller species in the Texas region. Other related species occur in eastern Asia, and these furnish the large edible so-called Japanese persimmons, now well known to consumers. *Diospyros* was common in western North America from the Upper Cretaceous to the Miocene, and the Latah species or closely related forms occur at Florissant, Colo., in Yellowstone Park, in western Oklahoma, in the John Day Basin of Oregon, in California, and in the Ellensburg formation of Washington.

The genus *Porana*, represented by capsular fruits of which the persistent calyx lobes constitute a parachute, is no longer present in North America and apparently was never common on this continent. Although its geologic history is imperfectly known, its absence in North America except in the middle or upper Miocene of eastern Washington and the Florissant lake beds of Colorado suggests a late Tertiary introduction into North America from Asia by way of the Bering land bridge. It also occurs in the European Tertiary but in the modern flora is restricted to southeastern Asia and Australia.

It has seemed important to give in some detail the geologic history and existing distribution of the genera of the Latah formation which no longer occur in the State of Washington. The remaining genera, which are still present in the State, may be passed over as of less interest. It would seem that the conclusions to be legitimately drawn from this survey are obvious, and I will therefore not dwell upon them at any length.

There are in this Latah flora many elements representing what may, to speak broadly, be called the holarctic Miocene flora, although I do not mean to

imply that this was at all uniform over all the northern continents. It did, however, contain numerous similar generic types. After the climatic changes due mainly to the uplift of the Sierra Nevada and the Cascade and Coast Ranges the distribution of these generic types was altered. Some survived in locally favorable situations on the western mountain slopes, along streams, or in the humid western part of the State or the adjacent region to the south. Others disappeared entirely from western North America, and, as we have seen, their nearest relatives have a remarkably consistent distribution. Some few still survive in Europe, but the great majority are now extinct on that continent. A considerable number survive in either eastern Asia or southeastern North America, but the majority are represented in both of these mesophytic Tertiary floral preserves. The remarkable pairing of eastern America and eastern Asia, first emphasized by Asa Gray in 1872, thus becomes understandable, and we have in the Latah and similar western floras the record of a time before the changes due chiefly to extinction of species or restriction of their ranges brought about the contrasts between the existing floras of Europe, Asia, and eastern and western North America and the correlative resemblance between the floras of eastern Asia and eastern North America.

The cause is not far to seek and has been frequently emphasized: The continent of Europe, lying as a whole poleward as compared with America or Asia, was extensively glaciated during Pleistocene time, not only by the continental ice sheet from the Scandinavian center but by mountain glaciers in the Pyrenees, Alps, Carpathians, Urals, and Caucasus. Its Tertiary flora, with magnolias, gums, walnuts, hickories, sassafras, tulip trees, etc., during the climatic stress of glacial time had its southward retreat cut off by a continuous barrier of high mountains or open seas from the Bay of Biscay eastward to the expanded Caspian Sea. Consequently many plant species became extinct, and the modern flora of Europe has an impoverished aspect when compared either with the Miocene flora of Europe or with the Recent flora of eastern Asia or eastern North America.

In western America the history is somewhat different but with a similar ending. The gradual elevation of the mountain systems and the changes in geographic pattern governing wind circulation resulted in developing rain shadows or inappropriately seasoned rains over areas of great extent, producing prairies like the great belt of country bordering the Rocky Mountains on the east, the grass lands of southeastern Washington, the semiarid to desert region east of the Sierra Nevada and west of the Rockies in the present Great Basin, or the arid to desert country of southern California, Arizona, and New Mexico. With these progressive changes, accompanied by regional uplift, the mesophytic plants—and the Miocene flora of Holarctica, as a whole, was a mesophytic one—were obliged to retire to the humid region around Puget Sound, to the westward-facing wetter slopes of the mountains, or to stream borders and canyon bottoms. This restriction of suitable areas and the vicissitudes of topographic and resulting climatic change resulted in the extinction of many forms and their replacement by high mountain species from the north and xerophytic species from the south.

In southeastern North America and southeastern Asia, in marked contrast to western North America and Europe, the relation of land and sea assured abundant precipitation, there was plenty of country unglaciated, and, in particular, the orientation of the moderately elevated mountains afforded every variety of temperate habitat over wide areas. Plants could readily find their accustomed environmental requirements either laterally or vertically. Consequently there were no extensive extinctions, most of the more widely ranging Miocene genera survived, and new local species were evolved. In the main these factors are adequate to account for the observed facts.

ENVIRONMENTAL CONDITIONS

The general history of the Latah region has been given in considerable detail by Pardee and Bryan in the paper already cited. In Knowlton's account of the flora several paragraphs are devoted to the probable ecologic conditions. Chaney in his account of the climatic relations of the Mascall flora[3] considers it to represent an assemblage like that of the oak-madrono forest of the present in California,[4] with an indicated annual rainfall of 30 inches. It seems to me that it is highly hazardous to exclude from consideration, as Chaney does, those species which are no longer represented in Pacific floras, for their absence in the recent flora is the most conclusive evidence that the Miocene physical conditions differed from those of the present in that region. Otherwise there is no reason to account for their lack of survival.

I would also dispute the assertion of a progressive trend toward aridity throughout the Tertiary. There is certainly no indication of such a trend as late as the middle or upper Miocene Latah epoch. Possibly there was such a trend during the Pliocene.

The Latah flora is overwhelmingly mesophytic in its facies. I can not name a single genus of the 75 enumerated that can be unquestionably considered to have been xerophytic, although it is quite possible that some of the pines and oaks were. Omitting such obviously water-side plants as *Alnus*, *Typha*, and *Salix*, we have the bald cypress, chestnut, beech, hornbeam, fig, sycamore, *Menispermites*, tulip tree,

[3] Chaney, R. W., The Mascall flora—its distribution and climatic relation: Carnegie Inst. Washington Pub. 349, 1925.

[4] See Cooper, W. S., The broad-sclerophyll vegetation of California: Carnegie Inst. Washington Pub. 319, 1922.

magnolia, sassafras, sweet gum, horse-chestnut, linden, *Ternstroemites*, persimmon, *Asplenium*, *Arisaema*, hickory, poplar, birch, elm, hydrangea, maple, exceedingly large-leaved Lauraceæ, and *Nyssa*, which are all forms of deep, fertile, well-watered soils, humid atmospheric conditions, and equable summer temperatures. I would hesitate to give a quantitative estimate of either the rainfall or the temperature, as in our eastern hardwood forests or those of Asia, where the modern representatives of these Latah genera still exist, they occupy situations of considerable diversity as to altitude and latitude and consequently as to climate. Furthermore, so much depends upon the availability of soil water, the distribution of precipitation throughout the year, the evaporating power of the air, and the influence of water vapor in preventing extremes of temperature, and still other factors that dogmatism is to be deprecated.

The Latah flora is an overwhelmingly temperate flora entirely appropriate to the latitude where it is found and indicative of an ample, well-distributed rainfall of possibly between 30 and 40 inches annually. It is rather closely paralleled among existing floras by those of such a Middle Atlantic State as Maryland.

AGE

In the present contribution 152 species are recorded from the Latah formation. This by no means exhausts the flora, for the local students are constantly collecting new forms, and I have not attempted to determine a considerable number of forms that are obviously new but are represented so far by inadequate material. Of the 152 species 105 are not yet known from other regions and are therefore peculiar to the Latah flora and lack precise correlation value, except as this is indicated by their general facies and degree of relationship to known forms from other localities.

Our knowledge of the Tertiary floras of the Pacific border is still in the formative stage, and there exists considerable uncertainty regarding the exact age of a number of these floras. The present study throws considerable light on some of these.

On the 42 species found in the Latah that occur in other formations, all except the widely ranging and probably botanically composite *Ginkgo adiantoides*, *Sequoia langsdorfii*, and *Taxodium dubium* have a rather short chronologic range. The *Ginkgo* occurs in the Eagle Creek and Mascall formations, the *Sequoia* in the upper part of the Clarno, in the Mascall, and at Florissant, Colo., Blue Mountain, Oreg., and Pit River, Calif., and the *Taxodium* in the Mascall. Of the remaining and more significant species 4 occur in the upper part of the Clarno of the John Day Basin in Oregon, 21 in the Mascall formation of the same region, 9 in the Eagle Creek formation of the Columbia gorge, on both sides of the river, 4 at Ellensburg, Wash., 7 in the Payette formation of Idaho, 4 in the Miocene of Yellowstone National Park, 13 at Florissant, Colo., 11 in the so-called auriferous gravel of California, 2 in the Puente formation of California, 3 at Blue Mountain, Oreg., 2 at Trout Creek, Oreg., and 2 at Fortynine Camp, Nev.[5]

The predominance of Mascall, Florissant, and California species in the Latah flora, despite the uncertainty regarding the age of some of the California forms, and the ascertained relationships of the Mascall and Florissant floras as a whole are conclusive evidence, in my opinion, that the Latah flora is not older than middle Miocene. Whether it may be younger depends partly on the age of other western plant beds about which no general agreement has yet been reached. In Knowlton's preliminary paper the Latah flora was stated to be "not younger than middle Miocene and not older than lower Miocene." In the same paper it was stated that the Payette and Eagle Creek floras and probably the flora of Bridge Creek, in the John Day Basin, were Miocene, and that the flora from Ellensburg, Wash., and the Mascall formation of the John Day Basin was very definitely middle Miocene. The resemblance between the Latah flora and that found at Florissant, Colo., was not recognized by Knowlton, as it was not especially pronounced in the material which he studied. The subsequent collections from the Latah emphasize this resemblance, and the preliminary accounts of studies made by Chaney show the presence of certain characteristic species such as *Populus lindgreni*, *Fagopsis longifolia*, and *Platanus dissecta* at numerous localities in the West and tend to give them an especial stratigraphic value.

The Florissant flora was considered for a number of years, after Cockerell's work to be middle Miocene. Knowlton's latest expressed opinion (not published) was that the Florissant flora was of upper Miocene age. In this opinion I concur most heartily. If the Florissant flora is upper Miocene, the Mascall, Payette, and Ellensburg floras are probably upper instead of middle Miocene. The Latah flora, as Knowlton recognized in his preliminary account of it, has a very modern facies, and it seems to me that the lateness of mountain uplift in the Pacific region, which presumably was the major factor in bringing about the changes of distribution and the extinction of species in the Tertiary floras of western North America, strongly favors an upper Miocene rather than a middle Miocene age.

This probability of the Latah flora being upper rather than middle Miocene and the tendency among students of west-coast geology to consider the formations involved younger than they were formerly thought to be has considerable bearing on the age of other Tertiary plant beds in the West. Thus the

[5] These localities are taken from incomplete lists published by Chaney in 1925.

upper part of the Clarno formation of Oregon seems to me to be clearly younger than Eocene and may well be as young as Miocene; the Eagle Creek formation, which Chaney considers Oligocene, I would consider Miocene; the Payette formation of Idaho is clearly Miocene, as Chaney has already announced,[6] is certainly not older than middle Miocene, and is probably upper Miocene. If the Payette flora is upper Miocene then the plant-bearing part of the Esmeralda formation of western Nevada, a collection from which I have studied recently and found to be very similar to the Payette flora, is also upper Miocene. These conclusions bring the Payette and Esmeralda formations more nearly in accord with the age determinations of the vertebrate paleontologists. I hesitate to be dogmatic about the age of the Mascall flora, because I have never worked it over systematically, but I do believe it to be somewhat younger than middle Miocene. There is much in common between the Latah and Mascall floras, and if the Latah flora is upper Miocene it furnishes additional evidence tending to prove that the Mascall flora is younger than middle Miocene and also has a significant bearing on the age of the Columbia River lava flows, because the only decisive means of dating these flows is that of the fossil plants contained in the associated sedimentary beds.

[6] Chaney, R. W., Notes on the flora of the Payette formation [Idaho and Oregon]: Am. Jour. Sci., 5th ser., vol. 4, pp. 214-222, 1922.

Outside distribution of the Latah flora

	Upper part of Clarno formation, Oregon	Mascall formation, Oregon	Eagle Creek formation, Oregon and Washington	Ellensburg formation, Washington	Payette formation, Idaho	Miocene, Yellowstone Park	Florissant lake beds, Colorado	Auriferous gravel, California	Puente formation, California	Blue Mountains, Oregon	Trout Creek, Oregon	49 Camp, Nevada
Ginkgo adiantoides[a]		×	×									
Sequoia langsdorfii[a]	×	×					×			×		
Taxodium dubium[a]		×										
Palaeopotamogeton florissanti							×					
Smilax lamarensis						×						
Juncus? crassulus							×					
Hicoria juglandiformis							×					
Comptonia insignis							×					
Salix perplexa		×			×							
Salix florissanti		×					×					
Populus lindgreni		×		×	×					×		
Betula heteromorpha	×		×									
Castanea castaneaefolia		×						×				
Fagopsis longifolia		×					×		×			
Quercus payettensis					×							
Quercus merriami		×	×									
Quercus ursina		×										
Quercus simulata			×		×							
Ulmus speciosa	×		×									
Platanus aspera	×		×									
Platanus dissecta		×		×	×			×		×	×	×
Platanus appendiculata								×				
Magnolia californica						×		×				
Magnolia dayana	×			×				×				
Liquidambar californicum		×	×				×	×				
Hydrangea bendirei		×										
Amelanchier scudderi							×					
Cassia idahoensis					×							
Sapindus spokanensis		×					×	×				
Celastrus lacoei							×					
Rhus typhinoides			×					×				
Acer oregonianum		×									×	×
Acer merriami		×										
Acer bendirei		×						×				
Acer minor		×										
Laurus princeps					×	×		×				
Laurus similis			×									
Umbellularia dayana		×										
Aralia whitneyi		?				×		×	×			
Vaccinium americanum		×		×			×					
Diospyros princetoniana							×					
41 species	5	21	9	4	7	4	13	11	2	3	2	2

[a] Recorded from many other localities and horizons.

SYSTEMATIC DESCRIPTIONS

Phylum BRYOPHYTA

Class MUSCI

Family POLYTRICHACEAE

Genus POLYTRICHITES E. G. Britton

Polytrichites spokanensis E. G. Britton

Polytrichites spokanensis E. G. Britton in Knowlton, U. S. Geol. Survey Prof. Paper 140, p. 24, pl. 8, figs. 3, 4, 1926.

This characteristic species is represented in the present collection by good material from a new locality.

Occurrence: Deep Creek, northwest of Spokane; Spokane, Portland & Seattle Railway cut No. 4, Spokane, Wash.

Phylum PTERIDOPHYTA

Order POLYPODIALES

Family POLYPODIACEAE

Genus ASPLENIUM Linné

Asplenium occidentale Berry, n. sp.

Plate 49, Figures 3, 4

Habit of frond unknown, as only the detached pinnules are preserved. Pinnules lanceolate, slightly falcate, tapering from point near the base to the acute tip. Base abruptly contracted and obliquely truncated, fuller on one side (apparently the proximal) than on the other. Margin with regular closely spaced teeth ranging from crenate to serrate and slightly more prominent and acute in the tip. Midvein fairly stout and prominent. Lateral veins well marked, diverging from the midvein at angles of 45° or more, the basal pair several times dichotomous; above the basal pair there are several pairs of twice dichotomous laterals, above which this type alternates with a lateral, the proximal fork of which is simple and the distal fork is once dichotomous. Higher up the veins are once dichotomous, and the distal four or five pairs are simple. Length about 6.25 centimeters. Maximum width about 1.2 centimeters. One specimen from Vera shows the somewhat poorly preserved parts of five pinnules and a stout winged rachis.

Occurrence: Vera, Wash.; Spokane, Portland & Seattle Railway cut No. 1 and brickyard at Spokane, Wash.

Genus WOODWARDIA J. E. Smith

Woodwardia praeradicans Berry, n. sp.

Plate 64, Figures 22, 23

Although the specimens thus far collected from the Latah formation are fragments of sterile pinnae, the venation leaves no doubt that they represent the genus *Woodwardia*.

The pinnae are long and lanceolate, suboppositely to alternately cut by narrow ultimately rounded sinuses two-thirds inward toward the rachis, forming relatively short, pronouncedly falcate segments, whose margins are minutely serrulate. The venation shows a row of long, narrow areoles on each side and parallel to the midvein of the pinna and similar areoles on each side of the midvein of the segments; outside of these there is a row of shorter, oblique, nearly isodiametric areoles, and outside of these a series of veinlets running to the marginal teeth. The veins except the midveins are thin. The texture is distinctly subcoriaceous.

The only other Miocene species of *Woodwardia* known to me is *Woodwardia florissanti* Cockerell,[7] both figure and description of which are so vague that it is unrecognizable. The Latah form may represent the same species, but as the Florissant form is said to be entire-margined, shows no venation, and has the segments (the so-called long linear pinnae of Cockerell) longer and straighter than in the Latah form, and also long stipitate, I believe the two are distinct.

The present species is remarkably like the living *Woodwardia radicans*, our most magnificent species, which occurs in shaded environments along streams in the Sierra Nevada and Coast Ranges from California to Mexico and Guatemala. The same or a related species occurs throughout the Mediterranean region of the Old World and in South America and Australia. The genus contains about six existing species, of which three are North American. Seven well-characterized fossil species have been reported from North America, including two from the late Upper Cretaceous, three from the early Eocene, one from Florissant, and one from the supposed Pliocene of Oregon.

The Latah species differs from all of these, being perhaps most similar to the last, *Woodwardia columbiana* Knowlton.[8] The genus is represented in the present flora of Washington by *Woodwardia spinulosa* Martens and Galeotti, a quite different species of the humid transition zone.

Occurrence: Brickyard at Spokane, Wash.

Genus WOODSIA B. Brown

Woodsia bonseri Berry, n. sp.

Plate 64, Figures 20, 21

Frond small, pinnate. Pinnules thin, small, ovate, incised marginally in the lower two-thirds by narrow pointed sinuses to form two or three ligulate lobes. The upper entire part is slightly crenulate. The apex is roundly pointed. The base is broad and almost

[7] Cockerell, T. D. A., The fossil flora of Florissant, Colo.: Am. Mus. Nat. Hist. Bull., vol. 24, p. 77, pl. 6, fig. 2, 1908.

[8] Knowlton, F. H., Two new fossil chain ferns (*Woodwardia*) from Oregon and Wyoming: Smithsonian Misc. Coll., vol. 52, p. 491, pl. 63, figs. 1, 2, 1910.

truncate and appears to have been sessile. The midvein is flexuous and not stronger than the laterals except at its extreme base. There are five or six pairs of thin alternating laterals, the lower ones once forked and extending into the marginal lobes, the upper ones simple.

The material is sterile but has all the vegetative features of *Woodsia* and does not resemble any other temperate North American genus, so that the identification is conclusive. *Woodsia* is a small genus of about 15 existing species of temperate and cold temperate regions. Seven of these are found in the United States and Canada. The genus has not been found fossil in North America heretofore.

The present species is similar to all the North American forms and is especially like *Woodsia alpina* (Bolton) S. F. Gray, a species of moist rocky environments, ranging from Labrador and Maine to Alaska and southward to or slightly south of the Canadian border. *W. alpina* does not, so far as I know, occur in Washington, where the genus is represented by *Woodsia scopulina* Eaton and *Woodsia oregana* Eaton, of the transition zone.

Occurrence: Brickyard at Spokane, Wash.

Genus PTERIS Linné

Pteris sp.

Fern, fragment, Knowlton, U. S. Geol. Survey Prof. Paper 140, p. 24, pl. 9, fig. 10, 1926.

This very incomplete fragment figured by Knowlton has not been recognized in subsequent collections. It undoubtedly represents a part of a *Pteris* pinnule and is closely related to the existing widespread *Pteris aquilina* Linné.

Occurrence: Cut No. 2 on Oregon-Washington Railroad & Navigation Co.'s line, Spokane, Wash.

Phylum CONIFEROPHYTA

Order PINALES

Family TAXACEAE

Genus TUMION Rafinesque

Tumion bonseri Knowlton

Tumion bonseri Knowlton, U. S. Geol. Survey Prof. Paper 140, p. 25, pl. 10, fig. 3, 1926.

A single specimen in the recent collections from Republic is rather more complete than Knowlton's type from Spokane.

Occurrence: Spokane and Republic, Wash.

Family CUPRESSINACEAE

Genus SEQUOIA Endlicher

Sequoia langsdorfii (Brongniart) Heer

Sequoia langsdorfii (Brongniart) Heer. Knowlton, U. S. Geol. Survey Prof. Paper 140, p. 26, pl. 9, figs. 3–6. 1926.

The occurrence of this species in the Latah formation has been fully described and illustrated by Knowlton in the paper cited. It is a common form, somewhat variable, and liable to be confused with the associated *Taxodium dubium*. Knowlton referred all the material from the immediate vicinity of Spokane to *Taxodium dubium*, but in the later collections which I have studied a considerable proportion of the specimens appear to me to represent the present species. This species has recently been recorded by Chaney from the Blue Mountains, Oregon, and Pit River, California.

Occurrence: Stanley Hill, Coeur d'Alene, Idaho; Deep Creek northwest of Spokane, Wash.; cut 1 mile west of Shelley Lake, about 10 miles east of Spokane, Wash.; well at Mica, Wash.; Vera, Wash.; Chicago, Milwaukee & St. Paul Railway cut, Deep Creek Canyon, Spokane, Portland & Seattle Railway cut, and brickyard at Spokane, Wash.

Genus TAXODIUM L. C. Richard

Taxodium dubium (Sternberg) Heer

Taxodium dubium (Sternberg) Heer. Knowlton, U. S. Geol. Survey Prof. Paper 140, p. 27. pl. 9, figs. 2, 7–9; pl. 10, fig. 2, 1926.

Taxodium nevadensis Lesquereux, U. S. Geol. and Geog. Survey Terr. Ann. Rept., 1873, p. 272, 1874.

Mason, Carnegie Inst. Washington Pub. 346, p. 154, pl. 5, figs. 2, 5, 6, 1927.

The occurrence of this species in the Latah formation has been fully described and illustrated by Knowlton in the paper cited. The species is abundant in the recent collections and shows considerable variation in size. It is readily confused with the associated *Sequoia langsdorfii* unless the material is excellently preserved.

Occurrence: Stanley Hill, Coeur d'Alene, Idaho; Deep Creek northwest of Spokane, Wash.; cut 1 mile west of Shelley Lake, 10 miles east of Spokane, Wash.; Vera, Wash.; Republic, Wash.; cut along Spokane, Portland & Seattle Railway; and brickyard at Spokane, Wash.

Taxodium, staminate ament

Plate 63, Figure 2

Knowlton[9] described and figured the staminate flowers of *Taxodium* from the Latah formation at Deep Creek, but his specimen is not nearly so typical as the one here figured from the later collections. This agrees exactly with the aments of the existing species, and there can not be the slightest doubt regarding the relationship of the fossil.

Occurrence: Brickyard at Spokane, Wash., collected by E. E. Alexander.

Genus LIBOCEDRUS Endlicher

Libocedrus praedecurrens Knowlton

Libocedrus praedecurrens Knowlton, U. S. Geol. Survey Prof. Paper 140, p. 28, pl. 8, fig. 8, 1926.

Fragmentary specimens of this species are represented at several localities in the present collections.

[9] Knowlton, F. H., Flora of the Latah formation of Spokane, Wash., and Coeur d'Alene, Idaho: U. S. Geol. Survey Prof. Paper 140, p. 28, pl. 10, fig. 4, 1926.

The type and only specimen previously known came from the Spokane, Portland & Seattle Railway cut at Spokane. It is of interest to note that a specifically unnamed *Libocedrus* is recorded by Chaney from the Mascall and Payette formations and from Trout Creek, Oregon.

Occurrence: Chicago, Milwaukee & St. Paul Railway cut No. 2, brickyard, and Spokane, Portland & Seattle Railway cut No. 1, Spokane, Wash.

Family PINACEAE

Genus PINUS Linné

Pinus macrophylla Berry, n. sp.[9a]

Plate 49, Figure 9

This species is based upon the single specimen figured showing elongated slender leaves quite unlike the associated forms or any previously described.

Leaves in threes, with long persistent leaf sheaths. Slender, about 1 millimeter or slightly over in diameter, and with a minimum length of 21 centimeters; the tips are all broken away, so that their maximum length remains unknown.

This interesting form may be compared with several existing pines of the Pacific slope, such as the western yellow pine (*Pinus ponderosa* Lawson), the Jeffrey pine (*Pinus jeffreyi* Vasey), the Digger pine (*Pinus sabiniana* Douglas), and the Torrey pine (*Pinus torreyana* Parry). In the character of the sheath and the slenderness of the leaves the fossil approaches most closely *P. ponderosa*, which, however, has 2-faced leaves.

Occurrence: Republic, Wash.

Pinus latahensis Berry, n. sp.

Plate 49, Figure 7

Leaves in fives, 2-faced, pointed, about 9 centimeters long and 1 millimeter broad. Sheath clearly deciduous; hence it belongs to the so-called white or hard pines.

These leaves in arrangement and size are very close to those of the existing western white pine (*Pinus monticola* Douglas) and sugar pine (*Pinus lambertiana* Douglas) and are most similar to those of the sugar pine. However, as the associated seeds are unlike those of the sugar pine and are, on the other hand, almost identical with the seeds of the western white pine, it is possible that the leaves and seeds, described separately, represent a single botanic species that may have been the Miocene ancestor of *Pinus monticola*. *P. monticola* has a wide range and is adapted to a variety of soils. It is found west of the Continental Divide in the mountains from northern Montana and southern British Columbia to Washington, Oregon, and California. At the north it is most common and largest in moist valleys, and in northern Idaho it reaches its greatest development on gentle north slopes and flats.

Occurrence: Republic, Wash.

Pinus monticolensis Berry, n. sp.

Plate 49, Figures 5, 8

In the collections from the Latah formation studied by Knowlton *Pinus* was represented by a single foliar specimen. The untrustworthy character of negative evidence is illustrated by the abundance of this genus in the later collections, where the pines are represented by four different kinds of leaves and by equally characteristic seeds.

The present species, which undoubtedly represents one or the other of the species based upon leaves, is represented by four specimens. These vary considerably in size and outline, but the alternative to regarding them as belonging to a single species is to consider them to represent four distinct species, which is not worthy of consideration. They agree in the form of the seed but differ in the size and shape of the wing. They may be described as follows:

Whole fruit of medium size, ranging in length from 17 to 26 millimeters and in maximum width from 4 to 9 millimeters. The inner margin is nearly straight, with the seed at the base. The seed is about twice as long as it is wide and but moderately elevated. The tip of the wing may be almost evenly rounded, as in the narrower specimen figured, or it may be subtruncate, as in the wider specimen figured. The outer wing margin may be but slightly rounded and subparallel with the inner margin, or it may flare at the top and narrow downward, in all specimens forming an outer margin nearly or quite to the base of the seed.

These seeds are very close to those of the existing western white or silver pine, *Pinus monticola* Douglas, whose distribution has been discussed under *Pinus latahensis*. They are also comparable to the seeds of *Pinus ponderosa* Lawson, the widespread western yellow pine, which is of some interest because the Latah collections contain a long-leafed pine that might represent a similar fossil form. However, the fossil leaves are two-faced instead of three-faced, as in the existing western yellow pine.

Occurrence: Republic and Spokane, Wash.

Pinus tetrafolia Berry, n. sp.

Plate 49, Figure 6

Leaves coriaceous, with a single bundle and two-faced, in fours, about 6 centimeters long and less than a millimeter in diameter. Sheaths persistent.

It is highly improbable that this should represent a distinct botanic species, not only because of the well-known variability among three-leaved and five-leaved forms but also because the present species is based

[9a] In a publication that appeared after the present paper was written Mason has made an interesting contribution to our knowledge of the fossil conifers of western America (Mason, H. L., Carnegie Inst. Washington Pub. 346, pp. 139–158, 1927). It is impossible to discuss Mason's conclusions here.

upon a single specimen. However, I have given it a name rather than multiply the already numerous unnamed pines in the literature. The leaves are more slender than in the associated *Pinus* sp. Knowlton.

