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**SOME PALEOZOIC PLANTS FROM CENTRAL  
COLORADO AND THEIR STRATI-  
GRAPHIC SIGNIFICANCE**

**BY**

**CHESTER A. ARNOLD**



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*Editor:* EUGENE S. McCARTNEY

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## SOME PALEOZOIC PLANTS FROM CENTRAL COLORADO AND THEIR STRATI- GRAPHIC SIGNIFICANCE

By CHESTER A. ARNOLD

THE presence of fossil plants in rocks of supposed Permian age in Colorado has been known for a long time. In 1882 Lesquereux (7) published a list (unaccompanied by descriptions or figures) of a number of species collected by Arthur Lakes near Fairplay. He concluded that the plants indicated the Permian age of the beds, although the associated insects were then believed to be Triassic forms. Many years later White (10) collected in the same region, but was unable to locate the exact place where the previous collections had been made. The plants he secured, however, were probably from the same formation. White never figured or described his material, but of the twenty-five species listed seventeen are said to be indicative of Permian age. The remaining eight were known from either Pennsylvanian or Permian. Among the distinctively Permian plants White recognized three species of *Walchia*, and one each of *Ullmannia*, *Voltzia*, *Aracaurites*, and *Gomphostrobus*. These coniferous remains, he says, together with *Sphenopteris lebachensis*, *S. gutzholdi*, and two species of *Callipteris*, "leave little room for doubt but that this flora is of Permian age, probably Rothliegende."

The plants described in the present account were secured from four areas. Along the canyon of the Arkansas River southeast of Salida, in eastern Fremont County, *Neuropteris Dluhoschi*, *N. gigantea* (?), and *Asterophyllites charaeformis* (Pl. I, Figs. 2-5) were collected in a black-shale bed near the base of the Pennsylvanian section just below the Wellsville bridge. This is probably the locality mentioned by White (10, p. 510). This bed, which contains

thin coal seams, is probably near the stratigraphic level of the *Lepidodendron* bed in the Weber (?) at the south end of Chubb Gulch below Trout Creek Pass (Arnold, 1), and the plant bed reported by Read (9) east of Leadville. Near the eastern limit of the Paleozoic exposures within the canyon *Walchia stricta* and *Cordaites anguloso-striatus* were found in a dark gray shale bed about seven and one-half miles below the mouth of Badger Creek and three and one-third miles above Coaldale. This locality is probably high in the section, in beds usually regarded as Permian:

In the vicinity of Trout Creek Pass silicified *Lepidodendron* trunks occur 155 feet above the base of the Weber (?) formation (mentioned above). In the succeeding Coffman conglomerate member of the Maroon no plants were seen by the author, but Gould (5) mentions impressions of *Calamites* and *Lepidodendron*, which tentatively date the bed as Pennsylvanian. Remains of the conifer *Lecrosia Gouldii* came from the upper part of the Chubb siltstone member of the Maroon, and in the Bath submember of the Pony Springs siltstone *Walchia* sp. (Pl. II, Fig. 20) and *Calamites gigas* (Pl. I, Fig. 1) were found.

In the Gore region north of Leadville, in Eagle County, fragmentary plant remains, including *Walchia stricta* (Pl. III, Figs. 21-22), were collected from Brill's Division B, Interval 155 of the Battle Mountain formation (Brill, 2). On the basis of invertebrate remains Brill considers the Battle Mountain to be of Lower Pennsylvanian (Des Moines) age. He correlates it with the Weber (?) and the lower part of the Maroon of the Mosquito Range. Above the "*Walchia* bed" (Interval 155) Brill found numerous invertebrate fossils indicative of early Pennsylvanian age.

Interval 74 of the McCoy formation in the near-by McCoy region contains the greatest number of plants yet observed in any of the beds above the Weber (?). The Battle Mountain formation is correlated with the McCoy, and Interval 74 probably corresponds to Interval 155 of the former. Identical plant remains abound in both. Interval 74 has yielded two forms of *Walchia*, *Odontopteris mccoyensis* (Pl. II, Figs. 8-14), and *Samaropsis hesperius* (Pl. II, Fig. 15). In addition to these there are other fragments, including

small seeds probably belonging to *Walchia* and a microsporangiate fructification of some unknown pteridosperm.

