CONTRIBUTIONS FROM THE MUSEUM OF PALEONTOLOGY

THE UNIVERSITY OF MICHIGAN

VOL. XX, No. 5, pp. 89–119 (6 pls., 1 fig.) MAY 10, 1966

ADDITIONS TO AND REVISION OF THE OLIGOCENE RUBY PAPER SHALE FLORA OF SOUTHWESTERN MONTANA

BY

HERMAN F. BECKER

Published with aid from the Paleontology Accessions Fund
through the generosity of
MR. AND MRS. EDWARD PULTENEY WRIGHT

MUSEUM OF PALEONTOLOGY
THE UNIVERSITY OF MICHIGAN
ANN ARBOR

CONTRIBUTIONS FROM THE MUSEUM OF PALEONTOLOGY

Director: LEWIS B. KELLUM

The series of contributions from the Museum of Paleontology is a medium for the publication of papers based chiefly upon the collection in the Museum. When the number of pages issued is sufficient to make a volume, a title page and a table of contents will be sent to libraries on the mailing list, and to individuals upon request. A list of the separate papers may also be obtained. Correspondence should be directed to the Museum of Paleontology, The University of Michigan, Ann Arbor, Michigan.

VOLS. II–XIX. Parts of volumes may be obtained if available.

VOLUME XX

1. Upper Devonian and Lower Mississipian Pectinoid Pelecypods from Michigan, Ohio, Indiana, Iowa, and Missouri, by Thomas W. Hutchinson and Erwin C. Stumm. Pages 1–48, with 7 plates.
2. Two New Middle Devonian Species of the Starfish *Devonaster* from Southwestern Ontario, by Robert V. Kesling and Jean D. Wright. Pages 49–61, with 4 plates.
3. A Revision of the Ordovician Trilobite *Asaphus platycephalus* Stokes, by David G. Darby and Erwin C. Stumm. Pages 63–73, with 2 plates.
4. *Proctothylacocrinus esseri,* a New Crinoid from the Middle Devonian Silica Formation of Northwestern Ohio, by Robert V. Kesling. Pages 75–87, with 5 plates.
5. Additions to and Revision of the Oligocene Ruby Paper Shale Flora of Southwestern Montana, by Herman F. Becker. Pages 89–119, with 6 plates.

VOL. XX, No. 5, pp. 89-119 (6 pls., 1 fig.) MAY 10, 1966

ADDITIONS TO AND REVISION OF THE OLIGOCENE RUBY PAPER SHALE FLORA OF SOUTHWESTERN MONTANA

BY

HERMAN F. BECKER

The New York Botanical Garden

ABSTRACT

Systematic descriptions of twenty-four species are presented which are new to the Tertiary record of the Ruby Paper Shale flora. Among these, *Alnus dorfi* Becker is a new name for *Myrica dorfi* Becker, and the following are new species: *Pinus drepanogona, Prunus eleanorae, Pyrus rubyensis,* and *Rhus cotinoides*. A revised list of the complete composition of the flora identifies ninty-nine species and twenty-five generically determined forms. A table of previously known species, but new to the Ruby record since 1961, is given, as well as a table of species republished or discussed for reasons of revision on the basis of more diagnostic compressions. Additional species since 1959, and a correlation with the recently described Kilgore flora of Nebraska, assume an important role in the modified reinterpretation of the Ruby flora. Deciduous trees and shrubs are predominant in comparison with gymnosperms and herbaceous plants. Of forty families in the Ruby flora, the Rocaceae, with 16 per cent of all species, is the largest. In all recently discovered species the leaf size is smaller than average, which is consistent with the flora as a whole and supports earlier conclusions about the environment.

CONTENTS

INTRODUCTION

THE FOSSIL FLORA of the Oligocene age "paper" shales in the Ruby valley in southwestern Montana was described in a series of my contributions dating from 1959 to 1965. In the present report some species new to the flora are described, some of the earlier published material is revised, and the composition of the flora is shown in tables.

In the revision of the flora that follows, it may be noted that certain groups such as the gymnosperms and the families Rosaceae, Berberidaceae, and Anacardiaceae, of which some members are tolerant of subarid environments, tend to stand out because of numbers of species. Furthermore, it is of interest to note that the fossil leaves of these groups in the Ruby flora are smaller than average. These tend to support earlier conclusions about the environment that were based in part on the smaller than average size of the leaves in the flora as a whole.

During 1963 the United States Geological Survey completed mapping of the upper Ruby River basin and surrounding mountains, and published a topographic map of the Metzel Ranch Quadrangle in Madison County. On the map the area yielding the fossils is labeled "Fossil Basin" (Fig. 1). In addition, extensive geological studies of the upper Ruby River basin have been completed by Dorr and Wheeler (1964) with emphasis on the structural relationships and the fossil-bearing beds.

TAXONOMIC REVISIONS AND ALTERATIONS

An attempt is made here to correct some previous errors in determination. MacGinitie (1961, p. 853; 1965), and Wolfe (1965), believe that *Myrica dorfi* (Becker, 1961, p. 56, Pl. 12, Figs 3, 4) is related to the *Alnus relata* Brown complex. It is true that from figures of leaf shapes, *M. dorfi* would fit into the *A. relata* group, but this species is also almost identical with *Quercus tenerrima* Weber (Hirmer, 1942, Pl. 8B). *M. dorfi* possesses what appear to be upper and lower epidermal glands or trichomes which could be interpreted as minute, sessile, peltate scales of the kind on leaves of *Alnus maritima* Nuttall. In the case of *Myrica dorfi* it is nearly impossible to decide whether its epidermal emergences are glands or trichomes. The opinion is herewith accepted that it is an alder and the species is therefore transferred to that genus, and henceforth is designated as *Alnus dorfi* n.n. If subsequent examination of the type material of *Quercus tenerrima* should show it to possess trichomes or scales, then a transfer of *Alnus dorfi* to this species would be in order.

It has furthermore been suggested (Fry, 1961, p. 369) that *Myrica metzeli* Becker (1961, p. 56, Pl. 12, Fig. 1) is a sapindaceous leaf. A

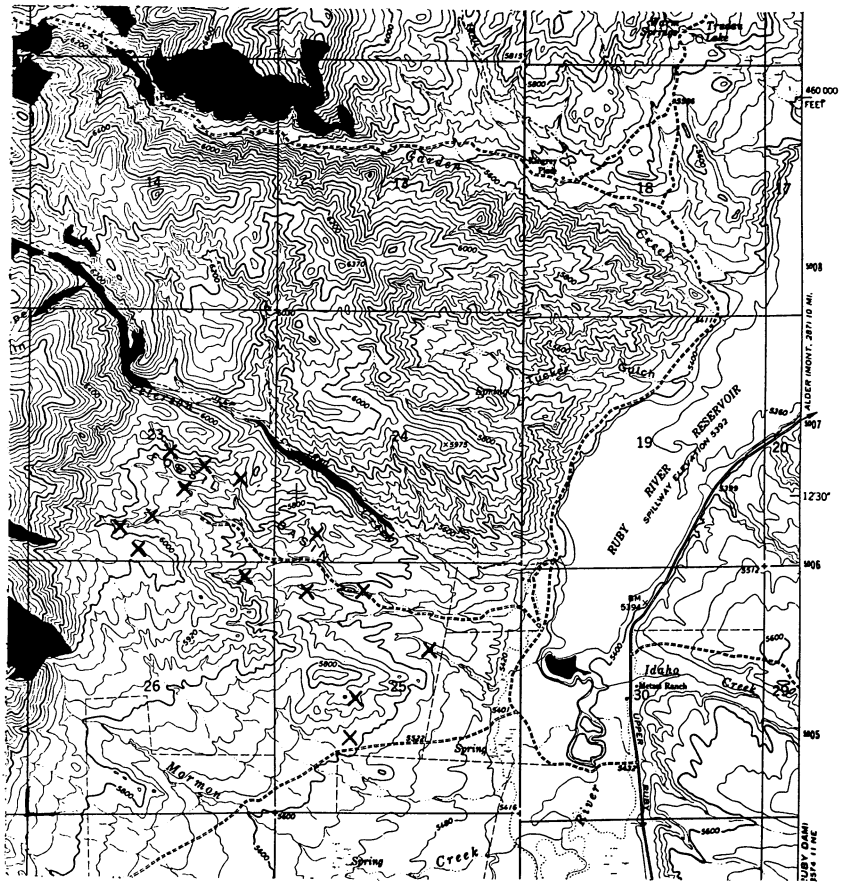


FIG. 1. A segment of the fossiliferous upper Ruby River basin from the new U.S. Geological Survey Topographic Map "Metzel Ranch Quadrangle, Montana, Madison County." From four distinct floras of this area, at least 12,000 specimens of fossil plants and insects were taken since 1947. The area which is now marked "Fossil Basin" contains the sites of the paper shales. × — collecting sites.

re-examination of this species, and also of *Myrica serrulata* Becker, shows that both possess an abundance of typical epidermal globular glands (not trichomes). Foliar glands in living species of *Myrica* are ever-present in varying patterns and numbers. Such glands are equally diagnostic in fossil compressions. Therefore I see no reason for making any changes of *Myrica metzeli* and *M. serrulata*. Their glands, venation, teeth, and bases can be matched on leaves of living species.

In the case of *Populus balsamoides* Goeppert (Becker, 1961, Pl. 13, Fig. 1) insertion of the figure was an error. However, fragments of this species on which the discussion is based (Pl. II, Fig. 2) had been found in 1957. The misplaced figure is of a specimen from the Ruby Mormon Creek flora (Becker, 1960, Palaeontographica B, Vol. 107, Pl. 26, Fig. 9). In regard to Fry's suggested erroneous identification of *Cercidiphyllum* as *"elongatum"* (Becker, 1961, Pl. 10, Fig. 8; Pl. 19, Figs. 1–5) it may be that most of the leaves should be assigned to *C. arcticum* (Heer) Brown or to *C. crenatum* (Unger) Brown. There are, however, often differences of opinion in the identity of fossil *Cercidiphyllum* leaves. R. W. Brown (1933), having seen the specimens, refrained from commiting himself as to the precise species, but, in his thorough treatise on *Cercidiphyllum* (Brown, 1939) suggested that they may be *C. elongatum.* In fact, one specimen of *C. elongatum* (Brown, 1939, Pl. 56, Fig. 9) from the Salmon-Idaho locality, is identical with most of the paper shale forms and could justifiably be cited as the reason for retaining the Ruby specimens in *C. elongatum.* This figured leaf, however, appears to be somewhat atypical of Brown's *C. elongatum,* but it emphasizes the difficulty of separating species where a wide variation of leaf shapes exists. It seems prudent, therefore, to make the following change: The specimens of *Cercidiphyllum elongatum* Brown by Becker (1961) on Pl. 10, Fig. 8; Pl. 19, Figs. 1, 3, 5, are now synonymized with *Cercidiphyllum crenatum* (Unger) Brown. Furthermore, the figures of *C. elongatum* by Becker (1961) on Pl. 19, Figs. 2, 4, are now synonymized with *Cercidiphyllum arcticum* (Heer) Brown. It is academic and unimportant to which species the fruits and seeds are assigned. (Becker, 1961, Pl. 19, Figs. 6–8; Pl. 20, Figs. 22–28).