Occurrence: Republic, Wash.

Pinus sp. Knowlton

Pinus sp. Knowlton, U. S. Geol. Survey Prof. Paper 140, p. 26, pl. 8, fig. 9, 1926.

Based by Knowlton on a single specimen from a well near Mica, southeast of Spokane, which may be identical with *Pinus knowltoni* Chaney,[10] from the Eagle Creek formation of Oregon. There are three specimens in the more recent collections. The leaves are short, and one specimen distinctly shows the sheath, so that it can not be one of the soft pines, as Knowlton inferred.

Occurrence: Well near Mica, Wash.; brickyard, Spokane, Wash.

Pinus, staminate aments

Plate 64, Figures 17–19

The staminate aments of a conifer are relatively common at the brickyard locality, as I have six rather well preserved specimens, which is a large number for such accidental fossils. They are about 2½ centimeters long and 5 millimeters in diameter, are slightly pedunculate, and consist of spirally arranged thick scales on a stout axis with ends turned up and imbricated. At the base there is a mass or involucre of flat pointed imbricated bracts.

I at first thought these basal bracts represented a gall of some gall midge and have to thank Dr. E. P. Felt for looking at them for me and giving me his opinion. I have compared them with various coniferous catkins, and they agree best with those of *Pinus*. As several species of *Pinus* are represented by foliage and seeds in the Latah formation, I have attached no name to the catkins.

Occurrence: Brickyard at Spokane, Wash.

Genus TSUGA Endlicher

Tsuga latahensis Berry, n. sp.

Plate 63, Figures 3, 4

Cone scales detached, thin, ovate to nearly orbicular. These vary considerably in size and form and presumably represent scales from different parts of the cone.

It might be expected that the deciduous cone scales of *Tsuga* would be of common occurrence in the later Tertiary deposits, but such has not been the case, and the only American occurrence known to me is the record (nomen nudum) of a member of this genus in the Bridge Creek beds of the John Day Basin in Oregon,[11] which is based on a twig and not a cone scale. One or two Tertiary species have been recorded from Eurasia, and this sparseness again disappoints one's expectation.

The existing species number seven, of temperate North America, Japan, central and western China, and the Himalayan region.

Occurrence: Brickyard at Spokane, Wash., collected by E. E. Alexander and C. O. Fernquist.

Glyptostrobus?, staminate aments

Plate 63, Figure 1

The present object represents what in the United States have been considered the staminate aments sometimes called *Glyptostrobus europaeus ungeri* Heer [12] and sometimes *Glyptostrobus ungeri* Heer [13] and by European paleobotanists referred to either of these or to *Glyptostrobus europaeus* Heer. The last has been identified all over the world from almost every possible Tertiary horizon and is unquestionably a composite. I think that there can be no question but that the Latah specimen is homologous with Heer's numerous records of staminate aments of *Glyptostrobus*, but the idea that they can be specifically determined is preposterous, and it is by no means certain that the present specimen even represents *Glyptostrobus*. Its chief interest in the present connection is that similar remains occur in the Mascall formation of Oregon.

Occurrence: Brickyard at Spokane, Wash., collected by C. O. Fernquist.

Phylum SPERMATOPHYTA

Class ANGIOSPERMAE

Subclass MONOCOTYLEDONAE

Order PANDANALES

Family TYPHACEAE

Genus TYPHA Linné

Typha? sp. Knowlton

Typha? sp. Knowlton, U. S. Geol. Survey Prof. Paper 140, p. 28, pl. 9, fig. 11, 1926.

Fragments of linear monocotyledonous leaves similar to the small fragment from Spokane which Knowlton tentatively referred to the genus *Typha* are common in the recent collections. Beyond their monocotyledonous nature their affinity is entirely problematic, although they might well represent the genus *Typha*.

Occurrence: Deep Creek Canyon and brickyard at Spokane, Wash.

[10] Chaney, R. W., The flora of the Eagle Creek formation: Walker Mus. Contr., vol. 2, No. 5, p. 160, pl. 5, figs. 3, 4, 1920.

[11] Chaney, R. W., Quantitative studies of the Bridge Creek flora: Am. Jour. Sci., 5th ser., vol. 8, p. 129, 1924.

[12] Lesquereux, Leo, The Cretaceous and Tertiary floras: U. S. Geol. Survey Terr. Rept., vol. 8, p. 222, pl. 46, figs. 1–1c, 1883.

[13] Knowlton, F. H., Fossil flora of the John Day Basin, Oreg.: U. S. Geol. Survey Bull. 204, p. 26, 1902.

Order NAIADALES

Family NAIADACEAE

Genus POTAMOGETON Linné

Potamogeton heterophylloides Berry, n. sp.

Plate 50, Figures 1–3

Potamogeton sp. Knowlton, U. S. Geol. Survey Prof. Paper 140, p. 29, pl. 10, figs. 5, 6, 1926.

The fragment from the Spokane, Portland & Seattle Railway cut which Knowlton described is represented by 11 specimens in the recent collection, most of which are complete. They are slightly smaller than the type but vary considerably in size, ranging from 3 to 8 centimeters in length. The tip, absent in the type, is abruptly narrowed to a point.

I have ventured to give it a specific name in allusion to its resemblance to *Potamogeton heterophyllus* Schreber, which is found nearly all over North America as well as in Europe. Our eastern *Potamogeton nuttallii* Chamisso and Schlechtendal has submerged leaves even more like the fossil.

Occurrence: Cut on Spokane, Portland & Seattle Railway, Chicago, Milwaukee & St. Paul Railway cut No. 2, and brickyard at Spokane, Wash.

Genus PALAEOPOTAMOGETON Knowlton

Palaeopotamogeton florissanti Knowlton

Palaeopotamogeton florissanti Knowlton, U. S. Nat. Mus. Proc., vol. 51, p. 251, pl. 16, fig. 1; pl. 17, fig. 3, 1916.

Fruits exactly like those described by Knowlton for this species occur in the Latah formation, where they are found detached and unaccompanied by the foliage. There can be no doubt of their identity with the fruits from Florissant. I can see no evidence from either the fruits or foliage that there is any relationship with the Potamogetonaceae, but I have no suggestions to offer regarding their botanic affinity. Under the circumstances I would have ignored these small hard spherical fruits of the Latah formation except for the fact that they are an additional element in synchronizing the floras from Florissant, Colo., and those in the vicinity of Spokane.

Occurrence: Brickyard at Spokane, Wash., collected by C. O. Fernquist

Order LILIALES

Family SMILACEAE

Genus SMILAX Linné

Smilax lamarensis Knowlton

Plate 63, Figure 15

Smilax lamarensis Knowlton, U. S. Geol. Survey Mon. 32, pt. 2, p. 685, pl. 121, figs. 3, 4, 1899.

The single specimen figured is referred to this species with some hesitation. It approaches the minimum size of the leaves from Yellowstone Park and appears to be of a less firm texture, but in view of the well-known variability in the leaves of this genus it seems undesirable to multiply fossil species unless really distinctive specific characters are present. The Latah specimen indicates an ovate leaf about 8 centimeters long, with a maximum width in the lower half of slightly over 4 centimeters. The base is rounded and cordate. There are three principal primaries; the midvein is slightly more prominent than the laterals which are acrodrome. There is a second thinner pair of acrodrome primaries about 3 millimeters inside the margins which they parallel. The secondary venation is thin but well marked consisting of rather closely spaced obliquely somewhat sinuate transverse veins, forking or inosculating or connected by cross branches, and perfectly characteristic of the genus. The leaf texture is thin and soft, as is indicated by the way the veins stand out above the lamina and the somewhat crumpled character of the lamina.

The type came from the supposed Miocene of Yellowstone Park and was compared by its describer with the existing *Smilax rotundifolia* Linné and *Smilax pseudochina* Linné. It might equally well be compared with *Smilax hispida* Muhlenberg, *Smilax walteri* Pursh, or still other existing species. Such comparisons, however, have but slight ecologic or geographic significance.

Smilax is new to the Latah flora but has been recorded from the upper Miocene at Florissant, Colo., and the Eagle Creek and Mascall of Oregon. The species at Florissant is *Smilax labidurommae* Cockerell,[14] a considerably smaller deltoid form with a truncate base. The Mascall species is *Smilax wardii* Lesquereux,[15] an elongated hastate-sagittate leaf. Both are very different from the Latah species.

The genus, with well-defined characters, goes back certainly as far as the early Eocene and probably to the later Cretaceous. The existing species number about 200 widely distributed and for the most part in moist environments, most abundantly in tropical America and Asia. There are about 20 species in temperate North America, several extending as far northward as southern Canada.

Occurrence: Brickyard at Spokane, Wash., collected by E. E. Alexander.

Family JUNCACEAE?

Genus JUNCUS? Linné

Juncus? crassulus Cockerell

Juncus crassulus Cockerell, Am. Mus. Nat. Hist. Bull., vol. 24, p. 79, pl. 10, figs. 44, 45, 1908.

There are several specimens from the Latah formation which I am unable to distinguish from the so-

[14] Cockerell, T. D. A., Two new plants from the Tertiary rocks of the West: Torreya, vol. 14, p. 135, text fig. 1, 1914.

[15] Lesquereux, Leo, Recent determinations of fossil plants from Kentucky, Louisiana, Oregon, California, Alaska, Greenland, etc.: U. S. Nat. Mus. Proc., vol. 11, p. 19, pl. 13, fig. 1, 1888.

called flowers from Florissant, Colo., described by Cockerell as those of *Juncus*. I have queried the generic name, as I am by no means convinced that they can be conclusively shown to be referable to that genus.

Occurrence: Brickyard at Spokane, Wash., collected by C. O. Fernquist.

Subclass DICOTYLEDONAE

Series CHORIPETALAE

Order JUGLANDALES

Family JUGLANDACEAE

Genus HICORIA Rafinesque

Hicoria juglandiformis (Sternberg) Knowlton

Phyllites juglandiformis Sternberg, Versuch einer geognostich-botanischen Darstellungder Flora der Vorwelt, Band 4, index, p. 40, pl. 35, fig. 1, 1825.

Carya bilinica Lesquereux, U. S. Geol. Survey Terr. Rept., vol. 8 (Cretaceous and Tertiary floras), p. 191, pl. 39, figs. 1, 2, 13, 1883.

Hicoria juglandiformis Knowlton, U. S. Geol. Survey Bull. 152, p. 117, 1898.

Cockerell, Am. Mus. Nat. Hist. Bull., vol. 24, p. 80, 1908.

A typical large leaf of this species is present in the recent Latah collections. It is altogether improbable that this represents the same botanic species as that described from Europe, and it would probably be proper to take up Kirchner's *Juglans affinis* from Florissant as the proper name for the American fossil. It has hitherto not been found outside the Florissant Miocene.

Occurrence: Brickyard at Spokane, Wash.

Order MYRICALES

Family MYRICACEAE

Genus COMPTONIA Banks

Comptonia insignis (Lesquereux) Cockerell

Plate 50, Figure 5

Comptonia insignis Cockerell, Colorado Univ. Studies, vol. 3, p. 173, 1906; Am. Mus. Nat. Hist. Bull., vol. 24, p. 81. 1908.

Berry, Am. Naturalist, vol. 40, p. 499, 1906.

Knowlton, U. S. Nat. Mus. Proc., vol. 51, p. 260, 1916.

Myrica insignis Lesquereux, U. S. Geol. and Geog. Survey Terr. Ann. Rept. for 1874, p. 312, 1876; U. S. Geol. Survey Terr. Rept., vol. 7, p. 135, pl. 65, figs. 7, 8, 1878.

Myrica alkalina Lesquereux, U. S. Geol. Survey Terr. Rept., vol. 8, p. 149, pl. 65–A, figs. 10–15, 1883.

This handsome species, abundant at Florissant, Colo., is represented in the recent collections from the Latah formation by the fine and characteristic specimen figured.

Occurrence: Republic, Wash.

Comptonia hesperia Berry, n. sp.

Plate 50, Figure 6

It is certainly exasperating that the more rare the type generally the more scanty the material. The present species is based upon a tiny fragment showing the parts of but seven lobes. Fortunately these are characteristic enough to permit recognition of the genus but hardly sufficient to define the species accurately. However, as nothing else of the kind is known it may be made the type of a distinct species and may be described as follows:

Leaf lanceolate, dimensions unknown. Midvein stout. Lamina rather regularly divided nearly to the midvein into relatively narrow, falcate-pointed lobes about 7 millimeters long and 4 millimeters in maximum width. There are two relatively stout lateral veins in each lobe—the upper running to the tip, the lower camptodrome; a third and thinner lateral runs close to and subparallel with the lower arched margin until it disappears by inosculating distad; all are connected by fine oblique veinlets and camptodrome marginal arches. The margins of lobes are entire. The sinuses between them are evenly rounded. Texture subcoriaceous.

The only other plant with comparable foliage is the monotypic rosaceous genus *Lyonothamnus* Gray, of the southern California islands. In this the normal as well as the ancestral leaf is entire, becoming lobulate below and finally irregularly pinnately parted into numerous segments which are themselves lobulate as in *Comptonia*. *Lyonothamnus* is more coriaceous, less regularly lobate, and with more numerous veins than *Comptonia*.

The present specimen is evidently from the middle region of a leaf and may be readily matched among the rather variable leaves of the existing sweet fern, *Comptonia peregrina* (Linné) Coulter. The genus *Comptonia* is now a monotypic genus of dry and rocky hillsides from Nova Scotia to Manitoba and southward to North Carolina in the Appalachian region, although it had a holarctic range in the later Tertiary, and includes numerous fossil species from the Upper Cretaceous onward. Eight other fossil species are known from the Tertiary of western North America. There are at least two characteristic species at Florissant, and a third from the Miocene of Elko station, Nevada—all unlike the present fossil. There are two upper Eocene species in Alaska (Kenai formation), and two or three additional in the upper Eocene or Oligocene of British Columbia. Of these both *Comptonia diforme* (Sternberg) Berry (*C. columbiana* Dawson) and *Comptonia predryandroides* Berry (*C. cuspidata* Dawson, not Lesquereux) are similar to the Latah form but are smaller and differ in specific features such as the shape and division of the lobes, the character of the margin, and minor features of the venation. *Comptonia predryandroides* may well stand in an ancestral relationship to *Comptonia hesperia*.

Although the genus has failed to perpetuate itself in the existing less arid regions of the Pacific slope, it was evidently endemic there, as well as in eastern Asia, throughout the later Tertiary. That it can not

be considered indicative of other than mesophytic conditions during Latah time is shown by its associates in the past in that general region and by the range of the sole surviving species. It was not a denizen of the Latah bottoms but of more or less rocky slopes with lessened ground water and a somewhat thinned cover.

Occurrence: Brickyard at Spokane, Wash

Order SALICALES

Family SALICACEAE

Genus SALIX Linné

Salix florissanti Knowlton and Cockerell

Plate 64, Figure 16

Salix florissanti Knowlton and Cockerell, U. S. Geol. Survey Bull. 696, p. 566, 1919.

Salix amygdalaefolia Lesquereux, Cretaceous and Tertiary floras, p. 156, pl. 3, figs. 1, 2, 1883. (Not Gilib, 1792.)
Knowlton, U. S. Geol. Survey Bull. 204, p. 30, 1902.
Lesquereux, U. S. Nat. Mus. Proc., vol. 11, p. 17, 1888.
Cockerell, Am. Mus. Nat. Hist. Bull., vol. 24, p. 82,1908.

Salix bryani Knowlton, U. S. Geol. Survey Prof. Paper 140, p. 33, pl. 12, fig. 6, 1926.

This, the smaller of the two more typical willows of the Latah formation, occurs also at Florissant, Colo., and in the Mascall formation at Van Horn's ranch in the John Day Basin of Oregon. Knowlton described the Latah remains as a new species, but it is obviously identical with the *Salix amygdalaefolia* of Lesquereux.

Occurrence: Cut on Chicago, Milwaukee & St. Paul Railway and brickyard at Spokane, Wash.

Salix inquirenda Knowlton

Salix inquirenda Knowlton, U. S. Geol. Survey Prof. Paper 140, p. 32, pl. 11, figs. 1, 2, 1926.

This fine and characteristic *Salix* is not uncommon in the recent collections from the Latah formation. It varies considerably in size, the largest specimen having a maximum width of 4.5 centimeters, but preserves the marginal and venation features throughout. The petiole is complete in two specimens and is 2 and 3 centimeters long, respectively. The new occurrences are given below.

Among existing species this appears to me to be closest to some of the forms of *Salix lasiandra* Bentham, a wet-soil type of middle altitudes found west of the Sierra Nevada in California, western Oregon, Washington, and southern British Columbia.

Occurrence: Vera, Wash.; Twelfth Avenue and Thor Street and brickyard, Spokane, Wash.

Salix remotidens Knowlton

Salix remotidens Knowlton, U. S. Geol. Survey Prof. Paper 140, p. 32, pl. 12, fig. 7, 1926.

Although it shows some minor differences, especially in the more rounded base and less conspicuous teeth, it is doubtfully distinct from the associated *Salix inquirenda* Knowlton.

Occurrence: Spokane, Portland & Seattle Railway cut and brickyard at Spokane, Wash.

Salix, pistillate flower

Plate 63, Figure 5

Ovary slenderly fusiform, short stipitate, about 45 millimeters long and 1.25 millimeters in maximum diameter. Stipe about 1 millimeter long. Style practically nonexistent. Stigmas two, short and spreading. Scale small and narrow, about half the length of the ovary, villous distad.

This unique fossil is naturally represented by a single specimen, which was preserved by some lucky accident. That it is a willow can not be doubted, as the stigmas of *Populus* are dilated, parted, or lobed and are frequently three and more rarely four in number, whereas in *Salix* they are always two in number, although in some species these may be parted. Among recent species that I have seen the fossil is most like the pistillate flowers of *Salix cordata* Muhlenberg, a wet-soil shrub ranging from New Brunswick to British Columbia and south to Virginia, Missouri, Colorado, and California.

It is an unusual pleasure to find such a flower in association with the fossil foliage, and the present occurrence is, so far as I am aware, the first to be recorded, although poorly preserved catkins and the valved capsules have been found fossil.

Occurrence: Brickyard at Spokane, Wash., collected by C. O. Fernquist.

Salix sp., stipule

Plate 52, Figure 6; Plate 64, Figure 9

In addition to the leaves of three species of *Salix* recorded from the Latah formation there are several specimens of remarkably well preserved stipules which might belong to one or the other of these leaf species. Detached stipules, when nonfugaceous, are exceedingly rare as fossils. The present specimens range from 0.8 to 2.5 centimeters long and 4 to 12 millimeters wide, sheathing at the basal side, pointed, and with numerous serrate teeth and a characteristic venation. The fossil can be exactly matched by selected stipules from the living tree.

Occurrence: Brickyard at Spokane, Wash.

Genus POPULUS Linné

Populus heteromorpha Knowlton

Populus heteromorpha Knowlton, U. S. Geol. Survey Prof. Paper 140, p. 30, pl. 12, figs. 8–10; pl. 13, figs. 1–7; pl. 14, figs. 1–3; pl. 15, figs. 3–5, 1926.

Populus fairii Knowlton, idem, pl. 15, fig. 2; pl. 16, figs. 1–3.

This exceedingly protean species is the most abundant form in the Latah collections. It occurs in all sizes and shapes and shows a corresponding range of variation in its marginal characters. These have been sufficiently illustrated in the large suite of specimens

figured by Knowlton. As he suspected, the forms called *fairii* are not distinct from the type, but every gradation is represented, and leaves with three, four, or five primaries are not distinctive. Every locality in the recent collections that contains one contains the other.

Occurrence: Deep Creek Canyon, brickyard, and Spokane, Portland & Seattle Railway cuts Nos. 1 and 4, Spokane, Wash.

Populus lindgreni Knowlton

Populus lindgreni Knowlton, U. S. Geol. Survey Eighteenth Ann. Rept., pt. 3, p. 725, pl. 100, fig. 3, 1898; U. S. Geol. Survey Bull. 204, p. 29, pl. 2, fig. 1, 1902; U. S. Geol. Survey Prof. Paper 140, p. 31, pl. 14, figs. 4–7, 1926.

This species, described originally from the Payette formation of Idaho, was subsequently recorded from the Mascall and Latah formations. Recently Chaney has reported it from the Blue Mountains, Oregon, and Ellensburg, Wash.

Occurrence: Stanley Hill, Coeur d'Alene, Idaho; Vera, Bigelow Gulch near Hillyard, and Republic, Wash.

Populus, bud scales

Plate 50, Figure 4; Plate 63, Figure 8

Characteristic bud scales of *Populus* are not uncommon in the present collection. They are truncate at the base, acute at the tip, 1.25 to 2 centimeters long, longitudinally veined, and of considerable consistency. They are involute, as shown by the splitting of specimens that have been flattened during fossilization. They are in every way comparable with the large and more or less resinous outer winter bud scales of the existing species and presumably belong to one of the species represented by leaves in the Latah formation.

Occurrence: Brickyard at Spokane, Wash

Populus, pistillate ament

Plate 63, Figure 7

A segment of fruit-bearing catkin of some species of *Populus*, presumably belonging to one of the named leaf species of the Latah formation, is contained in the collection. The axis is stout, the capsules are well spaced and small, ovate conical, about as wide as long and two-valved; some are open and others closed.

Occurrence: Brickyard at Spokane, Wash., collected by E. E. Alexander.

Populus, amentiferous bract

Plate 63, Figure 6

A single specimen undoubtedly represents a bract from the catkin of a *Populus*, presumably one of the species so prolifically represented by leaves in the Latah formation. This bract is about 5 millimeters long, truncate or slightly excavated at the base, expanding upward, the substance thickened in its upper half and lacerate. The details of the specimen are not clear throughout, but it is obviously flat and not tubular as it would be if it were a sympetalous calyx or corolla, and it agrees closely with the bracts of various existing species of *Populus*, in which the bracts are characteristic.

Occurrence: Brickyard at Spokane, Wash., collected by C. O. Fernquist.

Order FAGALES

Family BETULACEAE

Genus BETULA Linné

Betula heteromorpha Knowlton

Betula heteromorpha Knowlton, U. S. Geol. Survey Bull. 204, p. 39, pl. 3, figs. 6, 7; pl. 5, fig. 1, 1902; U. S. Geol. Survey Prof. Paper 140, p. 34, pl. 17, figs. 5, 6, 1926.
Chaney, Walker Mus. Contr., vol. 2, No. 5, p. 165, 1920.
Betula bryani Knowlton, U. S. Geol. Survey Prof. Paper 140, p. 34, pl. 18, fig. 1, 1926.
Betula thor Knowlton, idem, p. 35, pl. 17, fig. 3.

This species, described originally from the upper part of the Clarno formation of the John Day Basin in Oregon, is very common in the Latah formation and occurs also in the Eagle Creek formation. The forms that Knowlton described as *Betula bryani* and *Betula thor* are nothing but variants of *Betula heteromorpha*, with which they are connected by insensible gradations. These leaves are separated with difficulty from some of the existing western leaves of *Alnus*. The variations of this Latah species of *Betula* can be matched among the leaves of the existing *Betula occidentalis*, which it closely resembles and which occurs along stream borders in rich soil through British Columbia, Washington, Idaho, and Montana.

Occurrence: Stanley Hill, Coeur d'Alene, Idaho; Vera, Wash.; Bigelow Gulch below Hillyard, Wash.; Republic, Wash.; Deep Creek Canyon, brickyard, and cuts on Spokane, Portland & Seattle Railway and Chicago, Milwaukee & St. Paul Railway, at Spokane, Wash.

Betula fairii Knowlton

Betula fairii Knowlton, U. S. Geol. Survey Prof. Paper 140, p. 33, pl. 17, fig. 4, 1926.
Betula nanoides Knowlton, idem, p. 34, pl. 18, fig. 2.

I can not see any adequate features distinguishing what Knowlton referred to the two species cited above; in fact, I imagine that both represent merely small leaves of the associated and more abundant *Betula heteromorpha* Knowlton.

Occurrence: Cuts on Chicago, Milwaukee & St. Paul Railway and Spokane, Portland & Seattle Railway and brickyard at Spokane, Wash.

Betula largei Knowlton

Plate 50, Figure 12

Betula? largei Knowlton, U. S. Geol. Survey Prof. Paper 140, p. 34, pl. 17, figs. 1, 2, 1926.

This species was queried by Knowlton because he thought it might be an *Alnus* or *Corylus*. There are five specimens in the recent collections, including the perfect minimum-sized leaf figured. It is very similar to the existing *Betula luminifera* Winkler, of central China, which it resembles much more closely than it does any existing North American birches.

Occurrence: Cut on Spokane, Portland & Seattle Railway and brickyard at Spokane, Wash.; well at Mica, Wash.

Betula, winged fruit

Plate 63, Figure 9

Winged nutlets (samara), roundly obcordate, 6.75 millimeters in width, thus relatively large. The nut is fusiform, compressed, widest and fullest above the middle, with basal scar, 4.5 millimeters long and 1.75 millimeters in maximum width. It is crowned with two slender persistent curved styles 1 millimeter in length. The wings are very delicate, full and rounded, and very faintly and openly reticulate-veined.

This beautiful and characteristic fruit very probably represents the genus *Betula*, the leaves of which are among the commonest fossils in the Latah formation. It does not seem wise to multiply specific names by naming it, as it almost certainly represents the fruit of one of the forms represented by leaves which have already been named. It can not be conclusively proved that *Alnus* should be excluded from consideration, but as the leaves of *Betula* are so exceedingly common in this deposit, as all the existing species of *Betula* have winged nuts, whereas in the existing species of *Alnus* the wing is greatly reduced or entirely absent, and as the leaves of *Alnus* are less common in these beds, it seems probable that the reference to *Betula* is correct.

Occurrence: Brickyard at Spokane, Wash., collected by C. O. Fernquist.

Genus ALNUS Gaertner

Alnus elliptica Berry, n. sp.

Plate 50, Figures 8–10

Leaves of small size, elliptical in general outline. Margin with close-set, prominently crenate teeth. Length 1.5 to 2.5 centimeters; maximum width 9 to 14 millimeters. Petiole very stout, about 4 millimeters long. Midvein stout, prominent. Secondaries relatively stout, regularly spaced, subparallel; they diverge from the midvein at angles of about 45°, pursue relatively straight ascending courses, and are craspedodrome. The tertiaries are obsolete.

As no larger leaves with these characters occur in the collections it is assumed that these small specimens were mature. This species is much like what Winkler calls *Alnus alnobetula* var. *crispa* in his monograph of the *Betulaceae*.[16] That variety ranges from Newfoundland to Alaska and south to New York, Michigan, and British Columbia.

Occurrence: Republic, near Spokane, Wash.

Alnus prerhombifolia Berry, n. sp.

Plate 50, Figure 11

Leaves of medium size; broadly elliptical, almost orbicular in general outline, with a shortly pointed tip and a rounded or truncate base. Texture subcoriaceous. Margin variously toothed, entire proximad. Teeth crenate or serrate and dimorphic. Length 4 to 6 centimeters; maximum width 2.5 to 4.5 centimeters. Petiole stout, of unknown length. Midvein stout, prominent. Secondaries relatively stout and straight, subparallel, regularly spaced. Tertiaries well marked, craspedodrome from outer distal part of secondaries; percurrent between them.

I have associated as this new species a somewhat variable series of leaves, some of which suggest *Betula* but which appear to me to represent *Alnus*, especially as undoubted cones of *Alnus* are not uncommon in these deposits. They are quite similar to the leaves of the existing *Alnus rhombifolia* Nuttall, a tree of stream borders, found from Idaho and Washington to southern California. The genus has a considerable geologic history and is abundant in the present Canadian and Hudsonian life zones.

Eight normal species from the western Miocene in California, Oregon, Washington, and Colorado have been described. These all differ decidedly from the present fossil form.

Occurrence: Vera, Deep Creek Canyon, and brickyard at Spokane, Wash.

Alnus sp. Knowlton

Alnus sp. Knowlton, U. S. Geol. Survey Prof. Paper 140, p. 33, pl. 18, figs. 3–5 a, 1926.