The plants in the Paleozoic rocks of central Colorado are of great interest because of the apparent discrepancy between them and the marine invertebrates as indicators of the age of the beds. Brill (2) and others have placed the *Walchia*-bearing beds of the McCoy and Battle Mountain formations in the Des Moines series.

Coniferous genera such as *Walchia*, *Ullmannia*, and *Voltzia* have long been regarded as typical members of the Permian flora, supposedly having superseded the coal-swamp vegetation as arid conditions became widespread over the earth. David White has pertinently remarked: "The conifers are the children of adversity in Permian as well as later times." It has long been known, however, that *Walchia* exists in the Radstockian and Staffordian rocks of Great Britain, and it has rather recently been found in the Conemaugh of Pennsylvania. Still more recently *Walchia* and other so-called "Permian" genera have been discovered in the upper Missouri series of Kansas, which thus bring the genus well within the middle Pennsylvanian. In Kansas, however, *Walchia* occurs in association with a number of typical Pennsylvanian genera, and the "Permian" plants are explained as upland forms which entered the flora as a result of increased aridity. This admixture shows that *Walchia* is not a strict time marker, but is, rather, a reflection of the environment.

The discrepancy under consideration in this paper is not an isolated instance. There are numerous instances in which the testimony of plants and animals as to chronology does not agree, and most of them are concerned with the late Paleozoic. Some of the difficulties have been cleared by more exact identification of the fossils. Others were due to conclusions based upon incomplete or mixed collections and to incomplete knowledge of the range of so-called species. In the case under discussion here a more complete sequence of fossil plants than we now have would be of value. We do not know how late typical Pennsylvanian forms persisted in Colorado or when the "Permian" plants first appeared. No overlapping of early and late types has been observed, and no middle Pennsylvanian plants are known. As a contribution to this

much-needed information a few plant remains are described in the following pages.

*Calamites gigas* Brong.

(Pl. I, Fig. 1)

The specimen referred to *Calamites gigas* is a portion of a large sandstone cast. Slight flattening of the cast had obliterated most of the finer surface details, but the general shape and the measurements of the ribs agree with those shown in European examples.

The specimen is 15 cm. broad and has parts of seven internodes. The internodes are from 17 to 27 mm. long, and the longitudinal ribs are 4–5 mm. broad and slightly flattened, probably owing to pressure. The furrows are narrow and deep. The internodes become successively shorter from the basal part upward. Most of the ribs alternate at the nodes, although some are opposite, probably as a result of pressure. The alternating ribs narrow abruptly to a sharp point, which fits into the angle between the tapering ends of those above. The nodal line is therefore rather distinctly zigzag.

*Calamites gigas* is rare in North America, but in Europe it occurs frequently in the late Carboniferous and Permian.

*Locality and horizon.* — Northeastern slope of the divide between Chubb Gulch and Muleshoe Gulch about one mile north of Trout Creek Pass, Park County, Colorado. Bath submember (of Gould) of the Maroon formation. In association with *Walchia* sp. No. 21002.

*Odontopteris mccoyensis*, sp. nov.

(Pl. II, Figs. 8–14)

Fronde at least bipinnate; pinnae short, stout, acute, or very slightly tapering, and rounded or subacute at apex; pinnules rounded or entire, or very shallowly lobed, those near tip attached by a broad base, but lower ones becoming gradually constricted and attached by a short stalk, usually well separated but occasionally slightly overlapping; terminal pinnule obtusely or acutely triangular and rounded at tip; venation odontopteroid but obscure; veins simple, or once or twice forked; texture coriaceous.

*Odontopteris mccoyensis* is the sole example of filicoid foliage

recently found in the post-Weber beds in central Colorado. It is rather abundant in the "Walchia bed" (Interval 74 of Brill) on the McCoy formation. It is always in a fragmentary state, and the specimens seldom consist of more than portions of pinnae bearing a few pinnules. Nothing is known of the size or the habit of the plant, or of its fructifications. Even the smallest fragments are easy to recognize. The rounded pinnules are usually well preserved, although the venation is obscure because of the thick coriaceous texture. To judge from the consistent small size of the fragments, the plant was probably of stunted growth. It may be a dwarfed remnant of the more lush type of vegetation of the swamps that existed at least locally in this region. The fragmentary state indicates deposition at some distance from the place of growth, and preservation was possible only because of the resistant character of the tissues.

