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I hereby recommend that the thesis prepared under my supervision by Arthur F. Beyer, Jr.

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THE IDENTIFICATION OF SOME PETRIFIED WOODS FROM YELLOWSTONE NATIONAL PARK

A dissertation submitted
to the

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by

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B. S. the Ohio University, Athens, Ohio 1943

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The Identification of some Petrified Woods from Yellowstone National Park

Introduction:

In the Yellowstone National Park practically all of the exposed rock formations are igneous or metamorphic consisting mostly of ash, obsidian and basalt. The central sector is made up of plateau country which though 7,000 to 8,500 feet above sea level, is nearly completely surrounded by mountain ranges rising 2,000 to 4,000 feet above it.

The jet black obsidian of spectacular Obsidian Cliff and the lava masses of Specimen Ridge in the Lamar River region are proof of the volcanic orgin of the surrounding strata which are considered by geologists as having been ejected from Mount Washburn during the early part of the Miocene or late Eocene.

The Specimen Ridge cliffs which outcrop 2,000 feet above the plateau extend for 20 miles along the Lamar River and include strata which contain some of the most remarkable petrified trees in the entire park.

Many superposed layers of upright petrified trunks (not less than 15 according to Knowlton [1899]) appear to indicate that in past geologic time a cyclic succession of forests flourished only to be caught by catastrophes and repeatedly covered with volcanic ash and lava.

The great wealth of extinct plants of the Lamar River region must have astonished the early explorers of those regions but though reference to the area is made in the writing of the early naturalist W. H. Holmes (Hayden, 1873) few if any detailed studies of the fossilized woods were made before 1899, when Professor Knowlton published his monograph "The Fossil Flora of Yellowstone National Park."

The fossil wood specimens which Knowlton collected from the Specimen Ridge area of the park form the main body of material for anatomical reports in his monograph (1899); however, he collected plant fossils at sites other than Specimen Ridge, some of which he later investigated.

Conrad (1933) wrote on Pityoxylon amethystinum Knowlton.

In 1933, Read investigated the fossil woods of Specimen Ridge and described several woods which he identified as Pinus baumani Read, Pinus fallax (Felix) Read, Cupressinoxylon lamarense Read and Sequoia magnifica Knowlton.

In 1939, Andrews reported on the anatomical details of several collections of fossil woods from Yellowstone National Park with particular reference to the fossil forest of the northwest corner of the park known as the Gallatin region. Geologically, this area is not distinct from Specimen Ridge. Andrews redescribed Sequoia magnifica Knowlton, Cupressinoxylon lamarense Read and Pityoxylon spp.

The present paper deals with a large number of pieces of petrified wood collected in Yellowstone National Park in

1941 [1], with the permission of the proper authorities, which are now part of the Paleobotanical collections of the University of Cincinnati (CINC) [2].

For the most part, the specimens represent silicified material, but there are occasional calcified specimens, a condition already noted by Read (1933). The silicified forms are better preserved and lend themselves better to investigation with the thin section technique.

In some specimens there is partial opalization, while in others there is complete replacement of the woody tissues, and thus they are not sufficiently preserved to show structure. It is apparent from the earlier records that Knowlton (1899) also encountered this condition, since he noted that the details of the rays and the pitting of both tracheids (horizontal and vertical) and rays were difficult to determine in some cases because of poor preservation. In the present investigation, only those specimens which demonstrated good preservation in all three views were used in specific diagnosis.

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[1] The material was collected by Dr. J. H. Hoskins, University of Cincinnati, Dr. T. H. Just, Chicago Museum of Natural History, Dr. A. T. Cross, West Virginia Geological Survey and Dr. A. H. Blickle, Ohio University.

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[2] The collection (specimens and slides) include the following numbers: B-641 to B-824a.

The majority of the specimens represent small fragments of larger tree trunks and only secondary wood, but a few pieces exhibit both primary and secondary wood. The specimens were collected at random as the field party ascended the slope of Specimen Ridge and since the greater number of specimens were loosely scattered no attempt has been made in this report to place the fossils in their correct stratigraphic layer.

Acknowledgments:

The writer is greatly indebted to Professor J. H. Hoskins for suggesting work on the University of Cincinnati collection of fossil woods from the Yellowstone National Park. Dr. H. R. Muegel and Dr. Hoskins gave freely of their time in valuable consultations and with stimulating help in the diagnosis of most of the specimens. Dr. Muegel was very helpful with suggestions for naming the new species and also for some very important translations. Finally, Dr. Hoskins, Dr. Muegel and Dr. Margaret Fulford were very helpful in the reading of the original and subsequent copies of the manuscript.

Description of the Specimens

Gymnospermae

Coniferales

Pinaceae

Pinus L.

Growth rings usually distinct, very variable in width; longitudinal and transverse resin ducts present; epithelial cells thin-walled; wood rays of two types; normal, most often uniseriate, sometimes biseriate in part; and fusiform, in which case there is always an included resin duct; ray tracheid walls smooth or dentate; pits of ray parenchyma usually simple; bordered pits on radial walls of wood tracheids in one or two rows, most often one; occasionally pits occur on tangential walls of some species; well developed crassulae usually present.

Pinus fallax (Felix) Read. Carn. Inst. Pub. 416, p. 13, 1933.

Pityoxylon fallax Felix. Zeitschr. Deutschr. d. geol. Gesell., 1896.

Pityoxylon Aldersoni Knowlton. U. S. Geol. Sur. Mon. 32 (2), p. 763, 1899.

Pityoxylon amethystinum Knowlton. op. cit. p. 764.

Transverse section:

Growth rings usually broad, from 0.5 mm. to 10 mm. in width; line of separation between early wood and late clear, transition gradual (fig. 18); however, as is usually the case, growth rings distinct: early wood tracheids 42 mu. to 60 mu. in radial diameter, averaging 48 mu.: from 1 - 18 rows of tracheids between wood rays, mostly 7 - 10: resin ducts present (fig. 18), usually abundant, although in a few cases not so numerous, but in all cases characterized by the presence of thin-walled epithelial cells surrounding the duct; resin ducts from medium to large in transverse diameter, mostly of the larger sort; resin ducts vary as to position; in some specimens located mostly in late wood, in others scattered throughout the ring.

Radial section:

Most of the specimens which fall within the range of this species do not demonstrate all pertinent features in the radial section. This is to be expected, for Knowlton (1899) and Conrad (1930), have commented on the lack of preservation on the radial surface of some of the petrifactions from the Yellowstone National Park.

A number of specimens, however, were observed in which every detail of radial character was adequately (and sometimes excellently preserved. From these specimens it was clear that the bordered pits on the radial walls of the tracheids were in a single series for the most part while in some few instances they were in two rows, in which case they were usually opposite each other (fig. 6). The bordered pits of these tracheids varied from 19 - 20 mu., with most being 20 - 21 mu. in diameter. Cross field pits few in number (1 - 4; mostly 1 - 3) and oval in shape. In some specimens ray tracheids were observed, in which case they were usually marginal (fig. 6); tracheids have blunt rounded tips similar to those observed in the Pityoxylon dis-
by Conrad (1930): in a few cases

crassulae were observed.

Tangential section:

Normal rays rather low (2 - 15, mostly 4 - 10 cells); uniseriate with occasional biseriation, but never for the entire height of the ray (fig. 5); individual cells of rays elongate with the exception of the marginal cells which are triangular, averaging 18 mu. in width (fig. 5); none of the ray cells contain resinous material; fusiform rays usually relatively abundant and always have a large central resin duct which occupies the entire width of the ray; epithelial cells of resin ducts conspicuously thin-walled; no bordered pits observed in tangential section.

Specimens and slides numbered: B-641, B-682, B-697, B-704, B-720, B-726, B-738, B-756, B-762, B-780, B-781, B-817, B-818, B-819, B-820, B-823 and B-824. Pityoxylon sp. B-661, B-664, B-667, B-677, B-680, B-688, B-689, B-706, B-709, B-715, B-721, B-722, B-731, B-747, B-749, B-750, B-760, B-764, B-767, B-769, B-770, B-775, B-778 and B-783 (CINC).

Discussion:

Of the 41 specimens examined only 17 were suitable for accurate measurement and diagnosis; the remainder were insufficiently preserved on one or all three sections to allow for complete investigation. We have referred these to the form genus Pityoxylon. An interesting situation presents itself: the measurements and characters of all 41 specimens in so far as they could be determined were so uniform as to justify the conviction that all belong in the same species. If several species are represented their anatomical peculiarities are not sufficient to separate them.

The variations in characters encountered in the various specimens studied do not exceed those which are normal for Pinus fallax (Felix) Read (1933) who properly placed Pityoxylon fallax Felix, Pityoxylon Aldersoni Knowlton and Pityoxylon amethystinum Knowlton in synonomy.

Read (1933) described Pinus baumani and differentiated it from Pinus fallax mainly on the presence of a lesser number of resin ducts in P. baumani and also because most of the resin ducts were located in the late wood in Pinus baumani. Differences of such a nature in modern woods can occur within different parts of the same tree. A single transverse section of some of the specimens showed areas in which there were a few resin ducts and other areas in which the resin ducts were more numerous. There is a strong suggestion, therefore, that Pinus baumani and Pinus fallax represent minor anatomical variations of the same species.

Pinus pseudotsugoides Beyer, sp. nov.

Transverse section:

Growth rings relatively abrupt, line of separation of the late and early wood more or less sharply delineated (fig. 19), the early wood band about twice the width of the late wood band; 2-20 rows of tracheids between wood rays, averaging 7; early wood tracheids averaging 42 mu. x 77 mu., about four times as large as the late wood tracheids: resin ducts relatively numerous, scattered throughout the early and late wood areas; tylosoids present (fig. 19); epithelial cells of resin ducts not clearly seen in transverse section but apparently thin-walled (definitely so in tangential section).

Radial section:

Bordered pits uniseriate, with occasional biseriation, but never for a great distance (fig. 7); averaging 20 mu. with a large circular aperture (11 mu.); ray pitting observed, but the preservation is poor and complete diagnoses or measurements cannot be made; ray tracheids appear to be present, however.

Tangential section:

Rays numerous, of two types; normal and fusiform (fig. 8); normal rays mostly uniseriate, with occasional biseriation, but never for their entire height; variation in height of wood rays from 2 - 22 cells; greatest number 5 - 10 cells, averaging 8 cells; individual cells of wood rays elongate with round to oval lumina and relatively thick-walled (2.5 mu.); average width 22 mu.; fusiform rays with a single large resin duct which occupies the entire width of the ray; thin-walled epithelial cells clearly seen: spiral thickenings are present with moderate abundance in the early wood tracheids (fig. 8).

Holotype specimen and slides numbered: B-725; isotype specimen and slides numbered B-763 (CINC).

Discussion:

Spirals on the walls of the wood tracheids suggest, at least, a relationship with Picea Link., Larix Tourn. or Pseudotsuga Carr. Record (1925) states that

> ".....spiral wood tracheids are sporadic in Picea and Larix, but in some instances are highly developed. In a specimen (Yale, No. 3851) from India, said to be Picea morinda Link., the structure closely approximates that of Pseudotsuga; in places, especially in the late wood, the thickenings give place to striations."[3]

The specimen under consideration is characterized by the presence of many more vertical resin ducts than are uaually observed in Picea, Larix or Pseudotsuga. Also, the specimen is Pinus - like in that the epithelial cells

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[3] Spirals on the walls of the wood tracheids can also be seen in specimens of Picea Smithiana

of the resin ducts are thin-walled, a character which differentiates Pinus from Picea, Larix or Pseudotsuga.

According to Penhallow (1907), furthermore, broad fusiform rays with the included resin duct occupying the entire width of the ray is a Pinus character. Picea, Larix and Pseudotsuga all have thinner fusiform rays and the included resin duct does not usually occupy the entire width of the ray.