Pistillate cones of *Alnus*, identical with those figured by Knowlton from Coeur d'Alene, Idaho, are contained in the present collections from around Spokane, where leaves of this genus have also been recognized.

Occurrence: Stanley Hill, Coeur d'Alene, Idaho; Deep Creek Canyon, Spokane, Wash.

Alnus or Betula, staminate catkin

The collection contains a single specimen of a cylindrical staminate catkin about 3.5 centimeters in length and about 6 millimeters in diameter which almost certainly represents *Alnus* or *Betula*.

Occurrence: Brickyard at Spokane, Wash.

[16] Winkler, C., in Engler, A., Betulaceae: Pflanzenreich, IV, vol. 61, p. 107, 1904.

Family FAGACEAE

Genus CASTANEA Adanson

Castanea castaneaefolia (Unger) Knowlton

Fagus castaneaefolia Unger, Chloris Protogaea, p. 104, pl. 28, fig. 1, 1847.

Castanea ungeri Lesquereux, U. S. Geol. Survey Terr. Rept., vol. 8 (Cretaceous and Tertiary floras), p. 246, pl. 52, figs. 3–7, 1883.

Castanea castaneaefolia Knowlton, U. S. Geol. Survey Bull. 152, p. 60, 1898; U. S. Geol. Survey Prof. Paper 140, p. 35, pl. 18, figs. 7, 8; pl. 19, fig. 1, 1926.

This species is not uncommon in the more recent collection from the Latah formation. As noted by Lesquereux in the material from California, the present material shows considerable variation in size and proportions, the largest leaf seen having a length of 24 centimeters and a maximum width of 5.5 centimeters. It is highly doubtful if these western North American leaves represent the same botanic species as the European form to which they have been referred.

Occurrence: Deep Creek Canyon, brickyard, and Spokane, Portland & Seattle Railway cuts Nos. 1 and 4, Spokane, Wash.

Castanea orientalis Chaney

Plate 51, Figures 4, 5

Castanea orientalis Chaney, Carnegie Inst. Washington Pub. 346, p. 110, pl. 12, figs. 1, 4, 1927.

Among the leaves from the Latah formation which both Knowlton and I have referred to *Castanea castaneaefolia* (Unger) Knowlton are several in which the marginal teeth are very narrow and long. These agree with the species from the Bridge Creek formation of the Crooked River Basin, in eastern Oregon, recently described by Chaney. For the present I have retained both species, but it is highly improbable that there were two botanic species of chestnut at Spokane, and it is equally improbable that these western American chestnuts should belong to the same botanic species as that from the European Miocene described by Unger.

More material of *Castanea orientalis* may demonstrate that it varies from the typical form sufficiently to include *Castanea castaneaefolia*, but the two are best kept separate for the present. In the character of the type material of *Castanea orientalis* there is a considerable resemblance to the existing *Castanea henryi* Rehder, of central China.

Occurrence: Brickyard at Spokane, Wash.

Genus FAGOPSIS Hollick

Fagopsis longifolia (Lesquereux) Hollick

Plate 50, Figure 7

Fagopsis longifolia Hollick, Torreya, vol. 9, p. 2, text figs. 1, 2, 1909.

Knowlton, U. S. Nat. Mus. Proc., vol. 51, p. 265, pl. 20, fig. 5, 1916.

Chaney, Am. Jour. Sci., 5th ser., vol. 2, p. 90. 1921.

Planera longifolia Lesquereux, U. S. Geol. and Geog. Survey Terr. Ann. Rept. for 1872, p. 371, 1873; U. S. Geol. Survey Terr. Rept., vol. 7, p. 189, pl. 27, figs. 4–6, 1878.

Newberry, U. S. Geol. Survey Mon. 35, p. 81, pl. 58, fig. 3, 1898.

Penhallow, Roy. Soc. Canada Trans., 2d ser., vol. 8, p. 70, 1902; Report on Tertiary plants of British Columbia, p. 73, 1908.

Knowlton, U. S. Geol. Survey Mon. 32, pt. 2, p. 712, 1899.

Quercus semiellíptica Goeppert. Lesquereux, U. S. Geol. and Geog. Survey Terr. Ann. Rept. for 1871, p. 286, 1872.

Fagus longifolia (Lesquereux) Hollick and Cockerell, Am. Mus. Nat. Hist. Bull., vol. 24, p. 88 (footnote), 1908.

Zelkowa longifolia (Lesquereux) Engler, in Engler and Prantl, Natürlichen Pflanzenfamilien, Teil 3, Abt. 1, p. 65, 1888.

Myrica oregoniana Knowlton, U. S. Geol. Survey Bull. 204, p. 33, pl. 3, fig. 4, 1902.

Chaney, Walker Mus. Contr., vol. 2, No. 5, p. 163, 1920.

The finding of attached fruits by Hollick in 1909 conclusively showed these leaves to be referable to the Fagaceae, and it is difficult to see any reason for not referring them directly to the modern genus *Fagus*. Not having examined the fruits personally, I have retained Hollick's genus *Fagopsis* for the present.

The species is represented in the Latah formation by small leaves, which depart from the type merely in having the base somewhat more oblique than in most of the Florissant leaves. To the same species belongs the form from the Mascall formation referred by Knowlton to the genus *Myrica*.

The species as now conceived is an abundant and widely ranging Miocene type in western North America occurring in British Columbia; at Elko station, Nev.; in the Yellowstone Park; in the Mascall formation of Oregon; in the Puente formation of California; and in the Eagle Creek formation of Oregon. If the rarity of this form in the Latah formation is of any significance, which is by no means certain, it was not a common element in the Latah flora.

Occurrence: Brickyard and Spokane, Portland & Seattle Railway cut No. 4, Spokane, Wash.

Genus QUERCUS Linné

Quercus cognatus Knowlton

Quercus cognatus Knowlton, U. S. Geol. Survey Prof. Paper 140, p. 36, pl. 20, figs. 1–4; pl. 21, figs. 1, 2, 1926.

The form of oak to which Knowlton gave this name is one of the commonest types in the Latah formation. As Knowlton has pointed out, it approaches very closely *Quercus pseudolyrata* Lesquereux,[17] of the Mascall formation of Oregon, and *Quercus merriami* Knowlton,[18] of the Mascall and Latah formations.

I can see no valid reason for discriminating *Quercus cognatus* and *Quercus merriami*, and both *Quercus*

[17] Lesquereux, Leo, Report on the fossil plants of the auriferous gravel deposits of the Sierra Nevada: Harvard Coll. Mus. Comp. Zoology Mem., vol. 6, No. 2, p. 8, pl. 2, figs. 1, 2, 1878.

[18] Knowlton, F. H., Fossil flora of the John Day Basin, Oreg.: U. S. Geol. Survey Bull. 204, p. 49, pl. 6, figs. 6, 7, pl. 7: figs. 4, 5, 1902.

payettensis Knowlton[19] and *Quercus rustii* Knowlton[20] are, I believe, variants of the same botanic species. The leaves of the lobate species of oaks are always variable, and the Miocene forms of this series differ in relative width, number of lobes, and extent to which the lobes are incised or extended. It is also most improbable that there should have been so many Latah species of *Quercus*. I have not, however, made these suggested combinations in the present paper—first, because I do not wish to do any injustice to Knowlton's opinion, and, second, because if they represent a single botanic species, this can not be conclusively demonstrated, and their description and illustration serve to show the variations, which might be ignored if they were definitely considered one species.

Occurrence: Stanley Hill, Coeur d'Alene, Idaho; Bigelow Gulch, near Hillyard, Wash.; Vera, Wash.; brickyard (very common) and Spokane, Portland & Seattle Railway cut No. 4, Spokane, Wash.

Quercus payettensis Knowlton

Quercus payettensis Knowlton, U. S. Geol. Survey Eighteenth Ann. Rept., pt. 3, p. 730, pl. 102, fig. 9, 1898; U. S. Geol. Survey Prof. Paper 140, p. 37, pl. 21, figs. 5–7, 1926.

As stated in the account of *Quercus cognatus*, this form is probably a variant of the same botanic species. It was described originally from the Payette formation of Idaho. It was recorded by Knowlton from the Latah formation at the Edwards ranch, Coeur d'Alene, Idaho What I regard as identical material occurs at two localities near Spokane.

Occurrence: Stanley Hill, Coeur d'Alene, Idaho; Vera, Wash.; brickyard at Spokane, Wash. (10 specimens).

Quercus rustii Knowlton

Quercus rustii Knowlton, U. S. Geol. Survey Prof. Paper 140, p. 36, pl. 21, figs. 3, 4, 1926.

As stated in my account of *Quercus cognatus* I regard the form to which Knowlton gave the name *Quercus rustii* as another variant of a single botanic species. Knowlton points out its affinity with what he called *Quercus payettensis* and *Quercus merriami*. It is not so common around Spokane as the other variants but occurs at two localities.

Occurrence: Stanley Hill, Coeur d'Alene, Idaho; Vera, Wash.; brickyard at Spokane, Wash.

Quercus merriami Knowlton

Quercus merriami Knowlton, U. S. Geol. Survey Bull. 204, p. 49, pl. 6, figs. 6, 7; pl. 7, figs. 4, 5, 1902; U. S. Geol. Survey Prof. Paper 140, p. 35, pl. 19, figs. 4, 5, 1926.

This form represents leaves like *Quercus cognatus*, *Q. rustii*, and *Q. payettensis*, in which the lobes are extended and become narrowly conical and cuspidate, often bristle-tipped. Leaves with very slightly incised lobes have the same texture, venation, and tips, and these serve to connect the extremes represented by the nominal species named above. The present form occurs at several hitherto unrecorded outcrops around Spokane.

Occurrence: Stanley Hill, Coeur d'Alene, Idaho; Chicago, Milwaukee & St. Paul Railway cut No. 2, brickyard, and Spokane, Portland & Seattle Railway cut, Spokane, Wash.

Quercus ursina Knowlton?

Quercus ursina Knowlton, U. S. Geol. Survey Bull. 204, p. 51, pl. 7, figs. 2, 3, 1902.

There are a few specimens from the brickyard at Spokane which, by their small size, obovate general outline, extended conical bristle-tipped lobes, with an accessory tooth, are indistinguishable from this species.

Quercus ursina has hitherto been known only from the Mascall formation of Oregon, where it is associated with *Quercus pseudolyrata* Lesquereux and *Quercus merriami* Knowlton—the former doubtfully and the latter positively identified by Knowlton in the Latah formation. *Quercus ursina* is probably an extreme variant of *Quercus merriami*.

Occurrence: Brickyard at Spokane, Wash.

Quercus simulata Knowlton, emended

Plate 51, Figures 6, 7, 9–11

Quercus simulata Knowlton, U. S. Geol. Survey Eighteenth Ann. Rept., pt. 3, p. 728, pl. 101, figs. 3, 4; pl. 102, figs. 1, 2, 1898; U. S. Geol. Survey Prof. Paper 140, p. 38, pl. 22, figs. 3, 4, 1926.
Chaney, Walker Mus. Contr., vol. 2, No. 5, p. 168, pl. 12, fig. 1, 1920.
Salix elongata Knowlton [not O. Weber], U. S. Geol. Survey Prof. Paper 140, p. 32, pl. 12, fig. 4, 1926.
Quercus chaneyi Knowlton, idem, p. 38, pl. 22, fig. 1, 1926.
Quercus praenigra Knowlton, idem, p. 37, pl. 19, fig. 6, 1926.

This species was described by Knowlton from the Payette formation of Idaho and was identified by the same author from the Latah formation and by Chaney from the Eagle Creek formation. I have recently detected it in the Esmeralda formation of Nevada.

There are a large number of specimens of a simple, prevailingly entire oak in the recent collections made around Spokane. These exhibit considerable variation in both size and form, ranging from narrowly to broadly lanceolate, with entire or sparingly toothed margins; the apex may be acuminate or bluntly pointed; the base ranges from narrowly cuneate to rounded, like the original Payette type and like the single Latah specimen which Knowlton described as *Quercus praenigra*. The similarity in texture and venation have convinced me that the citations in the above synonymy represent nothing more than the variants of a single Miocene species, comparable with

[19] Knowlton, F. H., The fossil plants of the Payette formation: U. S. Geol. Survey Eighteenth Ann. Rept., pt. 3, p. 730, pl. 102, fig. 9, 1898.

[20] Knowlton, F. H., Flora of the Latah formation of Spokane, Wash., and Coeur d'Alene, Idaho: U. S. Geol. Survey Prof. Paper 140, p. 36, pl. 21, figs. 3, 4, 1926.

and showing less variation than such a recent species as *Quercus chrysolepis* Liebmann. The fossil is not especially close to the canyon live oak but is more like the recent *Quercus hypoleuca* Engelmann or our eastern willow oak, *Quercus phellos* Linné. Whatever the relationship between the fossil and recent species I am sure that anyone who has handled a series of specimens of the latter will agree that these Latah leaves represent a single botanic species.

Occurrence: Stanley Hill, Coeur d'Alene, Idaho; Vera, Wash.; brickyard, Spokane, Portland & Seattle Railway cut, and Deep Creek Canyon, near Spokane, Wash.

Quercus treleasii Berry, n. sp.

Plate 52, Figures 1–3

Leaves of relatively small but variable size, ovate or subelliptical, somewhat narrowed distad to the obtusely pointed tip. Base rounded. Margins entire. Texture coriaceous. Length from 3.25 to 9 centimeters; maximum width from 1.5 to 3 centimeters. Petiole short and stout. Midvein stout and prominent. Secondaries stout, prominent; five to seven pairs diverge from the midvein at wide angles, pursue rather angular courses, and are camptodrome in the marginal region. The areolation consists of stout nervilles in a fine mesh.

These leaves, which are abundant, have the outline of several unrelated genera, but their venation and characteristic facies, easily seen but difficult to define, stamp them as belonging to *Quercus*. They are named for Prof. William Trelease, our most eminent student of the existing oaks.

Occurrence: Vera and brickyard at Spokane, Wash.

Quercus sp. Knowlton

Quercus, cup, Knowlton, U. S. Geol. Survey Prof. Paper 140, p. 39, pl. 21, fig. 10, 1926.

A cupule of an oak from the Latah formation at Coeur d'Alene was figured by Knowlton. The recent collections contain many more or less crushed specimens, doubtless representing more than a single botanic species, but the preservation is such that no sharp differences can be made out.

Occurrence: Stanley Hill, Coeur d'Alene, Idaho; Deep Creek Canyon, brickyard, and Spokane, Portland & Seattle Railway cut No. 1, Spokane, Wash.

Order URTICALES

Family ULMACEAE

Genus ULMUS Linné

Ulmus speciosa Newberry

Ulmus speciosa Newberry, U. S. Nat. Mus. Proc., vol. 5, p. 507, 1883; U. S. Geol. Survey Mon. 26, p. 80, pl. 45, figs. 3–4, 7 (not figs. 2, 5, 8), 1895 [1896].

Knowlton, U. S. Geol. Survey Bull. 204, p. 53, 1902; U. S. Geol. Survey Prof. Paper 140, p. 39, pl. 18, fig. 6, 1926.

Penhallow, Report on Tertiary plants of British Columbia p. 94, 1908.

Chaney, Walker Mus. Contr., vol. 2, No. 5, p. 171, 1920.

Knowlton in his preliminary account of the Latah flora regards the large leaves (Newberry's figs. 3 and 4) as typical for this species. The smaller leaves described by Newberry are referred by Chaney [21] to his Eagle Creek species, *Ulmus tanneri*. Newberry's Figure 2 and *Quercus pseudoamericana* Lesquereux,[22] which Knowlton united with *Ulmus speciosa*, differ from the others in the very highly developed dimorphic teeth and are here excluded from that species.

Only one specimen of *Ulmus speciosa* was contained in the collections from the Latah formation studied by Knowlton, but it is abundant in the recent collections and occurs in all sizes and also exhibits great variations in marginal characters. Dentate and serrate teeth occur on the same leaf, and although there is a tendency for them to be simple they usually show some subordinate teeth, and individual specimens will have such teeth well developed.

The type came from the upper part of the Clarno formation of Oregon, and it is doubtfully recorded from supposed Oligocene beds in British Columbia and occurs also in the Eagle Creek formation of Oregon. It is associated in the Latah with *Ulmus* fruits which differ from any previously described.

Occurrence: Republic, Wash.; Deep Creek Canyon, brickyard, and Spokane, Portland & Seattle Railway cuts Nos. 1 and 4, near Spokane, Wash.

Ulmus, fruit

Plate 51, Figure 1; Plate 64, Figures 3, 4

Fruit a samara, long stipitate, broadly lanceolate, with an acuminate decurrent base and a deeply cleft apex. Texture diaphanous, margin thickened. Finely reticulate veined. Length 1.5 to 2 centimeters; maximum width 6 to 8 millimeters; carpellary area 6 by 3, 4 by 4, 5 by 4, and 7 by 4 millimeters; the slender curved stipe 1 centimeter.

This very characteristic fruit is represented by six specimens, of which the most perfect are figured. In several specimens the rather large calyx is preserved about midway of the stipe.

Among existing American elms the one most similar to the fossils is the white elm, *Ulmus americana* Linné, a widely ranging species extending from Newfoundland to the eastern base of the Rocky Mountains and southward to Florida and Texas and reaching its maximum of size and abundance in the northern part of this range. The samaras of *Ulmus americana* are relatively wider, and the apical auricles are less produced.

[21] Chaney, R. W., The flora of the Eagle Creek formation: Walker Mus. Contr., vol. 2, No. 5, p. 172, pl. 14, figs. 1, 2, 1920.

[22] Lesquereux, Leo, Cretaceous and Tertiary floras: U. S. Geol. Survey Terr. Rept., vol. 8, p. 249, pl. 54, fig. 10, 1883.

The present fruit very probably belongs to the same botanic species which is represented by leaves in the Latah formation. It is quite distinct from previously described *Ulmus* fruits. *Ulmus* with more than a score of existing species is widely distributed in the Northern Hemisphere except in western North America, reaching southward to the Sikkim Himalayas in Asia and to the mountains of southern Mexico in America. Despite its absence in the modern flora of western North America the genus is well represented throughout the Tertiary of that region and in the Miocene has four species in California and at Florissant, two in Oregon (Mascall formation), and one in the Yellowstone Park.

Occurrence: Brickyard at Spokane, Wash.

Family MORACEAE

Genus FICUS Linné

Ficus? washingtonensis Knowlton, emended

Plate 54, Figures 1–3; Plate 55, Figures 5, 6; Plate 62

Ficus? washingtonensis Knowlton, U. S. Geol. Survey Prof. Paper 140, p. 40, pl. 25; pl. 26, figs. 1–3, 1926.

This species, as described by Knowlton, was based upon four incomplete specimens, only one of which came from the Spokane area, the other three coming from Coeur d'Alene, Idaho. In the recent collections there are a large number of specimens, several of which are complete—all of the same species, in my opinion, and some not to be distinguished from Knowlton's type. I am inclined to think that they represent the genus *Ficus*, and I agree with Knowlton that they are specifically distinct from *Ficus sordida* Lesquereux, of the California Miocene, although the two are closely related.

The present specimens greatly extend our conception of the species and show it to have been exceedingly variable in size and form. The petiole is long (over 4.5 centimeters) and exceedingly stout. The base may be rounded, truncate, or cuneate. The primaries in the narrower and more elongated forms are frequently three instead of five in number and sometimes diverge from above the base, although they are normally basal.

A large specimen (pl. 62), collected by E. E. Alexander after this manuscript was submitted for publication, still further widens its limits of variation. The specimen, which is nearly complete, indicates a length of 18 centimeters and a maximum width of 11.5 centimeters. About 2 centimeters of the long petiole is preserved, and this adds an unsuspected feature—that is, for a distance of about 1 centimeter immediately below the leaf it is conspicuously alate. The total maximum width of this lanceolate affair is 5 millimeters, of which two-thirds consists of marginal wings. An additional peculiarity is that the normal full rounded leaf margin on one side about two-thirds of the distance above the base is interrupted by an acute conical lobe subtending an open rounded sinus. There can be no question but that this specimen represents the same botanic species to which Knowlton first applied this name. The present specimen comes from the brickyard at Spokane.

A representative series of specimens, illustrating the variations, are figured herewith.

Occurrence: Republic, Wash.; Vera, Wash.; Spokane, Portland & Seattle Railway cut No. 1 and brickyard, Spokane, Wash.

Order PLATANALES

Family PLATANACEAE

Genus PLATANUS Linné

Platanus aspera Newberry

Platanus aspera Newberry, U. S. Nat. Mus. Proc., vol. 5, 1882, p. 509, 1883; U. S. Geol. Survey Mon. 35, p. 102, pl. 42, figs. 1–3; pl. 44, fig. 5; pl. 59, fig. 3, 1898.
Knowlton, U. S. Geol. Survey Bull. 204, p. 64, 1902.
Chaney, Walker Mus. Contr., vol. 2, No. 5, p. 175, 1920.

This somewhat protean species was described by Newberry from the upper part of the Clarno formation at Bridge Creek, Oreg. It has also been recorded by Chaney from the Eagle Creek formation of Oregon. A single specimen in the Latah is unquestionably identical with the type in its long, stout petiole, numerous prominent marginal teeth, and closely spaced subparallel secondaries. A second specimen, less well preserved, from cut No. 1 also probably represents this species. It is very distinct from the associated leaves of *Platanus* and could not possibly represent a variant of any of these.

Occurrence: Spokane, Portland & Seattle Railway cuts No. 1 and 4, Spokane, Wash.

Platanus dissecta Lesquereux

Plate 53, Figures 1, 2; Plate 61

Platanus dissecta Lesquereux, Harvard Coll. Mus. Comp. Zoology Mem., vol. 6, No. 2, p. 13, pl. 7, fig. 12; pl. 10, figs. 4, 5, 1878; U. S. Geol. Survey Terr. Rept., vol. 8 (Cretaceous and Tertiary floras), p. 249, pl. 56, fig. 4; pl. 57, figs. 1, 2, 1883.
Knowlton, in Smith, U. S. Geol. Survey Geol. Atlas, Folio 86 (Ellensburg, Wash.), p. 3, 1903.
Chaney, Carnegie Inst. Washington Pub. 349, p. 27, 1925.
Acer trilobatum productum (Al. Braun) Heer. Lesquereux, U. S. Geol. Survey Terr. Rept., vol. 8 (Cretaceous and Tertiary floras), p. 253, pl. 59, fig. 3, 1883.

This species, described originally from the auriferous gravel (Miocene) of California and subsequently recorded from Ellensburg, Wash., was apparently a common element in the Latah flora, although no specimens were contained in the collections studied by Knowlton. *Platanus dissecta* Lesquereux does not differ appreciably from the leaves of the existing *Platanus racemosa* Nuttall, a large tree of the canyon bottoms and alluvial stream benches from Shasta County on the north to Lower California on the south

and from the foothills of the southern Sierra Nevada to the coast. It has evidently retreated to streams with the progressive aridity of the region and must have undoubtedly enjoyed a less restricted range in its early history. It may be a descendant of the Miocene *Platanus dissecta*. Recently Chaney has recorded *Platanus dissecta* from the Mascall formation and from the Blue Mountains and Trout Creek in Oregon; from Ellensburg, Wash.; and from 49 camp, Nevada.

Occurrence: Deep Creek Canyon and Spokane, Portland & Seattle Railway cut near Spokane, Wash.

Platanus appendiculata Lesquereux?

Plate 52, Figure 5

Platanus appendiculata Lesquereux, Harvard Coll. Mus. Comp. Zoology Mem., vol. 6, No. 2, p. 12, pl. 3, figs. 1–6; pl. 6, fig. 7b, 1878.

This species, described by Lesquereux from Nevada and Placer Counties, Calif., was doubtfully recorded by Knowlton [23] from the Ione formation (upper Eocene) of that State.

A single incomplete specimen of a *Platanus* leaf from Republic, Wash., differs conspicuously from any other *Platanus* leaves found in the Latah and is referred to this species on account of the agreement in venation and the markedly decurrent perfoliate base.

Occurrence: Republic, Wash.

Order RANALES

Family MENISPERMACEAE

Genus MENISPERMITES Lesquereux

Menispermites latahensis Berry, n. sp.

Plate 52, Figure 4

Leaves of relatively small size, about as long as their maximum width, trilobate, with a wide central lobe and a pair of basal lateral lobes. Sinuses rounded, extending inward about halfway to the midvein. Margin with shallow, irregularly spaced dentate teeth, most prominent toward the tip of the central lobe and on the proximal side of the lateral lobes. Apex rounded. Tips of lateral lobes rounded, asymmetric. Base perfoliate. Texture thin. Length about 4.8 centimeters, maximum width, across lateral lobes, 5.25 centimeters. Primaries stout, diverging from the base at angles of about 45°, the laterals curving outward to the tips of the lateral lobes. Secondaries numerous, ascending, indifferently camptodrome or craspedodrome according as the margin at their extremities is entire or toothed. Areolation large, polygonal.

This characteristic species is clearly a member of the Menispermaceae and is not unlike some of the modern forms which American botanists refer to the genus *Cebatha* Forskal but which the Europeans generally include in the large genus *Cocculus* De Candolle. It is also similar to some of the forms referred to *Menispermum* Linné, which, as now restricted, includes an existing species in eastern North America and another in eastern Asia. In view of the uncertainty of the generic affinity I prefer to refer the fossil to the form genus *Menispermites*, proposed by Lesquereux to fit just such cases.

Leaves of this family are common in the Upper Cretaceous of western North America but are extremely rare in the Tertiary of that region. The present species is not only a link with the past but also a link between eastern Asia and eastern North America, where its descendants still survive.

Occurrence: Vera, Wash.; brickyard at Spokane, Wash.

Family MAGNOLIACEAE

Genus LIRIODENDRON Linné

Liriodendron hesperia Berry, n. sp.

Plate 51, Figures 2, 3

Carpels dry, ligneous, indehiscent; with a proximal laterally compressed pericarp and a distal ligneoscarious wing; broadly lanceolate, abruptly pointed distad. The wing has a conspicuous midvein, which is a continuation of the vertical angles of the pericarp, and two or three subparallel longitudinal veins from the base; these fork distad, as shown in the illustrations; the surface is transversely roughened between the veins, more prominently centrally. The roughened surface of an existing fruit does not show this clearly, but if comparison is made with a partly decayed modern fruit it is seen to have the same transverse knots of sclerotic tissue, exactly like that seen in the fossils. This species is based upon the two specimens figured, neither of which is entirely complete. The larger, which has a length of not quite 3 centimeters, of which one-third is pericarp, and a width of 7 millimeters, shows the inner side of a carpel in which the pericarp is somewhat distorted and flattened; the midvein is wider than on the opposite surface, and the specimen shows distinctly the more coriaceous tip. The smaller specimen, which lacks the apex, is an impression of the outer surface of a carpel; it has an estimated length of 2.5 centimeters and a maximum width of 5.5 millimeters; the impression of the pericarp is fusiform, 5.5 millimeters long and 2.5 millimeters in maximum width, deeply impressed in the clay matrix.

Of the two living species, *Liriodendron tulipifera* and *L. chinensis*, the fossil is most like the former, American form—in fact, the two can not be distinguished. The carpels of the Chinese species are readily differentiated from both.

These specimens are unique in the Cenozoic history of western North America. The genus *Liriodendron*, as is well known, attained a holarctic distribution during Upper Cretaceous time and is represented by

[23] Knowlton, F. H., in Turner, H. W., Auriferous gravels of the Sierra Nevada: Am. Geologist, vol. 15, p. 378, 1895.

numerous species in both eastern and western North America, the Arctic region, and Europe. No North American occurrences of Tertiary age have heretofore been recorded,[24] although fossil species of this age have been found in the Arctic region and as late as the Pliocene of Holland and France in Europe and the Altai region in Asia. The Holland occurrence is represented by carpels which have been referred to *Liriodendron tulipifera*. As the two existing and closely related living species are found in China and in southeastern North America, and as the genus was so abundantly represented all over North America during the Upper Cretaceous period, its apparent absence in the Tertiary deposits has been incomprehensible and its presence has been freely predicted. Its discovery in the Latah formation adds a most important mesophytic element to the Latah flora, and we may confidently expect the discovery of the foliage, for the carpels are absolutely characteristic.