The plant closely resembles some figures of the highly variable *Odontopteris osmundaeformis*, and does not seem readily separable from this species. The reason for distinguishing *O. mccoyensis* as a species is that it may serve as a stratigraphic marker in the upper Paleozoic in central Colorado. In Europe *O. osmundaeformis* is an important member of the Permian flora, although it exists also in the Upper Carboniferous.

*Locality and horizon.* — (1) Highway cut along the Colorado River one mile northwest of Bond and (2) one and one-half miles southeast of McCoy, a few hundred yards northeast of the Yarmony schoolhouse, Eagle County, Colorado. Interval 74 (of Brill) of the McCoy formation. Nos. 21003, 21007, and 21016.

*Cordaites anguloso-striatus* Grand'Eury

(Pl. I, Figs. 6-7)

Fragments of cordaitean foliage which appear identical with *Cordaites anguloso-striatus* occur in the canyon of the Arkansas River seven and one-half miles below the mouth of Badger Creek. These fragments are somewhat more slender than those usually figured, but the coarseness of the lengthwise striations indicates identity. This species occurs in the Permo-Carboniferous of central France.

*Locality and horizon.* — Canyon of the Arkansas River, Fremont County, Colorado, seven and one-half miles below the mouth of Badger Creek. Permian (according to Geological Map of Colorado, 1935). No. 22128.

***Samaropsis hesperius*, sp. nov.**

(Pl. II, Fig. 15)

Platyspermic, broadly circular seed with a broad wing; length about 10 mm., width 17 mm.; nucule circular in outline, 8 mm. in diameter; wing 4.5 mm. broad, notched at base and apex.

This description is based upon a single seed of the broad-winged type. In general appearance it resembles *Samaropsis Newberryi*, the only important difference being its smaller size. There are no clues whatsoever to the plant which bore this seed. Being provided with a broad wing it might have been carried a great distance.

*Locality and horizon.* — Interval 74 (of Brill) of the McCoy formation. One and one-half miles southeast of McCoy, a few hundred yards northeast of the Yarmony schoolhouse, Eagle County. No. 22127.

*Lecrosia Gouldii* Arnold (in Florin, 1940, p. 317)

(Pl. III, Figs. 23-26)

*Lecrosia Gouldii* was recently described by Florin in Part V of his monograph on Paleozoic conifers recently published in *Palaeontographica* (4). The following is a translation of his specific diagnosis:

Woody plants. Lateral foliage shoot systems irregularly branched, possessing a main stem of penultimate (first) order which bears sparsely arranged branchlets, 10 cm. or more in length, and all expanded in the same plane, and leaves of the *Gomphostrobus* type, diameter (including the leaves) 6.5 mm. Leaves on the main (penultimate) axis spirally but not densely disposed, bifacial, directed to all sides, firm, slightly concave adaxially but not inwardly curved at the apex, spreading at an angle of 35-50 degrees or when subtending branchlets, divaricate, 12-15 mm. long, 3-4, 5 mm. broad at base, but narrowing to 0.7-1.2 mm. halfway to apex, overlapping, decurrent, and each leaving a rhombic scar (4.5-5.5 mm. high) on the surface, triangular-linear in face view, in all probability uninerved in basal and middle portions, and bifurcating at apex, where two narrowly linear, acute or almost acute lobes are produced, which form an angle of 20-25 degrees, and are 1-1.3 mm. broad at the base and 4.5-6.5 mm. long. Each lobe is probably traversed by a branch



of the median vein. Lateral foliage shoots of the penultimate (second) order (which sometimes bear shoots of the third order) 10–18 mm. broad (including the leaves) and almost straight, forming an angle of 25–60 degrees with the main axis, and possessing a thinner axis (up to 5 mm.), which is rather densely covered from base to tip by isomorphic, bifacial, spirally disposed leaves which are overlapping, firm, and directed to all sides, but not at all or only slightly incurved. Leaves 6–12 mm. long, 2–3.5 mm. broad at base and about 1 mm. broad halfway to apex, spreading at an angle of 35–60 degrees, decurrent, and each leaving a broadly or elongate rhombic scar 2.5–5 mm. high, narrowly triangular, occasionally slightly tapering at the base, acute and probably uninnervated. Lateral shoots of ultimate (third) order closely resembling those of second order, up to 10 mm. thick (including the leaves), but characterized by shorter and narrower leaves (4–7 mm. long and 2–2.5 mm. broad).