Again, according to Penhallow (1907), there are spirals in the tracheids of Pinus taeda L. and according to Bailey (1909) they occur in "Pinus attenuata Lemm. and several other species." In the case of Pinus taeda and Pinus attenuata, the spirals are located in the late wood tracheids; while, in our specimen, the spirals are, as far as can be determined, in the early wood only.

The anatomical characters of this species, other than the spiral thickenings, are similar to those found in Pinus fallax. The occurrence of spiral thickenings is, however, a distinction of sufficient significance to isolate this species. The specific name was chosen to reflect this outstanding character.

Piceoxylon Gothan. Gymnospermenhölzer. Abh. K. Preus. Geol. Landes. N. F., Heft XLIV, p. 1. 1905.

Pityoxylon p. p. Kraus in Schimper. Traité de Paléontologie

Végétale, vol.
2: p. 377, 1872.

The form genus, Piceoxylon Gothan includes those fossil woods with anatomical characters similar to those found in Picea, Larix and Pseudotsuga (Seward, 1919). The main characters of this form genus are the thick-walled epithelial cells, abietineous pitting and an absence of dentately thickened walls in the ray tracheids.

Piceoxylon laricinoides Beyer, sp. nov.

Transverse section:

Vertical resin ducts few in number a nd surrounded by thick-walled epithelial cells (fig. 20); resin ducts small, averaging 145 mu. in diameter including epithelial layer; transition between early wood and late wood markedly abrupt (fig. 20); in most growth rings the late wood is pronounced and is from 3 - 4 to 18 - 20 cells in width; average diameter of early wood tracheids is 42 mu., but some of the larger elements in this tissue are up to 50 mu. in diameter; early wood tracheids 3 - 4 times as large as their late wood counterparts; tracheids squarish to hexagonal in outline (fig. 20); moderately numerous parenchymatous resin cells present in all growth rings and usually in short radial bands (fig. 20); four to eight rows of tracheids separate wood rays; mostly 7 - 8.

Radial section:

Bordered pits most often in a single series, although sometimes in a double row, usually opposite, but rarely for greater than 3 - 4 pits; bordered pits average 19 mu., the aperture 6.5 mu. in diameter; both ray tracheids and ray parenchyma present (fig. 3); ray parenchyma has 2 - 4 simple pits per cross field area.

Tangential section:

Rays of two types: normal and fusiform (fig. 4); normal rays up to 27 cells in height, mostly 8 - 12; most often uniseriate with occasional biseriation, but never for their entire height; individual ray cells often occluded with resinous material (fig. 4) and oblong to elongate in outline with round lumina; average width of ray cells 16 mu.; fusiform rays few in number, but always include a resin duct (fig. 4); thick-walled epithelial cells (sometimes resinous) are characteristic.

Holotype specimen and slides numbered: B-714 CINC.

Discussion:

This specimen is one which must be compared with wood of <u>Larix</u> and <u>Picea</u>. According to some investigators (Slyper, [1933] and others) the woods of these genera are difficult to separate on the basis of secondary wood characters alone. Brown and Panshin (1940) separate <u>Larix</u>

and *Picea* on the following characters:

> *Larix*....."Summer wood pronounced: transition from spring to summer wood abrupt; pits leading from ray parenchyma to longitudinal tracheids 1 - 12 (generally 4 - 6) per ray crossing, often in double horizontal rows" and continues for *Picea*, "Summer wood not pronounced; transition from spring to summer wood usually gradual; pits leading from ray parenchyma to longitudinal tracheids 1 - 6 (generally 2 - 4), per ray crossing, generally in a single horizontal row."

Slyper (1933) maintains that to differentiate accurately one must have pith tissue, since *Larix* has no sclerenchyma cells; while in *Picea*, the pith is characterized by the presence of sclerenchyma cells.

Slyper (1933) differentiates the two on the following characters:

Picea	*Larix*
1. "Spiral thickenings present in the tracheids, either in whole growth ring or else in the mid-season and late wood, in which case, however ray tracheids with denticulations	1. "No or few spiral thickenings in tracheids and never in early wood. If spiral striations are present, spiral thickenings are lacking. Ray tracheids with only very small denticulations, only

Picea	Larix
and spiral thickenings are present and no or very little wood parenchyma.	exceptionally with larger ones.
2. "No or little wood parenchyma near limit of growth ring."	2. "Very abundant wood parenchyma not only in vicinity of limit of growth ring, but also throughout late wood and even, sparingly in the early wood."

It is true that to differentiate between the two genera on the basis of secondary wood alone is difficult, but this specimen appears to resemble Larix more closely than it does Picea on the basis of the following characters:

1. The transition between the early and the late wood is abrupt.
2. Parenchyma cells are present in all of the growth rings.
3. There is a small number of simple pits in each cross-field area (this does not necessarily preclude Picea, but is, at least a strong suggestion that the specimen is Larix or Larix-like because Larix usually

has a fewer number of simple pits in the cross-field area than does *Picea*).

4. No spiral striations or spiral thickenings were observed.

The specimen has been referred to the form genus *Piceoxylon* Gothan, rather than to the genus *Larix* since there must remain a reasonable doubt as to the exact generic relationship of the specimen. The genus *Piceoxylon* Gothan was separated along with *Pinuxylon* Gothan from the form genus *Pityoxylon* Kraus, which includes the fossil representatives of the living genera *Pinus*, *Larix*, *Picea* and *Pseudotsuga* (Seward, 1919). *Pinuxylon* is obviously for fossil wood with characteristics of *Pinus*; *Piceoxylon*, for those with characters similar to *Picea*, *Larix* or *Pseudotsuga*.

The wood under consideration is not referable to *Pseudotsuga* because of a lack of spiral thickenings. Even with the close anatomical resemblance of this specimen to *Larix* it is not safe to assume that a close relationship to a Picea-like form can be eliminated, for in the absence of pith parenchyma a certain amount of caution must be exercised. Furthermore, the abruptness of the growth ring could possibly be a character of ecological variation.

Since this specimen shows the greater resemblance to *Larix* it seems best to place it in the form genus *Piceoxylon* Gothan as a new species *Piceoxylon laricinoides*.

Cedroxylon Kraus, in Schimper. Traité de Paléontologie Végétale, vol. 2: p. 370, 1872.

Growth rings well defined, sometimes narrow: resiniferous tracheid cells in the transverse section more or less abundant; bordered pits in the radial section circular, usually in one row, if in two rows, opposite. Only xylem parenchyma is present in the wood rays and there can be several small pits in the cross field area. No resin ducts, except in traumatic tissue (Seward, 1919). This form genus (Cedroxylon) was created by Kraus (1872) to include wood with structural characters similar to present day Cedrus, Abies and Tsuga.

Cedroxylon abietoides Beyer, sp. nov.

Transverse section:

Tracheids large, averaging 70 mu. in the early wood, but up to 91 mu.; resin cells scattered, few in number, occurring in the early wood, more frequently in the late summer wood, then often in short radial bands (fig. 22): growth rings sharply defined, but the transition from the early wood to the late wood is gradual: rays fine and invisible without the aid of the microscope, then faint; from 4 - 10 rows of tracheids between rays (fig. 22). Resin ducts not observed.

Radial section:

Bordered pits usually uniseriate; occasionally in two rows, but never for a great distance; average diameter of the bordered pits is 20 mu.; from 1 - 4, mostly 2 - 3 simple pits per cross field area; cross field pits average 16 mu. in diameter (fig. 2).

Tangential section:

Resin cells present; usually short, 160 mu. to 170 mu. in length; included material appears dark and carbonaceous; rays uniseriate, individual cells roundish, with terminal cells being elongate-tapered (fig. 1); ray cells averaging 17 mu. in width, rather thin-walled; rays 6 - 31 cells in height.

Holotype specimen and slides numbered: B-788; isotypes and slides: B-710, B-717, B-759 and B-793 (CINC).

Discussion:

In spite of the broad and diversified nature of the form genus <u>Cedroxylon</u> Kraus, and in the absence of plant parts other than secondary wood, it seems best to place these specimens in this genus. The anatomical similarity of the specimens to <u>Abies</u> (Tourn.) Hill is readily demonstrated with the use of the analytical keys of Penhallow (1907), Slyper (1933), Piccioli (1919), Record (1934) and Brown and Panshin (1940). The specimen does not agree with any of the modern species of Abies or of Cedroxylon and is designated as C. abietoides.

Taxodiaceae

Sequoia Endl. Syn. Conif. p. 197. 1847.

Transition from the late to the early wood is generally abrupt; growth rings usually narrow but highly variable: as seen on transverse section resiniferous parenchyma cells are abundant and zonate: resin ducts, when present, traumatic only, then in either or both vertical or horizontal planes: wood rays usually uniseriate, but occasional biseriation sometimes present: ray tracheids absent: resin deposits commonly present in wood rays and bordered pits on longitudinal tracheids in 1 - 2 rows (up to 4); in some species tangential pitting has been observed (Read, 1933); crassulae sometimes present.

Sequoia magnifica Knowlton. U. S. Geol. Surv. Mon. 32 (2), p. 761, 1899.

Transverse section:

Transition from early wood to late wood rather abrupt, but not sharply so (fig. 21); growth rings 1 - 3 mm. wide, distinct to the unaided eye, with late wood exhibiting extreme variation in width, from 2 cells up to 10 - 17 cells, with a maximum number of 25[4]; early wood tracheids from 48 mu. to 75 mu. averaging 60 mu. in diameter; late wood tracheids average 52 mu. in diameter; for the most part, tracheids are hexagonal in outline (fig. 21); lumina of early wood tracheids readily visible with aid of a hand lens; 3 - 12 rows of tracheids between wood rays, most varying from 5 - 7, averaging 6 rows; parenchyma cells visible in all growth rings observed, scattered throughout the transverse section (fig. 21); discernible by dark resinous contents of cells; presence of resinous cells held by Penhallow (1907), Brown and Panshin (1940), Peirce (1936) and others to be characteristic for the genus; no resin ducts were observed.

Radial section:

Bordered pits usually well preserved, often in two rows, although uniseriation is not infrequent, averaging 25 mu. in diameter; crassulae occasionally distinctly visible (fig. 15); no ray tracheids observed; the ray parenchyma characterized by 1 - 4 simple oval shaped pits per cross field area (fig. 15): resiniferous parenchyma cells visible on both the radial and tangential sections.

Tangential section:

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4 Similar to coppice-grown stock (Brown and Panshin, 1940).

Rays mostly uniseriate with occasional biseriation but never for entire height of ray; fusiform rays not present; individual ray cells ovoid to elongate and many have dark resinous contents (fig. 16); rays 2 - 27 cells in height (up to 420 mu.), mostly 10 - 15 cells high.

Specimens and slides: Nos. B-642, B-644, B-647, B-666, B-667, B-675, B-702, B-703, B-712, B-732, B-757, B-773, B-784, B-785, B-790, B-792, B-793, B-794, B-797, B-809, B-810, B-812, B-815, B-816 and B-823.