The question has arisen (Fry, 1961, p. 369) whether *Smilax rubyensis* Becker (1961, Pl. 11, Figs. 9–11) does not belong to another genus, possibly *Clematis.* A search through fossil species, and a thorough comparison of *S. rubyensis* with leaves of living *Clematis,* render a relationship to *Clematis* out of the question. It is true that the acrodromous subprimary veins of *S. rubyensis* appear to arise slightly above the base of the midrib, but this is only apparent since the subprimaries do not begin here but run parallel alongside the midrib. An apparent basal thickening of the midrib confirms this anomaly. Several extant species of *Smilax,* such as *S. lancifolia* L. (Pl. II, Fig. 1), show this condition. *Cercocarpus bea-annae* is here reintroduced to show the validity of its specific status (see discussion in Systematic Descriptions below and Pl. I, Figs. 4, 7, 8, 9).

Paleobotanists are well aware of the difficulties inherent in valid specific identifications of leaves that have a wide variational range, that hybridize, or change only imperceptibly over long geologic epochs. Of this kind are leaves of *Populus, Salix, Quercus, Rosa,* and several others. In many cases, therefore, it is a matter of preference to which species a fossil is assigned. A case in point is *Quercus mohavensis* Axelrod (Becker, 1961, Pl. 16, Figs. 13–16), a live oak from the subarid segment of the ancient Ruby Basin. A perusal of western paleobotanical literature of the past few years will convince the discriminating reader how many overlapping, or even identical forms of fossil "live oaks" were described as different species. Oaks in general, and live oaks in particular, are one of the most difficult groups from a taxonomic viewpoint, even with available fructifications. In the fossil state, where often only a few leaves are available, definite speciation is frequently impossible (or imprudent) or often of precarious value, and such specific determination is to be taken with more than "a grain of salt." I therefore have no additional comments on the Ruby *Quercus mohavensis* or on *Q. consimilis* (Becker, 1961, Pl. 17, Figs. 4–7), which are thought to belong to other genera or to *Alnus* (Fry, 1961, p. 369).

On Plate VI several well-preserved but unidentified leaves are shown. It is hoped that further collecting will yield more material and will render identification possible.

RELATION TO THE FLORISSANT, KILGORE, AND OTHER WESTERN TERTIARY FLORAS

In its taxonomic and ecological relationship, the Ruby assemblage exhibits similarities in varying degrees to the Green River, Bridge Creek, Kilgore, and Florissant floras (Becker, 1961, p. 36). The Green River and Bridge Creek similarities are relatively minor, while the overlap with the Florissant flora discloses a kinship of specific and evolutionary significance. Since 1961, five additional Ruby species were discovered that are also present at Florissant. These species are *Sequoia affinis, Astragalus wilmattae* (formerly *Phaca wilmattae*), *Cercocarpus myricaefolius, Crataegus gracilens?*, and *Ulmus tenuinervis*. In spite of this addition, however, the per cent of overlap with the Florissant flora became reduced because ninteen additional Ruby species were reported since that time, lowering the specific identity from 40 to 35 per cent. The tendency toward decrease of species identity is obviously due to the continued addition of Ruby material while that of the Florissant is stabilized through less active collecting.

Additional species are recorded from all habitats of the ancient Ruby Basin, but they are significant only within a few families. A 40 per cent increase in named gymnosperm species elevates this group to a dominant segment of fourteen species through the addition of *Sequoia* and *Ginkgo,* and an expansion of *Pinus* by two new forms. One small, but diagnostic *Ginkgo* leaf was found (Becker, 1964). In view of the abundance of leaves on a living tree, and ready transportation by wind or water, it is assumed that *Ginkgo* was extremely rare in this area during Ruby time.

Similarly, the Rosaceae are increased by 50 per cent with addition of the following forms: *Cercocarpus myricaefolius, Crataegus gracilens?, Prunus eleanorae, Pyrus rubyvallis,* and *Spiraea harneyana.* There are now fifteen species of the Rosaceae in the flora as compared with eleven in the Florissant. Of the Leguminosae, by contrast, there are only two species in the Ruby flora, as against ten at Florissant. The Rosaceae, during mid-Tertiary time were already highly diversified, suggesting a genetically vary active family.

Among the Berberidaceae, two new species of *Mahonia* were added to three previously reported. This considerable increase indicates that the subarid localities of the Ruby region were especially favorable for that genus. Finally, the addition of *Rhus cotinoides* and *Rhus longipetiolata* to the previously reported *Cotinus fraterna* and *Astronium truncatum,* places the Anacardiaceae in a position nearly equivalent with the Aceraceae, Betulaceae, Fagaceae, Sapindaceae, and the Ulmaceae. Many members of the Anacardiaceae are found on dry, rocky mountain slopes and in seasonally dry water courses typical of the ancient Ruby Basin.

The obvious relationship of the Ruby flora with that of the Florissant flora of Colorado may be explained only partially on the basis of dispersal from the Florissant area, because distance and intervening unfavorable terrain were not conducive to unobstructed expansion. A difference in latitude of about 6 degrees suggests a colder and more subarid climate in the Ruby area. Furthermore, the Ruby flora occupied a marginal position in the Ruby-Florissant botanical province, with many species absent and with others present that were better adapted to the climate and ecology of the region. Climatic and precipitation tolerance is therefore expressed in corresponding leaf size and specific floral content. As a topographically more or less isolated region, the Ruby assemblage experienced its own peculiar evolution in place, modifying some forms that may have been derived from more distant floras of the province.

MacGinitie's recent study of the Kilgore flora of Nebraska (1962) sheds additional light on the structure of the botanical province to which the Ruby and Florissant floras belong. He finds similarities between them and postulates that "The Raton, Green River, Florissant, Ruby Basin, and Kilgore are points on a continuum. If we had more such points, we could more easily see the evolution of a flora in a certain area." His data (p. 88) favor the idea of evolution in place rather than by dispersal and variation based on changing climates and topography. At any rate, evolution in place appears the more important factor. A convincing relationship between the Ruby and Florissant floras, and to some extent the Kilgore, is expressed in their mutual pine-oak woodland vegetation that contained, in addition to some legumes, mahonias, roses, hawthorn, *Cotinus, Rhus, Paliurus, Sapindus, Dodonaea, Philadelphus,* and *Ribes*. A large segment of the Ruby Basin featured such a savanna-type plant formation, borne out not only in the flora, but subsequently also by typical grazing and browsing animals such as horses, camels, rhinos, and chalicotheres (*Moropus*?) from the contiguous Miocene beds (Dorr and Wheeler, 1964, p. 321–28). The only vertebrate from the Oligocene plant shales is a compression of a small sandpiper-like bird, complete with head and crest, long beak, legs, claws, and feathers, now on display in the Museum at Princeton University. A lack of sufficient bone components made its identification uncertain. With an abundance of insect remains in the Ruby Shales it was possible to deduce facets of plant-insect relationships from an evolutionary aspect (Becker, 1965).

ACKNOWLEDGMENTS

This contribution is partly facilitated through a grant from the National Science Foundation, administered by The New York Botanical Garden. I express my sincere appreciation to the Foundation, and equally to the following persons for aid and helpful suggestions: Dr. Chester A. Arnold, and Dr. Herbert W. Wagner, Jr., both of The University of Michigan, Ann Arbor; Dr. Harry D. MacGinitie, University of California, Berkeley; Dr. Jack A. Wolfe, U.S. Geological Survey, Washington, D.C.; Dr. Arthur Cronquist, Mrs. Eleanor Yarrow, and Mr. Walter Singer (photography), all of The New York Botanical Garden. I assume full responsibility for the identification of fossil material, interpretation, and statements in the text.

COMPOSITION OF THE RUBY PAPER SHALE FLORA

(All species reported in G.S.A. Mem. 82, 1961, except where noted; *—in present report)

Equisetaceae: *Equisetum* sp. (stems)
E. sp. (cf. Brown, 1936—rhizomes)*
Osmundaceae: *Osmunda occidentalis* (Berry) Brown
Polypodiaceae: *Dennstaedtia adamantea* Becker
Fern sp.
Pinaceae: *Abies laticarpa* MacGinitie
A. longirostris Knowlton
A. sp.

Picea lahontensis MacGintie
P. sp.
Pinus drepanogona Becker*
P. florissanti Lesquereux
P. hexaphylla Becker (1964)
P. monticolensis Berry
P. tetrafolia Berry
P. spp. :14 unidentified, possibly leaf variations
Pseudotsuga masoni MacGintie
Taxodiaceae: *Glyptostrobus oregonensis* Brown
Metasequoia occidentalis (Newberry) Chaney
Sequoia affinis Lesquereux*
Cupressaceae: *Chamaecyparis linguaefolia* (Lesquereux) MacGinitie
Ginkgoaceae: *Ginkgo adiantoides* Lesquereux (1964)
Typhaceae: *Typha lesquereuxi* Cockerell
Zosteraceae: *Potamogeton parvus* Brown
Cyperaceae: *Cyperacites lacustris* MacGinitie
Liliaceae: *Smilax rubyensis* Becker (and *)
Salicaceae: *Populus balsamoides* Goeppert (and *)
P. crassa (Lesquereux) Cockerell
P. salicoides Becker
Salix coloradica MacGinitie
S. longissima Becker
S. rivularis Becker
S. sp.
Myricaceae: *Myrica metzeli* Becker (and *)
M. serrulata Becker (and *)
Betulaceae: *Alnus carpinoides* Lesquereux
A. dorfi (Becker) Becker (and *)
A. relata (Knowlton) Brown
Betula sp.
Carpinus lanceolata Becker
Fagaceae: *Fagopsis longifolia* (Lesquereux) Hollick (and *)
Fagus washoensis LaMotte
Quercus brooksi Becker
Q. consimilis Newberry
Q. convexa Lesquereux
Q. mohavensis Axelrod (and *)
Ulmaceae: *Celtis mccoshi* Lesquereux (and *)
Ulmus montanensis Becker
U. paucidentata Smith