This description is based upon a number of specimens from Gould's Division 6 of the Chubb siltstone member of the Maroon, which were found on the refuse heap of a prospector's pit between Chubb Gulch and Muleshoe Gulch about one mile northwest of Trout Creek Pass. *L. Gouldii* is the only plant present at this place. Many of the irregularly laminated siltstone slabs consist almost entirely of compacted remains of the leafy twigs, which indicates a dense growth of the plant near the site of deposition.

Although the plant closely resembles *Walchia*, it is easily recognized by its irregular branching. The leaves on the penultimate axes of the first order are bifurcate and of the *Gomphostrobus* type, whereas those of the ultimate and penultimate branches of the second order are simple. They appear to have been firm and rigid. Minute striations on the surface are indicative of strands of supporting tissue alternating with bands of stomata on the surface.

The difficulty in getting good views of the bimorphic foliage is probably the reason *Lecrosia* has passed unnoticed among the conifers of the late Paleozoic in North America. The genus was first described by Florin (3) from the upper Stephanian of France. The type species, *Lecrosia Grand'Euryi*, differs from *L. Gouldii* in the smaller diameter of the lateral shoots and the shorter, broader, thicker leaves. The fructifications of *L. Gouldii* are unknown.

*Locality and horizon.* — West side of the divide between Chubb Gulch and Muleshoe Gulch about one mile northwest of Trout Creek Pass, Chaffee County, Colorado. Gould's Division 6 of the Chubb siltstone member of the Maroon. Holotype No. 21008. Syntypes Nos. 21005, 21011, 21012, 21013.

*Walchia stricta* Florin

(Pl. III, Figs. 21-22)

Remains of the form genus *Walchia* are frequently encountered in the later Paleozoic sediments of central Colorado, but preservation is usually unsatisfactory for accurate determination. It was largely on the basis of this genus and similar conifers that the original assignment to the Permian was made. That the distinctive characters of the species of *Walchia* have been in an extremely confused state is very apparent to anyone having occasion to determine material by recourse to existing literature. Not only has a great amount of guesswork entered into the making of determinations, but the resulting misplacements have been perpetuated by successive writers, and since the original descriptions and figures of most of the species are not distinctive, there has never been in existence any satisfactory basis for making authentic identifications. As a result of frequent misplacements such terms as *Walchia piniformis* came to be regarded as names for aggregates of similar species rather than for any well-defined form. Unless sufficiently large parts are present to reveal the pinnate branching, it is often impossible to distinguish between such forms as *Walchia*, *Ullmannia*, and *Araucarites*, and the detached leafy twigs have sometimes been mistaken for small branches of *Lepidodendron*. Florin (4) has completed a thoroughgoing revision of the Paleozoic conifers, and by utilization of epidermal characters in conjunction with the fructifications and the form and arrangement of the foliage and branches, he has been able to reestablish the specific lines of *Walchia* on a more satisfactory basis. He has proposed the name "*Lebachia*" for "*Walchia*" when the foliage, branching, epidermis, and fructifications are known. *Walchia*, therefore, is retained as a form genus for leafy twigs without fructifications or preserved epidermis.

Several specimens of *Walchia stricta* have been collected in Colorado. Some are short lengths of penultimate branches bearing pinnately arranged ultimate twigs, and others are detached ultimate twigs. Most of the ultimate twigs are from 3 to 4 cm. long, straight, and spaced at intervals of about 6 mm. along the pe-

nultimate axes, from which they depart at an angle of about 60 degrees. The leaves are 3-4 mm. long.

*W. stricta* is characterized by the extremely narrow ultimate branches which bear small, almost erect, appressed, acuminate leaves. Also the leaves on the penultimate branches are sparsely arranged. To some extent it resembles *Lebachia parvifolia* from the upper Pennsylvanian and lower Permian of Arizona, New Mexico, and Kansas, but differs in the smaller axes and leaves and in the sparsely distributed leaves on the penultimate branches.

The species has been previously reported from the Permian of Cotton County, Oklahoma, and from Russia (Florin, 4).

*Locality and horizon.* — (1) Highway cut along the north side of the Colorado River one mile northwest of Bond, and (2) one and one-half miles southeast of McCoy and a few hundred yards northeast of the Yarmony schoolhouse, Eagle County, Interval 74 (of Brill), McCoy formation, (3) along highway (U.S.-24) one and one-half miles west of junction of Gore Creek and Eagle River, Battle Mountain formation (of Brill), (4) Canyon of the Colorado River seven and one-half miles below mouth of Badger Creek, Fremont County. Permian (?). No. 22016.