Discussion:

There are few anatomical characters which serve to separate wood of living or fossil _Taxodium_ Richards, _Sequoia_ Endl. and _Sequoiadendron_ Bucholtz (1939). It is true that _Sequoia_ may be distinguished from _Sequoiadendron_ on wood characters. _Sequoiadendron_ is known to possess ray tracheids occasionally (Peirce, 1936), while, as far as is known they are not present in _Sequoia_. Separation of the wood of _Sequoia_ (and _Sequoiadendron_) from that of _Taxodium_ is difficult. Peirce (1936) differentiates _Taxodium_ and _Sequoia_ in the following way:

Taxodium	Sequoia
1. "Normal ray tracheids absent.	1. "Normal ray tracheids usually absent (present in _Sequoia gigantea_," =_Sequoia_-

Taxodium	Sequoiadendron giganteum [Lindl.] Buch., 1939)
2. "Transverse walls of ray cells 2 - 4 mu. thick, primary pit fields present, often numerous; tangential walls 3/4 to 2 mu. thick; radial walls 1 - 2 1/2 mu. thick.	2. "Transverse walls of ray cells 1 - 4 mu. thick, with occasional primary pit fields; tangential walls 1/2 to 2 mu. thick; radial walls 3/4 to 2 1/2 mu. thick.
3. "Indentures[5] absent or regularly present and pronounced.	3. "Indentures absent or rare and conspicuous.
4. "Ray cells non-resinous.	4. "Ray cells non-resinous.
5. "Tracheid pitting bi-seriate to multiseriate in early wood; crassulae abundant.	5. "Tracheid pitting uni-seriate to multiseriate in early wood; crassulae pronounced to indistinct.
6. "Ray cells 1 - 60 cells high, rarely to often partly biseriate.	6. "Ray cells 1 - 30 cells high, often partly bi-seriate, occasionally

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5 'employed to indicate the abruptly thin portion of the transverse wall of a ray cell at the point of juncture with the tangential wall.....;'.

Taxodium	Sequoia
	completely biseriate.
7. "Ray cells hexagonal, occasionally long elliptic, in cross section.	7. "Ray cells circular to long elliptic or squared to hexagonal, in cross section.
8. "Wood parenchyma abundant, scattered, transverse walls entire.	8. "Wood parenchyma abundant, scattered or somewhat banded tangentially, transverse walls thick.
9. "Transition usually gradual, occasionally abrupt.	9. "Transition moderately to extremely abrupt.
10. "Radial diameter of early tracheids, 40 - 90 mu; tangential diameter, 35 - 90 mu.; radial diameter of late tracheids 10 - 30 mu.; tangential diameter, 40 - 75 mu.	10. "Radial diameter of early tracheids 30 - 100 mu.; tangential diameter, 24 - 60 mu.; radial diameter of late tracheids, 7 - 24 mu.; tangential diameter, 24 - 60 mu.
11. "Wall thickness of early tracheids, 1 1/2 to 5 mu.; of late tracheids, 4 - 8 mu."	11. "Wall thickness of early tracheids, 1 - 3 mu.; of late tracheids, 3 - 8 mu."

It becomes increasingly apparent that a generic separation of Taxodium and Sequoia and/or Sequoiadendron on the basis of wood characteristics alone is, at best, difficult, and it is made increasingly so by the fact that certain characters, i. e. thickness of the tracheid walls, nature of the cross field pits, and the indentures are often altered or obliterated during, or before fossilization.

While the anatomy of the specimens compares favorably with that of Sequoia, i. e. as to the type of tracheid pitting, shape of the ray cells, height of the rays, and the abundance of crassulae, it does not differ materially from the anatomical characters of Taxodium.

Both genera have been reported from rocks of Tertiary age (Knowlton, 1919), i. e. Taxodioxylon credneri Platen, Taxodioxylon sequoianum Gothan and Sequoia magnifica Knowlton. In addition there are reports (Knowlton, 1919) of leaf compressions related to Taxodium which are found in the Tertiary (Miocene); and there are fossils of sequoia - like leaves in rocks of the same age. One of these latter, Sequoia langsdorfii (Brongniart) Heer has been transferred to the genus Metasequoia by Chaney (Hu and Cheng, 1948).

There are three generic names which could be applied to specimens having sequoian anatomical characteristics: Cupressinoxylon Goppert, Sequoioxylon Torrey and Sequoia Endl.

According to Torrey (1923) the form genus Cupressinoxylon is reserved for petrifactions of sequoian nature which do not show traumatic resin ducts, while those sequoian woods with traumatic resin ducts should be placed in the form genus Sequoioxylon.

Knowlton (1899), on the other hand, made no mention of any resin ducts in any of his sequoian specimens, but nevertheless referred his specimens to the genus Sequoia.

Our collection includes 25 wood specimens which are sequoian in nature. Neither normal nor traumatic resin ducts have been observed. Comparison of these specimens with Sequoia magn ifica Knowlton indicates that they are very similar, if not identical.

The problem of the choice of generic name for these specimens is therefore difficult. It would seem that these specimens should be referred to Sequoia magnifica for the following reasons:

1. The genus Sequoioxylon Torrey may not be used since it is reserved for those forms which have traumatic resin ducts. They were not observed in our specimens.
2. The genus Cupressinoxylon Goppert is reserved for those woods of taxodiaceous nature which do not show the presence of traumatic resin ducts. Torrey (1923) maintains that in the absence of traumatic resin ducts, wood of sequoian affinity should be placed in the aforementioned genus. While the living Sequoia sempervirens (Lamb.) Endl. does

occasionally produce resin ducts as a result of wounds (Record, 1919, and others), it does not necessarily follow that any great area of wood, or for that matter, any one tree would of necessity contain traumatic resin ducts. It is true that the presence of traumatic ducts would definitely prove that a given form of sequoian wood would be more closely allied to the genus Sequoia, but it does not conclusively prove that sequoian-like wood is not Sequoia if that character (which at best is negative) is absent.

3. The specimen under consideration closely resembles Sequoia magnifica Knowlton. This This generic designation also has priority over the other two (i. e. Sequoioxylon and Cupressinoxylon).

Knowlton (1899, p. 762) did not observe cross field pits; he said that, "the medullary rays in the living wood are provided with numerous round pores, or markings. These seem to be absent from the fossil specimens, but as already related under the diagnosis the fossil is not well preserved in the radial section and they may have been present there when it was living."

In the specimens under discussion these structures were seen (fig. 15) and thus definitely tend to correlate these specimens with the living form.

Sequoia burgessii Penhallow, has been closely compared to _Sequoia magnifica_ by Penhallow (1903); the only noticeable difference being in the occurence of resin ducts in the former. Perhaps, at a later date, it will be found that _Sequoia burgessii_ and _Sequoia magnifica_ are identical species, since Record (1934), Brown and Panshin (1940), Jeffrey (1917) and others recall that living _Sequoia_ does occasionally demonstrate the presence of traumatic resin ducts.

Cupressaceae

Cupressinoxylon Göeppert. Monographie der fossilen Coniferen. Naturwerkundige Verhand. Holland. Maatschap. Wettenschappen Haarlem. Leiden, p. 196, 1850.

Seward (1919, p. 186) comments on the genus _Cupressinoxylon_ Göeppert, in the following manner: ".....is usually applied to fossil wood exhibiting the following features: Annual rings well defined, often narrow; vertical rows of parenchyma, often containing resin and recognisable by their dark contents even in transverse section, scattered through the spring- and summer-wood. Bordered pits on the tracheids usually separate and circular, and if in more than one row, opposite; medullary-ray cells generally characterised by the presence of several small pits in the field....."

The genus Cupressoxylon Kraus (1872, p. 374) has the same scope, but is in this paper discarded because of the connotation that Cupressoxylon is closely allied to the present day Cupressus L. The specimens under consideration do not indicate a relationship to Cupressus.

In this paper the genus Cupressinoxylon Goeppert is interpreted (according to the above [Seward, 1919, p. 124, 189]) to include those fossil forms with characters similar to those found in the family Cupressaceae (Cupressus L., Chamaecyparis Spach., Libocedrus Torr., Thuya L., Juniperus (Tourn.) L., Fitzroya Hook., Diselma Hook., Thujopsis Sieb. and Zucc., Taxodium Rich., Glyptostrobus Endl., Cryptomeria D. Don., Taiwania Hayata, Athrotaxis D. Don., Tetraclinis Mast., and Fokienia .) anatomically described by Record and Hess (1943) and Peirce (1937).

Cupressinoxylon thuyoides Beyer, sp. nov.

Transverse section:

Growth rings distinct, narrow, the band of late wood tracheids only a few cells wide (fig. 24); resiniferous parenchyma cells absent; 2 - 8 rows of tracheids between rays, mostly 4 - 6; tracheids of early wood average 35 mu. with 49 mu. as a maximum; lumina of tracheids oval in outline, tracheid walls relatively thick (6 mu.).

Radial section:

Bordered pits uniseriate, averaging 16 mu. in diameter; the aperture of the bordered pits 8 mu. in diameter: ray tracheids absent: 1 - 2 simple pits per cross field area in the ray parenchyma (fig. 12). Preservation in the areas of the rays on the radial section is more or less faulty and this feature is open to question.

Tangential section:

Rays all of one kind, uniseriate with occasional biseriation, but never for more than 1 - 2 cells; rays moderately high, up to 22 cells, mostly 7 - 12; individual ray cells rather narrowly oblong, mostly 11 mu. x 19 mu. (fig. 14).

Type specimen and slides: No. B-782; and the paratype slides and specimens, B-736, B-740, B-757 and B-784 (CINC).

Discussion:

This specimen appears to be closely related anatomically to the living genus Thuya L. According to Brown and Panshin (1940), the genus Thuya is characterized as follows:

1. "Tallest rays generally less than 400 mu. in height; end walls of the ray cells smooth.
2. "Ray tracheids absent.

3. "Parenchyma wanting or very sparse and sporadic (sometimes abundant in a given growth ring but then wanting in neighboring rings).

4. "Tracheids without spiral thickenings.

5. "Resin canals absent."

There are, in addition, the following characters (Penhallow, 1907):

6. "Resin cells (transverse) rarely in bands, chiefly scattering, sometimes wanting.

7. "Ray cells (tangential) narrowly oblong."

Our specimens conform in all of the above respects. The selection of the generic epithet to house these specimens is a problem, however. Knowlton (1919) listed the genus Thuyoxylon Unger (1847, p. 31). The only species, Thuyoxylon americanum Unger is discussed by Roemer (1852, p. 95). Both of these descriptions, unfortunately, are much too brief. Thuyoxylon americanum cannot possibly be related to modern Thuya because of the presence of resin ducts in Unger's species, which he described thus, "ductibus resiniferis sat copiosis" (Roemer, 1852, p. 95).

The Thuites Sternberg and Thuya have been used for leaf compressions and suggest, at least, Thuya or thuya-like plants. Thuya garmani Lesq. (Lesquereux, 1883) and Thuya gracilis Newberry (Knowlton, 1919) have been reported from rocks of Tertiary (Miocene) age. While the presence of such leaf forms in the Miocene makes it probable that wood of the same affinity occurs, correlation of these leaf compressions with petrified wood cannot be made at present because no organic connections between them have been found.

It is thus seen that of the epithets Thuites Sternberg, Thuya L., Thuyoxylon Unger, Cupressoxylon Kraus, and Cupressinoxylon Göeppert, only the last may be employed in the present situation. Its generic relationship to Thuya is indicated in its name Cupressinoxylon thuyoides.

Cupressinoxylon libocedroides Beyer, sp. nov.

Transverse section:

Growth rings from 2 - 4 mm. wide; transition from early to late wood gradual (fig. 23): resinous parenchyma diffuse, but mostly in the late wood: tracheids square to hexagonal, up to 70 mu. in diameter, mostly 43 mu. to 65 mu. in diameter: 2 - 10, mostly 5 - 6 rows of tracheids between wood rays.

Radial section:

Bordered pits usually in a single series, occasionally in two rows, if so, then opposite, averaging 20 mu., with an 8 mu. aperture; crassulae present in most cases (fig. 17). As far as can be determined ray tracheids are absent. The cross field pitting was not observed, this character probably was obliterated during or before fossilization.

Tangential section:

Rays all of one kind, the highest 460 mu. (33 cells), uniseriate, with occasional biseriation for a few cells; individual ray cells ovoid with oval lumina, averaging 15 mu. in width, occasionally containing a dark resinous material (fig. 13).