	U. speciosa Newberry
	U. tenuinervis Lesquereux*
	U. sp. (and 1960*a*)
	Zelkova drymeja (Lesquereux) Brown (and *)
	Z. oregoniana (Knowlton) Brown
Moraceae:	*Morus symmetrica* Cockerell
Proteaceae:	*Lomatia lineata* (Lesquereux) MacGinitie
Eucommiaceae:	*Eucommia browni* Becker (and *)
Cercidiphyllaceae:	*Cercidiphyllum arcticum* (Heer) Brown (and *)
	C. crenatum (Unger) Brown (and *)
Berberidaceae:	*Mahonia lobodonta* Becker (1959)
	M. marginata (Lesquereux) Arnold
	M. obliqua MacGinitie
	M. peloronta Becker (1960*a*)
	M. subdenticulata (Lesquereux) MacGinitie (and *)
Cruciferae:	*Thlaspi primaevum* Becker (and 1960*a*)
Saxifragaceae:	*Philadelphus parvulus* (MacGinitie) Becker
	Ribes auratum Becker
	Ribes cerinum Becker
Rosaceae:	*Cercocarpus antiquus* Lesquereux
	C. bea-annae Becker (and *)
	C. myricaefolius (Lesquereux) MacGinitie*
	Chamaebatia prefoliolosa Brown
	Crataegus copeana (Lesquereux) MacGinitie (and *)
	C. gracilens MacGinitie ? *
	Potentilla passamariensis Becker
	P. salmonensis Brown
	Prunus eleanorae Becker*
	Pyrus rubyvallis Becker*
	Rosa hilliae Lesquereux (and 1963)
	Sorbus carcharodonta Becker
	Spiraea clavidens Becker (and *)
	S. harneyana Chaney and Axelrod*
	S. sp. *
	Waldsteinia insolita Becker
Leguminosae:	*Astragalus wilmattae* (Cockerell) LaMotte (1960*a*)
	Leguminosites sp. MacGinitie
Rutaceae:	*Ptelea cassioides* (Lesquereux) MacGinitie
Simaroubaceae:	*Ailanthus americana* Cockerell (and *)
Meliaceae:	*Cedrela lancifolia* (Lesquereux) Brown
Limnanthaceae:	*Floerkea rubyensis* Becker (1960*a*)

Anacardiaceae:	*Astronium truncatum* (Lesquereux) MacGinitie
	Cotinus fraterna (Lesquereux) Cockerell
	Rhus cotinoides Becker*
	R. longipetiolata (Lesquereux) Brown*
Aceraceae:	*Acer florissanti* Kirchner
	A. glabroides Brown (and *)
	A. sp.
	Dipteronia insignis (Lesquereux) Brown (and *)
Sapindaceae:	*Cardiospermum terminale* (Lesquereux) MacGinitie
	Dodonaea reniptera Becker (and *)
	Koelreuteria arnoldi Becker
	Sapindus coloradensis Cockerell
Rhamnaceae:	*Paliurus florissanti* Lesquereux (and *)
Vitaceae:	*Vitis muscadinioides* Becker
Theaceae:	*Gordonia idahoensis* (Knowlton) Berry?*
Cornaceae:	*Cornus cornella* Becker
Nyssaceae:	*Nyssa crenata* Chaney
Oleaceae:	*Fraxinus rupinarum* Becker
Verbenaceae:	*Holmskioldia speiri* (Lesquereux) MacGinitie
Caprifoliaceae:	*Symphoricarpos elegans* (Lesquereux) Smith
INCERTAE SEDIS:	*Archaeomnium browni* (Kirchner) LaMotte
	Caulinites acanthus Brown
	Antholithes rubyaster Becker
	A. rubyflorus Becker
	Carpites yuccapsulus Becker
Bryophyta:	*Musci* spp.
	Hepaticae spp.

NEW SPECIES DESCRIBED FROM THE OLIGOCENE RUBY PAPER SHALE FLORA

(All species were reported in G.S.A. Mem. 82, 1961, except where noted. *—in present report)

Alnus dorfi (n.n.*)
Antholithes rubyaster
Antholithes rubyflorus
Carpinus lanceolata
Carpites yuccapsulus
Cercocarpus bea-annae
Cornus cornella
Dennstaedtia adamantea
Dodonaea reniptera
Eucommia browni
Floerkea rubyensis (1960)
Fraxinus rupinarum
Koelreuteria arnoldi
Mahonia lobodonta (1959)
Mahonia peloronta (1960)
Myrica metzeli
Myrica serrulata
Philadelphus parvulus (n.n., 1961)

Pinus hexaphylla (1964)
*Pinus drepanogona**
Populus salicoides
Potentilla passamariensis
*Prunus eleanorae**
*Pyrus rubyvallis**
Quercus brooksi
*Rhus cotinoides**
Ribes auratum
Ribes cerinum
Salix longissima
Salix rivularis
Similax rubyensis
Sorbus carcharodonta
Spiraea clavidens
Thlaspi primaevum
Ulmus montanensis
Vitis muscadinioides
Waldsteinia insolita

PREVIOUSLY KNOWN SPECIES, BUT NEW FOR THE RUBY RECORD SINCE 1961

Astragalus wilmattae (Cockerell) LaMotte (1960*a*)
Cercocarpus myricaefolius (Lesquereux) MacGinitie
Crataegus gracilens MacGinitie ?
Equisetum sp. (cf. Brown, 1936; rhizome-tubers)
Ginkgo adiantoides Lesquereux (1964)
Gordonia idahoensis (Knowlton) Berry
Rhus longipetiolata (Lesquereux) Brown
Sequoia affinis Lesquereux
Spiraea harneyana Chaney and Axelrod
Spiraea sp. (cf. Weyland, 1948)
Ulmus tenuinervis Lesquereux

Species Republished or Discussed on the Basis of More Diagnostic Compressions or for Reasons of Revision

(All in present report except where noted)

Acer glabroides Brown
Ailanthus americana Cockerell
Celtis mccoshi Lesquereux
Cercidiphyllum arcticum (Heer) Brown
Cercidiphyllum crenatum (Unger) Brown
Cercidiphyllum elongatum Brown
Crataegus copeana (Lesquereux) MacGinitie
Dipteronia insignis (Lesquereux) Brown (1960*a*)
Dodonaea reniptera Becker (leaf)
Eucommia browni Becker (1960*a*)
Fagopsis longifolia (Lesquereux) Hollick
Mahonia subdenticulata (Lesquereux) MacGinitie

Myrica dorfi Becker = *Alnus dorfi* new name
Myrica metzeli Becker
Myrica serrulata Becker
Paliurus florissanti Lesquereux
Quercus spp.
Rosa hilliae Lesquereux (1963)
Smilax rubyensis Becker
Spiraea clavidens Becker
Thlaspi primaevum Becker (1960*a*)
Ulmus sp. (1960*a*; samara)
Zelkova drymeja (Lesquereux) Brown

SYSTEMATIC DESCRIPTIONS

Family Equisetaceae

Genus *Equisetum* Linnaeus

Equisetum sp. Brown (rhizome-tubers)

(Pl. II, Figs. 3, 4, 5)

Equisetum sp. Brown, 1937, p. 167, Pl. 45, Fig. 4.

Several underground tubers were found at various sites in the Ruby Shales. They correspond most nearly to specimens from Thunder Mountain, Idaho (Brown, 1937), but are larger than previously reported rootstocks from the Ruby (Becker, 1961, Pl. 7, Figs. 3, 4). Stem compressions are numerous in the Ruby.

Hypotypes UMMP 51430, 51431.

Family Pinaceae

Genus *Pinus* Linnaeus

Pinus drepanogona sp. nov.

(Pl. I, Figs. 5, 6)

Description.—Winged fruit, 2.3 cm long, .6 cm wide, dorsally and ventrally strongly curved, but wings uniformly parallel with parallel striations, and terminating bluntly; seed large, bluntly oviform, 6 mm long, 5 mm wide, stonelike.

Discussion.—This very unusual pinaceous winged seed is believed to be of a unique and rare species. It is the only one of its kind among hundreds of gymnospermous seeds in the Ruby Shales. In size, and vaguely in shape, the seed resembles that of *Pinus florissanti* Lesq. which, in turn, may be compared with *P. ponderosa* Douglas. Both of these, however, have nearly straight-edged upper wings and elongate-oval seeds, but in *P. pon-*

derosa the lower part of the wing is strongly convex. There appears to be no living form with which the fossil can be compared. These compressions do not belong to any of the previously described species of *Pinus* from the Ruby or any other locality, according to published leaf and seed combinations, and they are here specifically described for their unique characters.

It was suggested that the wings are abnormal forms of *Pinus ponderosa.* The fact, that among perhaps millions of seeds during Ruby time the "abnormal" was preserved, is highly improbable. It seems furthermore imprudent to combine this species simply with the living *Pinus ponderosa* because the Oligocene form is not likely to be identical with the present western yellow pine. The specific epithet refers to the "sickle" shape of the seed.

Holotype UMMP 51433.

Family Taxodiaceae

Genus *Sequoia* Endlicher

Sequoia affinis Lesquereux

(Pl. I, Figs. 1, 2)

Sequoia affinis Lesquereux, 1876*a*, p. 310; 1876, p. 384; 1878, p. 25, Pl. 7, Figs. 3–5; Pl. 65, Figs. 1–4.

A foliage shoot with counterpart, 10.5 cm long, and bearing staminate cones, resembles closely that from Florissant (MacGinitie, 1953, Pl. 16, Fig. 1). This is the first record of the genus for the Ruby flora. Similar specimens, but without cones, were previously identified as *Glyptostrobus oregonensis* Brown (Becker, 1961) on the basis of their cupressoid, lingulate foliage. There is a possibility that the *Glyptostrobus* material may also be *Sequoia.*

Hypotype UMMP 51434.

Family Fagaceae

Genus *Fagopsis* Hollick

Fagopsis longifolia (Lesquereux) Hollick

(Pl. II, Figs. 10, 11)

Fagopsis longifolia (Lesquereux) Hollick, 1909, p. 2, Text–Figs. 1, 2; MacGinitie, 1953, p. 98, Pl. 14; Pl. 33, Figs. 1–8; Becker, 1961, p. 59, Pl. 16, Figs. 8–12.