*Walchia* sp.

(Pl. II, Figs. 17-20)

The most abundant *Walchia* remains in central Colorado are detached leafy, ultimate branches of the type usually indiscriminately assigned to *Walchia piniformis*. The material is considerably more abundant than that of *Walchia stricta*, but is less completely preserved. The slender branches are straight, being as much as 6 cm. long, but seldom more than 8 mm. in diameter inclusive of the leaves. The leaves stand 2-3 mm. apart in vertical sequence as displayed along the edges of the branch in the impression. Leaf attachment is by a slightly enlarged base. The leaves are decurrent at the base, but immediately above the point of departure they bend abruptly outward at a rather wide angle of 60 or 70 degrees or more. The tips are slightly incurved. The leaves average 5 mm. in length. A poorly preserved cone (*Walchiostrobus*) probably belongs to this form (Pl. II, Fig. 16).

*Locality and horizon.* — (1) Highway cut along the Colorado River one mile northwest of Bond and (2) one and one-half miles southeast of McCoy, a few hundred yards northeast of the Yarmony schoolhouse, Eagle County. Interval 74 (of Brill), McCoy formation, (3) northeastern slope of divide between Chubb Gulch and Muleshoe Gulch about one mile north of Trout Creek Pass, Park County. Bath submember (of Gould) of the Maroon formation. Nos. 21004, 21010.

#### CONCLUSION

The plant remains in the Battle Mountain, McCoy, and Maroon formations (exclusive of those of the basal Coffman of the latter) are decidedly "Permian" in appearance and affinities. That they grew under conditions of considerable aridity is indicated not only by the plants themselves, but also by the presence of desiccation features in the rocks. Brill mentions beds of gypsum and other evidence of aridity in the Battle Mountain formation, and Johnson (6) figures casts of salt crystals in the Weber (?) at Trout Creek Pass. The plants are therefore not proof of Permian or even late Pennsylvanian age, but may be an early appearance due to conditions of the environment. There are other considerations, however, that must be taken into account, the main one being whether it is advisable to place a plant assemblage so predominantly "Permian" in all its aspects as far back in the time scale as early Pennsylvanian. A partial "Permian" environment must have existed during the Missouri epoch in Kansas (Moore, Elias, and Newell, 8), and the possibility of such conditions prevailing even earlier in central Colorado must be admitted. If such was the case, however, the "Permian" environment was even more completely established in Colorado during Des Moines times than in Kansas during the succeeding Missouri epoch, because we find in the former practically no relics of middle or early Pennsylvanian types such as occur at Garnett in Kansas. The fact must also be remembered that a typical Pottsville flora exists in the Weber (?) beds in Colorado, but in the succeeding formations the flora takes on a Permian facies. From the flora alone one would never suspect but that the Permian boundary in central Colorado should be

drawn at, or not far above, the top of the Weber (?) formation, where White claimed it should be and where Johnson (6) and Gould (5) have questionably placed it.

In view of the obvious discrepancy between the fauna and the flora of the Paleozoic in Central Colorado, the author is of the firm opinion that, because of our incomplete knowledge of either, final conclusions concerning the age of the beds are premature. It must be borne in mind that two environments are concerned, one marine, the other terrestrial. Both the plants and the character of the rocks indicate deposition under conditions of considerable aridity beginning even in the Weber (?). On this point the agreement is complete. During this time there were marked fluctuations in altitude, water level, and direction of flow which might have brought in erratic marine faunas, but which would have caused only local disturbances in the flora. After a period of relative quiescence in the early Pennsylvanian, during which coal-swamp conditions developed on a relatively small scale, there followed a marked mountain uplift to the east and to the west of the present Mosquito and Gore ranges which continued throughout the remainder of the Paleozoic. Studies of the sediments of the Gore Range indicate that some were derived from one direction and some from another, and the marine beds containing the invertebrates were laid down during temporary changes in the sea level after long periods of deposition of terrestrial sediments.

The whole question of the age of the beds resolves itself into whether the entire thickness of Weber (?) and McCoy (including the comparable Battle Mountain and lower Maroon) sediments were all laid down during a relatively short interval in the early Pennsylvanian, during which a "Permian" flora developed precociously as a response to increased arid conditions, or whether deposition extended into the late Pennsylvanian with occasional recurrences of earlier marine conditions and faunas. Which of these alternatives is correct can be satisfactorily determined only after full consideration has been given to everything that may bear upon them.