Type specimen and slides: No. B-718. The paratype specimens and slides: nos. B-681, B-700, B-724, B-754 and B-813 (CINC).

Discussion:

The anatomical characteristics of these specimens are similar to those of the living Libocedrus Torr. According to Brown and Panshin (1940) the genus Libocedrus has the following characters:

1. "Tallest rays more than 300 mu. in height; broadest rays (uniseriate) 15 to 25 mu. wide.
2. "Parenchyma metatracheal diffuse.
3. "Ray tracheids absent or extremely sparce.
4. "Bordered pits on radial walls of the tracheids in 1 - 2 rows (mostly 1).
5. "Parenchyma fairly abundant to abundant, present in every growth ring.

6. "Longitudinal tracheids without spiral thickenings.

7. "Resin canals absent."

There are, in addition, the following characters (Penhallow, 1907):

8. "Resin cells (transverse) prominent and in more or less conspicuous tangential bands, sometimes of distant growth rings or again widely scattering.

9. "Rays (tangential) broad, very sparingly resinous, often 2 - seriate at least in part."

The specimens under consideration, then, are similar to the living form as the characters listed above occur in both the fossil wood and in the living form. The difference in tracheid size might be noted: i. e. in the living form the summer wood tracheids average from 35 - 40 mu., the same in these specimens average 48 - 65 mu.

The problem arises as to whether these specimens should be referred to the form genus _Cupressinoxylon_ which includes forms with cupressaceous affinity, or to the genus _Libocedrus_ itself. At present we can use only the genus Cupressinoxylon with confidence, because no organic connection between leaves and stem has yet been found. The generic affinity of the wood is indicated in its name _Cupressinoxylon libocedroides_.

It must be pointed out that _Cupressinoxylon libocedroides_ and *Cupressinoxylon thuyoides* appear to have only superficial resemblances to *Cupressinoxylon lamarense* Read (Read, 1933). *Cupressinoxylon lamarense* evidently was a poorly preserved specimen since bordered pits were not definitely recognizable.

Libocedrus is not well known from rocks of Miocene age, although it has been reported from leaf compression material from France (Miocene) and Germany and Italy (Oligocene) and from the western part of North America (Pliocene).

Angiospermae

Monocotyledonae

Fagales

Fagaceae

Quercinium Unger. Neues Jahrb., 1843. p. 173.

Quercoxylon Hofmann. Verkieselte Hölzer von der Vashegy (Eisenberg) -Gruppe. Ann. Sabarienses, III, p. 81 - 87. Pls. I - IV, 1929 (*nomen nudum*).

Wood typically ring porous, with two types of rays present; narrow and inconspicuous, and broad and conspicuous. The late wood vessels are few and thick walled. Tyloses present, but sparse in the early wood vessels.

Quercinium rubidum Beyer, sp. nov.[6]

Transverse section:

Growth rings up to 2 mm. wide, mostly 1 - 1 1/2 mm.: wood typically ring porous, with rays of two types; very broad, multiseriate and narrow or simple (fig. 25).; early wood pores (vessels) measure 210 - 450 mu. in diameter and are easily seen with the unaided eye; mostly circular, some ovoid and some with tyloses (fig. 25): vasicentric tracheids present and intermingled with parenchyma: late wood vessels numerous, round in outline and visible with a lens.

Longitudinal sections:

Broad rays conspicuous (about 1 mm. wide), up to 700 mu. wide through the central portion; broad rays hundreds of cells high, i. e. up to 13 - 25 mm.; between the larger, multiseriate rays can be found a considerable number of the smaller rays, which without a lens are inconspicuous; the smaller rays extend for 1/2 inch (13 mm.) or more in staggered lines and are usually partially biseriated in the

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[6] This specimen was kindly provided for study through the courtesy of Dr. A. H. Blickle. It is a part of the same Specimen Ridge collection, but is housed in the Museum of the Ohio University, Athens, Ohio.

central portion (fig. 26); their height variable, from 4 - 5 to 21 - 23 cells.

On the radial section can be seen the round bordered pits which lead to the tracheary cells; these pits averaging 8 mu., while the tracheids themselves average 12 - 23 mu. (fig. 11).

Type specimen and slides: No. B-229 (the Ohio University Museum), and B-824a (CINC).

Discussion:

This specimen belongs to the red oak groud (section Erythrobalanus Spach.) on the basis of the following characters as given in Brown and Panshin (1940) as distinctions between the section Erythrobalanus and the section Lepidobalanus Endl.:

1. Thick-walled and rounded late wood pores which are visible with a lens. In the white oak group the late wood pores or vessels are barely visible with a lens.
2. The early wood pores only occasionally contain tyloses, most of them are open. In the white oak group the early wood pores usually are occluded with tyloses.
3. The large rays are up to 3/4 of an inch (25 mm.) in height. In the white oak group the same structures are frequently

1 1/2 inches (38 mm.) high.

In his monograph, Knowlton (1899) described a fossil wood Quercinium lamarense Knowlton which is not at all similar to the wood described as an oak in this paper. The late wood in Quercinium lamarense occupies but "1 or 2 rows of thickened cells." He stated further (p. 761) that "the medullary rays are neither very numerous or conspicuous," and added that 2 types of rays were present, broad ones (up to 20 cells wide), and narrow ones, mostly uniseriate. These are certainly questionable characters for oak wood, and it may be suspected that Knowlton was not even dealing with wood of oak affinity. He wrote that the spring wood vessels are larger than the summer wood vessels, but stated that the annual rings, though present are "faint." It appears from his description that Knowlton was dealing with either a diffuse porous or a semi-diffuse porous wood comparable possibly to Fagus (or Fagoxylon) or to the live oaks, cf. Quercus virginiana Hill. His specimen appears to have too many uniseriate rays (1899, plate CXXI, fig. 2) to agree anatomically with the fagus type. It must be said, however, that his description and figures are, at best, most confusing. If he was dealing with Quercus (or Quercinium) our specimen is noticeably different. Further, it cannot be allied with Quercinium knowltoni Felix of the same locality since according to Knowlton (1899) the latter (p. 761) "is closely allied to Quercinium lamarense, and may possibly be the same."

Regardless of the anatomical similarity of our specimen to other specimens of the same general type which have been described[7] it is not safe to assume on the basis of anatomical characters alone any identical species relationship with other fossil wood of similar structure. According to Brown and Panshin (1940), Record (1934), Boeshore and Jump (1938) and others, the woods of the various oaks cannot be identified with any assurance of accuracy further than to their sections, that is the section Erythrobalanus (the red oaks), the section Lepidobalanus (the white oaks) or the live oaks.[8] Our specimen belongs definitely to the section Erythrobalanus. Because of the difficulty in separating species of oaks of the same section on wood characters, this specimen is named Quercinium rubidum to indicate its relationships.

Fagoxylon Stopes and Fujii. Phil. Trans. Roy. Soc. London, B. CCI: 1 - 90. 1911.

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[7] There are 15 species listed by Boeshore and Jump (1938). In addition, Hofmann (1944) described an oak, Quercoxylon prambachense from Prambachkirchen, Germany which belongs to the section Lepidobalanus.

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[8] Included in part in the section Erythrobalanus on floristic characters by Trelease (1924).

Fegonium Vater. Zeitschr. deutsch. Geol. Ges., XXXVI, p. 836, 1884. (Nomen dubium)
Not Fegonium Unger, 101, 1842.

The wood is very similar to that of living Fagus (Tourn.) L. Characteristically the wood is diffuse porous, with rays of two types; broad rays 15 - 25+ seriate, narrow rays 1 - 5 seriate: parenchyma tissue abundant and metatracheal diffuse: intervessel pits crowded.

Fagoxylon grandiporosum Beyer, sp. nov.

Transverse section:

Vessels relatively numerous, wood typically diffuse porous; line of separation between late and early wood not sharp, band of late wood small: largest vessels up to 120 mu. in width, smallest (in the late wood) down to 35 mu. in width: parenchyma tissue abundant, usually metatracheal diffuse, occasionally metatracheal: rays of two types, large and small, with 2 - 5 smaller wood rays between larger rays (fig. 27); largest rays easily seen with the naked eye. The rays bulge at the junction of each growth ring, a character noted for the living Fagus by Jones (1924).

Longitudinal sections:

Rays from 1 - 6 mm. in height, largest rays 15 - 22 seriate, narrowest, 1- 3 seriate: intervessel bordered pits not as abundant as in living forms (fig. 10), but this may be a factor of preservation.

Type specimen and slides: No. B-807 (CINC).

Discussion:

The rays are of two sizes as in Quercus, but the specimen cannot possibly be included in this genus (red and white groups), because of the diffuse porous condition. Further, on the basis of the even spacing of the vessels (pores) it cannot be of the live oak type, which is characterized by a radial or flame-shaped alignment of the vessels. This specimen compares favorably with the modern representative (Fagus [Tourn] L.) in the following respects:

1. The rays are of two sizes.
2. The larger rays are not evenly spaced (as in Platanus L.).
3. There are several smaller rays between the larger rays.
4. The wood is diffuse porous.
5. The same type of intervessel pitting occurs in Fagus.
6. The wood rays bulge at the junction of each growth ring.

This genus has been reported only a few times previously from rocks of Mesozoic and Cenozoic age. These include Fagoxylon hokkaidense Stopes and Fujii (1911), from the Cretaceous of Hokkaido, Japan; Fagoxylon Kräusellii Hofmann (1944), from Oligocene rocks near Prambachkirchen, Germany; Fegonium dryandraeformae Vater from rocks of Lower Se-nonian age, Brunswick; Fegonium lignitum Beck (= F. dryandraeforme[?]) from the Oligocene of Saxony; Fegonium caucasicum Felix, from the Eocene (Sumgait Series); Caucasus (Apscheron); and Fegonium schenki Vater, from the Lower Senonian (derived from), Brunswick (Edwards, 1931). Knowlton (1919), lists 23 species of Fagus from leaf compressions, of which Fagus antipofii Abich., and Fagus undulata Knowlton occur in the Yellowstone River area. Two additional species occur elsewhere.

The specimen is not specifically similar to the wood of Fagus grandifolia Ehrh. and, according to the anatomical characters listed by Jones (1924), it does not agree specifically with Fagus sylvatica L. in that the largest vessels of the petrified specimen are considerably larger than those in the living species, a condition noted by Stopes and Fujii (1911) for Fagoxylon hokkaidense. The wide rays of the fossil specimen are not as many seriated as those in the living species. This perhaps, could be a normal growth variation. The intervessel bordered pits are about the same size in both the living and fossil forms, but they are not as abundant in our specimen; this possibly due to the effects of petrification, although the specimen is otherwise excellently preserved.

The specimen under consideration is similar to Fagoxylon hokkaidense which is in most respects similar to the living genus, but that in this fossil the vessels are larger than the average for the living form. The same is true for our specimen and perhaps the two are identical. Because of the difference in horizon between our speciman (Tertiary, probably Miocene) and the one of Stopes and Fujii (Cretaceous), and the fact that our specimen has larger pores than the living form it is named Fagoxylon grandiporosum.

Hofmann's specimen (1944), Fagoxylon Kräusellii, may be similar to the two discussed above. Although she refers to a similarity to Fagus sylvatica no further details are given and therefore no comparison can be made with it.

Rosales

Platanaceae

Plataninium Unger. In Endlicher, Gen. Pl. Suppl. 2: 101, 1842.

Fegonium Unger. ibid[8]

The wood is very similar to that of Platanus (Tourn.) L. It is diffuse porous. Rays of only one type and intergraded in size; from 4 - 20+ seriate:

[8] fide Vater (1884, p. 836), Edwards (1931, pp. 41, 61.)

intervessel pits not crowded.