Recently discovered additional specimens of *Fagopsis* are typical and confirm previous finds from the Ruby locality. They are figured at this time to emphasize character of leaf shape which, in some variational stages, could be mistaken for *Zelkova.* The exact family status of the specimens is still in doubt, but a re-examination of the hypotype (1583A) at The New York Botanical Garden (MacGinitie, 1953, Pl. 33, Fig. 1), and a removal of matrix covering the apical portion of the terminal bud, revealed a characteristic elongate or slender, fagaceous bud of 6 mm length. The bur also is typically fagaceous and not too small in proportion to the leaves. Dr. E. Leopold has found fagaceous pollen by treating material scraped from one of the Florissant fossil cones, but MacGinitie suggests (p. 853) that "we cannot be sure that this pollen was borne by this particular cone; it could have lodged among the cone scales during deposition of the Florissant shales."

The general consensus regarding the taxonomy of *Fagopsis* seems to trend in favor of Fagaceae. It is still puzzling why *Fagopsis* should have been found in Florissant and in the Ruby Shales, but in no other flora.

Hypotypes UMMP 51435, 51436.

Family Ulmaceae

Genus *Celtis* Linnaeus

Celtis mccoshi Lesquereux

(Pl. II, Fig. 6)

Celtis mccoshi Lesquereux, 1883, p. 163, Pl. 38, Figs. 7, 8.

This species was reported previously from the Ruby Shales (Becker, 1961), but the present leaf represents a size and form variation intermediate between the smaller Ruby specimens and the larger Florissant compressions (MacGinitie, 1953).

Hypotype UMMP 51437.

Genus *Ulmus* Linnaeus

Ulmus tenuinervis Lesquereux ?

(Pl. II, Figs. 8, 9)

Ulmus tenuinervis Lesquereux, 1878, p. 188, Pl. 26, Figs. 1–3; MacGinitie, 1953, p. 105, pl. 21, Fig. 8; Pl. 32, Figs. 4, 6–8.

The leaf with counterpart is oblique, the apex is missing; it is 5.5 cm long (estim.), and 2.2 cm wide; the base is rounded-oblique. Marginal characters for this leaf exclude *Alnus* or *Ostrya,* and it is too narrow for most species of *Betula*. Alders often have coarse teeth, but usually also many fine subsidiary teeth. It is the secondary venation which aligns the specimen with the Ulmaceae. Three secondary veins bifurcate or branch (not a tertiary venation), often considerably before reaching the margin. This is a character of *Ulmus* frequent in almost all living species. Such a branching is generally absent in *Betula* and *Alnus*. Lesquereux's Figure 2 shows a base similar to our specimen, while Figure 3 has the rugged margin. MacGinitie's specimens from Florissant are more oblique than ours, but the coarse margin and bifurcating veins (especially on Pl. 21, Fig. 8) suggest strong affinity to *Ulmus tenuinervis* for the Ruby material. Extremely ragged margins also occur in specimens of *Ulmus paucidentata* Smith from the Ellensburg flora of Washington (Smiley, 1963, Pl. 8, Figs. 4, 5). Since the apex of our specimen is missing, specific identification cannot be made with certainty. Leaves of *Ulmus alata* Michaux show various marginal and venation characters of the fossil. The ultimate venation, as far as recognizable, also agrees with that of living *Ulmus*.

Hypotype UMMP 51438.

Genus *Zelkova* Spach

Zelkova drymeja (Lesquereux) Brown

(Pl. II, Fig. 7)

Zelkova drymeja (Lesq.) Brown, 1946, p. 345.

This species was cited previously (Becker, 1961) on the basis of one available leaf. Additional specimens suggest perhaps a greater abundance of the tree than indicated earlier. The present compression compares favorably with specimens of *Z. drymeja* from Florissant (MacGinitie, 1953), and is figured for this reason. *Z. oregoniana* (Knowlton) Brown remains the most numerous of the Ulmaceae in the Ruby record.

Hypotype UMMP 51439.

Family Berberidaceae

Genus *Mahonia* Nuttall

Mahonia subdenticulata (Lesquereux) MacGinitie

(Pl. IV, Fig. 1)

Mahonia subdenticulata (Lesq.) MacGinitie, 1953, p. 111, Pl. 36, Fig. 1; Pl. 49, Fig. 7.

This species was previously recorded from the Ruby sites (Becker, 1961) but only as a fragment of one specimen. The present leaflet with counterpart is complete except for one side of its cuneate base. Compared with specimens from Florissant and the earlier Ruby fragment, its slenderness (0.6 cm) and length (7.8 cm) add a variational character to the species.

Hypotype UMMP 51440.

Family Rosaceae

Genus *Cercocarpus* Humboldt, Bonplant, *et* Kunth

Cercocarpus bea-annae Becker

(Pl. I, Figs. 4, 7, 8, 9)

In the light of the opinion of Fry (1961, p. 369) that *Cercocarpus bea-annae* is actually *C. holmesii* (Lesq.) Axelrod (1944, p. 257, Pl. 43, Fig. 8; 1956, p. 299, Pl. 28, Figs. 4, 9, 11), old and recently collected specimens were re-examined. The leaves are abundant in the Ruby shales, varying in size from 2.5 cm to 6 cm in length, and in shape from broadly to narrowly lanceolate. *C. holmesii* ranges from 2 cm to 4 cm in length; its greatest width is below the middle, while *C. bea-annae* is usually wider above the middle. Some specimens are extremely slender and their numerous secondary veins are more steeply ascending than those of the Miocene material from the Alvord Creek locality in Oregon. There is no doubt that both species are related and that *C. bea-annae,* from the Oligocene, is probably ancestral to the later forms.

Hypotypes UMMP 51441, 51442, 51443, 51444.

Cercocarpus myricaefolius (Lesq.) MacGinitie

(Pl. I, Fig. 3)

Cercocarpus myricaefolius (Lesq.) MacGinitie, 1953, p. 115, Pl. 49, Figs. 3, 4; see also synonymy, p. 115.

Only a fragment of this species exists (apex missing), but it is sufficiently diagnostic for comparison with the Florissant material. Its estimated length is 9.5 cm, its width 1.5 cm, and the sharply ascending secondary veins terminate in large teeth. Other species in the Ruby Shales are *C. bea-annae* Becker, and *C. antiquus* Lesquereux. *Cercocarpus* generally emphasizes the subarid segment of a flora, but *C. myricaefolius,* in the Florissant flora, is said to be a streamside plant (MacGinitie, 1961, p. 854). It is doubtful that the Ruby species inhabited a similar niche.

Hypotype UMMP 51445.

Genus *Crataegus* Linnaeus

Crataegus copeana (Lesquereux) MacGinitie

(Pl. III, Fig. 1)

Crataegus copeana (Lesquereux) MacGinitie, 1953, p. 117, Pl. 41, Figs. 1, 2; Pl. 42, Fig. 1.

A recently discovered leaf is all but identical with a Florissant specimen figured by MacGinitie (1953, Pl. 42, Fig. 1) and corroborates a previous record for this species in the Ruby Shales. Apex and base are missing in this fragment, but the irregularly toothed margin and distinct venation leave no doubt as to its affinity. The estimated length of the leaf is 6 to 7 cm, below the average stated by MacGinitie (6 to 12 cm) and in keeping with the generally smaller leaf size of the Ruby flora.

Hypotype UMMP 51446.

Crataegus gracilens MacGinitie ?

(Pl. III, Fig. 5)

Cra'aegus gracilens MacGinitie, 1933, p. 57, Pl. 9, Fig. 6.

Unfortunately, only the upper portion of this excellently preserved compression is available. In lobation, the specimen is similar to the holotype but its dimensions are considerably smaller (length 5 cm est.; width 2.5 cm). Except for a smaller angle of departure of the secondary veins (30–35 degrees), its general venation also corresponds to that of the holotype. If the leaf were complete it might well have shown characters (basal) sufficiently diagnostic to warrant specific separation. Until complete specimens are found, it seems best to consider this fragment a variational form of *C. gracilens*. The relatively small size of the leaf is in keeping with the over-all diminutive size of most Ruby species.

A comparison of the compression with extant species of *Crataegus* aligns it so closely to *C. mollis* (T. et G.) Scheele that it could be considered ancestral to it. *C. gracilens* is new to the Ruby record.

Hypotype UMMP 51447.

Genus *Prunus* Linnaeus

Prunus eleanorae sp. nov.

(Pl. III, Figs. 2, 3, 4)

Description.—Leaf rhomboidal–ovate, 4 cm long, 1.9 cm wide; margin irregularly dentate; teeth numerous, some doubly serrate, pointing strongly forward; apex attenuate, base cuneate; petiole 5 mm long (incomplete); midrib strong basally, slightly irregular, becoming weak apically; secondary veins 8 pairs, alternate, arising at about 45 degrees, wavy or crinkly, multiple-camptodromous with branches entering teeth; texture thin. Flower petals broadly wedge-shaped, terminally rounded, 6 mm long, 4 mm wide.

Discussion.—At first glance, the irregular, crinkly condition of the secondary veins appears to have resulted from softening of the tissue before burial. Comparison with several living species of *Prunus*, however, reveals this condition to be quite prevalent. Large bacterial or fungal spots, as on the compressions, are also typical of living *Prunus* and other members of the Rosaceae. The new species is similar to leaves of *P. lanata* (Sudw.) Mack. and Busch. Several flower petals exist (Fig. 4) that match in size and venation those of *P. lanata,* and are therefore here included. The species is named in honor of Mrs. Eleanor Yarrow (1964), teacher of botany at The New York Botanical Garden, who first pointed out affinity to *Prunus.*

Holotype UMMP 51448.

Genus *Pyrus* Linnaeus

Pyrus rubyvallis sp. nov.

(Pl. III, Figs. 8, 9)

Description.—Leaf broadly ovate-elliptical, 7 cm long, 4 cm wide; base rounded, acute; apex acuminate (presumably); margin finely dentate with basal teeth doubly distant; midrib straight, strong, tapering apically; secondary veins basally subopposite, becoming alternate, arising at angles of 40 degrees, curving upward near middle of lamina, dividing, with branches entering teeth; some secondaries bifurcating; tertiary veins interconnecting at approximately 30 degrees, forming a network of an elongate mesh; areolation of profuse fine veinlets; texture firm.

Discussion.—Many extant species of *Pyrus (Malus)* have occasional bifurcating veins. Some leaves of cultivated apples may be matched closely with our specimens. The only fossil species similar, but certainly not identical, to our material is *Pyrus McKenziei* Arnold (1937) from the Sucker Creek flora, Oregon, of late Middle Miocene. An age difference of from 9 to 10 million years may account for foliar differences between the two species. *P. McKenziei* is more oval, broadest above the middle with nearly straight secondary veins and percurrent tertiaries at nearly right angles. The new species should be considered ancestral to *P. McKenziei.*

Holotype UMMP 51449.

Genus *Spiraea* Linnaeus

Spiraea clavidens Becker

(Pl. IV, Fig. 5)

Spiraea clavidens Becker, 1961, p. 75, Pl. 24, Figs. 1–6.