The only other possible comparison is with the samaras of *Fraxinus*, and they are obviously so differently organized that I have not deemed it necessary to enumerate the contrasts.

Occurrence: Brickyard at Spokane, Wash.

Genus MAGNOLIA Linné

Magnolia californica Lesquereux

Magnolia californica Lesquereux, Harvard Coll. Mus. Comp. Zoology Mem., vol. 6, No. 2, p. 25, pl. 6, figs. 6, 7 (not fig. 5), 1878.

There are four more or less complete specimens in the Latah collections characteristic of this species, which has been recorded previously from the Miocene of California and Yellowstone Park and from the supposed Eocene of southwestern Oregon.

Occurrence: Vera, Wash.; brickyard, Deep Creek Canyon, and Spokane, Portland & Seattle Railway cut No. 1 at Spokane, Wash.

Magnolia dayana Cockerell

Magnolia lanceolata Lesquereux, Harvard Coll. Mus. Comp. Zoology Mem., vol. 6, No. 2, p. 24, pl. 6, fig. 4, 1878.
Knowlton, U. S. Geol. Survey Bull. 204, p. 58, 1900.
Magnolia dayana Cockerell, Am. Naturalist, vol. 44, p. 35, 1910.
Knowlton, U. S. Geol. Survey Prof. Paper 140, p. 41, pl. 24, fig. 3, 1926.

There are in the Latah collections four specimens of this large *Magnolia* which are typical of this species. None are entirely complete, but some show the tip and others the base and indicate leaves about 24 centimeters long and 7 to 8 centimeters in maximum width.

The species has been recorded previously from the Miocene of California, the upper part of the Clarno formation of Oregon, the Ellensburg formation of Washington, and the supposed Eocene of southwestern Oregon.

Occurrence: Deep Creek Canyon and Spokane, Portland & Seattle Railway cut No. 1 at Spokane, Wash.

Order ROSALES

Family HAMAMELIDACEAE

Genus LIQUIDAMBAR Linné

Liquidambar californicum Lesquereux, emended

Liquidambar californicum Lesquereux, Harvard Coll. Mus. Comp. Zoology Mem., vol. 6, No. 2, p. 14, pl. 6, fig. 7c; pl. 7, figs. 3, 6, 1878.
Chaney, Walker Mus. Contr., vol. 2, No. 5, p. 174, 1920.
Liquidambar europaeum Lesquereux, U. S. Geol. Survey Terr. Rept., vol. 8 (Cretaceous and Tertiary floras), p. 159, pl. 32, fig. 1, 1883.
Newberry, U. S. Geol. Survey Mon. 35, p. 100, pl. 47, figs. 1–3, 1898.
Knowlton, U. S. Geol. Survey Bull. 204, p. 62, 1902; U. S. Nat. Mus. Proc., vol. 17, p. 226, 1894; Geol. Soc. America Bull., vol. 5, p. 585, 1893.
Chaney, Walker Mus. Contr., vol. 2, No. 5, p. 174, 1920.
Liquidambar protensum Lesquereux, U. S. Nat. Mus. Proc., vol. 11, p. 13, pl. 8, fig. 3, 1888.
Knowlton, U. S. Geol. Survey Bull. 204, p. 62, 1902.
Liquidambar sp. Knowlton, in Lindgren, Jour. Geology, vol. 4, p. 890, 1896.
Liquidambar europaeum patulum Knowlton, U. S. Geol. Survey Bull. 204, p. 62, pl. 10, fig. 5, 1902.
Liquidambar europaeum Al. Braun. Lesquereux, U. S. Nat. Mus. Proc., vol. 11, p. 14, 1888.
Liquidambar sp.? Knowlton, U. S. Geol. Survey Bull. 204, p. 63, pl. 12, fig. 4, 1902.
Liquidambar pachyphyllum Knowlton, U. S. Geol. Survey Bull. 204, p. 63, pl. 9, fig. 1, 1902; U. S. Geol. Survey Prof. Paper 140, p. 42, pl. 22, fig. 7; pl. 29, fig. 1, 1926.
Chaney, Walker Mus. Contr., vol. 2, No. 5, p. 174, pl. 15, figs. 2, 3, 1920.
Liquidambar convexum Cockerell, Am. Mus. Nat. Hist. Bull., vol. 24, p. 94, pl. 7, fig. 16, 1908.
Liquidambar acutilobum Chaney, Walker Mus. Contr., vol. 2, No. 5, p. 175, pl. 15, fig. 4, 1920.

Knowlton recorded five different forms from the Mascall formation and Chaney four forms from the Eagle Creek formation. To anyone who has collected the leaves of our existing *Liquidambar styraciflua* Linné or who contemplates Heer's excellent figures of *Liquidambar europaeum* Al. Braun, from the Swiss Miocene, it must be obvious that there is the widest variation in size, degree of lobation, and relative proportions in the same species; somewhat less, but still considerable variation in texture; and less but still some variation in the marginal teeth and details of venation. When a variety of species, based on foliar features, are described from a single outcrop such a differentiation does violence to the facts. All the western American Miocene leaves of *Liquidambar* could readily be matched among the material of *Liquidambar europaeum* from the type locality at Oeningen, Baden, or they could equally well be matched among the leaves of our existing sweet gum, *Liquid-*

[24] A doubtful leaf fragment from the upper Eocene of British Columbia has been referred tentatively to *Liriodendron* (Berry, E. W., Canada Geol. Survey Bull. 42, p. 110, 1926); and Chaney (Walker Mus. Contr., vol. 2, No. 5, p. 173, pl. 14, fig. 4, 1920) has recorded a very doubtful fragment from the Eagle Creek formation.

ambar styraciflua. If it is reasonable to conclude that the existing American species has not come down unchanged since Tertiary time it is unreasonable to suppose that an identical Miocene species inhabited Europe and western North America.

If Braun's name is discarded for American forms the oldest available is *Liquidambar californicum* Lesquereux, which I consider includes all the nominal species that have been referred to this genus from the western American Miocene.

The material in the Latah formation, although not abundant, admirably illustrates the usual situation. Knowlton figured both three-lobed and five-lobed forms from the Latah formation as *Liquidambar pachyphyllum*. The present collection contains narrow acuminately lobed three-lobed leaves with a cuneate base and larger five-lobed leaves with broad lobes and a cordate base. The venation and the very characteristic margin are identical in both, and I have not the slightest doubt that all the Latah leaves represent a single species.

The species, as conceived by me, is found in California, Oregon, Washington, and Colorado. Undoubtedly the fine fruit from the Latah formation described by Knowlton [25] belongs to it. This, too, is not at all different from the fruits of our existing eastern American species.

Occurrence: Well near Mica, Wash.; cut No. 2 on Oregon-Washington Railroad & Navigation Co.'s line, Deep Creek Canyon, and brickyard, Spokane, Wash.

Family GROSSULARIACEAE

Genus RIBES Linné

Ribes fernquisti Berry, n. sp.

Plate 63, Figure 21

Leaves relatively small, trilobate. Margin, except at base and in the sinuses, with course dentate teeth. Texture subcoriaceous. Length about 5 centimeters, as is also the maximum width. Apical lobe about as broad as it is long, bluntly pointed at apex. Base of the leaf truncate. Sinuses narrow and not deep. Primaries three from the top of the petiole, stout and prominent. Secondaries stout, prominent, diverging from the primaries at acute angles. There are three or four subopposite to alternate secondaries in the central lobe, curved proximad and more straight distad, and craspedodrome. In the lateral lobes the basal secondary on the outside diverges close to the base and is relatively straighter and more prominent than its fellows and might be termed a subprimary. There is a secondary on the outside below the basal secondary on the inside, and the latter is much curved, ascending inside the sinus margin and ending camptodromely if the margin is entire and craspedodromely if it has ascended to a point where there is a tooth on the margin. The primaries, particularly the lateral ones, are slightly flexuous with respect to the alternate divergence of the secondaries. The Tertiary branches from the distal parts of the secondaries are well marked, and the ultimate ones are usually craspedodrome. Internal tertiaries are transverse and percurrent or inosculating in the middle region. The areolation is an open mesh that agrees precisely with that in leaves of existing members of the genus.

The species is named for the collector.

With the exception that some modern leaves of *Ribes* tend to have a cordate base, this Latah species shows all the foliar features of the genus, especially in the form of the teeth and in the position and disposition of the veins.

Ribes has not often been recognized in the fossil state. Two species have, however, been recorded from Florissant, Colo., but both of these are unlike the Latah form. There are over 60 existing species of *Ribes*, all shrubby, and widely distributed in the North Temperate Zone and in the Andes of South America. Fully 50 species are known from North America. There are 18 in the Recent flora of Washington—5 in the arid transition zone and a sixth in the Sonoran zone.

Occurrence: Brickyard at Spokane, Wash., collected by C. O. Fernquist.

Family SAXIFRAGACEAE

Genus HYDRANGEA Linné

Hydrangea bendirei (Ward) Knowlton

Plate 52, Figure 7

Hydrangea bendirei Knowlton, in Merriam, California Univ. Dept. Geology Bull., vol. 2, p. 309, 1901.
Knowlton, U. S. Geol. Survey Bull. 204, p. 60, pl. 9, figs. 6, 7, 1902; U. S. Geol. Survey Prof. Paper 140, p. 42, pl. 24, fig. 6, 1926.
Marsilea bendirei Ward, U. S. Geol. Survey Fifth Ann. Rept., p. 446, 1885.
Porana bendirei (Ward) Lesquereux, U. S. Nat. Mus. Proc., vol. 11, p. 16, pl. 8, fig. 4, 1888.

There are two specimens of this species in the recent collections. The one figured is complete and of special interest, because it has five fully developed sepals instead of the normal four, a feature not uncommon in existing species. There is considerable variability in this feature in the sterile flowers of existing hydrangeas, and the fossil is otherwise identical not only with the type but with the single specimen from the Latah formation described by Knowlton in 1926.

Occurrence: Spokane, Portland & Seattle Railway cut, Spokane, Wash.; Republic, Wash.

[25] Knowlton, F. H., Flora of the Latah formation of Spokane, Wash., and Coeur d'Alene, Idaho: U. S. Geol. Survey Prof. Paper 140, p. 42, pl. 10, fig. 10, 1926.

Family DRUPACEAE

Genus PRUNUS Linné

Prunus rustii Knowlton

Plate 55, Figure 1

Prunus rustii Knowlton, U. S. Geol. Survey Prof. Paper 140, p. 43, pl. 24, figs. 4, 5, 1926.

This characteristic species, sparingly represented in the collections studied by Knowlton, is not uncommon in the later collections. A complete leaf is figured herewith.

Occurrence: Stanley Hill, Coeur d'Alene, Idaho; Republic, Wash.; Deep Creek Canyon, brickyard, and Chicago, Milwaukee & St. Paul Railway cut, Spokane, Wash

Family ROSACEAE

Genus AMELANCHIER Medicus

Amelanchier scudderi Cockerell

Plate 55, Figure 4

Amelanchier scudderi Cockerell, Torrey Bot. Club Bull., vol. 33, p. 310, text fig. 4, 1906.

This species was based upon a single incomplete specimen from Florissant, so that whatever variation was present can not be determined. The complete leaves in the Latah formation are not exactly like the type but are so similar that I have no doubt that they represent the same botanic species. They are relatively slightly longer and narrower and consequently have more secondaries; the base is rounded like the tip instead of being broadly cuneate, and the teeth are more numerous. The Latah leaves may be described as follows:

Leaves almost orbicular, widest in the middle and about equally rounded at the apex and base. Midvein straight and fairly stout. Secondaries thin, seven or eight pairs, mostly simple, regularly curved and subparallel, rarely forked, camptodrome. Areolation typical of the genus. Lower margins entire, upper two-thirds with regular teeth. Teeth with a broad crenate-like base and an ultimate apiculate serration. Each tooth receives a short tertiary veinlet.

This is distinctly an *Amelanchier* and not a *Malus*. It is close to the leaves of the existing *Amelanchier alnifolia* Nuttall, from some of the leaves of which it is scarcely distinguishable. *Amelanchier alnifolia* is a tall shrub or small tree ranging from Alaska through the Coast Ranges to northern California and eastward to northern Michigan. It is found alike in moist valleys, meadows, and dry slopes but makes its best growth in the rich bottom lands of the lower Columbia River and the similar meadow lands around Puget Sound.

The genus is widely distributed throughout the north temperate zone. It is abundant at Florissant, with three species, but is otherwise unknown in the Pacific slope Miocene.

Occurrence: Brickyard at Spokane, Wash.

Genus CERCOCARPUS Humboldt, Bonpland, and Kunth

Cercocarpus praeledifolius Berry, n. sp.

Plate 64, Figure 7

Leaves small, lanceolate, petiolate, widest medianly and about equally tapering to the pointed apex and slightly decurrent base. Texture coriaceous. Margins slightly irregular, involute. Length about 1 centimeter or slightly more; maximum width 3 to 4 millimeters. Petiole stout, about 1.5 millimeters long. Midvein stout, prominent. Secondaries stout, ascending, closely spaced, craspedodrome.

This characteristic little leaf is especially like those of the existing *Cercocarpus ledifolius* Nuttall, which is prevailingly a shrubby form of poor soils ranging from western Wyoming to Montana, Idaho (Coeur d'Alene Mountains), and Oregon (eastern Blue Mountains) and southward through the Great Basin and Wasatch Ranges to the eastern slopes of the Sierra Nevada and northern slopes of the San Bernardino Mountains, northern New Mexico and Arizona. Although commonly an arid type in chaparral, it reaches its largest size in moist richer soils, as on the hills of central Nevada.

The genus contains about six species confined to western North America and Mexico. Several fossil species have been described, including one, *Cercocarpus antiquus* Lesquereux,[26] from the supposed Miocene of California. This is much larger than the Latah species and more like the existing *Cercocarpus parvifolius* Nuttall.

Occurrence: Brickyard at Spokane, Wash.

Family CAESALPINIACEAE

Genus CASSIA Linné

Cassia idahoensis Knowlton

Plate 55, Figures 2, 3

Cassia obtusa Knowlton, U. S. Geol. Survey Eighteenth Ann. Rept., pt. 3, p. 731, pl. 100, figs. 4, 5, 1898 [not Clos, 1845].

Cassia idahoensis Knowlton, U. S. Geol. Survey Bull. 696, p. 146, 1919.

This species was described in 1898 from the Payette formation at Marsh, Idaho, to which it has hitherto been confined. There are three specimens from the Latah formation which are identical with the type in all their features except that they are larger.

Occurrence: Vera, Wash.; brickyard and Spokane, Portland & Seattle Railway cut, Spokane, Wash.

[26] Lesquereux, Leo, Report on the fossil plants of the auriferous gravel deposits of the Sierra Nevada: Harvard Coll. Mus. Comp. Zoology Mem., vol. 6, No. 2, p. 37, pl. 10, figs. 6–11, 1878.

Cassia sophoroides (Knowlton) Berry

Plate 56, Figure 1

Phyllites sophoroides Knowlton, U. S. Geol. Survey Prof. Paper 140, p. 48, pl. 26, fig. 8, 1926.

The single imperfect specimen of this species from the Edwards ranch, Stanley Hill, Coeur d'Alene, Idaho, was referred by Knowlton to the form genus *Phyllites*, although its leguminous character was recognized. These leaflets are inequilateral throughout; the petiolule is stout and about 3 millimeters long; the tip is usually slightly more extended than in Knowlton's type.

Although the features of these leaflets are shared by a large number of genera of the leguminous alliance, they conform to that found in many species of *Cassia*, both recent and fossil, and as this genus is one more likely to occur in this strictly temperate flora than tropical genera with similar leaflets, I have transferred them to *Cassia*.

Occurrence: Stanley Hill, Coeur d'Alene, Idaho; Spokane, Portland & Seattle Railway cut No. 4 and brickyard at Spokane, Wash.

Cassia spokanensis Berry, n. sp.

Plate 63, Figure 18

This is superficially like *Carpites paulownia* Knowlton,[27] of the Latah flora, but is clearly an altogether different object. The leguminous genera whose foliage has been recognized are *Cassia*, *Cercis*, *Sophora*, and *Leguminosites*. The last is a form genus, and both *Cercis* and *Sophora* have radically different pods, leaving only *Cassia*, and it is to *Cassia* that I have referred numerous similar pods from the Eocene of southeastern North America and various localities in South America.

Pod compressed, nearly equilateral in its oval profile, rapidly narrowed to the rounded tip and similarly narrowed to the stout stipitate portion above the calyx. Texture coriaceous and apparently indehiscent. Obviously single or few seeded. Length 4.3 centimeters; maximum width 2.4 centimeters. The stout stipitate basal portion included in the length as given above is 7 millimeters long and 2 millimeters wide. Placental margin conspicuously thickened.

Occurrence: Brickyard at Spokane, Wash.

Family PAPILIONACEAE

Genus SOPHORA Linné

Sophora spokanensis Knowlton

Plate 56, Figures 5, 6

Sophora spokanensis Knowlton, U. S. Geol. Survey Prof. Paper 140, p. 44, pl. 28, fig. 6, 1926.

This species was described from a single fragment of a leaflet. It is not uncommon in the recent collections from the Latah formation and may be more completely characterized as follows:

Leaflets showing considerable variation in size and outline, even on a single leaf; varying from elongate-elliptical to ovate-lanceolate; generally widest medially but sometimes in the lower half. Apex narrowly to broadly rounded and nearly equilateral. Base broadly rounded, inequilateral. Petiolule short and stout, 2 millimeters or less in length. Midvein stout, prominent. Secondaries thin, somewhat irregularly spaced, diverging from the midvein at angles of 45° or less, camptodrome. Length from 2.5 to 4.5 centimeters; a single terminal leaflet, obviously undeveloped, is 1.5 centimeters long and about 4 millimeters in maximum width.

One specimen shows part of a leaf with eight leaflets in position; these increase in size and relative width as well as spacing from the tip toward the base. The leaf is odd-pinnate, thus conforming to the arrangement in *Sophora*. I much doubt its reference to *Sophora*, however, and it appears to me to be more probably referable to *Robinia*, which has similar, odd-pinnate leaves. It is not greatly different, except for its larger size, from *Robinia brittoni* Cockerell,[28] from Florissant, Colo. I have not, however, changed the generic reference, preferring to wait for certainty before making the change.

Occurrence: Deep Creek Canyon, brickyard, and Spokane, Portland & Seattle Railway cut No. 1, Spokane, Wash.

Sophora alexanderi Knowlton

Plate 56, Figures 2, 3

Sophora alexanderi Knowlton, U. S. Geol. Survey Prof. Paper 140, p. 43, pl. 28, figs. 3–5, 1926.

This fine species is not uncommon in the Latah formation but thus far has been found only as detached leaflets. The numerous specimens in the recent collections are all confined to one locality.

Occurrence: Stanley Hill, Coeur d'Alene, Idaho; brickyard, Spokane, Wash.

Genus MEIBOMITES Knowlton

Meibomites knowltoni Berry, n. sp.

Plate 56, Figure 7

Leaflet rhomboidal, somewhat inequilateral, with a broadly cuneate pointed tip and a rounded base. Margins strictly entire. Texture of considerable consistency. Length about 6 centimeters; maximum width, midway between the apex and the base, about 4 centimeters. Petiolule short and stout, barely a millimeter in length. Midvein stout and prominent. Secondaries thin, three camptodrome pairs; the base pair are from the extreme base of the midvein, opposite, thickened, diverging at acute angles, ascending in such a way as to appear like lateral primaries, camptodrome.

[27] Knowlton, F. H., Flora of the Latah formation of Spokane, Wash., and Coeur d'Alene, Idaho: U. S. Geol. Survey Prof. Paper 140, p. 50, pl. 29, fig. 12, 1926.

[28] Cockerell, T. D. A., Descriptions of Tertiary plants: Am. Jour. Sci., 4th ser., vol. 26, p. 543, fig. 8, 1908.

This species is unfortunately represented only by the single specimen figured. The venation is typically leguminous, and the species may be a variant of *Meibomites lucens* Knowlton of the Latah formation or a terminal leaflet of which Knowlton's specimen was a lateral leaflet, as certain similar existing species of *Meibomia* have the terminal leaflet apparently triveined and the laterals pinnately veined, as in the species *M. nudiflora* (Linné) Kuntze, *M. grandiflora* (Walter) Kuntze, and others.

The present fossil shows considerable resemblance to what Cockerell described from Florissant as *Philadelphus palaeophilus*,[29] but that species is smaller and toothed distad.

The genus *Meibomia* Adanson (*Desmodium* Desvaux) contains more than 200 existing species of perennial herbs, some of them woody at the base, widely distributed in North and South America, Africa, and Australia.

Occurrence: Brickyard at Spokane, Wash.

Genus LEGUMINOSITES Bowerbank

Leguminosites bonseri Berry, n. sp.

Plate 56, Figure 4

Leaflets small, sessile, ovate-lanceolate and somewhat falcate, inequilateral, widest below the middle. Tip pointed, apiculate. Base markedly unsymmetrical, full and rounded on one side, pointed on the other. Margins entire. Texture relatively coriaceous. Midvein stout and prominent, curved. Secondaries relatively stout, about five pairs, diverging from the midvein at wide angles, camptodrome.

I am quite uncertain regarding the botanic affinity of these small leaflets. The four specimens in the collection are all from one locality, and all suggest that they might be small abnormal leaflets of some plant whose normal foliage was somewhat different.

Occurrence: Brickyard at Spokane, Wash.

Leguminosites alexanderi Berry, n. sp.

Plate 63, Figure 16

Pod (or follicle) of small size, unsymmetrically ovate, compressed, upper margin full, lower margin straighter. Apex missing. Stipe stout, about 3 millimeters long. Pod 1.2 centimeters long by 6 millimeters in maximum diameter. Substance of considerable consistency, with an open polygonal areolation. Evidently few or single seeded. Named for the collector.

This small pod is unlike any previously known from the Miocene. It seems obviously referable to the leguminous alliance, but its generic reference is uncertain.

Occurrence: Brickyard at Spokane, Wash., collected by E. E. Alexander.

[29] Cockerell, T. D. A., The fossil flora of Florissant, Colo.: Am. Mus. Nat. Hist. Bull., vol. 24, p. 92, pl. 10, fig. 37, 1908.

Order SAPINDALES

Family SAPINDACEAE

Genus SAPINDUS Linné

Sapindus spokanensis Berry, n. name

Sapindus angustifolius Lesquereux, U. S. Geol. and Geog. Survey Terr. Ann. Rept. for 1873, p. 415, 1874; U. S. Geol. Survey Terr. Rept., vol. 7 (Tertiary flora), p. 265, pl. 49, figs. 2–7, 1878.

Knowlton, U. S. Geol. Survey Bull. 204, p. 79, 1902 [not Blume].

The name *Sapindus angustifolius* was proposed by Lesquereux for the leaflets of *Sapindus* from Florissant, Colo. The species was subsequently recorded from the Fort Union formation of Montana and from the Mascall formation of Oregon. As conceived by Lesquereux it had wide limits, and at least two of its variants have been referred to new species by Cockerell.[30] The leaflets of *Sapindus* show a great variability and much convergence, and it may well be that fossil species have been unduly multiplied. Leaflets agreeing with Lesquereux's type material are sparingly represented in the Latah formation. *Phyllites crustacea* Knowlton,[31] from the Latah formation at Mica, may represent a leaflet of this species.

Occurrence: Brickyard at Spokane, Wash.

Sapindus armstrongi Berry, n. sp.

Plate 63, Figure 14

Leaflets relatively small, ovate, inequilateral. Tip acute. Base prolonged downward from the narrower side of the lamina about 2 millimeters below the base on the wider side of the lamina. Petiolule stout, curved, about 2 millimeters long. Margins entire, evenly rounded. Texture subcoriaceous. Length about 5.5 centimeters; maximum width about 2 centimeters. Midvein stout, prominent. Secondaries stout, about nine pairs, diverging from the midvein at wide angles and camptodrome in the marginal region. Tertiaries well marked, variably subpercurrent. Areolation of very fine subquadrangular meshes.

This apparently represents a new species, one that is uncommon in the present collections. It is named for L. K. Armstrong, president of the Northwest Science Association.

Occurrence: Brickyard at Spokane, Wash., collected by E. E. Alexander.

[30] Cockerell, T. D. A., The fossil flora of Florissant, Colo.: Am. Mus. Nat. Hist. Bull., vol. 24, p. 101, 1908.

[31] Knowlton, F. H., U. S. Geol. Survey Prof. Paper 140, p. 47, pl. 29, fig. 6, 1926.

Family CELASTRACEAE

Genus CELASTRUS Linné

Celastrus lacoei Lesquereux

Celastrus lacoei Lesquereux, Cretaceous and Tertiary floras, p. 184, 1883.

Knowlton, U. S. Nat. Mus. Proc., vol. 51, p. 281, pl. 24, fig. 6, 1916.

This species, which was described from Florissant, Colo., is represented by a single complete specimen in the recent collections from the Latah formation. The spatulate form, toothed margin, size, and venation are absolutely characteristic.

Occurrence: Brickyard at Spokane, Wash.

Celastrus spokanensis Berry, n. sp.

Plate 64, Figure 5

Leaves relatively small, obovate or broadly spatulate with a widely rounded tip and a decurrent base, about 3.5 centimeters long and 2 centimeters in maximum width. Leaf substance thin but apparently stiff. Margins with extremely fine, closely spaced serrate teeth. Petiole broad, with several parallel vascular strands. Midvein relatively broad but not especially prominent. Secondaries thin, numerous, diverging from the midvein at acute angles in a somewhat flabellate manner, ascending, sometimes forked and inosculating, not craspedodrome but sending branches to the marginal teeth. Tertiaries not made out.

In general appearance this leaf suggests, at first sight, the family Rosaceae, especially the crus-galli section of *Crataegus*. It is also not dissimilar from *Crataegus teutonica* described by Unger from the Miocene of Parschlug in Styria. The details of the venation, however, appear to me to be more like that characteristic of the family Celastraceae, as exemplified in the genus *Maytenus* or in numerous exotic existing species of *Celastrus* such as *trigynus*, *senegalensis*, *nutans*, and *nemorosus*.

There are species of *Celastrus* in the Miocene of the Mascall formation of Oregon, the Payette formation of Idaho, and two at Florissant, Colo., but these are all markedly distinct from the Latah species.

Occurrence: Spokane, Portland & Seattle Railway cut No. 1, Spokane, Wash., collected by C. O. Fernquist.

Genus EUONYMUS Linné

Euonymus knowltoni Berry, n. sp.

Plate 56, Figure 9

Leaves of medium size, ovate-lanceolate. Tip acuminate, not greatly produced. Base broadly cuneate. Texture subcoriaceous. Margin with fine, closely spaced, inconspicuous serrate teeth. Length about 11 centimeters; maximum width, near the middle of the leaf, about 3.5 centimeters. Petiole not preserved. Midvein stout and prominent. Secondaries thin, five or six irregularly spaced pairs; diverging from the midvein at angles of about 45°; more in the tip; sweeping upward in long ascending curves and arching along the margins. Tertiaries thin, typical of the Celastraceae, and exactly matched in the genus *Euonymus*.

This characteristic form is not common in the collections, but this is probably without significance. The genus makes its appearance in the basal Eocene but has heretofore been unknown in American post-Eocene deposits, although common in European deposits of later Tertiary age and present in the existing flora of North America, in which there are about five temperate species and five or six additional in Central America.

The existing species number about 65 and are widely distributed throughout the Northern Hemisphere but massed in the southeastern Asiatic region. Two survive as shrubs in the moister parts of the Pacific coastal region.

Occurrence: Brickyard at Spokane, Wash.