Platananinium Haydeni Felix. Untersuchung über fossile Hölzer. V. Zeitschr. d. Geol. Gesell. 48: p. 251, 1896.

Transverse section:

Wood characteristically diffuse porous: vessels 43 mu. to 140 mu. in diameter; vessels distinctly separate, occasionally closely compacted, irregularly spaced, long (fig. 28): growth rings present, barely discernable with the unaided eye, 2 - 2.5 mm. wide: parenchyma tissue metatracheal diffuse and paratracheal, the former more abundant: fibers thick-walled (8 mu.), averaging 24 mu. in diameter: most rays easily visible without the aid of a lens; sometimes there are 2 - 3 smaller rays between larger rays; occasionally they are absent. At any rate, the larger rays are spaced at close intervals, and all are more or less uniform in width.

Longitudinal sections:

Rays from 3 - 10 seriated, all of one type: intervessel pitting widely spaced, included aperture horizontal or nearly so (fig. 9); diameter of intervessel bordered pits averaging 4 - 6 mu.; perforation plates simple (fig. 29).

Specimens and slides: Nos. B-705, B-707, B-730, B-737, B-742, B-765, B-777 and B-779 (CINC).

Discussion:

This specimen conforms so closely to Plataninium Haydeni Felix, that the deviations are only minute and well within a reasonable variation for this species. Knowlton (1899) noted the close similarity of this form to Platanus occidentalis L. The present fossil brings the comparison even closer with the well preserved bordered pits, a character not observed by Knowlton.

Leaf compressions of the sycamore type are abundant in rocks of Tertiary (Miocene) age. Dorf (1936) reported the occurence of Platanus dissecta Lesquereux from the Miocene of Southwestern Idaho. Knowlton (1919) listed a number of leaf compressions believed to be Platanus from the Tertiary, among which are: Platanus appendiculata Lesq., P. guillemae Goppert, P. montana Knowlton, and many others. Hu and Chaney (1940, p. 14), on the other hand, state that "although an abundant member of the Tertiary floras of Europe and North America, Platanus is comparatively rare in the floras of northeastern Asia."

With so many different species of sycamore leaves preserved in the fossil condition, one would almost expect to find at least more than one type of sycamore wood in the fossil condition from rocks of this age. According to Brush (1917), however, there is a great deal of anatomical similarity in living species of *Platanus* wood. He discussed the three species native to North America, i. e. *Platanus occidentalis* L., *P. Wrightii* S. Wats. and *P. racemosa* Nutt. He stated (1917, p. 481) that "the chief distinguishing characters of sycamore woods are the color of the sapwood and heartwood and the size of the pith rays." Obsiously, the only character listed which can be deemed reliable, at least for the fossil wood, is the latter and the specimens under consideration agree favorably with the critera listed for *Platanus occidentalis*, a condition already noted. At any rate, Brush maintained that the woods of the three mentioned spècies of living sycamore very closely resemble each other.

Because of the abundance of sycamore leaf compressions in the area and the fact that only one species of wood has been described from this area it is not improbably that *Platanınium Haydeni* may include the wood of more than one fossil sycamore.

Summary:

This investigation deals with a collection of petrified woods (Tertiary) from the Specimen Ridge area of the Yellowstone National Park, Wyoming.

Seven species of gymnosperms and three species of angiosperms are described. The following are new:

1. *Pinus pseudotsugoides* Beyer
2. *Piceoxylon laricinoides* Beyer

3. *Cedroxylon abietoides* Beyer

4. *Cupressinoxylon thuyoides* Beyer

5. *Cupressinoxylon libocedroides* Beyer

6. *Quercinium rubidum* Beyer

7. *Fagoxylon grandiporosum* Beyer

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Appendix

List of species of woods reported from the Specimen Ridge area of the Yellowstone National Park, Wyoming. A plus sign (+) indicates those discussed in this paper.

Gymnospermae

Coniferales

Pinaceae

Pinus L.

P. fallax (Felix) Read +

P. baumani Read

P. pseudotsugoides Beyer +

Cedroxylon Kraus

C. abietoides Beyer +

Piceoxylon Gothan

P. laricinoides Beyer +

Taxodiaceae

Sequoia Endl.

S. magnifica Knowlton +

Cupressaceae

Cupressinoxylon Goeppert

C. lamarense Read

C. thuyoides Beyer +

C. libocedroides Beyer +

Angiospermae

Dicotyledonae

Fagales

Fagaceae

<u>Quercinium</u> Unger

<u>Q</u>. <u>lamarense</u> Knowlton

<u>Q</u>. <u>Knowltoni</u> Felix

<u>Q</u>. <u>rubidum</u> Beyer +

<u>Fagoxylon</u> Stopes and Fujii

<u>F</u>. <u>grandiporosum</u> Beyer +

Rosales

Platanaceae

<u>Plataninium</u> Unger

<u>P</u>. <u>Haydeni</u> Felix +

Salicales

Salicaceae

<u>Rhamnacinium</u> Felix

<u>R</u>. <u>radiatum</u> Felix (similar to <u>Populus</u>)