In order to facilitate comparisons, the figure of a recently discovered leaf of the previously described species is here presented. The Rosaceae contain the most numerous genera of any family in the Ruby Shales, namely 3 species of *Spiraea* (here figured), 3 of *Cercocarpus,* 2 of *Crataegus,* 2 of

Potentilla, and 1 each of *Chamaebatia, Prunus, Pyrus, Rosa, Sorbus,* and *Waldsteinia.*

Hypotype UMMP 51450.

Spiraea harneyana Chaney and Axelrod

(Pl. III, Fig. 6)

Spiraea harneyana Chaney and Axelrod, 1959, p. 186, Pl. 37, Fig. 3.

This rosaceous leaf appears to have strong affinity to *Spiraea,* in fact, our compression is nearly identical with Chaney and Axelrod's material from the Stinking Water flora of Oregon. The oval leaf is 3 cm long, 1.3 cm wide with a rounded apex terminating in a bluntly acute tip, and a tapering, subacute base. The somewhat flexuous, pronounced midrib tapers sharply toward the apex and is flanked by a nearly basal pair of flexuous, steeply ascending secondaries which in turn give rise to numerous subparallel tertiary veins. These tertiaries loop upward before reaching the margin to fuse with those above, their branches entering the teeth. In venation, leaves of *Spiraea japonica* L. appear to be similar, but also those of *M. menziesii* Hooker. The species is a new addition to the Ruby flora.

Hypotype UMMP 51451.

Spiraea sp.

(Pl. IV, Fig. 6)

cf. *Spiraea* sp., Weyland, 1948, p. 129, Pl. 20, Figs. 11, 11A.

On the basis of this fragment (basal portion of leaf), though excellently preserved to the finest areolation, it seems not prudent to establish a new species or combine it with *Spiraea clavidens* Becker from the Ruby Shales since it is entirely too large and incomplete. Weyland's unnamed species, however, appears to be almost a duplicate of the Ruby material. This European species comes from the productive Rhineland-Siebengebirge-Rott locality, is of Upper Oligocene age, as are the Ruby compressions, and appears to have had intercontinental, or even worldwide distribution. There is a vague similarity in shape and venation to *Spiraea thunbergi.*

Bacterial or fungal decay spots on the fragment, so common in the Rosaceae, may possibly be of affinity-significance. The Ruby compression is 6.5 cm long (estimated), 1.5 cm wide, as against 4 cm length and 1.1 cm width for the Rott specimen. *Spiraea* in the Ruby Shales is represented by *S. harneyana* Chaney and Axelrod (in this paper) and *S. clavidens* Becker (1961).

Hypotype UMMP 51452.

Family Simaroubaceae
Genus *Ailanthus* Desfontaines
Ailanthus americana Cockerell

(Pl. V, Fig. 6)

Ailanthus americana Cockerell, 1908, p. 539, Text-Fig. 3; Becker, 1961, p. 77, Pl. 24, Figs. 13–17.

There is no indication on the compression of this *Ailanthus* fruit that it consists of two specimens. It appears that this samara represents a double fruit containing two seeds, and it is figured here only as an unusual occurrence. Previously (Becker, 1961, p. 77) an attempt has been made to clarify the taxonomic tangle of fossil *Ailanthus*.

Hypotype UMMP 51453.

Family Anacardiaceae
Genus *Rhus* Linnaeus
Rhus cotinoides sp. nov.

(Pl. V, Figs. 1, 2)

Description.—Leaflet broadly ovate-lanceolate, 3.5 cm long, 1.6 cm wide; margin entire, each with one small, lobate irregularity; apex bluntly cuspidate, base cuneate; petiole 1 mm (incomplete); midrib straight, becoming weak apically; secondary veins seven to eight pairs, alternate, arising at angles of 55 degrees in lower portion, to 45 degrees in upper portion of leaf, curving upward near margin, branching once or twice with branches terminating at margin; tertiary veins forming coarse network, areolation indistinct.

Discussion.—A comparison of this species with *Nyssa* and *Cotinus* shows that characteristics of shape and venation are diagnostically *Rhus,* although similarities with *Cotinus* exist. A search through literature and published figures reveals nothing identical to this form. The compression compares favorably in similar characters found in *Rhus ovata* Wats., *Toxicodendron radicans* (L.) Kuntze, and particularly in *Rhus choriophylla* Woot *et* Standl. from the southwestern United States (Fig. 3). It is the bluntly-cuspidate apical portion that gives the leaflet a saddlelike appearance which is also pronounced in *R. choriophylla.*

Holotype UMMP 51454.

Rhus longipetiolata (Lesquereux) Brown

(Pl. V, Figs. 4, 5)

Rhus longipetiolata (Lesq.) Brown, 1934, p. 60, 1937, J, p. 179, Pl. 55, Figs. 2, 3.

The status of *Rhus longipetiolata* is thoroughly discussed by Brown (1934, 1936, 1946) and Becker (1961). A recently discovered specimen from the Ruby locality is identical to those from the Eocene Green River (Fossil, Wyoming) in shape, margin, and venation. The new compression, however, is somewhat smaller, 4 cm long, .9 cm wide, which is to be expected for the Ruby flora. The fossil resembles some forms of *Rhus typhina*.

Hypotype UMMP 41455.

Family Aceraceae

Genus *Acer* Linnaeus

Acer glabroides Brown

(Pl. IV, Figs. 2, 3, 4)

Acer glabroides Brown, 1937, p. 180, Pl. 58, Figs. 13–15; see synonymy in Chaney, 1959, p. 193.

Acer florissanti Kirchner, Becker, 1961, Pl. 25, Fig. 6

To determine the specific affinity of a fossil leaf or samara of *Acer* is frequently a precarious task. If the total range of leaf variations is considered, our present leaf with partial counterpart shows a possible relationship to *A. bolanderi* Lesquereux, *A. florissanti* Kirchner, *A. glabroides* Brown, and doubtless various others. Chaney (1959) has summarized and synonymized many species of *Acer* in a revision that appears to be a valuable guide for future identifications. According to criteria used by Chaney, the leaf here shown as a new form for the Ruby flora has the greatest affinity to *A. glabroides*. This leaf is nearly identical to several known compressions (see Chaney, 1959, Pl. 39, Fig. 10; Pl. 40, Fig. 6 especially, and Fig. 11). Furthermore, it is suggested that *A. florissanti* is "closely allied" to *A. glabroides*, although several distinct differences remain. In *A. florissanti* the tips of the lobes are acuminate, differing from the more blunt and acute apices of *A. glabroides*. The base in *A. florissanti* is often truncate to rounded, and the leaf lobes are pronounced. In *A. glabroides* the base may be subcuneate to nearly cuneate, and the leaf lobes are reduced in size. If criteria of a blunt tip are valid, then the specimen of *A. florissanti* (Becker, 1961, Pl. 25, Fig. 6 only) should be synonymized with *A. glabroides* Brown.

Among extant species, *Acer ginnala* Maximowicz, is most nearly like the fossil. Considering the difficulties in identifying fossil species of *Acer, Populus, Salix, Quercus,* and others, a general agreement seems to prevail among many paleobotanists that the taxonomy of these forms experiences a progressively more complex muddle. There are far too many species in each genus to represent a reasonable image of specific content in many floras.

The double samaras (Fig. 4) are similar to those of *Acer ginnala* or *A. rubrum* L., but, also to *A. glabrum* Torrey, and may well have belonged to *A. glabroides*.

Hypotypes UMMP 51456, 51457 (samaras).

Family Sapindaceae

Genus *Dodonaea* Linnaeus

Dodonaea reniptera Becker (leaf)

(Pl. IV, Fig. 7)

Dodonaea reniptera Becker, 1961, p. 82.

Dodonaea is well represented in the Ruby shales by numerous winged fruits, but leaves, so far, had escaped attention.

The fossil leaf is entire, 31 mm long, 3 mm wide, and identical in venation to leaves of the living *Dodonaea viscosa* Jacq. (Fig. 8). It differs from *D. umbrina* MacGinitie which is broader apically, almost club-shaped, and tapers very gradually toward the base. The fossil leaf is new to the Ruby record and substantiates the identification of fruits.

Hypotype UMMP 51458.

Family Rhamnaceae

Genus *Paliurus* Miller

Paliurus florissanti Lesquereux

(Pl. III, Fig. 7)

Paliurus florissanti Lesquereux, 1878, p. 274, Pl. 50, Fig. 18.

In contrast to the original, earlier fragment of this species from the Ruby Valley (Becker, 1961), the present specimen with counterpart is complete. The compressions retain little carbon but details of outline and venation are diagnostic, and definitely confirm the presence of the species in the flora.

Hypotype UMMP 51459.

Family Theaceae

Genus *Gordonia* Ellis

cf. *Gordonia idahoensis* (Knowlton) Berry ?

(Pl. V, Fig. 7)

Gordonia idahoensis (Knowlton) Berry, 1934, p. 120. Chaney and Axelrod, 1959, p. 197, Pl. 43, Fig. 6; see synonymy.

Our specimens are typical of *Arbutus trainii* MacGinitie (1933) and *Arbutus idahoensis* (Knowlton) Brown (1937) which Chaney and Axelrod

(1959) combined under *Gordonia idahoensis* (Knowlton) Berry. The reasons advanced are based on careful comparison of leaf characters in living *Arbutus* and *Gordonia.* Leaves of our specimens, typical for published fossils of *Gordonia,* have rounded, crenate teeth. A network of complex undulating, anastomosing and looping secondary veins is perhaps the most diagnostic character for the genus. All of these characters are distinguishable from those of *Arbutus* which are "either entire-margined or sharply serrate (Wolfe, 1964)." Axelrod (1964, p. 135), however, commenting on *Arbutus trainii* MacGinite (1933, p. 64), *A. idahoensis* (Knowlton) Brown (1937, p. 184), and *Gordonia idahoensis* (Knowlton) Berry (Chaney and Axelrod, 1959, p. 197), states "That the fossils listed above were assigned by Chaney and Axelrod to *Gordonia.* It is now my opinion (Axelrod, *ibid.*) that it all represents *Arbutus,* as seen in the long petiole, the anastomosing venation and the crenate-serrate or entire margin." In an additional paragraph the author justifies his combinations and reassignments. The specimens, on which Axelrod's and Chaney and Axelrod's opinions are based, are not available to me at this time, and since only apical halves of the Ruby material exist, a final assignment remains reserved.

Hypotype UMMP 51432.