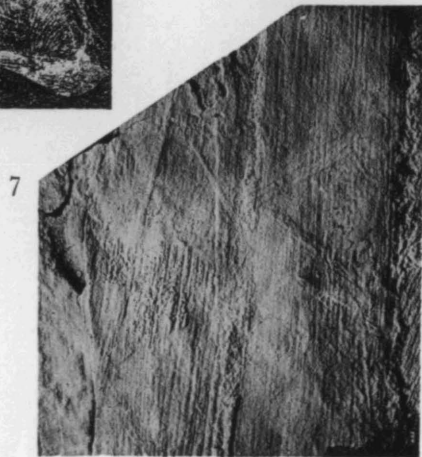
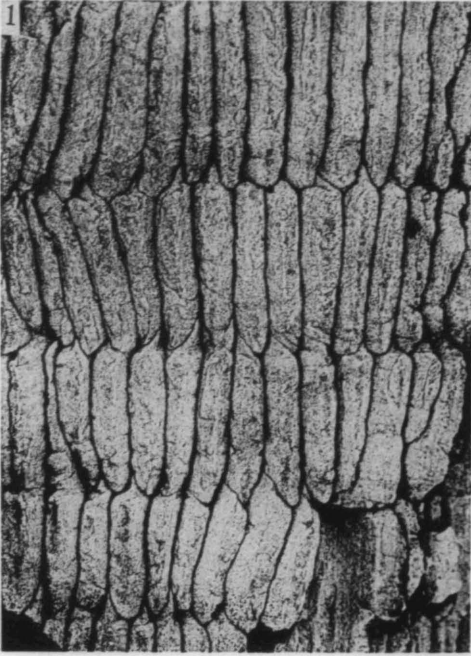
## LITERATURE CITED

1. ARNOLD, C. A. 1940. *Lepidodendron Johnsonii*, sp. nov., from the Lower Pennsylvanian of Central Colorado. Contrib. Mus. Pal., Univ. Mich., Vol. VI, No. 2, pp. 21-52.
2. BRILL, K. G. 1939. Pennsylvanian Rocks of the Gore Area, Colorado. Unpublished thesis, No. 1460, University of Michigan.
3. FLORIN, R. 1929. Paleozoic Conifers. Proc. Int. Congr. Sci., Ithaca, N. Y., 1926., Vol. I, pp. 401-411.
4. ——— 1938-40. Die Coniferen des Obercarbons und des unteres Perms. Palaeont., Vol. 85, Abt. B, Lief. I-V.
5. GOULD, D. B. 1935. Stratigraphy and Structure of Pennsylvanian Rocks of Salt Creek Area, Mosquito Range, Colorado. Bull. Am. Assn. Petrol. Geol., Vol. 19, pp. 971-1009.
6. JOHNSON, J. H. 1934. Paleozoic Formations of the Mosquito Range, Colorado. U. S. G. S., Prof. Pap. 185-B.
7. LESQUEREUX, L. 1882. On some Specimens of Permian Fossil Plants from Colorado. Harvard Coll. Mus. Comp. Zoöl., Bull. 7, Geol. Ser. 1, pp. 243-247.
8. MOORE, R. C., ELIAS, M. K., AND NEWELL, N. D. 1936. A "Permian" Flora from the Pennsylvanian Rocks of Kansas. Journ. Geol., Vol. 44, pp. 1-31.
9. READ, C. B. 1934. A Flora of Pottsville Age from the Mosquito Range, Colorado. U. S. G. S., Prof. Pap. 185-D.
10. WHITE, D. 1912. The Characters of the Fossil Plant *Gigantopteris* Schenk and Its Occurrence in North America. Proc. U. S. Nat. Mus., Vol. 41, pp. 493-516.