Ranunculales

Lauraceae

<u>Laurinoxylon</u> Felix

<u>L</u>. <u>pulchrum</u> Knowlton

<u>Perseoxylon</u> Felix

<u>P</u>. <u>aromaticum</u> Felix

Plate I

Fig. 1. <u>Cedroxylon</u> <u>abietoides</u> Beyer

2. <u>C</u>. <u>abietoides</u>

3. <u>Piceoxylon</u> <u>laricinoides</u> Beyer

4. <u>P</u>. <u>laricinoides</u>

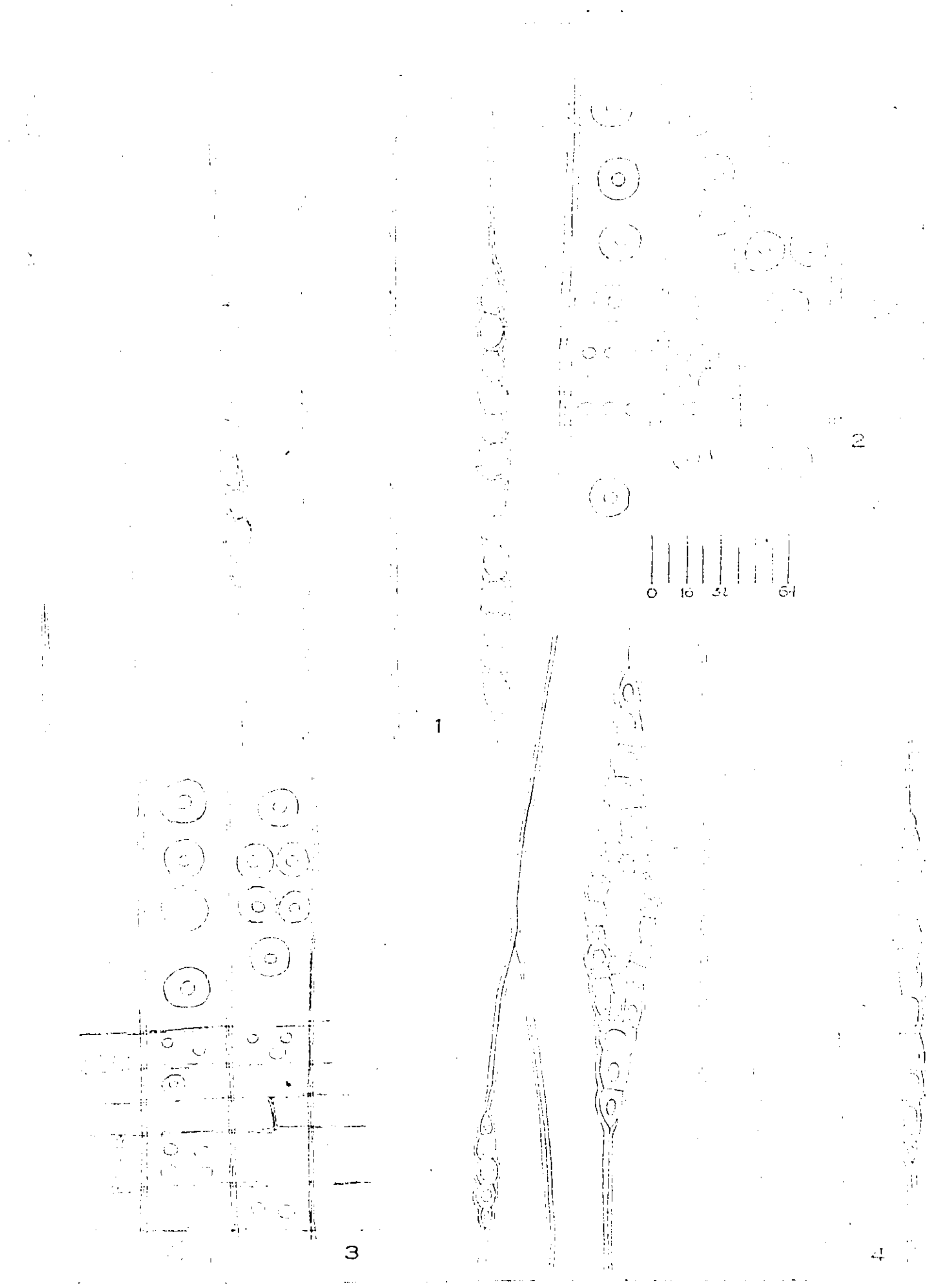


Plate I

Plate II

Fig. 5. Pinus fallax (Felix) Read

6. P. fallax

7. P. pseudotsugoides Beyer

8. P. pseudotsugoides

9. Plataninium Haydeni Felix

10. Fagoxylon grandiporosum Beyer

11. Quercinium rubidum Beyer

12. Cupressinoxylon thuyoides Beyer

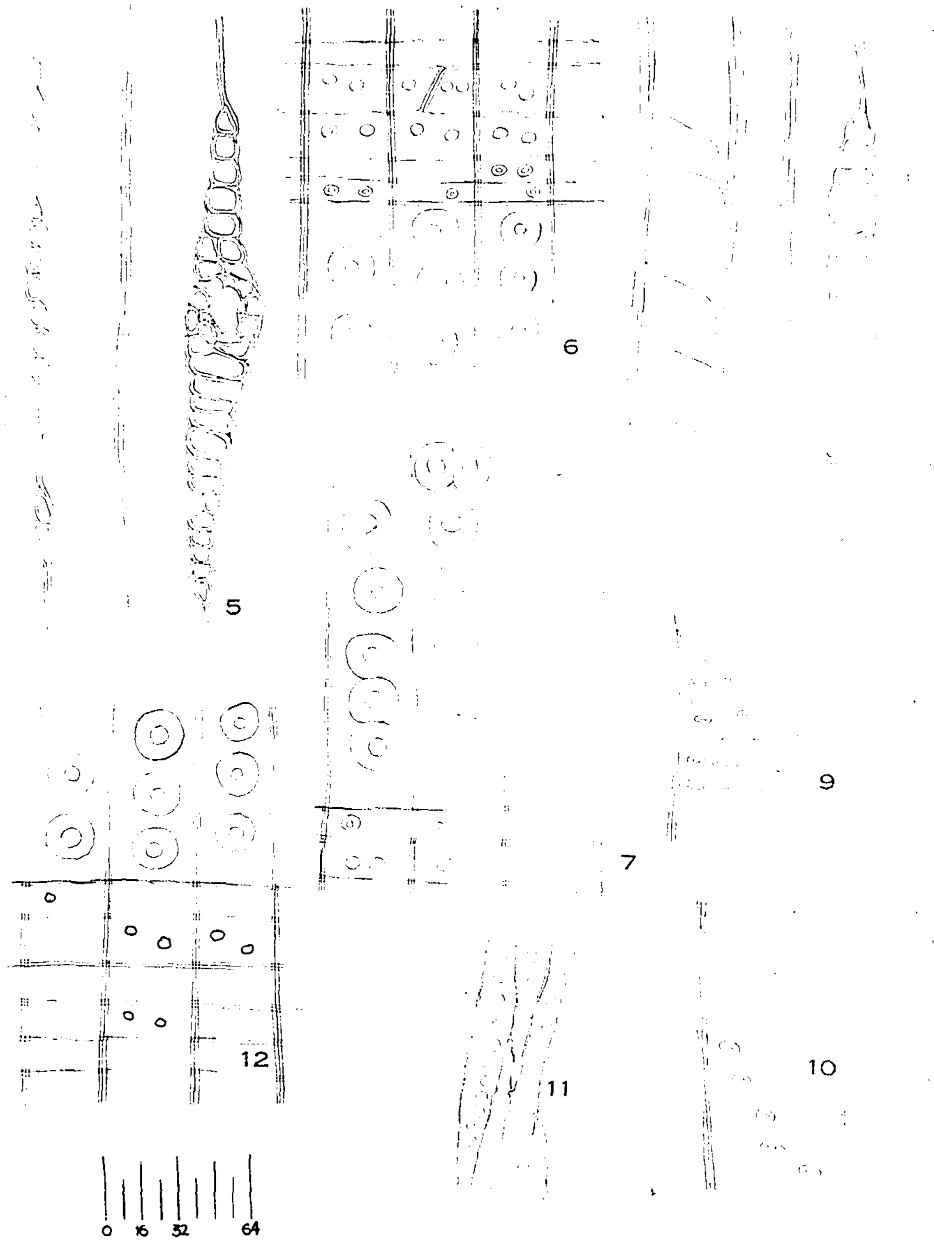


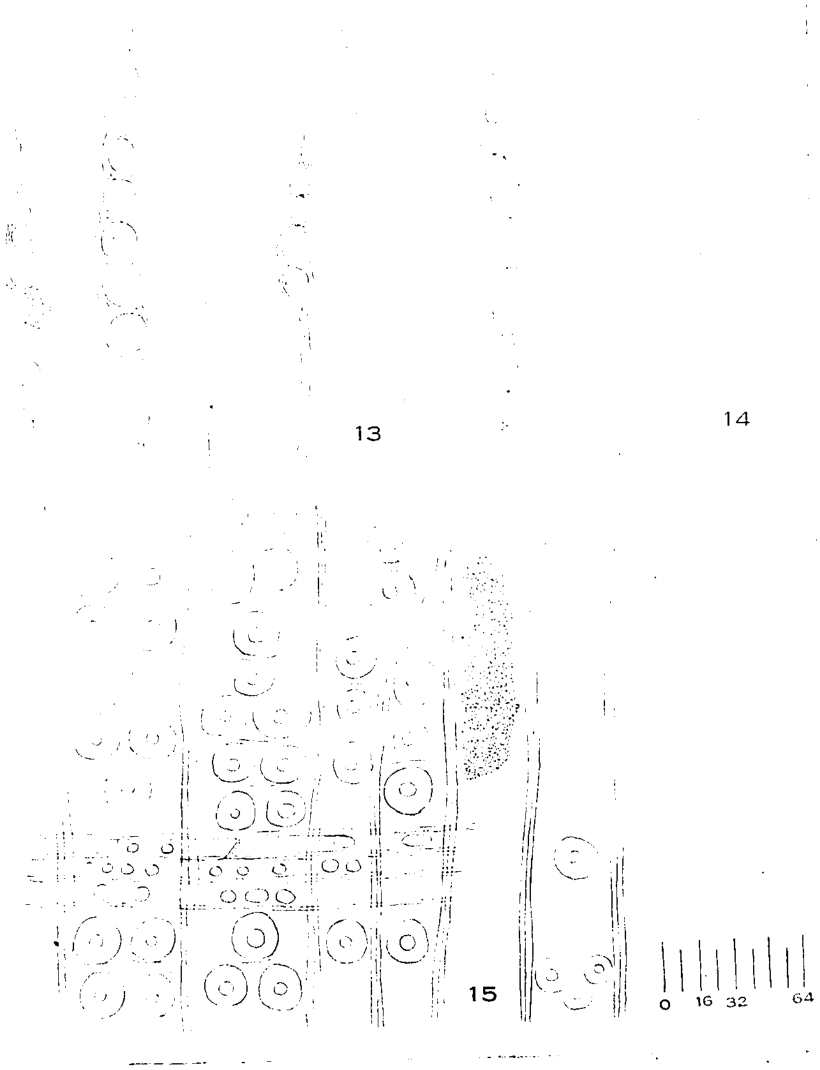
Plate II

Plate III

Fig. 13. *Cupressinoxylon libocedroides* Beyer

14. *C. thuyoides* Beyer

15. *Sequoia magnifica* Knowlton



Pl ate III

Plate IV

Fig. 16. Sequoia magnifica Knowlton

17. Cupressinoxylon libocedroides Beyer

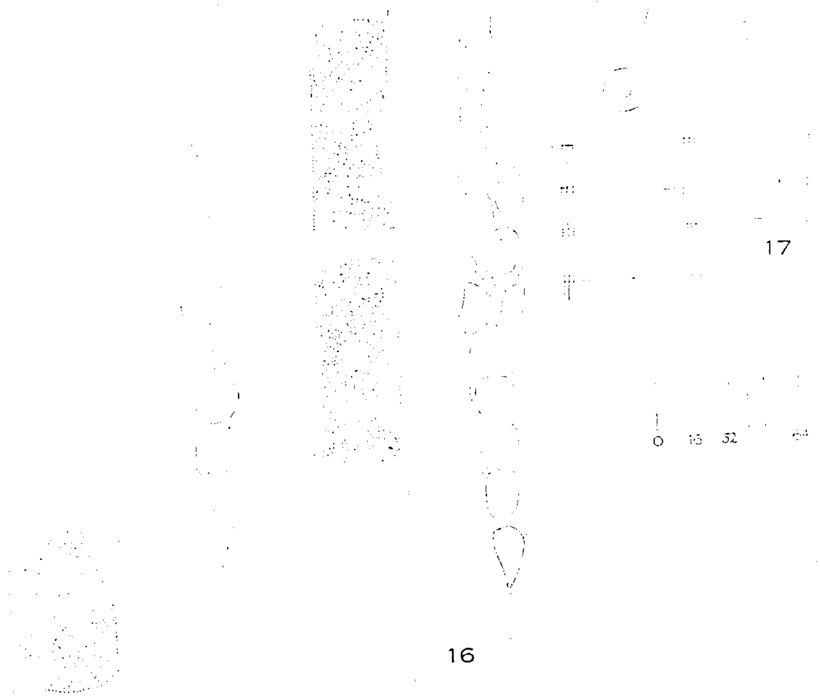


Plate IV

Plate V

Fig. 18. Pinus fallax (x 55)

19. P. pseudotsugoides (x 55)

Fig. 18

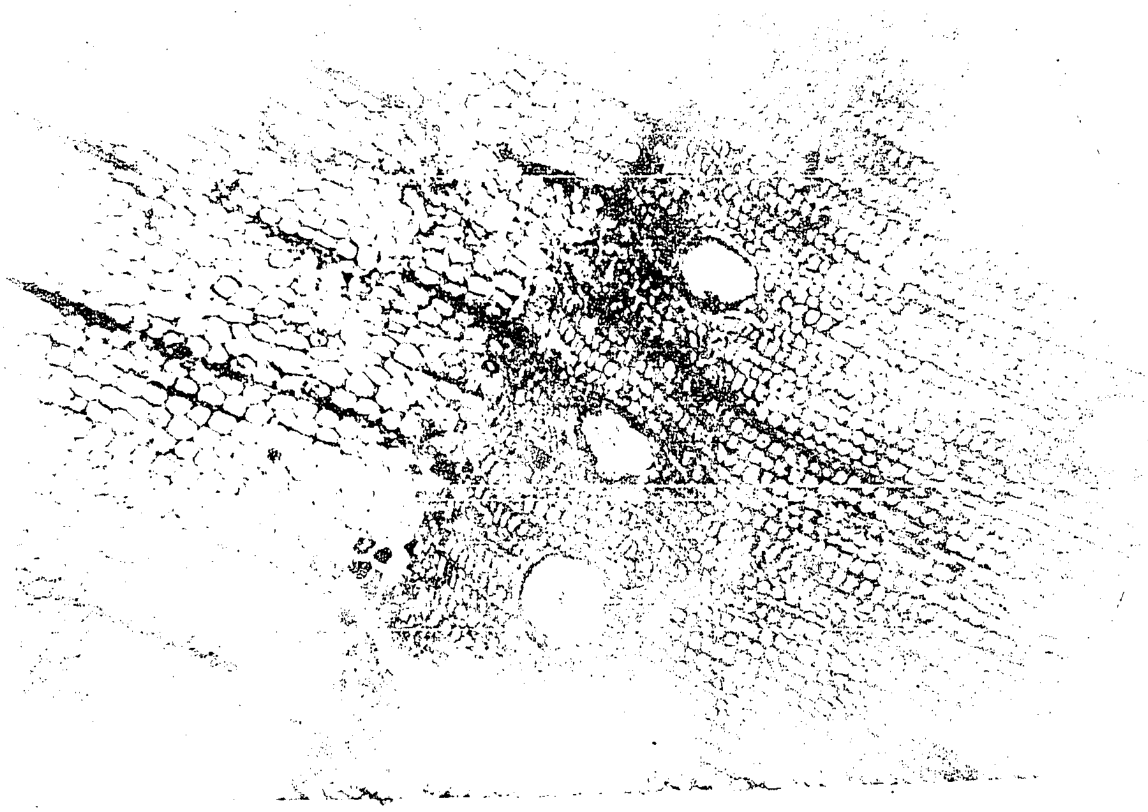


Fig. 19

Plate V

Plate VI

Fig. 20. Piceoxylon laricinoides (x 55)

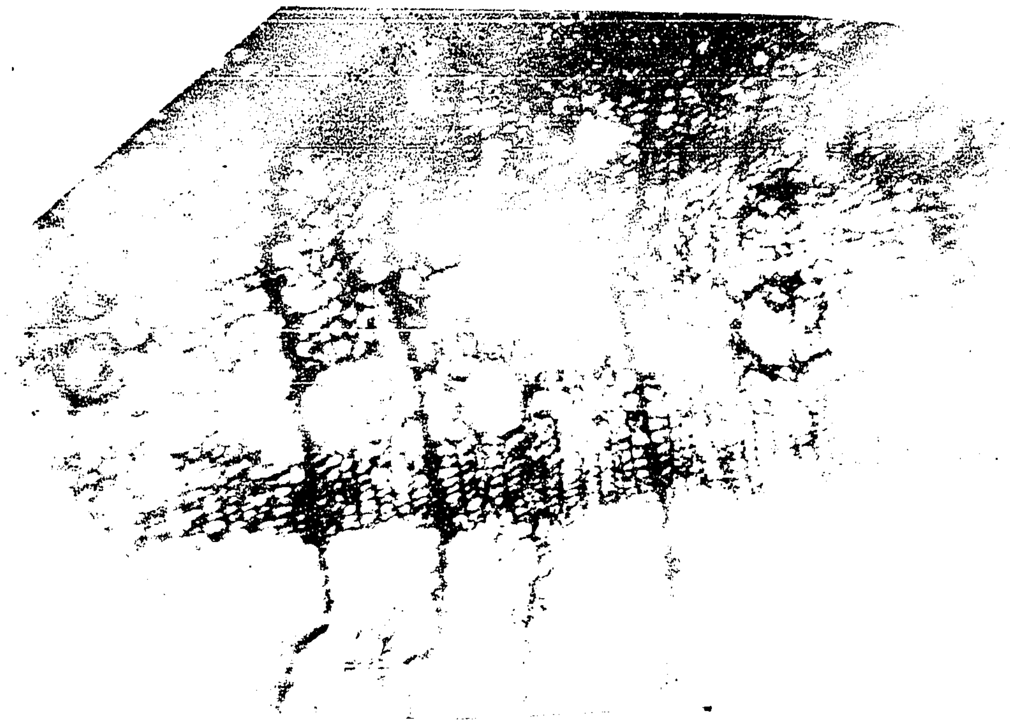


Fig. 20

Photo VI

Plate VII

Fig. 21. *Sequoia magnifica* (x 55)