Unidentified Species

(Pl. VI, Figs. 1–12)

Figures 1, 2. *Celastrus* ? *Evonymus* ? *Viburnum* ? A leaf of rosaceous affinity ?; sharp, antrorse teeth, texture near-coriaceous; counterparts; UMMP 51865. Fig. 3. Leaf of fagaceous affinity, possibly *Quercus* or *Castanea* ?; UMMP 51864. Fig. 4. *Hamamelis* ? *Quercus* ? *Cissus* ?; UMMP 51863. Fig. 5. A deeply lobed angiospermous leaf with marginal glands; cf. rosaceous ? UMMP 51857. Fig. 6. An Angiospermous leaf, possibly Compositae (cf. *Ratibida* ? or related genus ?); UMMP 51858. Fig. 7. A rosaceous leaf, possibly *Amelanchier, Rosa* ?; UMMP 51861. Fig. 8. *Rhus* ? *Chaetoptelea* ? *Planera* ?; UMMP 51862. Fig. 9. *Chamaebatia prefoliolosa* Brown ? except for apparent thickenings at the tips of the leaflet lobes; UMMP 51859. Fig. 10. cf. rosaceous petal ? with only upward trending, branching venation; UMMP 51856. Figs. 11, 12. Counterparts; rosaceous ? petal of *Rosa* ?; UMMP 51867. Fig. 13. Glandular leaf; *Alnus* ?; rosaceous ?; UMMP 51444.

LITERATURE CITED

ARNOLD, C. A. 1937. Observations on the Fossil Flora of Eastern and Southeastern Oregon. Part I. Contrib. Mus. Paleontol. Univ. Mich., Vol. 5, No. 8, pp. 79–102, 10 pls., 3 text-figs.

AXELROD, D. D. 1944. The Alvord Creek Flora. Carnegie Inst. Wash. Publ. 553, pp. 225–62, pls. 40–46.

——— 1956. Mio-Pliocene Floras from West-Central Nevada. Univ. Calif. Publ., Geol. Sci., Vol. 33, 322 pp., 32 pls., 18 figs.

——— 1964. The Miocene Trapper Creek Flora of Southern Idaho. Univ. Calif. Publ., Geol. Sci., Vol. 51, 180 pp., 16 pls.

BECKER, H. F. 1959. A New Species of *Mahonia* from the Oligocene Ruby Flora of Southwestern Montana. Contrib. Mus. Paleontol. Univ. Mich., Vol. 15, No. 3, pp. 33–38.

——— 1960. The Ruby Flora of Southwestern Montana. Billings Geological Soc. Guide Book 1960 for the West Yellowstone Earthquake Field Conf., Sept. 7, 1960.

——— 1960*a*. Additions to the Ruby Paper Shale Flora of Southwestern Montana. Bull. Torrey Bot. Club, Vol. 87, No. 5, pp. 386–96.

——— 1961. Oligocene Plants from the Upper Ruby River Basin, Southwestern Montana. Geol. Soc. Amer. Mem. 82, 127 pp., 32 pls.

——— 1962. The Resurrection of a Landscape. The Garden Journal, Vol. 12, No. 1, pp. 8–11.

——— 1963. The Fossil Record of the Genus *Rosa*. Bull. Torrey Bot. Club, Vol. 90, No. 2, pp. 99–110.

——— 1964. Gymnospermous Additions to the Oligocene Flora of Southwestern Montana. *Ibid.,* Vol. 91, No. 3, pp. 206–13.

——— 1965. Flowers, Insects and Evolution. Natural History. Amer. Mus. Nat. Hist., Vol. 74, No. 2, pp. 38–45 (Feb.).

BERRY, E. W. 1914. The Upper Cretaceous and Eocene Floras of South Carolina and Georgia. U.S. Geol. Survey Prof. Paper, 84, 200 pp., 29 pls.

——— 1934. Miocene Plants from Idaho. *Ibid.,* 185-E, pp. 97–125, pls. 19–24.

BROWN, R. W. 1934. The Recognizable Species of the Green River Flora. U.S. Geol. Survey Prof. Paper, 185-C, pp. 45–77, pls. 8–15.

——— 1937. Additions to some Fossil Floras of the Western United States. *Ibid.,* 186-J, pp. 163–206, pls. 45–63.

——— 1939. Fossil Leaves, Fruits, and Seeds of *Cercidiphyllum*. Journ. Paleontol., Vol. 13, No. 5, pp. 485–99.

——— 1946. Alterations in some Fossil and Living Floras. Wash. Acad. Sci., Vol. 36, No. 10, pp. 344–55, text-figs. 1–15.

CHANEY, R. W., 1927. Geology and Paleontology of the Crooked River Basin, with Special Reference to the Bridge Creek Flora. Carnegie Inst. Wash., Publ. 346, pp. 45–138, 20 pls.

CHANEY, R. W., and AXELROD, D. D. 1959. Miocene Floras of the Columbia Plateau. *Ibid.,* Publ. 617, 237 pp., 44 pls.

COCKERELL, T. D. A. 1908. Description of Tertiary Plants, II (Florissant, Colorado). Amer. Jour. Sci., 4th Ser., Vol. 26, pp. 537–44, text figs. 1–9.

DORR, JOHN A., JR., and WHEELER, WALTER H. 1964. Cenozoic Paleontology, Stratigraphy, and Reconnaissance Geology of the Upper Ruby River Basin, Southwestern Montana. Contrib. Mus. Paleontol. Univ. Mich., Vol. 13, No. 12, pp. 297–339, 2 pls., 4 figs.

FRY, W. L. 1961. (Review of Becker, 1961.) Bull. Torrey Bot. Club, Vol. 88, No. 5, pp. 369–70.

HIRMER, M. 1943. Die Forschungsergebnisse der Palaeobotanik auf dem Gebiet der Kaenophytischen Floren. Bot. Jahrb., Vol. 72, No. 3–4, pp. 347–563.

HOLLICK, A. 1909. A New Genus of Fossil Fagaceae from Colorado. Torreya, Vol. 9, pp. 1–3, text-figs., 1, 2.

——— 1936. The Tertiary Floras of Alaska. U.S. Geol. Survey Prof. Paper 182, 185 pp., 122 pls.

LESQUEREUX, L. 1876. A Review of the Fossil Flora of North America. U.S. Geol. and Geogr. Survey Terr., Bull. 5, 2d Ser., Vol. 1, pp. 233–48.

——— 1876*a*. On the Tertiary Flora of the North American Lignitic. *Ibid.,* 8th Ann. Rept., pp. 273–315.

——— 1878. Contributions to the Flora of the Western Territories, Pt. II, The Tertiary Flora. Rept. of the U.S. Geol. Survey Terr., Vol. 7, 366 pp., 65 pls.

——— 1883. The Flora of the Green River Group; Contributions to the Fossil Flora of the Western Territories, Pt. Three. *Ibid.,* Vol. 8, No. 3, pp. 127–217, pls. 21–45A.

MACGINITIE, H. D. 1933. The Trout Creek Flora of Southeastern Oregon. Carnegie Inst. Wash. Publ. 416, II, pp. 21–68, 6 pls.

——— 1953. Fossil Plants of the Florissant Beds, Colorado. *Ibid.,* Publ. 599, 198 pp., 74 pls.

——— 1961. (Review of Becker, 1961.) Ecology, Vol. 42, No. 4, pp. 853–54.

——— 1962. The Kilgore Flora—A Late Miocene Flora from Northern Nebraska. Univ. Calif. Publ., Geol. Sci., Vol. 32, No. 5, pp. 67–158, 16 pls., 2 text figs.

——— 1964, 1965. Personal Communication. Museum of Paleontol., Univ. Calif., Berkeley, Calif.

Metzel Ranch Quadrangle, 1965, Montana, Madison Co. U.S. Geol. Survey, Dept. Int. Topographic Map (N 4507, 5-W 11207.5/7.5—1962 AMS 3474 11 NW Series 894).

SMILEY, C. J. 1963. The Ellensburg Flora of Washington. Univ. Calif. Publ., Geol. Sci., Vol. 35, No. 3, pp. 159–276, 17 pls., 8 figs.

WAGNER, H. W., JR. 1965. Personal communication. Univ. Mich., Ann Arbor.

WEYLAND, H. 1948. Beitraege zur Rheinischen Tertiaer Flora, VII, Palaeontographica B, Vol. 88, pp. 113–88, pls. 18–23.

WOLFE, J. A. 1964. Miocene Floras from Fingerrock Wash, Southwestern Nevada. U.S. Geol. Survey Prof. Paper 454-N, p. N1–N36, pls. 1–12.

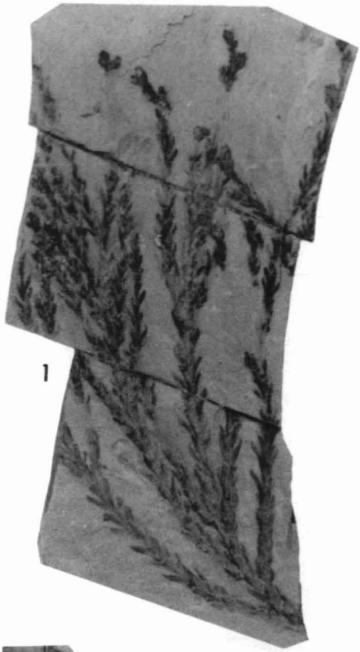
——— 1965. Personal Communication. U.S. Geol. Survey, U.S. Nat'l. Mus., Washington, D.C.