Family ACERACEAE

Genus ACER Linné

Acer oregonianum Knowlton

Plate 57, Figure 2; Plate 63, Figure 11

Acer oregonianum Knowlton, U. S. Geol. Survey Bull. 204, p 75, pl. 13, figs. 5–8, 1902.

In addition to leaves of maple there are seven fruits contained in the recent collections from the Latah formation representing four localities. These are all of a single species and are indistinguishable from *Acer oregonianum*, of the Mascall formation of Oregon, and quite unlike the other three nominal species of *Acer* fruits which Knowlton described from the Mascall.

Knowlton compared *Acer oregonianum* with the fruits of the existing *Acer macrophyllum* Pursh, which they much resemble. They are somewhat smaller than these and about equally like the existing *Acer circinatum* Pursh. Both these modern species are abundant stream-bank and rich-bottom species of British Columbia, Washington, Oregon, and California—regions of deep moist soil and abundant precipitation. Over 15 species of *Acer* have been described from the Miocene of the Pacific slope of North America, but there is a certain duplication in the unavoidable practice of giving different names to the leaves and fruits. The genus is common at Florissant, Colo., and in the California, Mascall, and Eagle Creek Miocene. It has recently been reported by Chaney from Trout Creek, Oregon, and 49 camp, Nevada.[31a]

[31a] In an account of the flora of the Crooked River Basin of Oregon published since this paper was written (Chaney, R. W., Carnegie Inst. Washington Pub. 346, p. 126, 1927), Chaney refers fruits identical with those from the John Day Basin described by Knowlton as *Acer oregonianum* to *Acer osmonti*, without, however, mentioning Knowlton's specimens. Although it is probable that the fruits and leaves described as *Acer osmonti* belong to the same species, such practices are to be deprecated in the absence of direct proof of relationship.

Occurrence: Republic, Wash.; Deep Creek Canyon, brickyard, and Spokane, Portland & Seattle Railway cut No. 1, Spokane, Wash.

Acer chaneyi Knowlton

Plate 63, Figure 13

Acer chaneyi Knowlton, U. S. Geol. Survey Prof. Paper 140, p. 45, pl. 27, fig. 2, 1926.

This species was described from the single specimen figured, which was fairly complete but lacked the terminal lobe. This deficiency I am able to supply from a recent specimen collected by E. E. Alexander.

The species is a handsome one with long, slender, much cut lobes and appears to be very similar to if not identical with *Acer osmonti* Knowlton,[31b] described from the beds at Bridge Creek, in the John Day Basin, and recently recorded by Chaney [31c] from the Crooked River Basin in Oregon.

Occurrence: Brickyard at Spokane, Wash.

Acer merriami Knowlton

Acer merriami Knowlton, U. S. Geol. Survey Bull. 204, p. 76, pl. 14, figs. 2, 3, 1902; U. S. Geol. Survey Prof. Paper 140, p. 45, pl. 28, fig. 1, 1926.

A fragmentary specimen and its counterpart are contained in the present collection from the locality south of Vera. Knowlton's Latah material came from a well at Mica.

Occurrence: Well at Mica, Wash.; south of Vera, Wash.

Acer bendirei Lesquereux

Acer bendirei Lesquereux, U. S. Nat. Mus. Proc., vol. 11, p. 14, pl. 5, 1888.

Knowlton, U. S. Geol. Survey Bull. 204, p. 73, 1902; U. S. Geol. Survey Prof. Paper 140, p. 45, pl. 27, fig. 3, 1926.

There are two specimens of this species in the recent collections. It occurs also in the Miocene of Oregon (Mascall formation) and California. Knowlton's Latah specimen was obtained from a well at Mica.

Occurrence: Well at Mica, Wash.; brickyard and Spokane, Portland & Seattle Railway cut No. 1, Spokane, Wash.

Acer minor Knowlton

Plate 64, Figure 2

Acer minor Knowlton, U. S. Geol. Survey Bull. 204, p. 76, pl. 14, figs. 2, 3, 1902; U. S. Geol. Survey Prof. Paper 140, p. 45, pl. 27, fig. 4, 1926.

This species was described originally by Knowlton from the Mascall formation of the John Day Basin, Oregon, and was one of three species of fruits founded largely on differences of size. A very imperfect specimen from the Latah formation at Deep Creek, northwest of Spokane, was referred to this species in 1926 by Knowlton, who remarks that maples seem to be rare in the Spokane area. Subsequent collections in this area show this not to have been the case, as both leaves and fruits are not at all uncommon. Presumably the present fruit represents one of the leaf species. One other type of maple fruit has been described from the Latah formation in the present work and identified as *Acer oregonianum* Knowlton. The latter is three to four times the size of *Acer minor*, with more spreading wings and has less oval seed cavities. I have no doubt that the two represent different species and not merely differences in size and form of a single species.

The present specimen was collected recently by C. O. Fernquist and shows the complete fruit but lacks the peduncle. The seed cavities are relatively wide, and the base of the wings is incurved so that the wing axes are parallel. The whole is but 11 millimeters long and 7 millimeters wide. It adds another common element to the floras of the Mascall and Latah formations.

Occurrence: Deep Creek Canyon and brickyard, Spokane, Wash.

Family ANACARDIACEAE

Genus RHUS Linné

Rhus merrilli Chaney

Plate 51, Figure 8

Rhus merrilli Chaney, Carnegie Inst. Washington Pub. 346, p. 125, pl. 16, figs. 1, 2, 1927.

This new species, described since the major portion of this paper was written, is represented in the Latah flora by several specimens which I had supposed were variants of *Quercus simulata* Knowlton. The type came from the Bridge Creek formation of the Crooked River basin in eastern Oregon, and is said to bear a close resemblance to *Rhus sylvestris* Siebold and Zuccarini of central and southern China and Chosen; it is thus another link in the community of relationship between the present Chinese flora and the Miocene flora of western North America.

Occurrence: Brickyard at Spokane, Wash.

Family HIPPOCASTANACEAE

Genus AESCULUS Linné

Aesculus hesperia Berry, n. sp.

Plate 56, Figure 8

Leaflets large, obovate in general outline. Apex abruptly pointed. Base narrowly cuneate. Margins throughout with closely spaced serrate teeth, which become more prominent and aquiline or couchant-serrate distad. Length 18 centimeters; maximum width 8 centimeters. Midvein stout, prominent on the under side of the leaflet, slightly flexuous. Secondaries

[31b] Knowlton, F. H., U. S. Geol. Survey Bull. 204, p. 72, pl. 13, fig. 3, 1902.
[31c] Chaney, R. W., op. cit., p. 126, pl. 17, fig. 6; pl. 18, figs. 1, 3, 5, 1927.

stout, prominent; about ten opposite to alternate, irregularly spaced pairs; the lower four or five pairs diverged from the midvein at angles of 45° or less, are straight or flexuous ascending, eventually camptodrome but sending off on the outside numerous regular tertiaries, the distal craspedodrome, the proximal camptodrome and sending off regular craspedodrome veinlets to the marginal teeth; the distal secondaries diverge at wider angles, 45° or more, are more curved than the proximal ones, and likewise send branches of the second or third order to the marginal teeth. The internal tertiaries are prominent, regularly spaced, generally simple percurrent but occasionally forked.

This striking species is unfortunately represented only by the single specimen figured. It has the characters of this genus well marked and is quite unlike the other American Miocene species, which comprise a smaller form from the Mascall formation of Oregon and an undescribed species from the auriferous gravel of California.

Aesculus has about a dozen existing species and is represented in the warmer temperate parts of all the holarctic continents. Among these a single form, usually a small tree, survives on the Pacific slope, where it has become restricted to the wetter valleys and stream borders in California.

Occurrence: Spokane, Portland & Seattle Railway cut, Spokane, Wash.

Order RHAMNALES

Family RHAMNACEAE

Genus PALIURUS Jussieu

Paliurus hesperius Berry

Plate 57, Figure 1

Paliurus hesperius Berry, Am. Jour. Sci., 5th ser., vol. 16, p. 40, figs. 1–3, 1928.

Leaves of medium size, broadly ovate, widest below the middle; the apex pointed but not extended; base broadly rounded or slightly cordate. Texture subcoriaceous. Margins with closely spaced, prevailingly small, crenate teeth. Length about 7 centimeters; maximum width about 4.5 centimeters. Petiole not preserved. Midvein stout, prominent. Lateral primaries diverge from the base at acute angles; these are as stout as the midvein and curve upward and barely escape being acrodrome by uniting with short secondaries from the distal part of the midvein. The lateral primaries give off on the outside several camptodrome secondaries. The areolation is a fine mesh indistinctly preserved.

Leaves of this type have been referred to *Zizyphus*, *Grewiopsis*, and *Populus*, but their features are more distinctly those of *Paliurus*.

The genus is represented in existing floras by only two or three species of southern Europe and Asia and is no longer a native of the Western Hemisphere. About 30 fossil species have been described, based for the most part upon leaves. The oldest of these occur in the North American Upper Cretaceous. The fruits are perfectly characteristic, and the oldest known instance of their occurrence is *Paliurus mississippiensis* Berry,[32] of the lower Eocene in southwestern North America. Lesquereux [33] identified a leaf of somewhat dubious characteristics as a species of *Paliurus* from the Miocene of Florissant, Colo.

My reasons for referring the present form to *Paliurus* rather than to *Rhamnus* or *Ceanothus* is its perfect agreement with the existing Asiatic *Paliurus orientalis* and the presence of characteristic *Paliurus* fruits in beds of approximately the same age as the Latah formation at Grand Coulee, Douglas County, Wash.

Occurrence: Spokane, Wash.

Genus RHAMNUS Linné

Rhamnus spokanensis Berry, n. sp.

Plate 57, Figures 4, 5

Robinia? sp., Knowlton, U. S. Geol. Survey Prof. Paper 140, p. 44, pl. 28, figs. 7, 7a, 1926.

Additional material enables me to assign the correct botanic position to the small leaf which Knowlton tentatively referred to the genus *Robinia*. This was not a leaflet of a pinnate leaf but a complete leaf, the venation of which is entirely unlike that of *Robinia* and, on the other hand, characteristic of the genus *Rhamnus*. It may be described as follows:

Leaves of variable but small size, inequilaterally elliptical, with a rounded or subcordate decurrent base and a slightly narrowed rounded or bluntly pointed apex. Margins entire, sometimes slightly undulate. Texture subcoriaceous. Length ranging from 1.5 to 3.75 centimeters; maximum width, in median region, from 9 millimeters to 1.6 centimeters. Petiole stout, enlarging proximad, curved, about 5 millimeters long in the largest leaf seen. Midvein relatively very stout, somewhat flexuous curved proximad. Secondaries five or six pairs, relatively stout, at least two pairs diverging at acute angles from the top of the petiole, occasionally forking, eventually ascending subparallel with the lateral margins, along which they arch. The more distal secondaries are less straight than the basals, irregularly spaced, and ascending. The tertiaries are well marked, simple or inosculating, percurrent.

The genus *Rhamnus*, with about 60 existing species, is found in all temperate regions except Australia and

[32] Berry, E. W., The lower Eocene floras of southeastern North America: U. S. Geol. Survey Prof. Paper 91, p. 279, pl. 71, fig. 4, 1916.

[33] Lesquereux, Leo, The Cretaceous and Tertiary floras: U. S. Geol. Survey Terr. Rept., vol. 8, p. 188, pl. 38, fig. 12, 1883.

the islands of the Pacific. There are two species and as many varieties living on the Pacific slope, but these are quite different from the present fossil, which is also markedly distinct from previously described Miocene forms, of which there are four at Florissant and in Yellowstone Park.

The present species, except for its more rounded tip, is very much like the late Miocene *Rhamnus oeningensis* Heer, of Europe.

Occurrence: Spokane, Portland & Seattle Railway cut and brickyard at Spokane, Wash.

Order MALVALES

Family TILIACEAE

Genus TILIA Linné

Tilia hesperia Berry, n. sp.

Plate 57, Figure 3

Leaves large, broadly ovate and inequilateral, of thin texture, about 15 or 16 centimeters in length and 9 centimeters in maximum width below the middle. Apex acuminate. Base missing. Midvein stout and relatively straight. Secondaries stout, about six alternate pairs, diverging about 45°, curving upward, craspedodrome, giving off one or more craspedodrome branches on the outside toward their tips. The basal pair are not differentiated from their fellows except for the series of craspedodrome tertiaries which they give off on the outside. The inner tertiaries are regularly spaced subpercurrent, frequently inosculating veins of considerable caliber. The margin is regularly serrate, with relatively small teeth.

This leaf is about the size of the larger leaves of the existing Tilias of southeastern North America, from which it differs primarily in its somewhat less relative width and more produced tip. The only western Tertiary species known to me, *Tilia populifolia* Lesquereux, from Florissant, is similar except that the basal secondaries are differentiated as lateral primaries. A second Miocene species, *Tilia pedunculata* Chaney,[34] is based upon a fruit bract of a linden from the Eagle Creek formation of Oregon. As no foliage was discovered in the Eagle Creek formation, it is possible that this fruit bract may represent the botanic species of which *Tilia hesperia* is the foliage.

The genus *Tilia* is found at the present time widely distributed in the humid north temperate zone except in western America, central Asia, and the Himalayan region.

Occurrence: Spokane, Portland & Seattle Railway cut at Spokane, Wash.

[34] Chaney, R. W., The flora of the Eagle Creek formation: Walker Mus. Contr., vol. 2, No. 5, p. 179, pl. 19, figs. 3, 4, 1920.

Family MALVACEAE

Genus HIBISCUS? Linné

Hibiscus? occidentalis Berry, n. sp.

Plate 64, Figures 13–15

Carpels small, compressed, ovate, broadly rounded distad, asymmetrically contracted proximad. Embryo nearly straight. Carpel wall finely netted, veined, with scarious margin about 1 millimeter wide, radially veined. Length about 6 millimeters; maximum width about 3 millimeters.

These objects are not uncommon in the Latah formation and appear to be definitely referable to the Malvaceae and probably to the genus *Hibiscus*.

That genus, heretofore unknown in the fossil state, so far as I am aware, comprises nearly 200 recent species, widely distributed in warm and temperate regions.

Occurrence: Brickyard at Spokane, Wash., collected by C. O. Fernquist and E. E. Alexander.

Order PARIETALES

Family TERNSTROEMIACEAE

Genus TERNSTROEMITES Berry

Ternstroemites idahoensis (Knowlton) Berry

Plate 58, Figure 1

Myrica? idahoensis Knowlton, U. S. Geol. Survey Eighteenth Ann. Rept., pt. 3, p. 724, pl. 99, fig. 7, 1898; U. S. Geol. Survey Bull. 696, p. 395, 1919.

This species was described from the Payette formation of Idaho and doubtfully referred to the genus *Myrica* by Knowlton. If the type had shown the venation it would have been obvious that this form was not related to *Myrica*. Characteristic leaves are present in the Latah formation. These vary in length from 6 to 10 centimeters and in maximum width from 1.7 to 2.6 centimeters. The midvein becomes characteristically thickened and prominent in the lower half of the leaf. The marginal teeth show some variation in size and are obsolete below. The secondaries are largely immersed, about eight camptodrome pairs.

This leaf is clearly referable to the Ternstroemiaceae (Theaceae), which are so common in the early Tertiary of southeastern North America and in the existing floras of southern and eastern Asia and tropical America. It seems probable that the present fossil species represents either *Stuartia* Linné or *Gordonia* Linné, the only two surviving genera in temperate North America, both of which are represented in eastern North America and eastern Asia, but I prefer to refer it to the form genus *Ternstroemites*, although it is exceedingly like the leaves of *Gordonia*.

Occurrence: Brickyard at Spokane, Wash.

Order LAURALES

Family LAURACEAE

Genus LAURUS of authors

Laurus princeps Heer

Plate 58, Figure 5

Laurus princeps Heer, Flora tertiaria Helvetiae, Band 2, p. 77, pl. 89, figs. 16, 17; pl. 90, figs. 17, 20, 1856.
Lesquereux, Cretaceous and Tertiary floras, p. 250, pl. 58, fig. 2, 1883.
Knowlton, U. S. Geol. Survey Mon. 32, pt. 2, p. 725, pl. 95, fig. 3, 1899.
Laurus grandis Knowlton, U. S. Geol. Survey Prof. Paper 140, p. 41, pl. 23, figs. 1-3, 1926.

The type came from the European Miocene, and the propriety of considering a western American form as identical with it is highly questionable.

The species occurs in the auriferous gravel of California and probably in the Miocene of Yellowstone Park.

Occurrence: Bigelow Gulch, near Hillyard, Wash.; brickyard and Spokane, Portland & Seattle Railway cut, Spokane, Wash.; cut 1 mile west of Shelley Lake, 10 miles east of Spokane, Wash.

Laurus grandis Lesquereux

Plate 58, Figure 3

Laurus grandis Lesquereux, Cretaceous and Tertiary floras, p. 251, pl. 58, figs. 1, 3, 1883.
Knowlton, U. S. Geol. Survey Mon. 32, pt. 2, p. 725, pl. 93, fig. 3; pl. 95, fig. 1, 1899.

This species, which is recorded from California and Yellowstone Park, is represented by several specimens from the Latah formation, of which one of the more complete is figured.

Occurrence: Brickyard and Spokane, Portland & Seattle Railway cut, Spokane, Wash.

Laurus similis Knowlton

Plate 58, Figure 2

Laurus similis Knowlton, U. S. Geol. Survey Twentieth Ann. Rept., pt. 3, p. 48, pl. 5, figs. 1–4, 1900.
Chaney, Walker Mus. Contr., vol. 2, No. 5, p. 173, 1920.
Knowlton, U. S. Geol. Survey Prof. Paper 140, p. 41, pl. 23, figs. 4–6; pl. 24, fig. 2, 1926.

As may be gathered from the previously figured material, this species, as conceived by its describer, exhibits considerable variability. It was originally described from the west side of the Cascade Range in Oregon and subsequently recorded by Chaney from the Eagle Creek formation. It proves to be abundant in the Latah formation, Knowlton having recorded it from several localities, and several additional are represented in the recent collections. One medium-sized specimen shows the complete petiole, which is stout, expanding proximad to the stout base, and 3.5 centimeters long.

Occurrence: Deep Creek, Bigelow Gulch near Hillyard, Vera, Chicago, Milwaukee & St. Paul Railway cut, brickyard, and Spokane, Portland & Seattle Railway cut, all near Spokane, Wash.

Genus SASSAFRAS Nees

Sassafras hesperia Berry, n. sp.

Plate 59, Figure 2

This species is based upon the single leaf figured, which can not be expected to portray the foliage accurately. However, the leaf variations of the recent and fossil species have been so exhaustively studied that it is not difficult to surmise the limits of variation in the leaves of this Miocene species. The type may be described as follows:

Leaf of medium size and texture, oval in general outline, divided by a relatively narrow but rounded sinus, which extends about one-third of the distance to the base, into a broad, round-margined, bluntly pointed terminal lobe and a more pointed, subconical, lateral lobe. The base is broadly cuneate. The margins are entire but slightly undulate, and there is a slight emargination midway up on the right, where the leaf is deformed by lateral pressure after its inclusion in the clay. Length about 9 centimeters; maximum width about 5.25 centimeters. The petiole is stout but broken away just below the base of the leaf. The midvein is stout. Lateral primaries, nearly as stout as the midrib, diverge from the midvein at acute angles; the left-hand one runs to the tip of the lateral lobe; the right-hand one becomes thinner distad, where it is deformed and its ultimate course obscured, although it probably inosculates with a branch from the basal secondary on the right side. The secondaries diverge at angles of 45° or slightly more; those from the midvein comprise three pairs, which ascend in sweeping curves except for the lowermost on the left, which is straighter and continuously stouter and which runs directly to the sinus, where it joins the vein forming the marginal hem of the sinus. The secondaries from the lateral primaries form full curves except in the tip of the lateral lobe, where their initial course is straighter and they are more abruptly camptodrome. The tertiaries are well marked and are typical of the genus. In the base of the leaf a well-developed vein on each side ascends parallel and close to the margin to join a branch from the basal secondary on each side, giving an inverted triangle effect, which is characteristic of *Sassafras*.

As I have mentioned, the bilobate, mitten-like leaf of the type can hardly be considered to be characteristic of *Sassafras hesperia*, which must have had also entire and trilobate leaves as in our existing American species of *Sassafras*. It adds a striking element to the Latah flora and one that is unique in the Tertiary floras of North America, illustrating the danger of relying on negative evidence.

A second leaf of what is presumably this same species has been collected by C. O. Fernquist since the foregoing description was written and verifies the prediction there made. This second specimen is smaller and is symmetrically trilobate with three primaries. The lobes are broader, less elongate, and more abruptly conical than in the specimen figured.

Sassafras appears in the geologic record toward the end of the Lower Cretaceous in both western Europe (Albian) and eastern North America (Patapsco formation). It is exceedingly common in the Upper Cretaceous of North America, Europe, and the Arctic. The Eocene has several species in Greenland and Europe but only a single one in North America, and this in British Columbia, *Sassafras selwyni* Dawson.[35] *Sassafras hesperia* is sufficiently like *S. selwyni* to be considered its Miocene survivor in the West. The later Tertiary records are all from Europe, where the genus survived well into Pleistocene time. Among the abundant later Tertiary floras of North America not a trace of *Sassafras* has been discovered, although it must have been a member of our eastern mesophytic and Pacific humid floras during all of that long time. Our existing American species, long considered the sole survivor of the genus, ranges from Massachusetts to Iowa and Kansas and from Ontario and Michigan to Florida and Texas. *Sassafras* is one of the few genera of the large and prevailingly tropical family Lauraceae that are confined to the temperate zone. Recently two living species have been discovered in China, adding another example to the many previously known of closely related plants occurring in southeastern North America, western North America, and eastern Asia and no longer native in Europe, although present there in late Tertiary and even in Pleistocene time.[35a]

Occurrence: Brickyard at Spokane, Wash.

Genus UMBELLULARIA Nuttall

Umbellularia dayana (Knowlton) Berry

Plate 58, Figure 4

Salix dayana Knowlton, U. S. Geol. Survey Bull. 204, p. 31, pl. 2, figs. 9, 10, 1902; U. S. Geol. Survey Prof. Paper 140, p. 32, pl. 12, figs, 1, 2, 1926.

This species, described as a willow from the Mascall formation of Oregon, was recorded by Knowlton from the Latah formation at the Edwards ranch, Stanley Hill, Coeur d'Alene, Idaho. The venation is not that of *Salix* but is typically lauraceous, and I have therefore transferred it to the genus *Umbellularia*.

This genus, represented in the living flora by a single species which is associated with the redwood and which ranges from the Rogue River Valley in Oregon southward through the Coast Ranges and along the western slopes of the Sierra Nevada to the San Bernardino Mountains, is represented in the upper part of the Clarno formation of the John Day Basin in Oregon by *Umbellularia oregonensis* (Knowlton and Cockerell) Chaney.

Occurrence: Stanley Hill, Coeur d'Alene, Idaho; brickyard at Spokane, Wash.

Umbellularia lanceolata Berry, n. sp.

Plate 59, Figure 1

Leaves mostly small, lanceolate; widest medially and usually slightly more tapering distad than proximad, although occasionally the reverse is true. Margins entire, sometimes faintly undulate. Texture coriaceous. Length 6.5 to 8.5 centimeters; maximum width 1.5 to 1.85 centimeters. Tip acuminate. Base narrowly cuneate. Petiole stout, its length unknown. Midvein stout, prominent. Secondaries four to six stout, subopposite to alternate pairs, hence widely but fairly regularly spaced, curved, ascending, ultimately camptodrome. Areolation finely meshed, lauraceous.

This characteristic form differs from the associated *Umbellularia dayana* in its generally smaller size, lanceolate outline, narrower base, and much more ascending secondaries.

Occurrence: Deep Creek Canyon and brickyard at Spokane, Wash.

Order UMBELLALES

Family ARALIACEAE

Genus ARALIA of authors

Aralia whitneyi Lesquereux

Aralia whitneyi Lesquereux, Harvard Coll. Mus. Comp. Zoology Mem., vol. 6, No. 2, p. 20, pl. 5, fig. 1, 1878.
Knowlton, U. S. Geol. Survey Mon. 32, pt. 2, p. 748, pl. 99, fig. 3, 1899.
Chaney, Am. Jour. Sci., 5th ser., vol. 2, p. 90, 1921.

This characteristic species is represented by a specimen and its counterpart from Republic. It occurs in the Miocene of California and Yellowstone Park and doubtfully in the Mascall formation of Oregon. It has recently been recorded from the Puente formation of California.

Occurrence: Republic, Wash.

Family CORNACEAE

Genus CORNUS Linné

Cornus acuminata Berry, n. sp.

Plate 59, Figure 3

Leaves ovate-lanceolate, widest below the middle, with an extended acuminate tip, of somewhat delicate texture. Margins entire. Base missing, presumably cuneate. Midvein slender, curved. Sec-

[35] Berry, E. W., Tertiary floras of British Columbia: Canada Geol. Survey Bull. 42, p. 114, pl. 14, figs. 1–4, 1926.

[35a] Since this report was written R. W. Chaney (op. cit., p. 58) has recorded the presence of a *Sassafras* leaf in the Clarno formation of the Crooked River Basin in Oregon.

ondaries two opposite, subacrodrome pairs, originating in the basal third of the leaf.

This species is based upon the single incomplete specimen figured, and its botanic relationship is somewhat questionable. It is referred to *Cornus* because of its resemblance to the leaves of the existing *Cornus canadensis* Linné, from which its sole difference is the produced tip of the fossil leaf.

Cornus canadensis is a widely ranging herbaceous form of low woods found from Newfoundland to Alaska and southward to Colorado and California. The genus *Cornus* contains about 25 existing species in the North Temperate Zone and in South America. The fossil species are numerous and extend back to Upper Cretaceous time. There are three other Miocene species on the Pacific slope—one in Yellowstone Park and two in California.

Occurrence: Republic, Wash.

Genus NYSSA Linné

Nyssa knowltoni Berry, n. sp.

Plate 59, Figure 7

Leaves elliptical, bluntly pointed at the apex, rounded at the base, of thin texture. Margins entire except for a few scattered blunt points distad. Length about 10 centimeters; maximum width, near the middle of the leaf, 6.5 centimeters. Petiole not preserved. Midvein stout, prominent, curved. Secondaries stout, ten or eleven pairs, irregularly spaced and more crowded toward the base; they diverge from the midvein at wide angles and are camptodrome. Tertiaries mostly percurrent, thin. The single specimen is somewhat inequilateral.

This may represent the foliage of the same botanic species which furnished the *Nyssa* fruits in the Latah formation.

Occurrence: Brickyard at Spokane, Wash.

Nyssa magnifica (Knowlton) Berry

Carpites magnifica Knowlton, U. S. Geol. Survey Prof. Paper 140, p. 50, pl. 29, fig. 10, 1926.

Additional material from a new locality is contained in the recent collections. The ribs are more clearly defined than in the type and are six in number on the impression and hence must have been more numerous around the whole periphery. In life the cross section must have been round or but slightly compressed. This is clearly indicated by the present material. I see no reason for doubting that this represents a stone of a large-fruited *Nyssa*. I have handled a great many of these from the early Tertiary and Pleistocene, and the Latah species resembles some of the former very closely.

The genus is an old one, present in the early Tertiary of the western United States but not certainly known from the Miocene except in the eastern part of the continent. The existing species of *Nyssa* are all arborescent and are confined to southeastern Asia and southeastern North America, although they are not uncommon in the European Tertiary. The genus is apparently represented by a single leaf in the present collections. A somewhat dubious leaf form from the Eagle Creek formation of Oregon is referred to *Nyssa* by Chaney.[36]

Occurrence: Spokane, Portland & Seattle Railway cut and brickyard, Spokane, Wash.

Family UMBELLIFERAE

Genus UMBELLIFEROSPERMUM Berry, n. gen.

Umbelliferospermum latahense Berry, n. sp.

