

AN UNUSUAL NEW SPECIES OF *DICRANOPHYLLUM*
GRAND'EURY FROM THE VIRGILIAN (UPPER PENNSYLVANIAN)
OF NEW MEXICO, U.S.A.

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ABSTRACT

Upper Pennsylvanian (Virgilian) rocks of a lagoonal deposit in the Manzanita Mountains, north-central New Mexico, contain a rich biota of both plants and animals. The plants are mostly typical Pennsylvanian genera, but the assemblage is dominated by a new species of *Dicranophyllum* (*D. readii*), characterized by its unusually long leaves. The leaves are slender, consistently twice-bifurcate, and judging from the largest fragments, reached lengths of 75 cm or slightly more. Inasmuch as *Dicranophyllum* is very rare in North America, this large-leaved new species lends considerable interest to the New Mexico flora and indicates that palaeobotanical exploration in the south-western United States should prove continually productive.

Key-words — *Dicranophyllum*, Fossil leaves, Upper Pennsylvanian, Late Palaeozoic, New Mexico.

सारांश

न्यू मेक्सिको (संयुक्त राज्य अमेरिका) में वर्जीलियन (उच्च पेन्सिलवेनियन) से डाइक्रेनोफिलम ग्रेंड'यूरी की एक असामान्य नव जाति—सर्जियस एच० मैमे

उत्तर-केन्द्रीय न्यू मेक्सिको के मैन्सानीटा पर्वतों में एक लैगूनिय निक्षेप की उच्च पेन्सिलवेनियन (वर्जीलियन) चट्टानों में पौधों एवं जन्तुओं के जीवजातों का बाहुल्य है। पौधे अधिकतर प्रारूपिक पेन्सिलवेनियन वंशों के ही हैं, परन्तु समुच्चय असामान्य लम्बी पत्तियों से लक्षणित डाइक्रेनोफिलम (डी० रीडाई) की एक नई जाति से प्रभावी है। पत्तियाँ अर्द्ध, बराबर दो-दो बार विभाजित तथा सबसे बड़े उपलब्ध खंड के अनुमान से 75 सेन्टीमीटर अथवा कुछ और अधिक लम्बाई तक पहुँचती हैं। चूँकि उत्तर अमेरिका में डाइक्रेनोफिलम बहुत दुर्लभ है अतएव बड़ी पत्त वाली इस नई जाति का न्यू मेक्सिको वनस्पतिजात के लिए काफी महत्त्व है तथा यह व्यक्त होता है कि दक्षिण-पश्चिमी संयुक्त राज्य में पुरावनस्पतिक अन्वेषण निरंतर उत्पादक सिद्ध होंगे।

INTRODUCTION

DICRANOPHYLLUM is a genus of Late Palaeozoic plants that was described by Grand'Eury (1877, p. 275, pl. 14, figs 8-10) on the basis of leafy shoots from the Upper Carboniferous near St. Etienne, France. Typified by the species *D. gallicum* Grand'Eury, this genus is characterized by very narrow, ribbon-like leaves that bifurcate once or twice in the same plane; in some instances the leaves are more divided. The leaves were produced in densely spiral arrangements, reminiscent of foliar systems of the arborescent lycopods. When the leaves were shed, the surface of the parent shoot was left with a sym-

metrical pattern of contiguous, either vertically or transversely elongate leaf cushions, similar to lycopod bark patterns. These features of *Dicranophyllum* have been well-illustrated recently by Barthel (1977).

Some thirty species of *Dicranophyllum* have been described from both Carboniferous and Permian rocks, with occurrences reported in various parts of Europe, Scandinavia, England, Australia, North America, the U.S.S.R., China, and Korea. Unfortunately, many of these are based on very fragmentary material and consequently are poorly understood. Of seven species described from North America (*D. dichotomum* Lesquereux, 1880; *D. dimorphum*

Lesquereux, 1880; *D. glabrum* [Dawson] Stopes, 1914; *D. ?garnettensis* Elias, 1936; *D. rigidum* Mamay & Read, 1956; and *D. ?* sp. White, 1899), only two (*D. glabrum* & *D. rigidum*) are sufficiently well known for comparison with proposedly new species.