## EXPLANATION OF PLATE I

- FIG. 1. *Calamites gigas* Brong. Bath submember of Maroon, Trout Creek Pass. No. 21001
- FIG. 2. *Asterophyllites charaeformis* (Sternb.). Pottsville, Canyon of the Arkansas River. No. 22129
- FIGS. 3-4. *Neuropteris Dluhoschi* Stur. Pottsville, Canyon of the Arkansas River. No. 22130
- FIG. 5. *Neuropteris gigantea* Sternb. (?). Pottsville, Canyon of the Arkansas River. Pinnule enlarged two times. No. 22131
- FIGS. 6-7. *Cordaites anguloso-striatus* Grand'Eury. Permian (?), Canyon of the Arkansas River. No. 22128

PLATE I

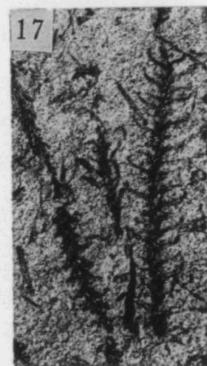
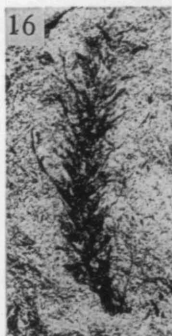
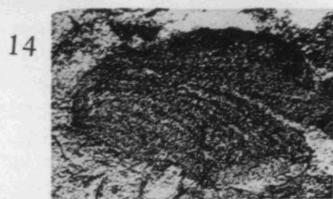
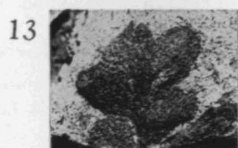


## EXPLANATION OF PLATE II

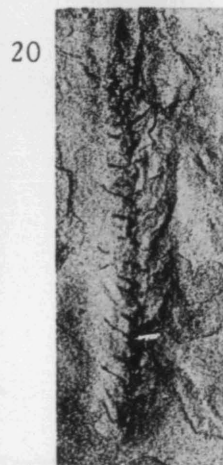
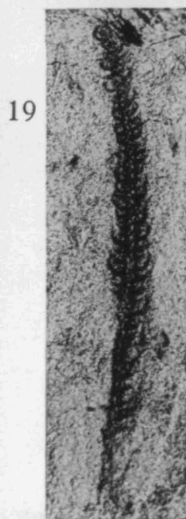
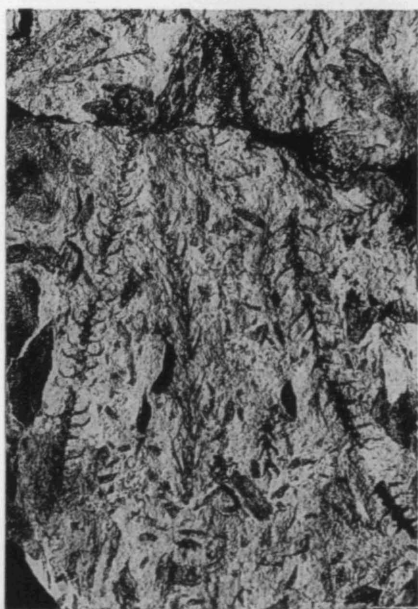
- FIGS. 8-14. *Odontopteris mccoyensis*, sp. nov. Syntypes. Interval 74 (of Brill), McCoy formation. Figs. 8-13, terminal and mid-portions of pinnae. Fig. 14, single pinnule enlarged to show odontopteroid venation. Nos. 21003, 21007, 21016
- FIG. 15. *Samaropsis hesperius*, sp. nov. Holotype. Interval 74 (of Brill) of McCoy formation. No. 22127
- FIG. 16. *Walchiostrobus* sp. Interval 74 (of Brill), McCoy formation. No. 21004
- FIGS. 17-19. *Walchia* sp. Interval 74 (of Brill), McCoy formation. No. 21004
- FIG. 20. *Walchia* sp. Bath submember of Maroon, Trout Creek Pass. No. 21010



PLATE II



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### EXPLANATION OF PLATE III

FIGS. 21-22. *Walchia stricta* Florin. Permian (?), Canyon of the Arkansas River. Fig. 21, view of three ultimate branches,  $\times 3$ . Fig. 22, penultimate branch bearing pinnately arranged ultimate branches. No. 22016

FIGS. 23-26. *Lecrosia Gouldii* Arnold. Chubb siltstone member of Maroon, Trout Creek Pass. Fig. 23, penultimate axis of first order bearing bifurcate leaves and penultimate branches of second order. Holotype.  $\times 2$ . No. 21008. Fig. 24, single bifurcate leaf (from holotype),  $\times 2$ . No. 21008. Fig. 25, penultimate branch of second order bearing simple leaves. No. 21011. Fig. 26, penultimate branch bearing ultimate branches of third order. No. 21005

PLATE III