Plate 64, Figures 10–12

The type and only species of this new genus is based upon four specimens, well shown in the accompanying figures. Fruit relatively large, dry, flattened, about 1 centimeter long and from 0.75 to 1 centimeter in maximum width; the carpellary part 10 millimeters long by 5 to 7 millimeters in maximum width; bordered by wings which are about 1 millimeter wide at the base and increase in width upward and extend beyond the top of the carpels as auriculate lobes. Carpel with one or two longitudinal ribs on the face, emarginate at the base, crowned with two styles about 4 millimeters long, their bases surrounded by a rosette of processes about half the length of the styles, presumably representing calyx teeth or stylopodium processes.

I have not been able to match these fruits exactly among the recent genera in this extensive family and have therefore coined for them the form genus *Umbelliferospermum*. Among similar recent Umbelliferae the fossils appear to most resemble the genus *Rhodosciadum* S. Watson or *Deania* Coulter and Rose, which comprises five or six existing Mexican species.

Occurrence: Brickyard at Spokane, Wash., collected by E. E. Alexander and C. O. Fernquist.

Series GAMOPETALAE

Order ERICALES

Family ERICACEAE

Genus ARCTOSTAPHYLOS Adanson

Arctostaphylos knowltoni Berry, n. sp.

Plate 59, Figure 4

Leaves sessile, obovate, subcoriaceous, entire margined. Length about 4 centimeters; maximum width 12 or 13 millimeters. Midvein stout, prominent. Secondaries largely immersed, diverging from midvein at varying acute angles, ascending, camptodrome. Tertiaries largely immersed.

These leaves appear to be clearly allied to those of the modern species of this genus, which number about a score, some holarctic in their distribution. The genus is especially abundant in western North America.

Occurrence: Brickyard at Spokane, Wash.

[36] Chaney, R. W., The flora of the Eagle Creek formation: Walker Mus. Contr., vol. 2, No. 5, p. 180, pl. 20, figs. 1–3, 1920.

Arctostaphylos spatulata Berry, n. sp.

Plate 64, Figure 6

Leaves small, narrow and elongated, spatulate, mucronate tipped, widest above the middle, the entire margins gradually and straightly narrowed to the narrowly cuneate and practically sessile base. Texture coriaceous. Length about 2.6 centimeters; maximum width 6 millimeters. Midvein stout and prominent, thickening proximad. Secondaries thin, about five ascending camptodrome pairs.

This is quite distinct from the associated *Arctostaphylos knowltoni* and apparently represents a second and hitherto undescribed late Tertiary species.

Occurrence: Brickyard at Spokane, Wash., collected by C. O. Fernquist.

Genus MENZIESIA J. E. Smith

Menziesia knowltoni Berry, n. sp.

Plate 63, Figure 12

Leaves small, slightly obovate, widest medially and the base slightly more narrowed than the tip. Thin in texture and with entire margins. Length 3 to 3.5 centimeters; maximum width 1.2 to 1.6 centimeters. Petiole stout and short, about 2 millimeters in length. Midvein stout and prominent. Secondaries thin, regularly spaced, five or six camptodrome pairs.

These leaves present the features of the genus *Menziesia*, which has not, so far as I know, been found fossil heretofore. The existing species number seven or eight, one in the eastern mesophytic region of North America, three in western North America, and the rest in eastern Asia. The present fossil species is much like *Menziesia glabella* Gray, a shrub found from Lake Superior to Oregon and British Columbia.

Occurrence: Brickyard at Spokane, Wash.

Family VACCINIACEAE

Genus VACCINIUM Linné

Vaccinium americanum (Lesquereux) Berry

Vaccinium salicoides Knowlton, U. S. Geol. Survey Prof. Paper 140, p. 46, pl. 28, figs. 9, 9a, 1926.

Salix pseudoargentea Knowlton, U. S. Geol. Survey Bull. 204, pl. 2, figs. 2–4, 1902; in Smith, U. S. Geol. Survey Geol. Atlas, Folio 86 (Ellensburg, Wash.), p. 3, 1902.

Santalum americanum Lesquereux, U. S. Geol. Survey Terr. Rept., vol. 8 (Cretaceous and Tertiary floras), p. 164, pl. 32, fig. 7, 1883.

This species, described from the Mascall formation of Oregon and also recorded from the Ellensburg formation of Washington, is sparingly represented in the Latah formation and at Florissant, Colo. It is obviously not a *Salix*, its somewhat coriaceous texture and areolation stamping it as a member of the Vacciniaceae, and it appears identical with what Knowlton called *Vaccinium salicoides* from the Latah formation of the Coeur d'Alene district, Idaho.

The genus *Vaccinium*, with over 100 existing species, is widely distributed in temperate and cooler parts of the world, with nine species in the present flora of Washington.

Occurrence: Stanley Hill, Coeur d'Alene, Idaho; brickyard at Spokane, Wash.

Vaccinium bonseri Berry, n. sp.

Plate 59, Figure 5

Leaves small, sessile, spatulate, coriaceous, with entire margins. Length 1.1 to 1.4 centimeters; maximum width 5.5 to 7 millimeters. Apex rounded, apiculate. Base cuneate. Midvein stout and prominent, expanding sixfold near the base. Secondaries four or five stout, largely immersed pairs, camptodrome.

These characteristic little leaves are very similar to those of *Vaccinium uliginosum* Linné and *V. vitis-idaea* Linné and perhaps are most like *Vaccinium lucidum* of gardens.

Occurrence: Spokane, Portland & Seattle Railway cut No. 1 and brickyard at Spokane, Wash.

Vaccinium bonseri serrulatum Berry, n. var.

Plate 63, Figures 19, 20

Leaves sessile, small, elongate-elliptical, relatively coriaceous. Margins with tiny, remotely and irregularly spaced, serrate teeth. Apex bluntly pointed. Base entire, slightly decurrent to the greatly expanded base of the midvein. Length about 11 millimeters; maximum width, midway between the apex and the base, about 6 millimeters. Midvein stout and curved, its proximal fourth much expanded, and prominent on the under side of the leaf. Secondaries three or four pairs, stout, irregularly camptodrome. Tertiaries well marked, inosculating and becoming attenuated to form an oblique mesh which becomes finer in the base of the leaf.

At first sight this leaf suggests some of the smaller leaflets of various Rosaceae, as, for example, *Rosa nitida* Willdenow, but the venation is ericaceous and not rosaceous, the Rosaceae differing in areolation and being characterized by more numerous and more clearly defined secondaries. It is also similar to leaves from the European Tertiary which Heer and Saporta have referred to the genus *Myrsine*.

The genus *Vaccinium* seems to be clearly indicated by the size, texture, venation, and marginal characters, and as the size and form are so similar to the associated *Vaccinium bonseri* it is described as a variety of that species, from which its chief difference is the toothed margin. As in the living species of *Vaccinium* there are a considerable number in which the margins range from entire to serrulate, it is not only possible but probable that the present form and *Vaccinium bonseri* represent a single Miocene species. This can not be demonstrated, however, except by the rather unlikely

contingency of finding material which would show both forms on a single twig.

Similarities between the present fossil forms and the leaves of several existing species of *Vaccinium* might be pointed out. There is considerable resemblance to the existing holarctic *Vaccinium vitis-idaea* Linné and to *Vaccinium caespitosum* Michaux, which ranges from Labrador and Maine to Colorado and Alaska, and also to several of more temperate habitat—for example, *Vaccinium vacillans* Kalm—and others might be mentioned.

Occurrence: Brickyard at Spokane, Wash.

Vaccinium spokanense Berry, n. sp.

Plate 64, Figure 8

Leaf small, ovate, with a bluntly pointed tip and a broad sessile base. Margins entire. Length about 1.9 centimeters; maximum width, midway between the apex and the base, 8 millimeters. Midvein stout and prominent, expanding at the truncate base to the full width, which is 2.5 millimeters. Secondaries relatively stout, five or six ascending pairs, diverging from the midvein at acute angles, especially the lower three pairs, which diverge from the expanded proximal part of the midvein, camptodrome.

This characteristic small leaf is thus far represented by only the specimen figured.

Occurrence: Brickyard at Spokane, Wash., collected by C. O. Fernquist.

Order EBENALES

Family EBENACEAE

Genus DIOSPYROS Linné

Diospyros princetoniana Cockerell

Plate 59, Figure 6; Plate 60, Figures 1–3

Diospyros princetoniana Cockerell, Am. Mus. Nat. Hist. Bull., vol. 24, p. 105, pl. 10, fig. 36, 1908.

This species, as described by Cockerell, was based upon a meager amount of material. According to Knowlton,[37] the material which he studied in the Hambach collection from Florissant, as well as Cockerell's species, is not to be distinguished from the American material which Lesquereux and others have referred to the European *Diospyros brachysepala* Al. Braun. The status of *D. brachysepala* is most uncertain. The type material came from the late Miocene (Sarmatian) of Baden, but various workers have recorded the species from every conceivable Tertiary horizon in Europe, and American students have recorded it from a large number of early Tertiary localities in North America. Obviously as the name stands in the literature it represents a composite species. Despite the similarity in the leaves from North America and Europe it is highly improbable that a single botanic species ranged over two continents.

Leaves of this type are not uncommon in the Latah formation, and I have taken up Cockerell's name for them, despite their practical identity with the European late Miocene leaves. The Latah leaves in my opinion are clearly referable to *Diospyros*, the venation and general facies being uniform despite the considerable variability in size and outline. The species may be more fully described as follows:

Leaves broadly lanceolate, usually widest medially but occasionally above the middle. Generally about equally pointed at both ends but showing a tendency for the tip to be less acute than the base. The base is normally decurrent, but the tip is frequently apiculate. Texture subcoriaceous. Petiole stout, 5 to 10 millimeters in length. Midvein stout, prominent on the under side of the leaf, frequently curved. Secondaries thin, not prominent, ascending, camptodrome. Length 3.5 to 8 centimeters; maximum width 1.1 to 3 centimeters.

The specimens from the Latah formation may be compared with the Miocene forms figured by Heer.[38]

I am not prepared to say whether the forms from Oklahoma and Yellowstone Park which have been referred to *Diospyros brachysepala* represent *Diospyros princetoniana* or not.

Occurrence: Brickyard, Spokane, Wasn., where it is common and to which it is confined.

Order GENTIANALES

Family APOCYNACEAE

Genus APOCYNOPHYLLUM Unger

Apocynophyllum latahense Berry, n. sp.

Plate 60, Figures 4, 7

Leaves of variable size, oblong lanceolate, the top missing in all the specimens, presumably pointed, the base abruptly incurved and decurrent. Margins entire. Length (estimated) 10 to 15 centimeters; maximum width 2.25 to 4.25 centimeters. Petiole long and very stout, preserved for 2.5 centimeters in a small specimen. Midvein very stout. Secondaries relatively thin, numerous, diverging from the midvein at wide angles, camptodrome.

These leaves, all of which are unfortunately incomplete, have all the features of the Apocynaceae. Their exact generic affinity is uncertain.

Occurrence: Deep Creek Canyon, Spokane, Portland & Seattle Railway cut No. 4, and brickyard at Spokane, Wash.

Order POLEMONIALES

Family CONVOLVULACEAE

Genus PORANA Burmann

Porana microcalyx (Knowlton) Berry

Diospyros? microcalyx Knowlton, U. S. Geol. Survey Prof. Paper 140, p. 46, pl. 22, figs. 5, 6, 1926.

An additional complete specimen of this form from a new locality enables me to correct Knowlton's tentative reference of it to the genus *Diospyros*. It

[37] Knowlton, F. H., U. S. Nat. Mus. Proc., vol. 51, p. 285, 1916.

[38] Heer, Oswald, Flora tertiaria Helvetiae, pl. 102, figs. 1–14, 1859.

does not belong to that genus, nor is Knowlton's description fully complete. The persistent sepals are five in number divided to the base, and narrow to blunt pointed when completely worked out of the matrix. The venation is not longitudnal but reticulate, with several veins from the base, much as in *Porana oeningensis* Heer, which it greatly resembles. The capsule is preserved as a spheroidal cavity about 2 millimeters in diameter.

The genus *Porana*, which is confined to the Old World in the recent flora, is not uncommon in the later Tertiary of Europe. It has not been previously recognized in North America except at Florissant, Colo., where it is not uncommon and represented by three species, all of which differ from the one under consideration.

Occurrence: Spokane, Portland & Seattle Railway cut and brickyard at Spokane, Wash.

Order RUBIALES

Family CAPRIFOLIACEAE

Genus VIBURNUM Linné

Viburnum lantanafolium Berry, n. sp.

Plate 60, Figure 6

Leaves entire, ovate, subcoriaceous. Margins with regular, closely spaced dentate teeth. Length about 11 centimeters; maximum width about 7 centimeters. Midvein stout, prominent. Secondaries stout, seven or eight mostly alternate pairs; diverging from the midvein at angles of 45° or less, ascending, craspedodrome; the two or three basal pairs curve upward and then outward distad, giving off several craspedodrome tertiaries; these craspedodrome branches from the secondaries become progressively less numerous toward the tip of the leaf. Internal tertiaries well marked, closely spaced, mostly percurrent.

This striking species is unfortunately represented by only the single incomplete specimen figured, but the generic character of the venation is so typical that there can be no doubt of its affinity. It adds a new type to the flora of the Pacific slope Miocene.

The genus has about 100 existing species, mostly in eastern Asia and North America but represented in Europe, Africa, Australia, and South America. There are about 20 species in the United States, but none of the western ones are arborescent. The genus is an old one with many fossil species and is well represented in the Eocene of the Western States but is not certainly known from the Miocene, although doubtfully recorded from California and Saskatchewan.

The present fossil species is extremely like the leaves of *Viburnum lantana* Linné, of middle Europe, the type of the section *Lantana* of the subgenus *Euviburnum*. It is also similar to *Viburnum palaeolantana* Unger, of the Pliocene of Styria.

Occurrence: Spokane, Portland & Seattle Railway cut No. 4 at Spokane, Wash.

Viburnum fernquisti Berry, n. sp.

Plate 63, Figure 10

Stone compressed, oval and slightly unsymmetrical in outline, widest medially, rounded proximad and bluntly pointed distad, coriaceous, with two or three low rounded unequally developed longitudinal ridges on each surface. Length 6.5 millimeters: maximum width 3.5 millimeters.

A species based upon foliage is associated with these stones, and it is quite probable that stones and leaves represent the same botanical species, but this can not be demonstrated.

Occurrence: Brickyard at Spokane, Wash., collected by C. O. Fernquist.

POSITION UNCERTAIN

Carpolithus pteraformis Berry, n. sp.

Plate 60, Figure 5

Winged fruits or seeds of considerable size, irregularly elliptical. Base rounded, expanding on one side of the seed or the seed cavity about one-fourth of the distance above the base to about twice its basal width, arching to the rounded sligthly inequilateral tip—the margin straighter on the opposite side. Seed or seed cavity but slightly thicker than the wing, rounded distad, pointed proximad, situated in the narrowed base of the wing, about 1.25 centimeters long and 5 millimeters wide. Whole fruit 3 centimeters long and 1.1 centimeters in maximum width. Wing substance coriaceous, without venation, obliquely wrinkled, with a conspicuously beveled distal margin. This and other features suggest that it represents a winged seed of a capsular fruit and that these seeds were closely packed in the fruit.

Superficially these fossils suggest the seeds of the winged-seeded conifers and also the samaras of *Acer*. They are clearly not related to either of these and are readily discriminated from the seeds of *Pinus* and the samaras of *Acer* occurring in the Latah formation. They are thicker and lack the venation of both of these types. They may represent the genus *Gordonia*.

Occurrence: Vera, Deep Creek Canyon, and brickyard at Spokane, Wash.

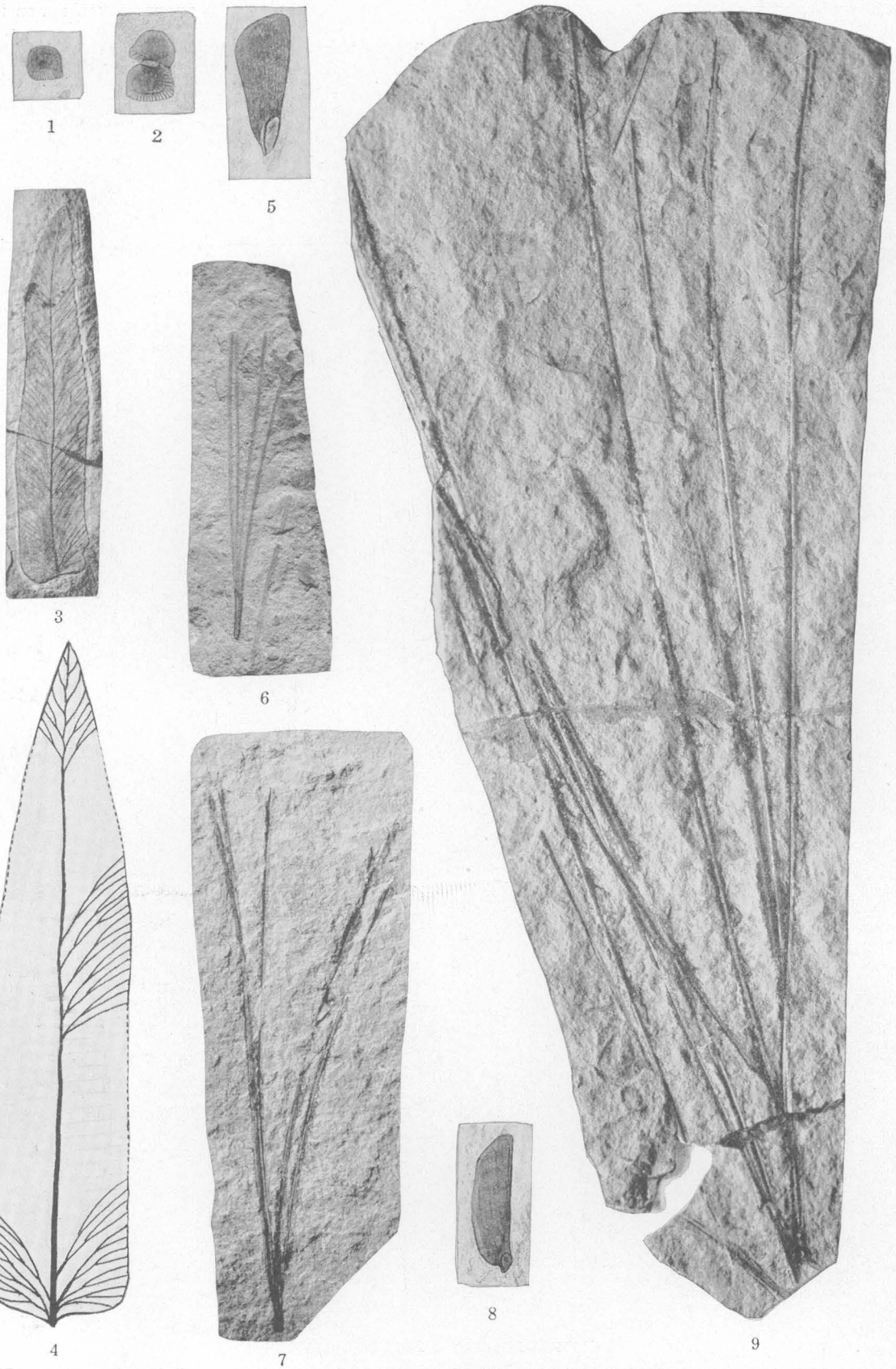
Carpites menthoides Knowlton

Carpites menthoides Knowlton, U. S. Geol. Survey Prof. Paper 140, p. 49, pl. 26, fig. 4, 1926.

Specimens ranging from 1 to 2 centimeters in diameter are contained in the recent collections. I regard their implied relationship with the Labiateae as entirely problematic.

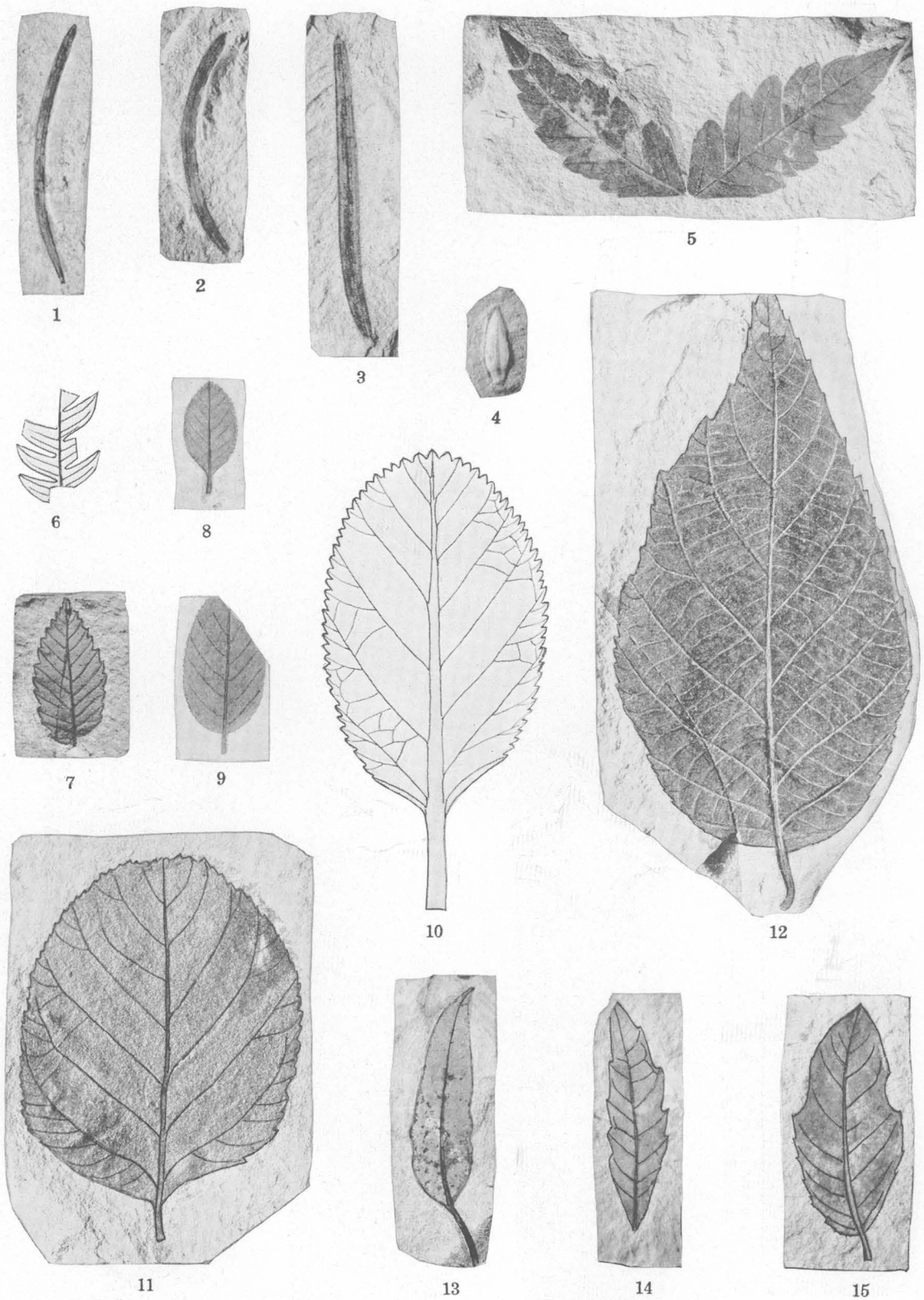
Occurrence: Deep Creek Canyon, Spokane, Portland & Seattle Railway cut No. 1, and brickyard at Spokane, Wash.

PLATES 49–64



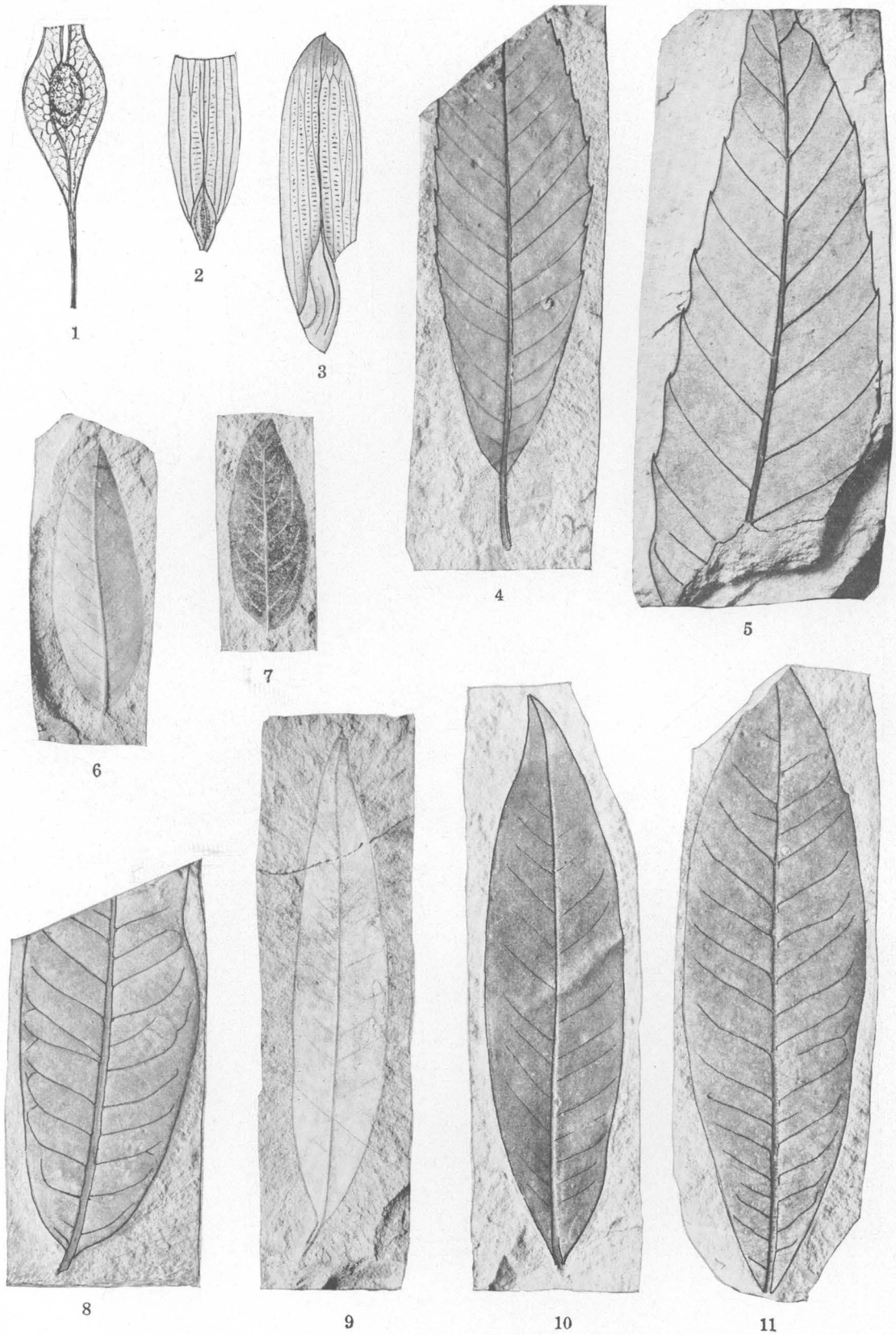
FOSSILS FROM THE LATAH FORMATION

1, 2. Fish scales, probably of *Leuciscus* (p. 226).
3, 4. *Asplenium occidentale* Berry, n. sp. (p. 236). Figure 4 shows the venation in the distal, medial, and proximal parts of a pinnule, × 2.
5, 8. *Pinus monticolensis* Berry, n. sp., winged seeds (p. 238).
6. *Pinus tetrafolia* Berry, n. sp. (p. 238).
7. *Pinus latahensis* Berry, n. sp. (p. 238).
9. *Pinus macrophylla* Berry, n. sp. (p. 238).