22. *Cedroxylon abietoides* (x 55)

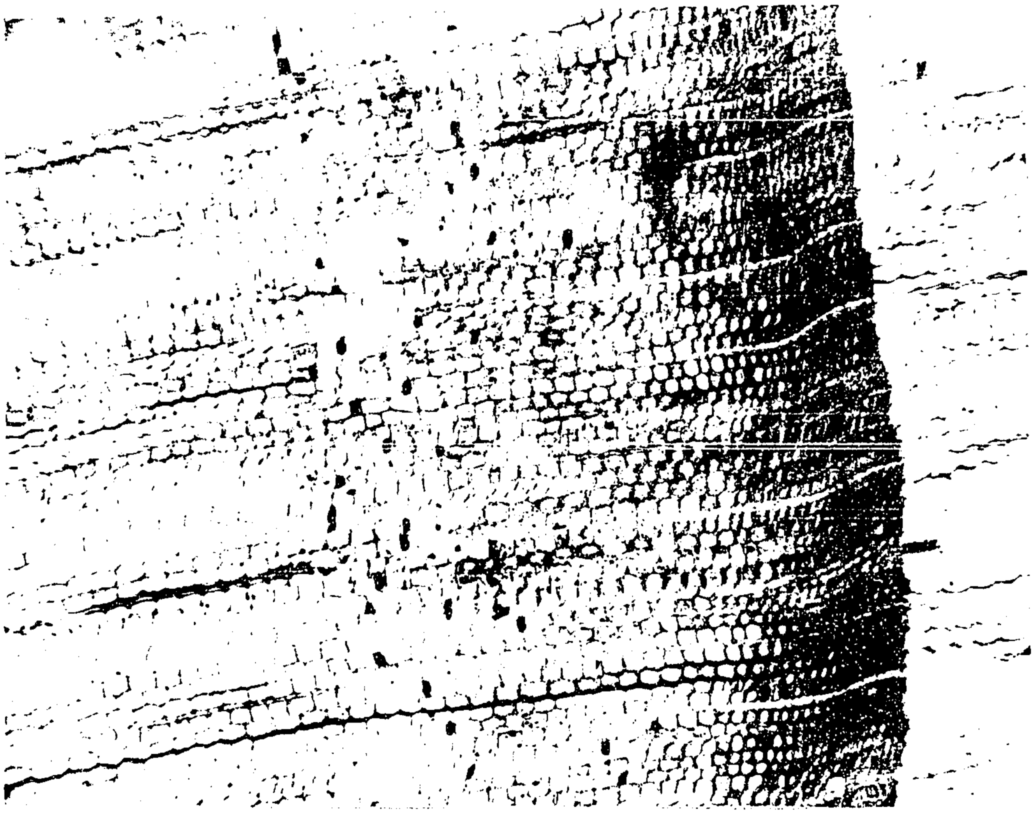


Fig. 21

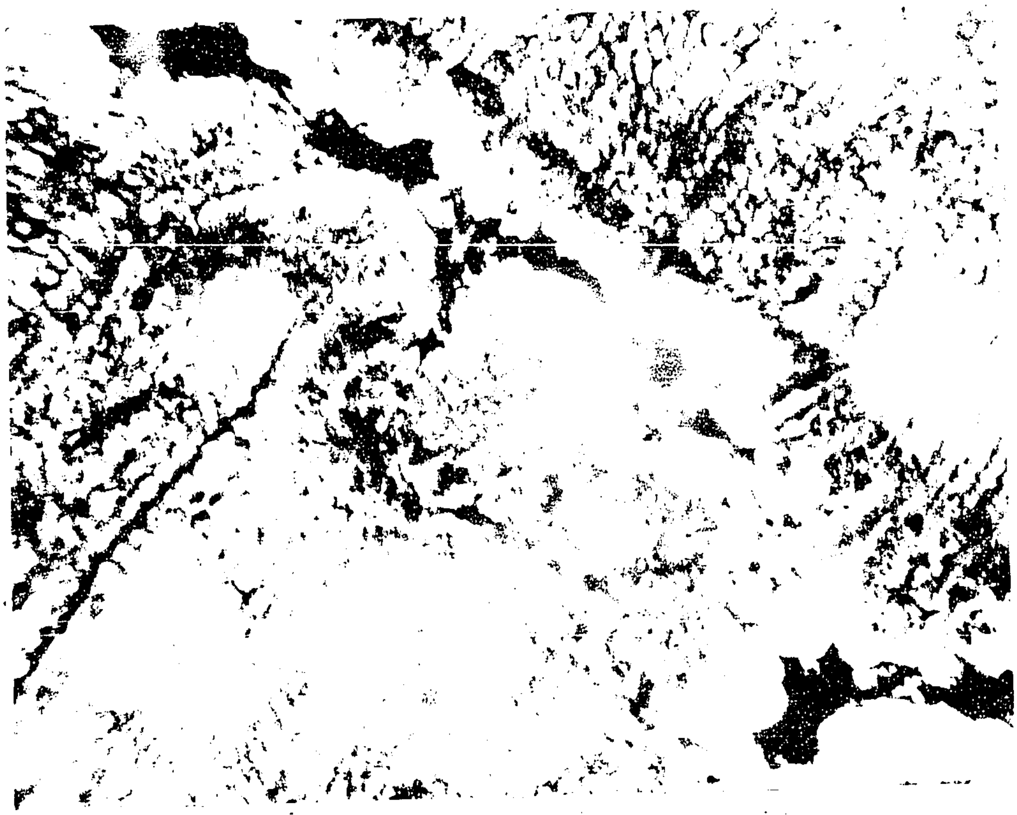


Fig. 22

Plate VII

Plate VIII

Fig. 23. Cupressinoxylon libocedroides (x 55)

24. C. thuyoides (x 55)

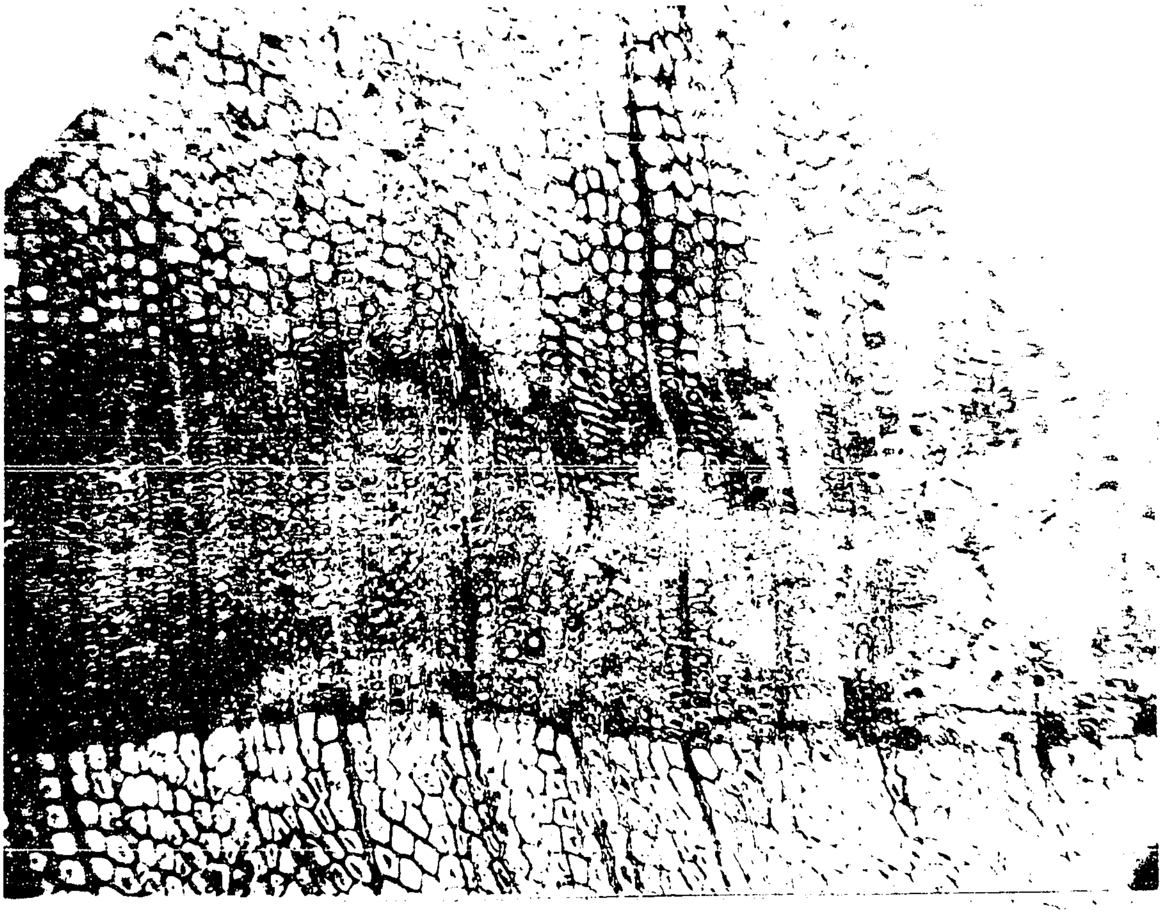


Fig. 23

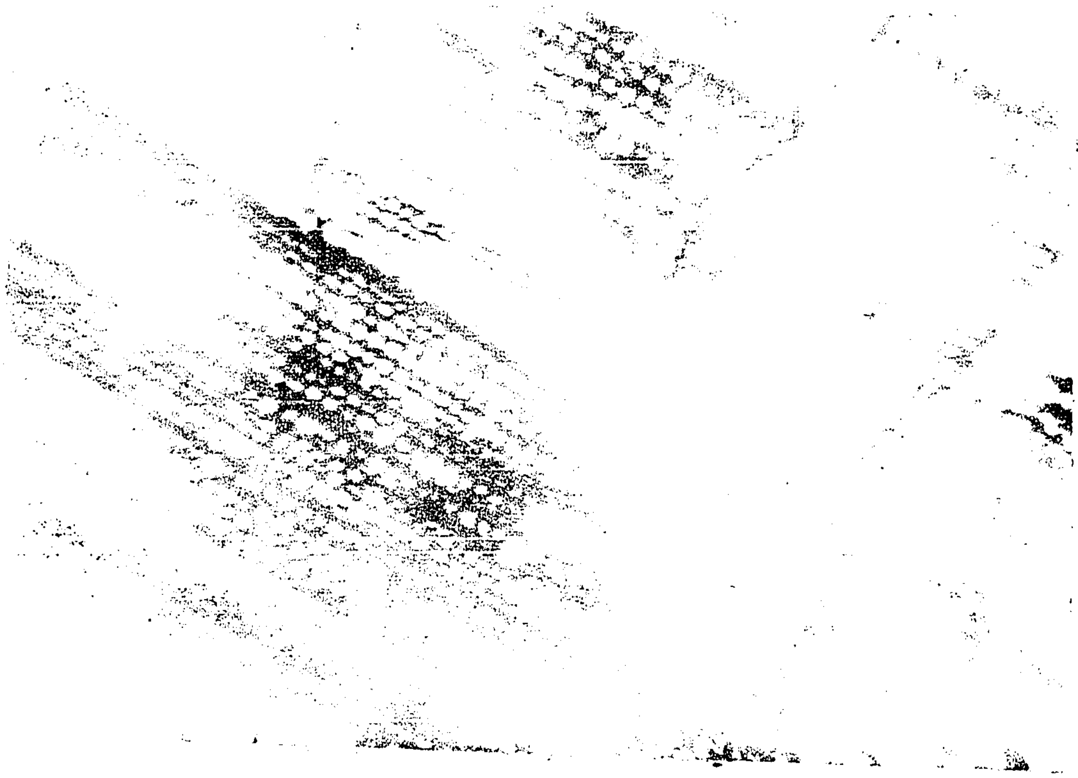


Fig. 24

Plate VIII

Plate IX

Fig. 25. *Quercinium rubidum* (x 55)