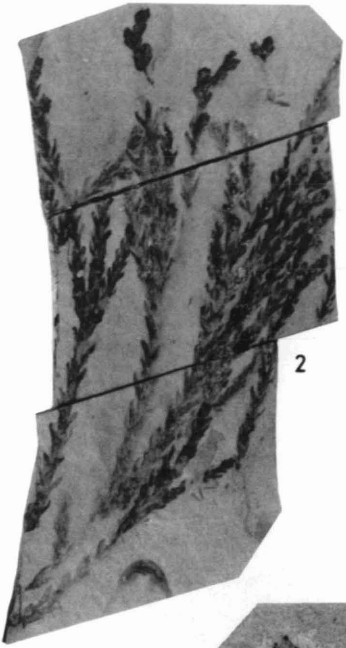
Submitted for publication June 18, 1965

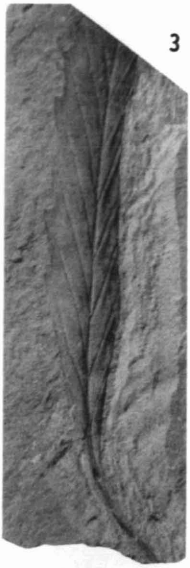
EXPLANATION OF PLATE I

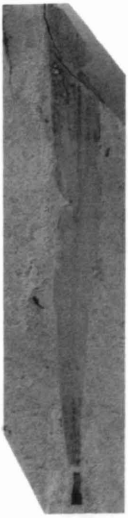
	PAGE
Fig. 1. *Sequoia affinis* Lesquereux. Hypotype UMMP 51434. × 1.	101
Fig. 2. Counterpart of specimen shown in Fig. 1.	101
Fig. 3. *Cercocarpus myricaefolius* (Lesquereux) MacGinitie. Hypotype UMMP 51445. × 1.	104
Figs. 4, 7, 8, 9. *Cercocarpus bea-annae* Becker. Hypotypes UMMP 51441, 51442, 51443. (Figs. 4, 7, counterparts.) × 2¼.	104
Fig. 5. *Pinus drepanogona* sp. nov. Holotype UMMP 51433. × 2.1.	100
Fig. 6. Counterpart of specimen shown in Fig. 5.	100

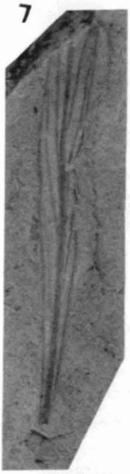
PLATE I


1

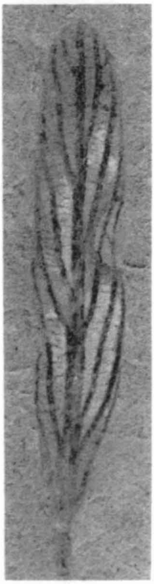

2


3


4


7


8


9


6

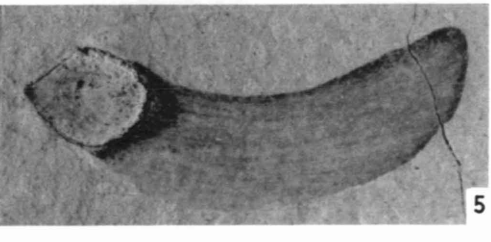
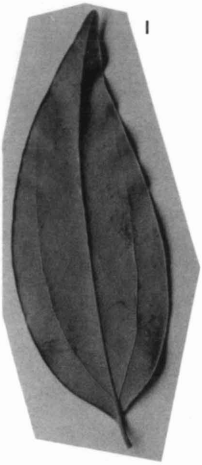
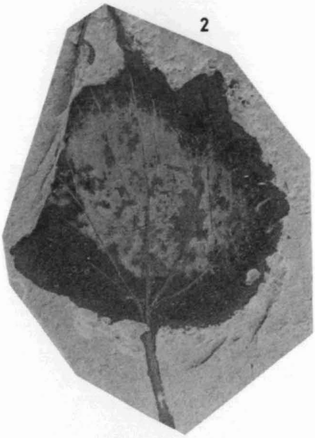

5

PLATE II

1



2

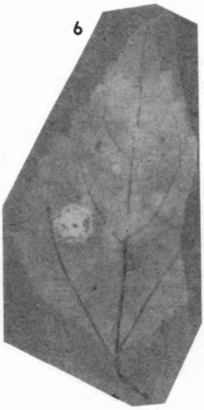


3

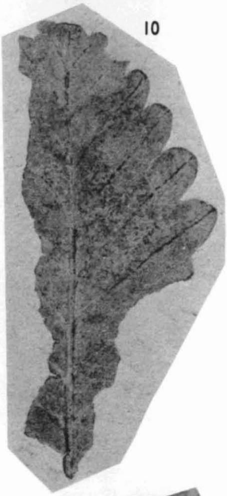
4

5

6



10

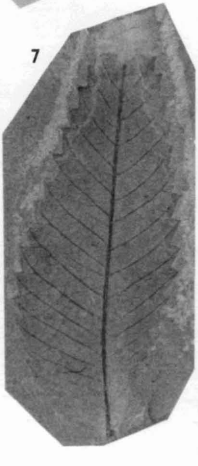


8

9

11

7



EXPLANATION OF PLATE II

PAGE

FIG. 1. *Smilax lancifolia* L. Herbarium specimen, The NYGB, for comparison with *Smilax rubyensis* Becker (Becker, 1961, Pl. 11, Figs. 9–11)............ 92

FIG. 2. *Populus balsamoides* Goeppert. Hypotype UMMP 38230. To substitute for Becker, 1961, Pl. 13, Fig. 1. × 1½ 92

FIGS. 3, 4, 5. *Equisetum* sp. Brown. Hypotypes UMMP 51430 and 51431. Rhizome-tubers. × 2. Figs. 4, 5 are counterparts 100

FIG. 6. *Celtis mccoshi* Lesquereux. Hypotype UMMP 51437. × 2. 102

FIG. 7. *Zelkova drymeja* (Lesquereux) Brown. Hypotype UMMP 51439. × 1½... 103

FIGS. 8, 9. *Ulmus tenuinervis* Lesquereux. Hypotype UMMP 51438. Counterparts. × 1½. 102

FIGS. 10, 11. *Fagopsis longifolia* (Lesquereux) Hypotypes UMMP 51435, 51436. Fig. 10. × 1½; Fig. 11, × 1. 101

EXPLANATION OF PLATE III

PAGE

FIG. 1. *Crataegus copeana* (Lesquereux) MacGinitie. Hypotype UMMP 51446. × 1¼. 104

FIGS. 2, 3, 4. *Prunus eleanorae* sp. nov. Holotype UMMP 51448. Figs. 2, 3 are counterparts; Fig. 4, a flower petal. × 1½. 105

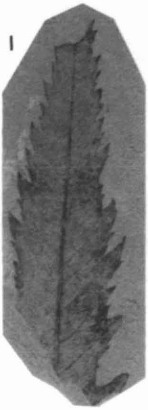
FIG. 5. *Crataegus gracilens* MacGinitie ? Hypotype UMMP 51447. × 1½. 105

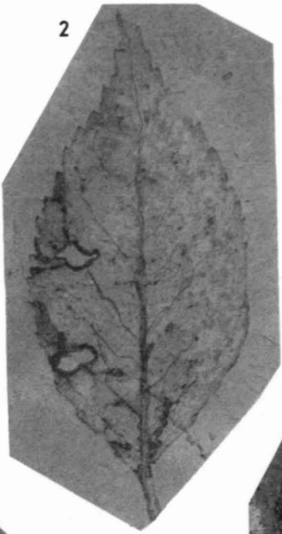
FIG. 6. *Spiraea harneyana* Chaney and Axelrod. Hypotype UMMP 51451. × 3. . . . 107

FIG. 7. *Paliurus florissanti* Lesquereux. Hypotype UMMP 51459. × 3. 110

FIGS. 8, 9. *Pyrus rubyvallis* sp. nov. Holotype UMMP 51449. Counterparts. × 1. . . 106

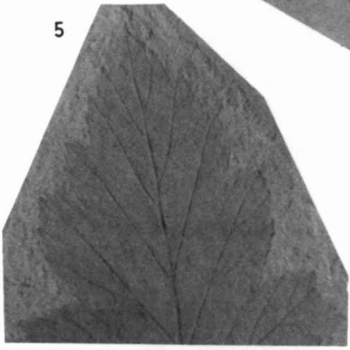
PLATE III

1


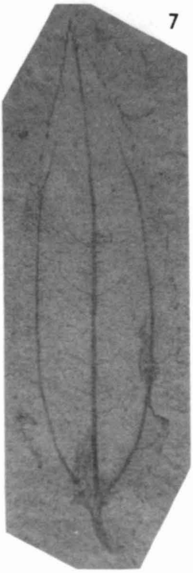
2


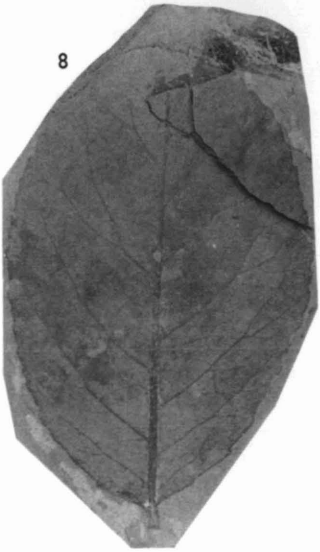
3


4


5


6


7


8


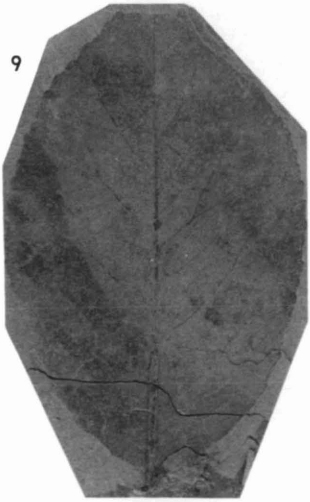
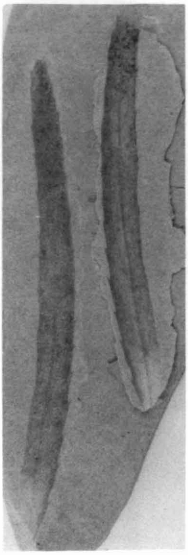
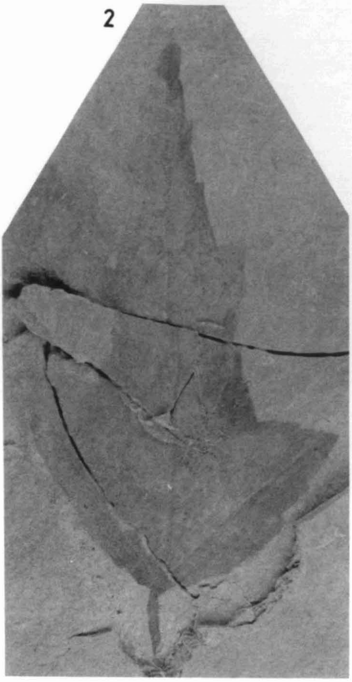
9