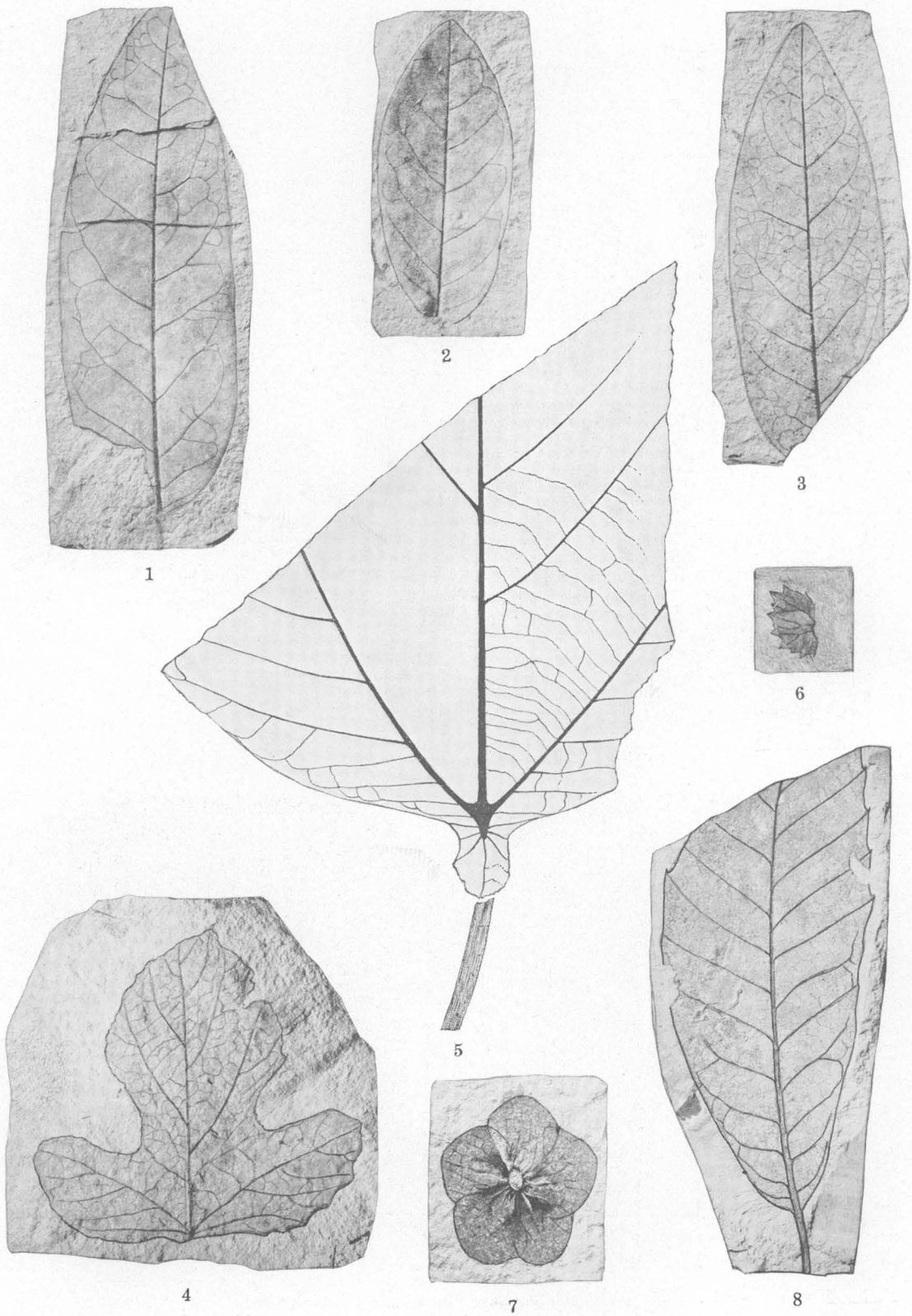
FOSSILS FROM THE LATAH FORMATION

1–3. *Potamogeton heterophylloides* Berry, n. sp., showing variation among the submerged leaves (p. 240).
4. *Populus*, bud scale (p. 243).
5. *Comptonia insignis* (Lesquereux) Cockerell (p. 241).
6. *Comptonia hesperia* Berry, n. sp., fragment of a leaf (p. 241).
7. *Fagopsis longifolia* (Lesquereux) Hollick, a small leaf (p. 245).
8–10. *Alnus elliptica* Berry, n. sp. (p. 244). Figure 10 shows Figure 8 × 4 to show details of marginal teeth and venation.
11. *Alnus prerhombifolia* Berry, n. sp. (p. 244).
12. *Betula largei* Knowlton (p. 244).
13–15. Unnamed anomalous or juvenile leaves of *Quercus*.



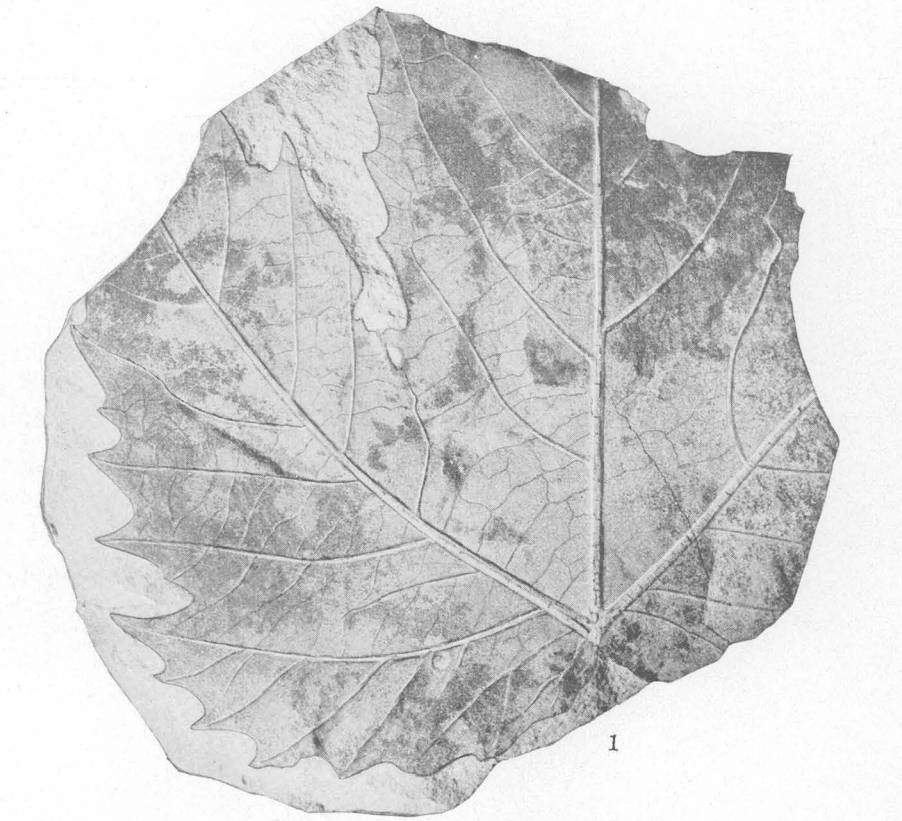
FOSSILS FROM THE LATAH FORMATION

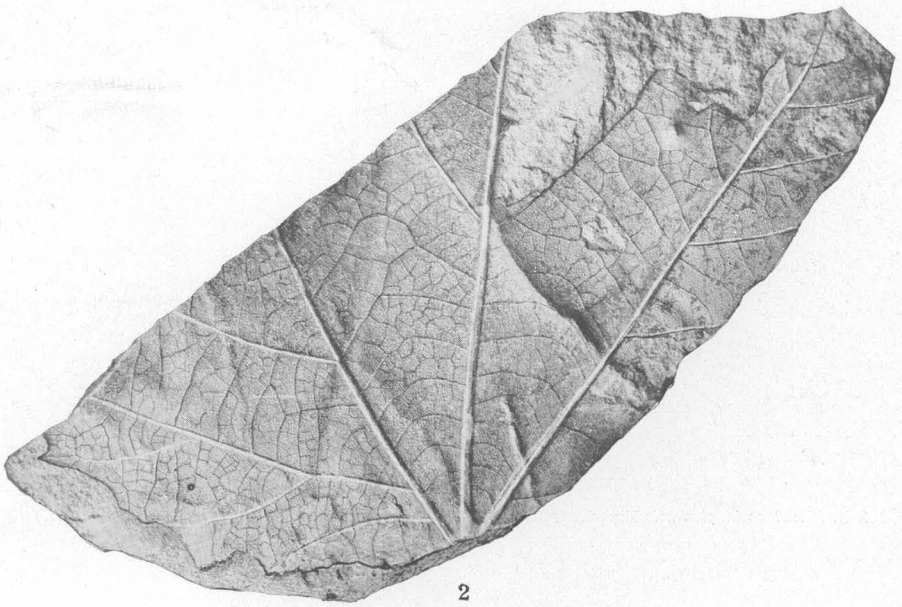
1. *Ulmus*, characteristic winged fruit, × 2 (p. 247).
2, 3. *Liriodendron hesperia* Berry, n. sp., winged fruits, × 2 (p. 249).
4, 5. *Castanea orientalis* Chaney (p. 245).
6, 7, 9–11. *Quercus simulata* Knowlton, illustrating variation in size and appearance of the leaves of this species (p. 246).
8. *Rhus merrilli* Chaney (p. 256).



FOSSILS FROM THE LATAH FORMATION

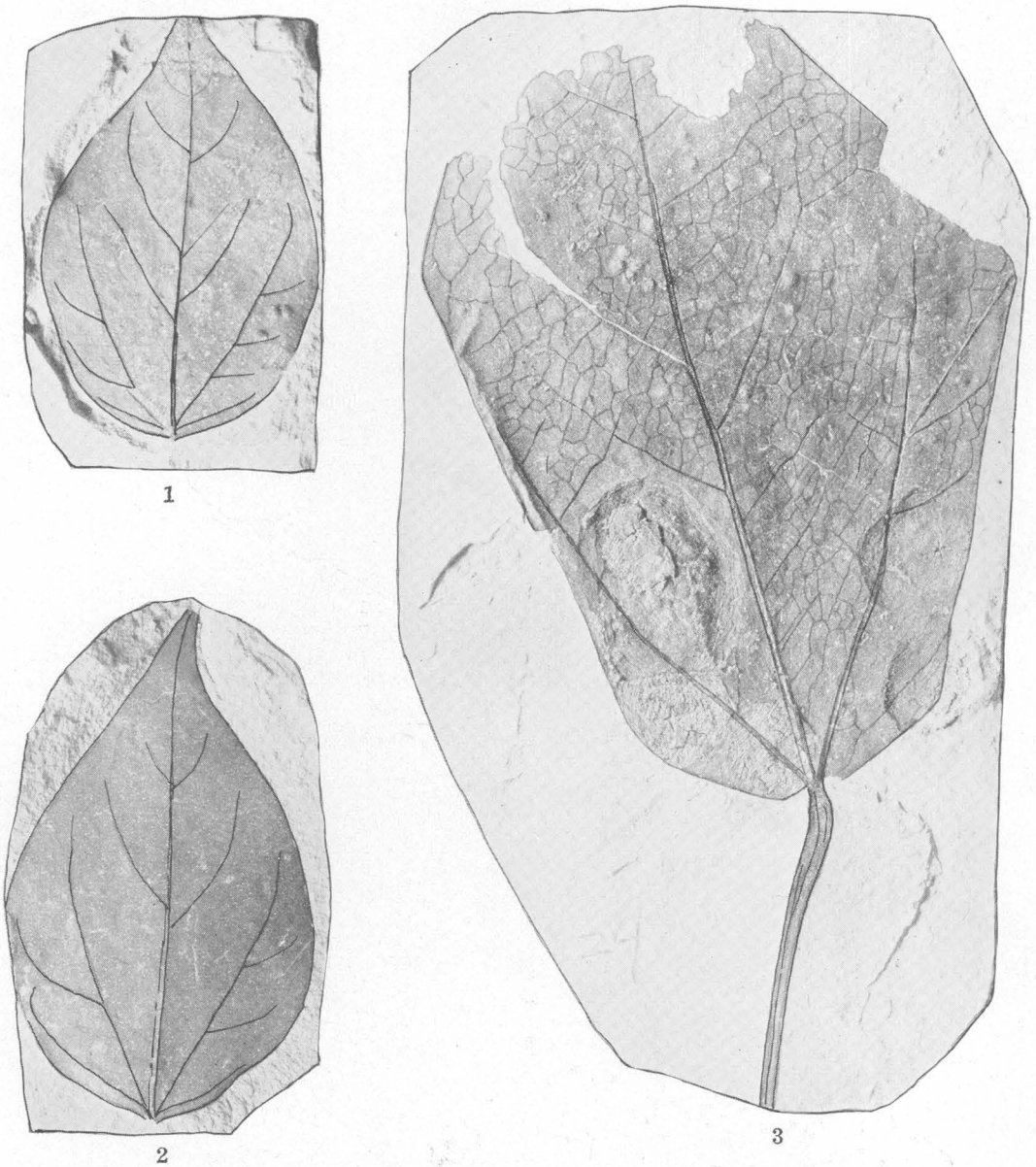
1–3. *Quercus treleasii* Berry, n. sp. (p. 247).
4. *Menispermites latahensis* Berry, n. sp. (p. 249).
5. *Platanus appendiculata* Lesquereux? (p. 249).
6. *Salix*, stipule (p. 242).
7. *Hydrangea bendirei* (Ward) Knowlton, sterile flower with five sepals (p. 251).
8. *Quercus*, unnamed leaf.





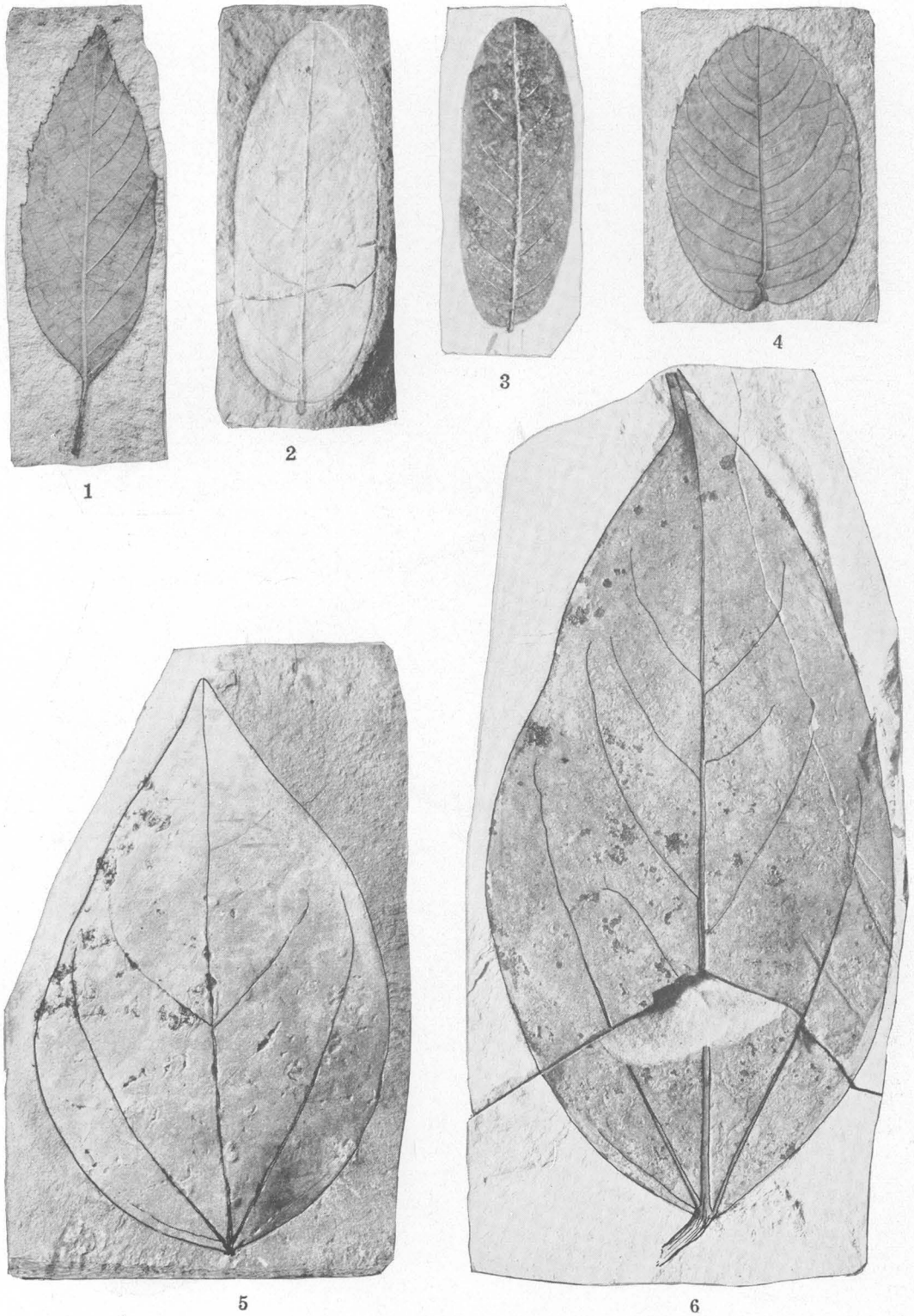
FOSSILS FROM THE LATAH FORMATION

1, 2. *Platanus dissecta* Lesquereux (p. 248). The fragment shown in Figure 2 gives the details of venation



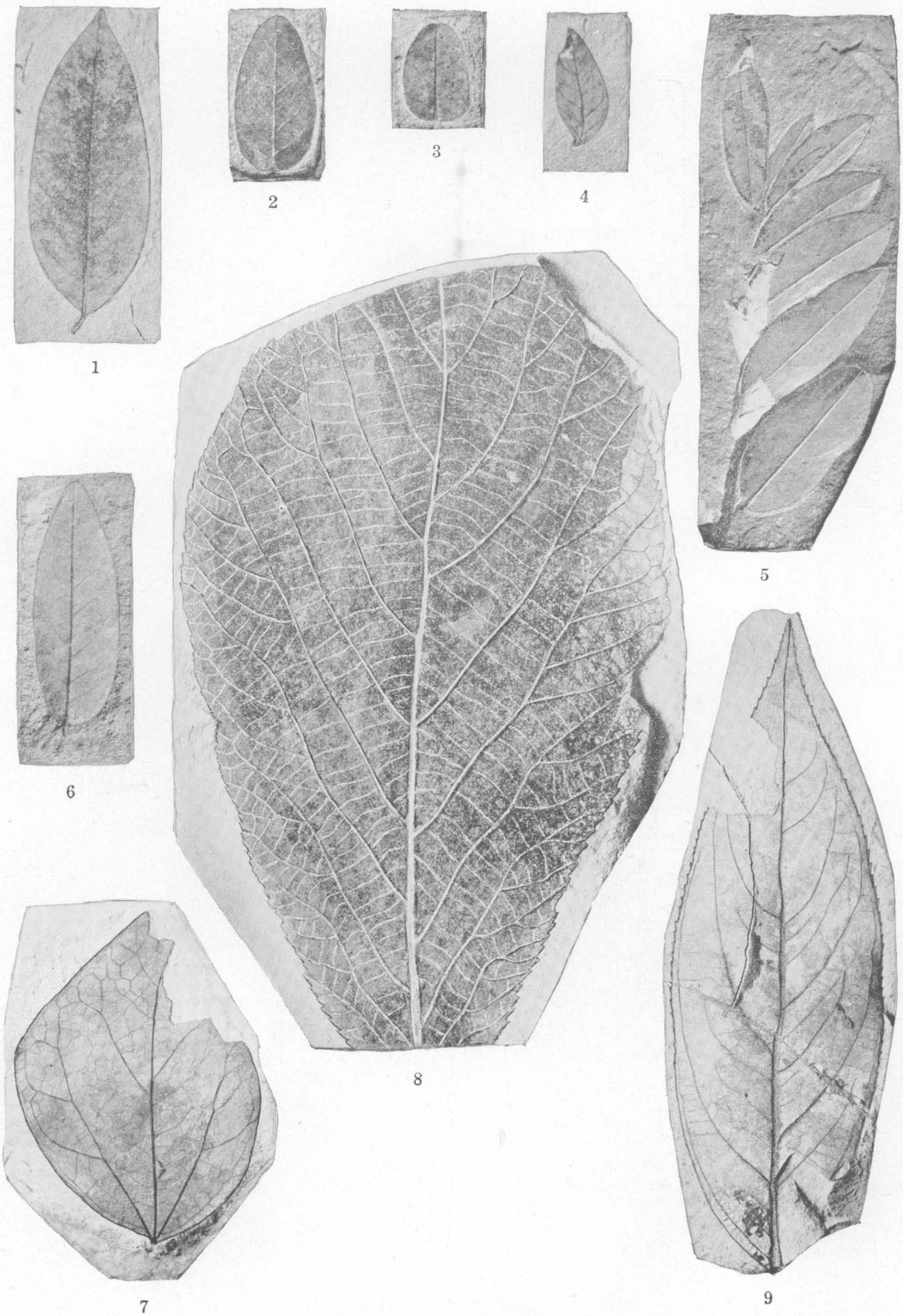
FOSSILS FROM THE LATAH FORMATION

1–3. *Ficus? washingtonensis* Knowlton, illustrating the variations of size and form in this species (p. 248)



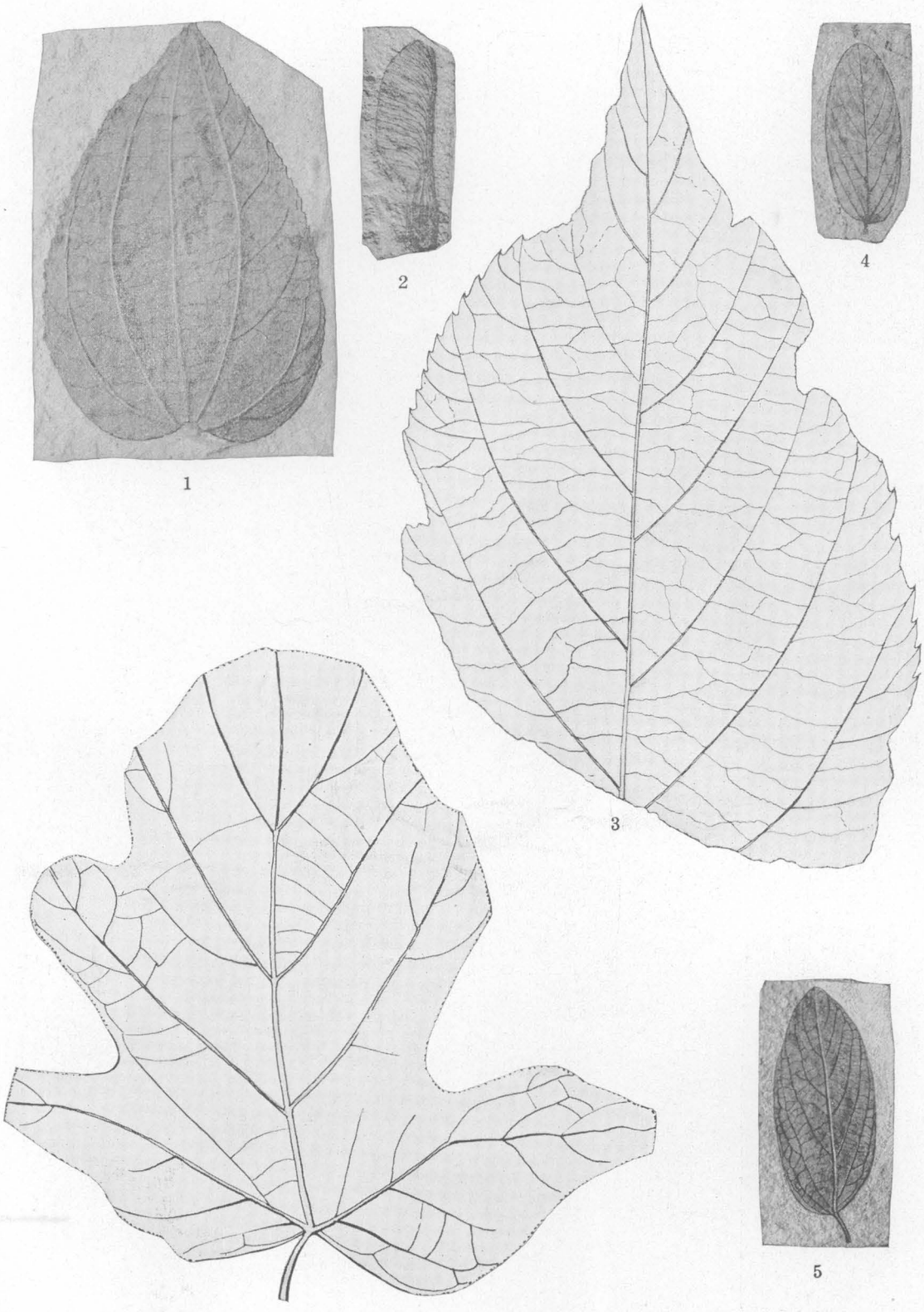
FOSSILS FROM THE LATAH FORMATION

1. *Prunus rustii* Knowlton (p. 252).
2, 3. *Cassia idahoensis* Knowlton (p. 252)
4. *Amelanchier scudderi* Cockerell (p. 252).
5, 6. *Ficus? washingtonensis* Knowlton (p. 248).



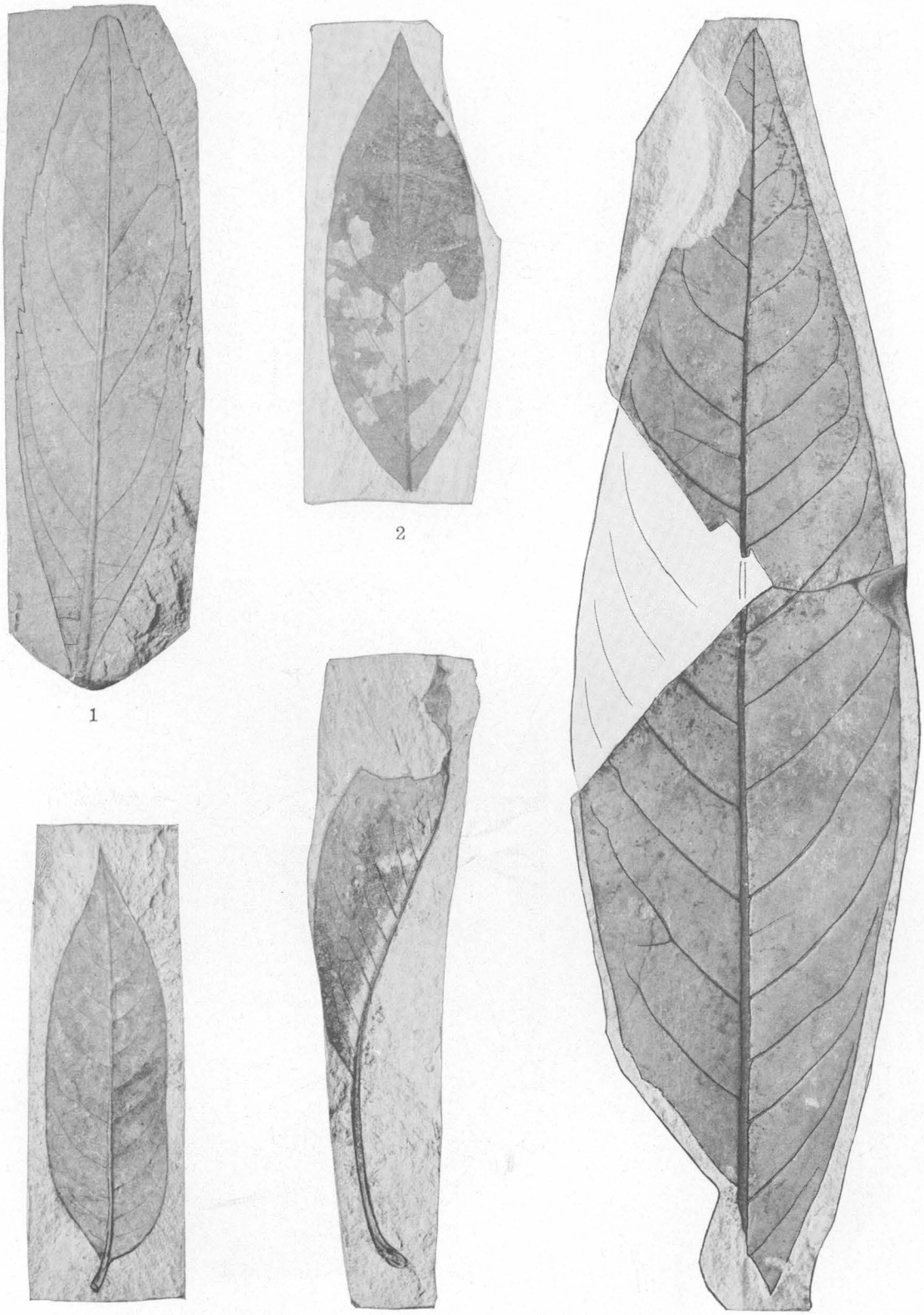
FOSSILS FROM THE LATAH FORMATION

1. *Cassia sophoroides* (Knowlton) Berry (p. 253).
2, 3. *Sophora alexanderi* Knowlton (p. 253).
4. *Leguminosites bonseri* Berry, n. sp. (p. 254).
5, 6. *Sophora spokanensis* Knowlton (p. 253). Much of the pinnate leaf is shown in Figure 5.
7. *Meibomites knowltoni* Berry, n. sp. (p. 253).
8. *Aesculus hesperia* Berry, n. sp. (p. 256).
9. *Euonymus knowltoni* Berry, n. sp. (p. 255).