26. *Q. rubidum* (x - 55)

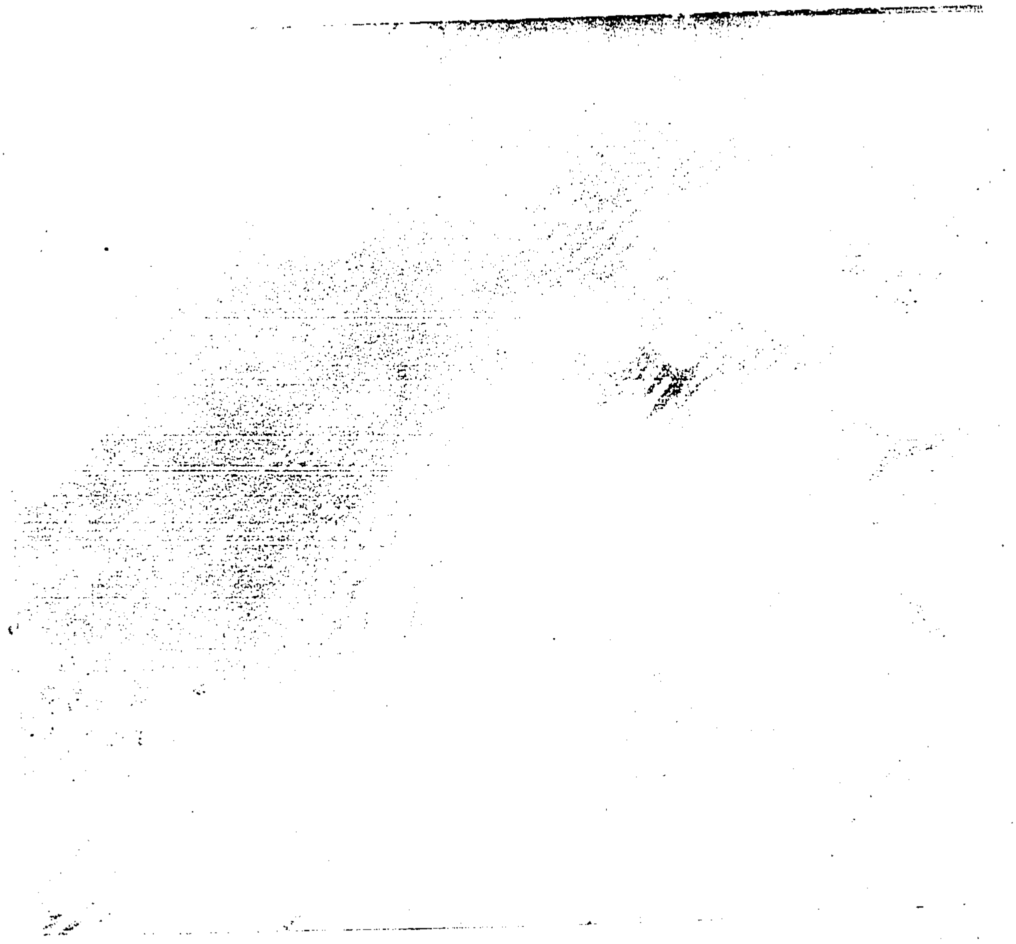


Fig. 25

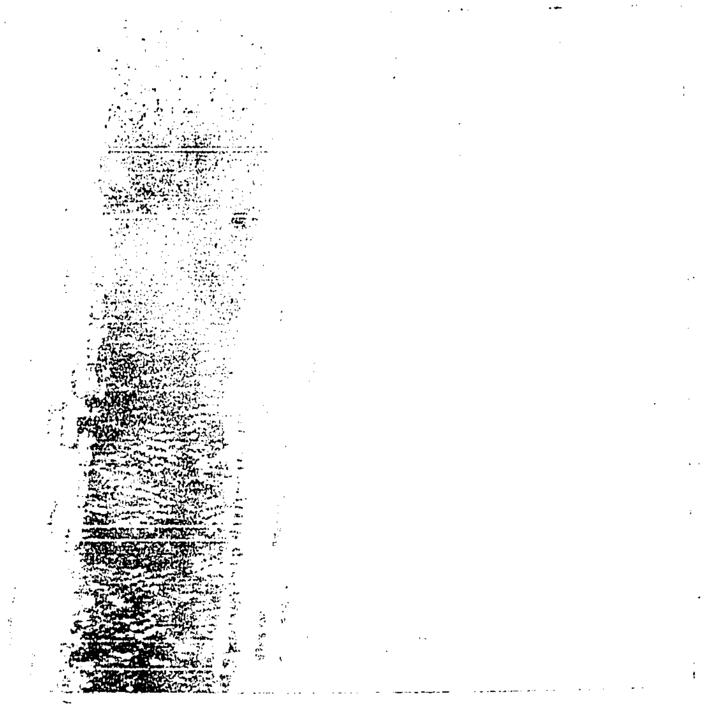


Fig. 26

Plate IX

Plate X

Fig. 27. Fagoxylon grandiporosum (x 55)

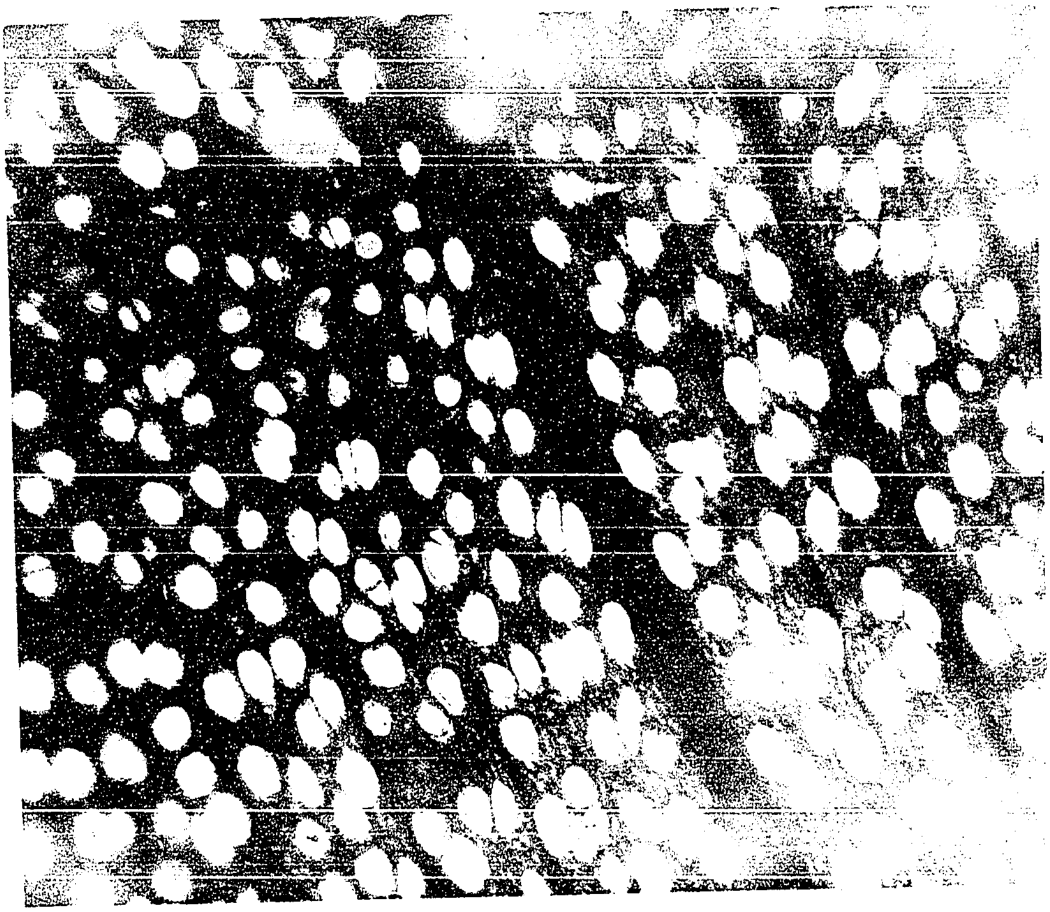


Fig. 27

Plate X

Plate XI

Fig. 28. Plataninium Haydeni (x 55)

29. P. Haydeni (x 150)

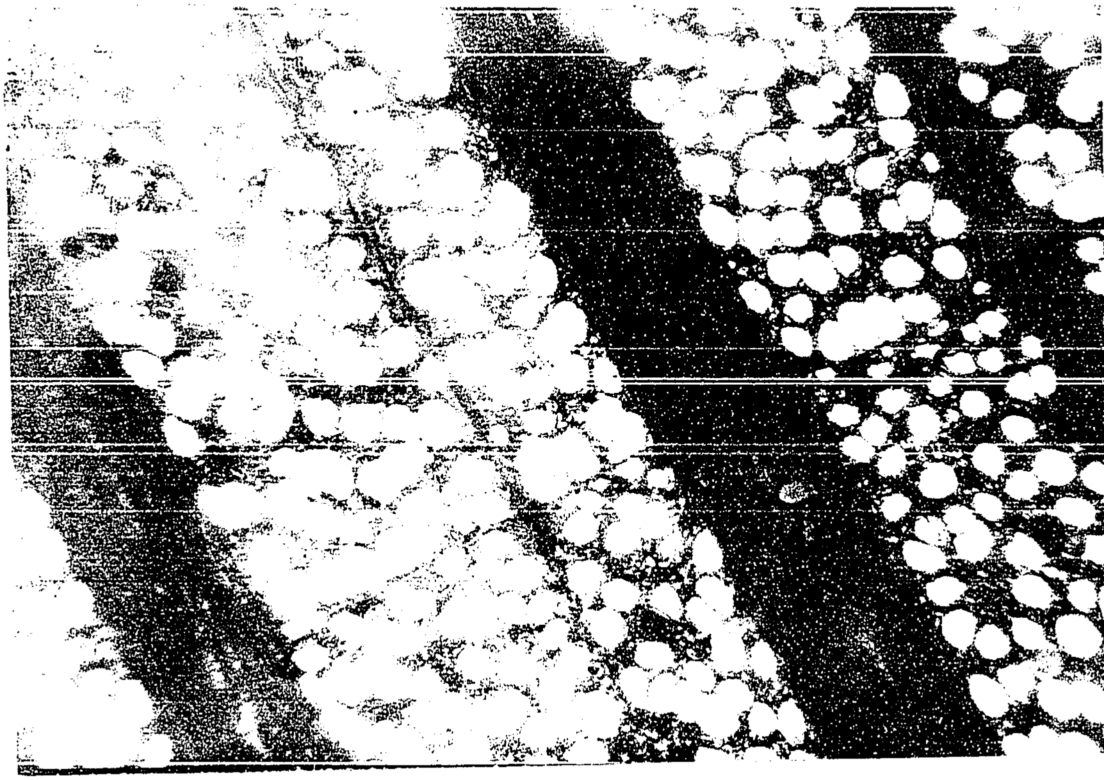


Fig. 28

Fig. 29

Plate XI