PLATE IV

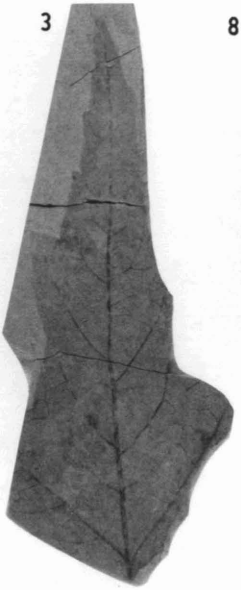
1



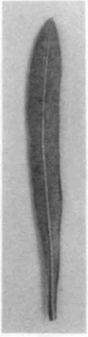
2



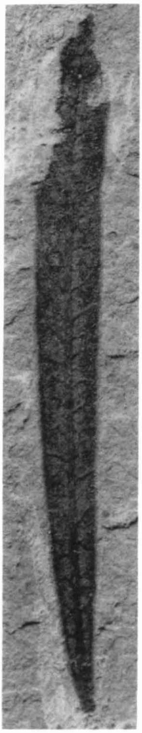
3



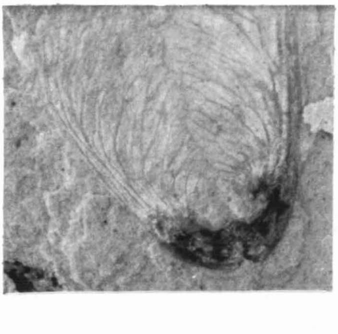
8



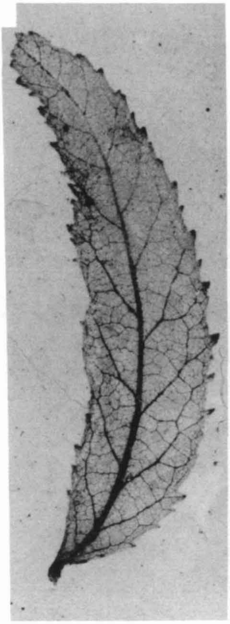
7



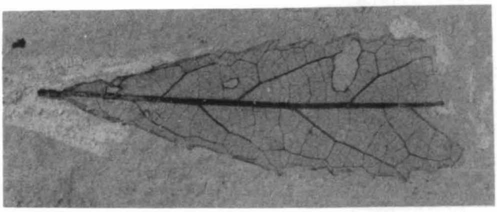
4



5



6



EXPLANATION OF PLATE IV

	PAGE
Fig. 1. *Mahonia subdenticulata* (Lesquereux) MacGinitie. Hypotype UMMP 51440. Counterparts. × 1.1.	103
Figs. 2, 3, 4. *Acer glabroides* Brown. Hypotypes UMMP 51456. Counterparts. × 1½; Hypotype UMMP 51457. Samara. × 2.	109
Fig. 5. *Spiraea clavidens* Becker. Hypotype UMMP 51450. × 2.	106
Fig. 6. *Spiraea* sp. Weyand. Hypotype UMMP 51452. × 2.	107
Fig. 7. *Dodonaea reniptera* Becker. Hypotype UMMP 51458. Leaf. × 3.	110
Fig. 8. *Dodonaea viscosa* Jacquin. Herbarium specimen, The NYBG, for comparison with Fig. 7. × 1.	110

EXPLANATION OF PLATE V

PAGE

Figs. 1, 2. ***Rhus cotinoides*** sp. nov. Holotype UMMP 51454. Counterparts. × 2. 108

Fig. 3. ***Rhus choriophylla*** Woot *et* Standl. Herbarium specimen, The NYBG, for comparison with Figs. 1, 2. × 1½. 108

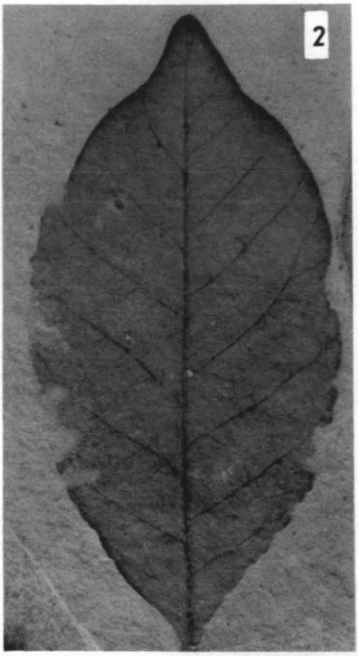
Figs. 4, 5. ***Rhus longipetiolata*** (Lesquereux) Brown. Hypotype UMMP 51455. Counterparts. × 2½. 109

Fig. 6. ***Ailanthus americana*** Cockerell. Hypotype UMMP 51453. Twin samara. × 2. 108

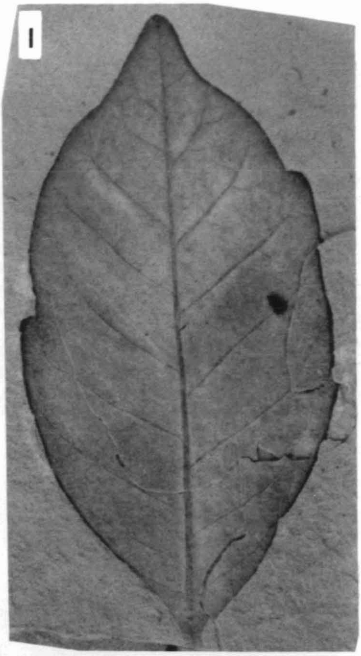
Fig. 7. cf. ***Gordonia idahoensis*** (Knowlton) Berry. Hypotype UMMP 51432. × 1¾. 110

PLATE V

2



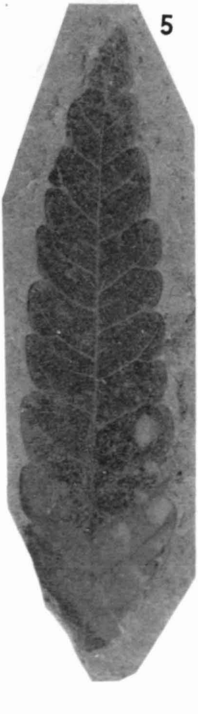
1



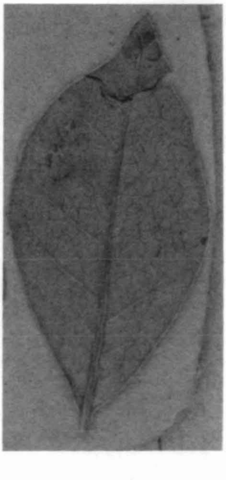
4

6

5



3



7

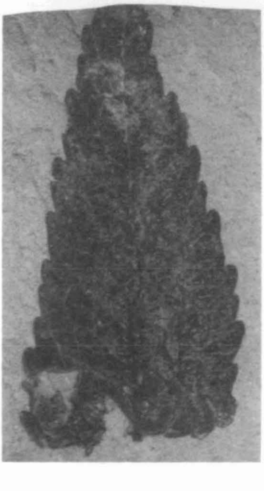
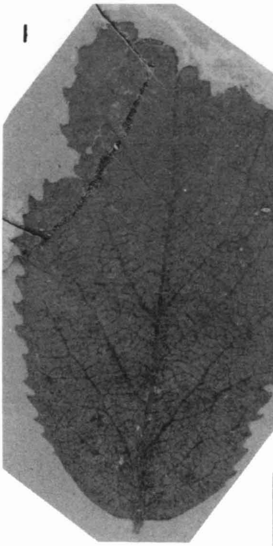
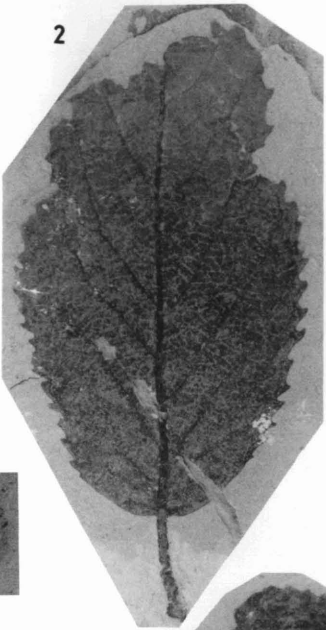


PLATE VI

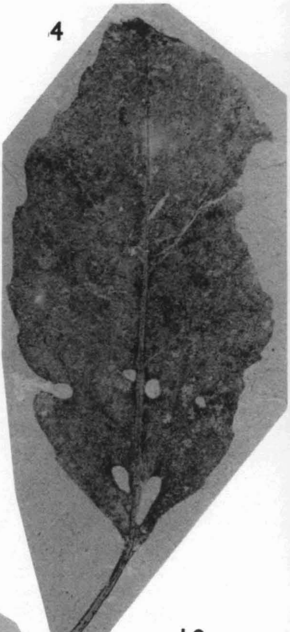
1



2

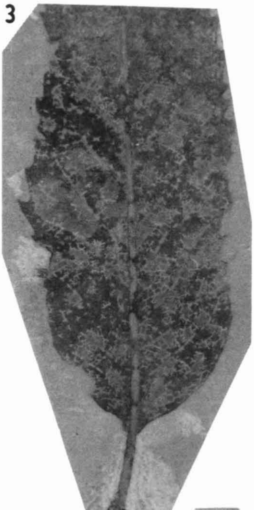


4



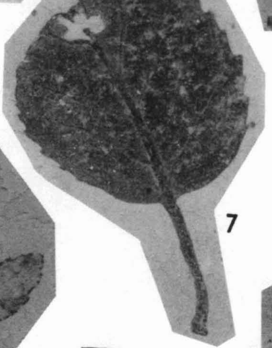
11

3

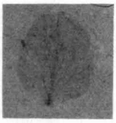


5

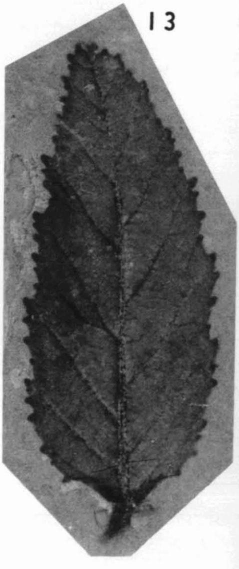
7



12



13



10

6

8

9

EXPLANATION OF PLATE VI

	PAGE
Unidentified species	111

FIG. 1, 2. cf. rosaceous ? Leaf. Figured specimen UMMP 51865. × 1¼, counterparts.

FIG. 3. Leaf of cf. Fagaceae? Figured specimen UMMP 51864. × 1¾.

FIG. 4. Leaf of Fagaceae ?, cf. *Quercus* ? Figured specimen UMMP 51863. × 1½.

FIG. 5. Angiospermous, glandular leaf ? Figured specimen UMMP 51857. × 2.

FIG. 6. Angiospermous leaf, Compositae ? Figured specimen UMMP 51858. × 2¼.

FIG. 7. cf. rosaceous leaf ? Figured specimen UMMP 51861. × 1½.

FIG. 8. cf. sapindaceous leaf ? Figured specimen UMMP 51862. × 1¼.

FIG. 9. cf. Chamaebatia ? Figured specimen UMMP 51859. × 2.

FIG. 10. cf. rosaceous petal ? Figured specimen UMMP 51856. × 1½.

FIGS. 11, 12. cf. rosaceous petals ? *Rosa* ? Figured specimen UMMP 51867. × 1¼.

FIG. 13. Glandular leaf; *Alnus* ? rosaceous ? UMMP 51444. × 2.