FOSSILS FROM THE LATAH FORMATION

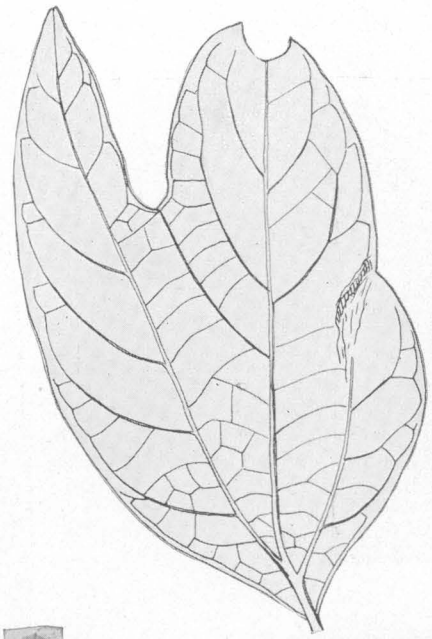
1. *Paliurus hesperius* Berry, n. sp. (p. 257).
2. *Acer oregonianum* Knowlton, winged fruit (p. 255).
3. *Tilia hesperia* Berry, n. sp., part of a large leaf (p. 258).
4, 5. *Rhamnus spokanensis* Berry, n. sp. (p. 257).
6. *Acer*, sp.



FOSSILS FROM THE LATAH FORMATION

1. *Ternstroemites idahoensis* (Knowlton) Berry (p. 258).
2. *Laurus similis* Knowlton (p. 259).
3. *Laurus grandis* Lesquereux (p. 259).
4. *Umbellularia dayana* (Knowlton) Berry (p. 260).
5. *Laurus princeps* Heer (p. 259).

1



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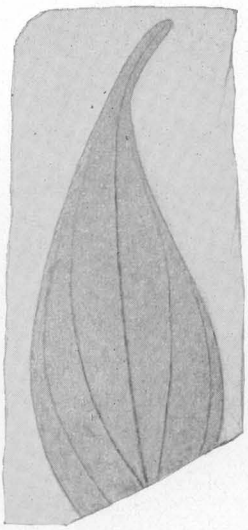

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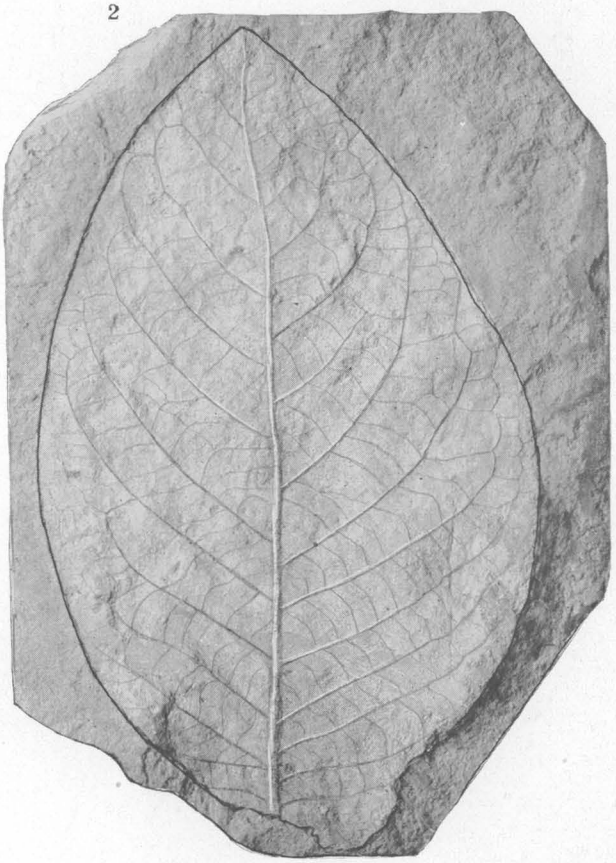
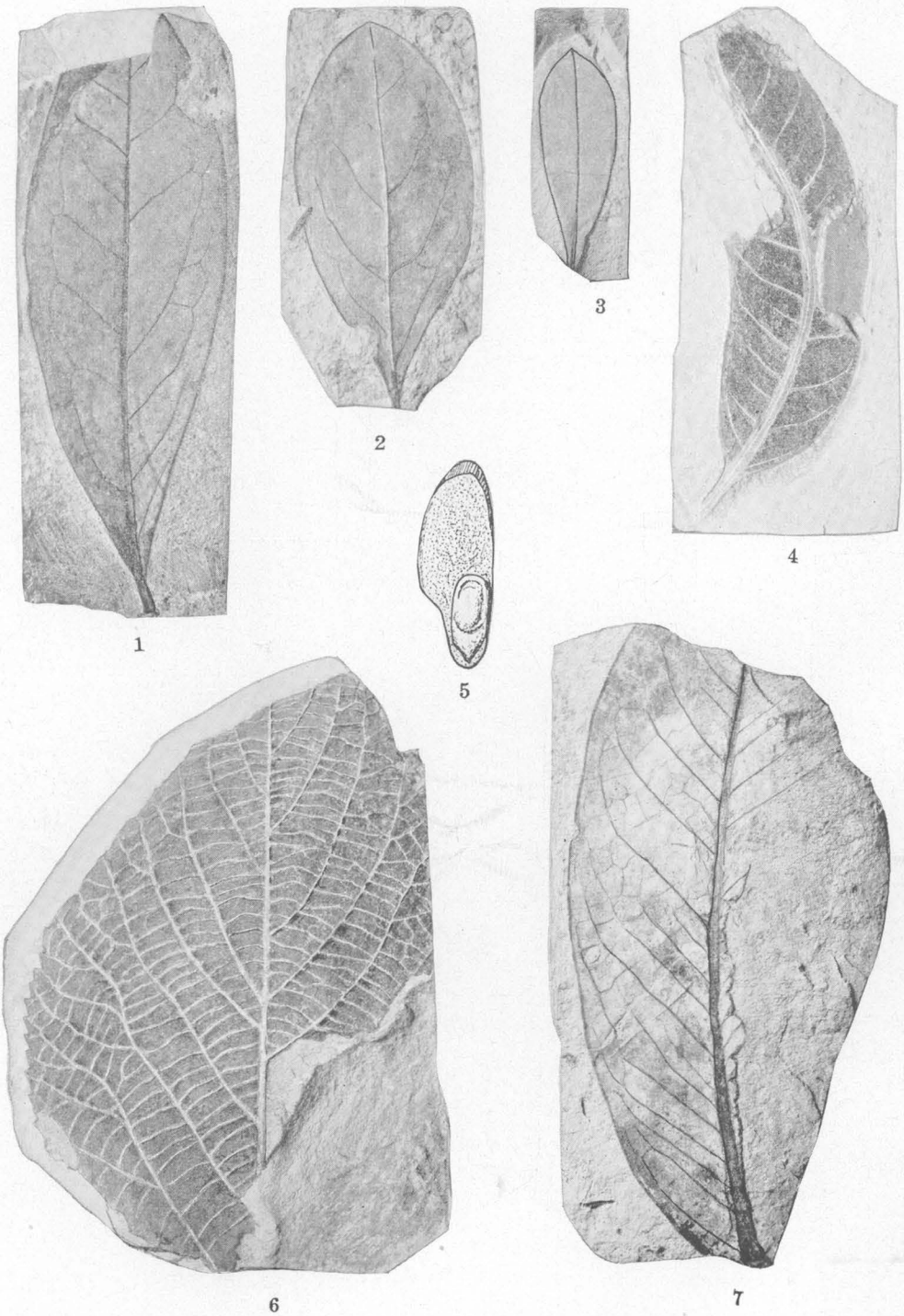


7

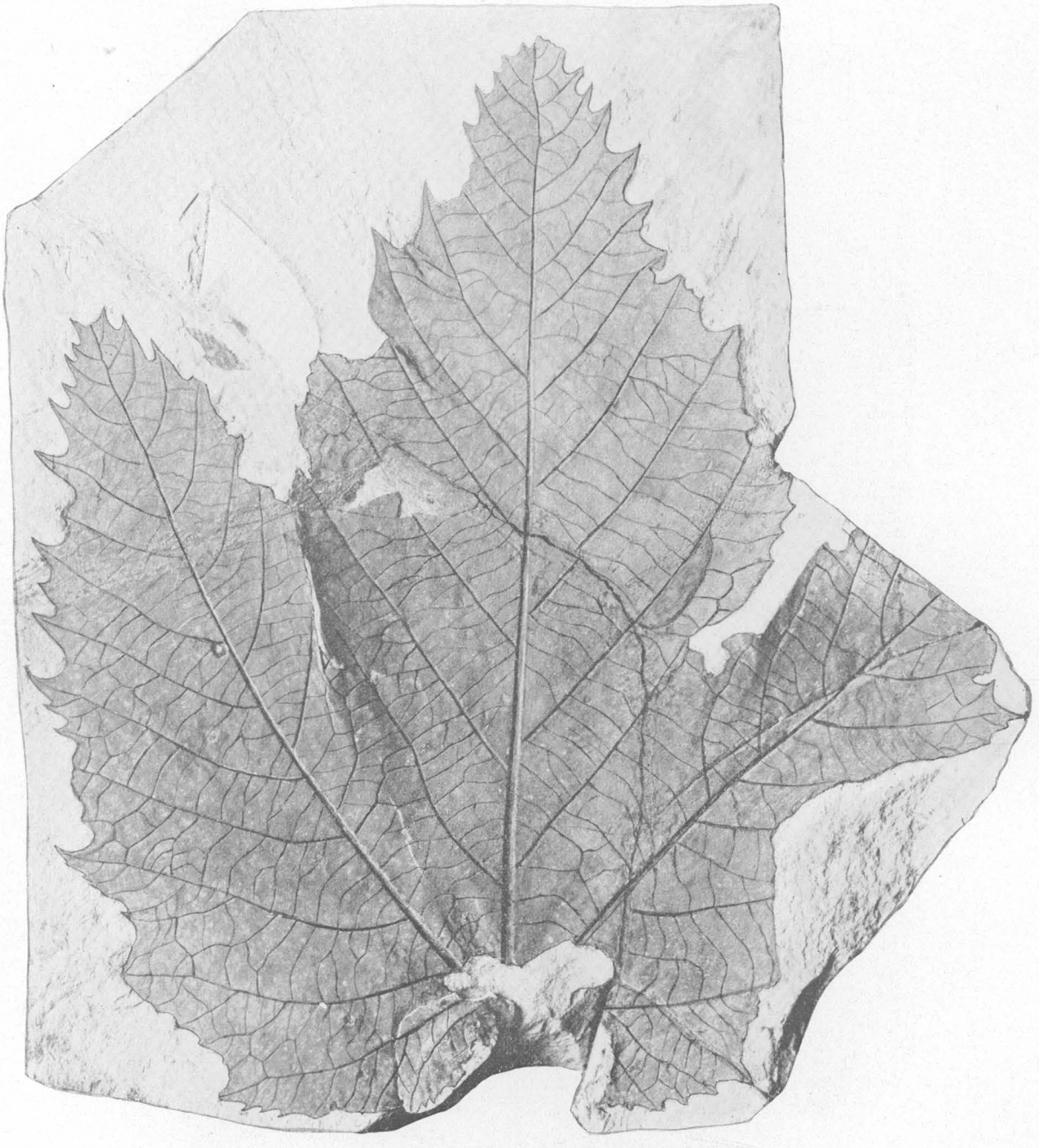
FOSSILS FROM THE LATAH FORMATION

1. *Umbellularia lanceolata* Berry, n. sp. (p. 260).
2. *Sassafras hesperia* Berry, n. sp. (p 259).
3. *Cornus acuminata* Berry, n. sp. (p. 260).
4. *Arctostaphylos knowltoni* Berry, n. sp. (p. 261).
5. *Vaccinium bonseri* Berry, n. sp. (p. 262).
6. *Diospyros princetoniana* Cockerell (p. 263).
7. *Nyssa knowltoni* Berry, n. sp. (p. 261).



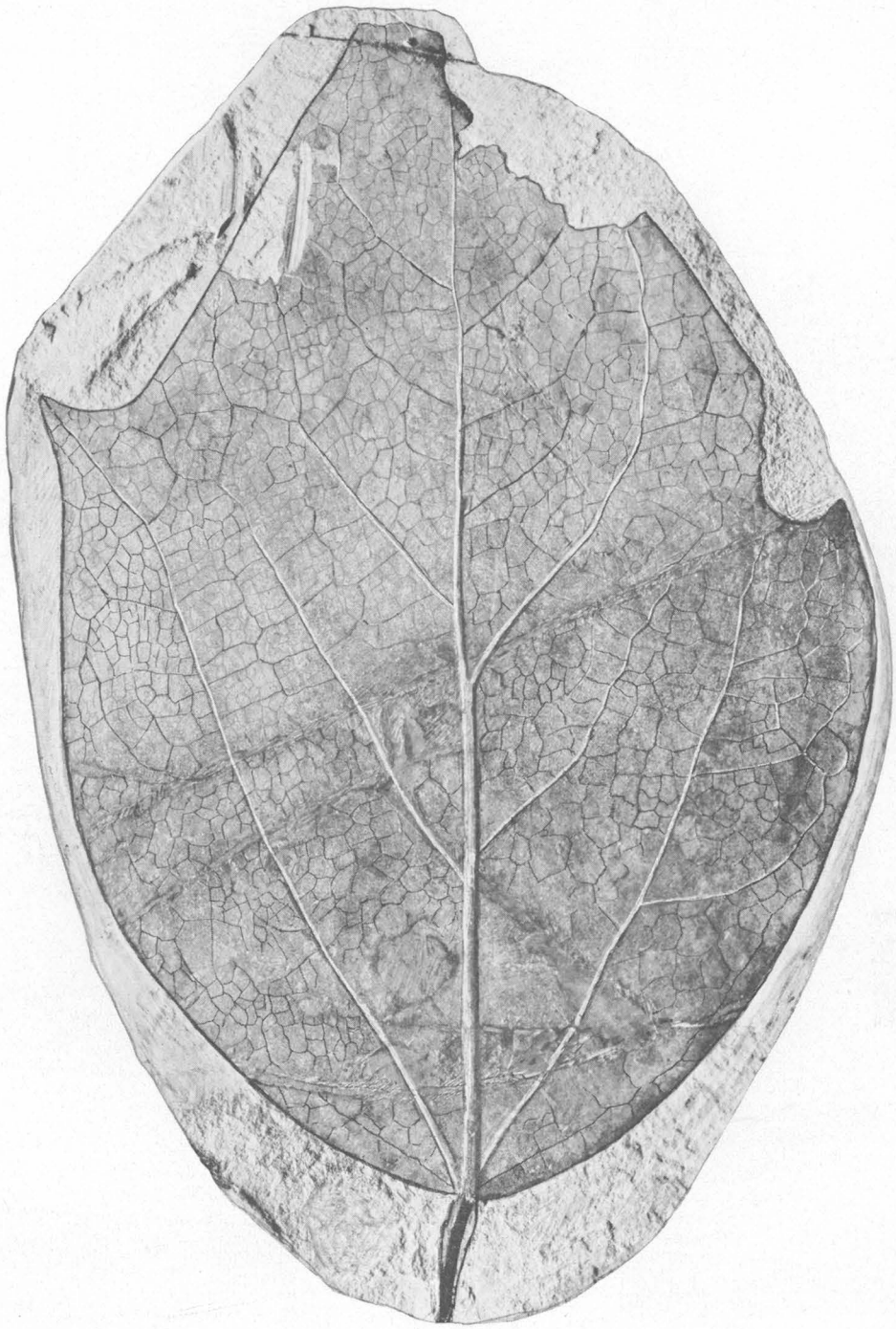
FOSSILS FROM THE LATAH FORMATION

1–3. *Diospyros princetoniana* Cockerell, showing the limits of variation of this species (p. 263).
4, 7. *Apocynophyllum latahense* Berry, n. sp., showing the limits of variation of this species (p. 263).
5. *Carpolithus pteraformis* Berry, n. sp., a characteristic winged fruit (p. 264).
6. *Viburnum lantanafolium* Berry, n. sp. (p. 264).



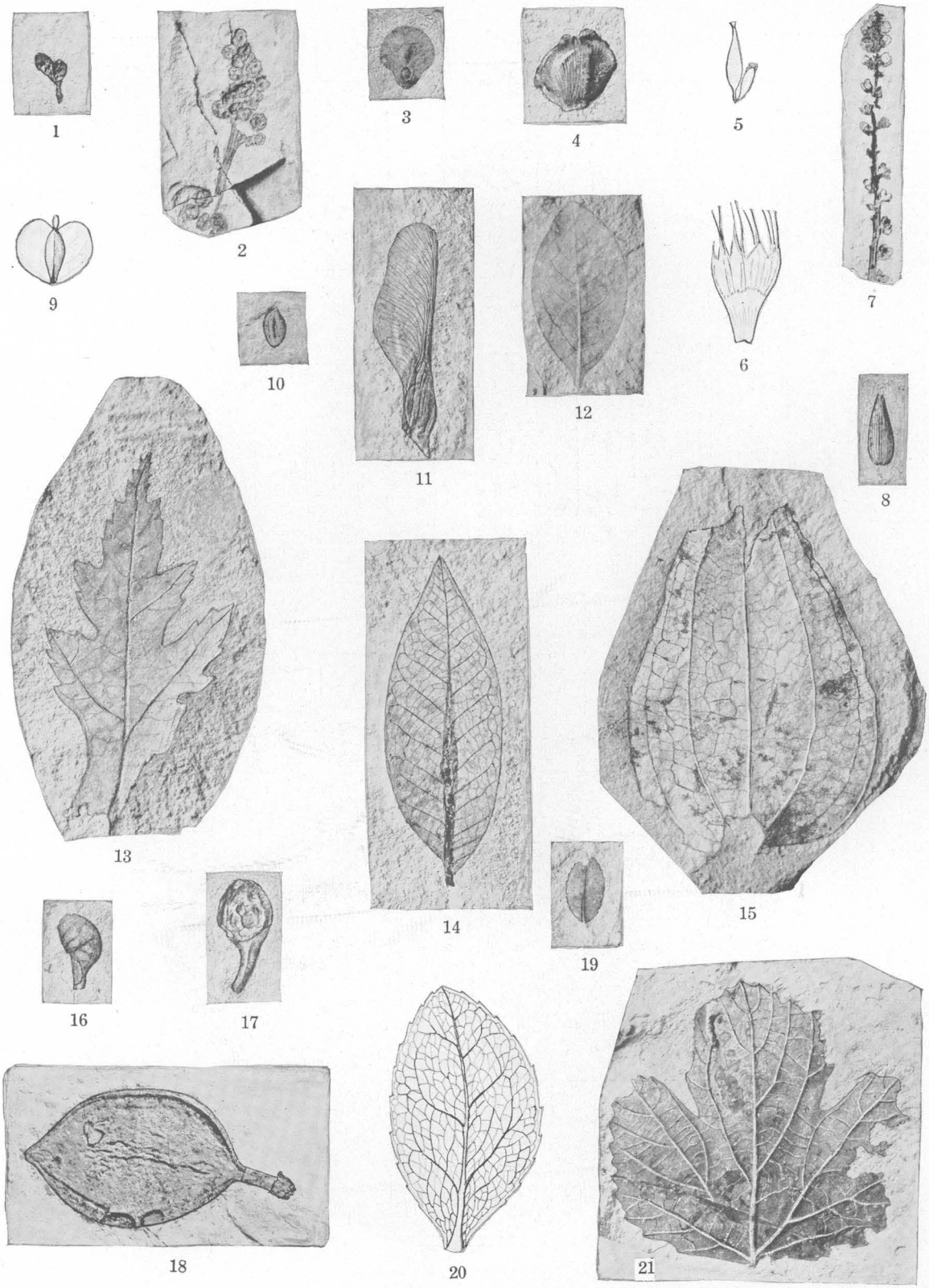
FOSSILS FROM THE LATAH FORMATION

Platanus dissecta Lesquereux (p. 248). A nearly complete leaf from the brickyard at Spokane, Wash.



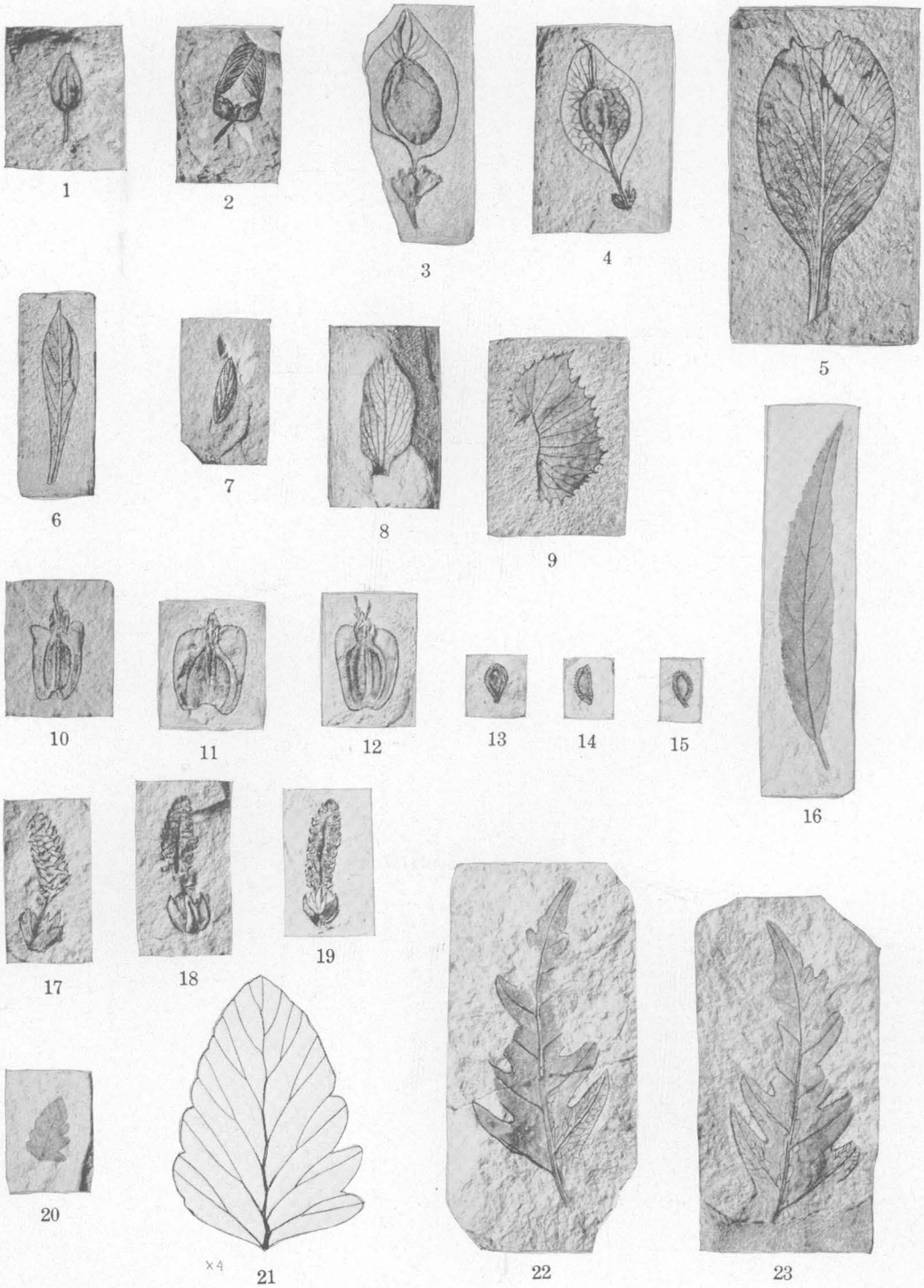
FOSSILS FROM THE LATAH FORMATION

Ficus? washingtonensis Knowlton (p. 248). An unusually large leaf from the brickyard at Spokane, Wash., showing a conical marginal lobe on one side, and the wings on the upper part of the petiole.



FOSSILS FROM THE LATAH FORMATION

1. *Glyptostrobus?*, staminate aments (p. 239).
2. *Taxodium*, staminate aments (p. 237).
3, 4. *Tsuga latahensis* Berry, n. sp., cone scales (p. 239).
5. *Salix*, pistillate flower, × 2 (p. 242).
6. *Populus*, bract of a pistillate flower, × 4 (p. 243).
7. *Populus*, pistillate ament (p. 243).
8. *Populus*, bud scale (p. 243).
9. *Betula*, winged fruit, × 2 (p. 244).
10. *Viburnum fernquisti* Berry, n. sp., stone (p. 264).
11. *Acer oregonianum* Knowlton (p. 255).
12. *Menziesia knowltoni* Berry, n. sp. (p. 262).
13. *Acer chaneyi* Knowlton, apical lobe (p. 256).
14. *Sapindus armstrongi* Berry, n. sp. (p. 254).
15. *Smilax lamarensis* Knowlton (p. 240).
16. *Leguminosites alexanderi* Berry, n. sp., pod (p. 254).
17. *Carpites ginkgoides* Knowlton.
18. *Cassia spokanensis* Berry, n. sp., pod (p. 253).
19, 20. *Vaccinium bonseri serrulatum* Berry, n. var., Figure 20 × 4 (p. 262).
21. *Ribes fernquisti* Berry, n. sp. (p. 251).
All from the brickyard at Spokane, Wash.



FOSSILS FROM THE LATAH FORMATION

1. Unnamed fruit, × 4.
2. *Acer minor* Knowlton (p. 256).
3, 4. *Ulmus*, fruits × 2 (p. 247).
5. *Celastrus spokanensis* Berry, n. sp. (p. 255).
6. *Arctostaphylos spatulata* Berry, n. sp. (p. 262).
7. *Cercocarpus praeledifolius* Berry, n. sp. (p. 252).
8. *Vaccinium spokanense* Berry, n. sp. (p. 263).
9. *Salix*, stipule (p. 242).
10–12. *Umbelliferospermum latahense* Berry, n. sp. (p. 261).
13–15. *Hibiscus? occidentalis* Berry, n. sp., seed (p. 258).
16. *Salix florissanti* Knowlton and Cockerell (p. 242).
17–19. *Pinus*, staminate aments (p. 239).
20, 21. *Woodsia bonseri* Berry, n. sp. (p. 236). Figure 21 × 4.
22, 23. *Woodwardia praeradicans* Berry, n. sp. (p. 236).
All from brickyard at Spokane, Wash.