The *Dicranophyllum* described here as *D. readii* n. sp., is of more than passing interest because of the scarcity of this genus in North America. It is also noteworthy because of the great size of its leaves, the length of which surpasses by far the leaves of any previously described species.

SOURCE AND AGE OF THE FOSSILS

The material is part of two collections, primarily of fossil plants, made in 1967 and 1969 by A.D. Watt and myself in the Manzanita Mountains of north-central New Mexico, U.S.A. The collecting site was in the Kinney clay pit, located in Bernalillo County (SE $\frac{1}{4}$, sec. 18, T. 9 N., R. 6 E), where the rock section exposed by quarrying operations then consisted of about 160 ft of limestone, siltstone, sandstone, shale, and conglomerate. This exposure lies in a Pennsylvanian sequence previously known as the Madera Limestone, whose nomenclature has been revised by Myers (1973). The classification of Myers combines the Madera Limestone and the Bursum Formation into the Madera Group and divides the group into three formations, the middle of which is named the Wild Cow Formation and contains the fossils discussed here. On the basis of foraminiferal evidence, Myers (1973) regards the fossiliferous sediments at the Kinney pit as early Virgilian in age; the plant assemblage includes no indicators of Permian age and thus presents no conflict with a Virgilian age for these rocks. Details of the geologic and stratigraphic setting of this locality have been reviewed by Kelley and Northrop (1975) and by Zidek (1975).

DESCRIPTION

Although the fossil flora of the Kinney clay pit is a relatively diverse assemblage, *Dicranophyllum* leaf material is one of the most conspicuous elements, both in numbers and size of specimens. Most of the leaves are fragmentary, but a few are sufficiently complete to confirm the identity of the

fossils as *Dicranophyllum*. Leaf fragments occurred in nearly the entire rock section, with the largest, most complete specimens found in the dark gray, calcareous shale near the bottom of the exposure; at higher levels, however, the soft, tan siltstones contained abundant specimens.

The most complete specimen, shown on Pl. 1, fig. 3, is a slightly distorted and incomplete leaf, which, nonetheless, illustrates the great length attained by leaves of *D. readii*. This specimen, selected as the holotype, bifurcates twice and is about 53 cm long, measured along the left member of the primary (basal) bifurcation; however, both the base and the four terminal segments resulting from the secondary bifurcation are incomplete, so that the entire leaf might have reached a length of 60 cm or even more. The specimen shown on Pl. 2, fig. 5, is slightly more than 50 cm long, measured along the right side. The base is apparently complete, and is shown as being noticeably enlarged for about 2 cm above its terminus. The four ultimate segments, however, are broken off slightly less than 2 cm above the secondary bifurcation, and to judge from the known lengths of other terminal segments in the collection (25 cm or more), this specimen, if complete, probably would have exceeded 75 cm in length. The undivided basal portion of this leaf is the longest in the collection; it is 35 cm long. Few other comparable leaf segments attain more than half that length.

The leaves are very slender in proportion to their lengths. The largest specimens are only 1.0-1.2 cm broad in their proximal segments, except for the enlarged bases, which attain widths of approximately 1.7 cm (Pl. 1, fig. 4). Width of the leaf segments is approximately halved above each of the two bifurcations, so that the terminal divisions are usually no more than 1.5 mm wide. The ultimate divisions end bluntly.

Division of the lamina in *Dicranophyllum* characteristically occurs through two successive dichotomies, always in the same plane; in some apparently aberrant specimens there is slight variation in the number of ultimate foliar segments, but it is always low. In *D. readii*, the dichotomies are consistently two-fold, resulting in four terminal segments. The secondary dichot-

tomies are always equidistant from the primary one, so that the penultimate foliar segments are of equal length; likewise, the four terminal segments are usually of the same length. Dichotomous divisions of *D. readii* are well-shown in Pl. 1, figs 1-3, and Pl. 2, figs 5-7. The two leaf segments resulting from the first, or primary divisions usually include an angle of about 20 degrees, but in the specimen shown in Pl. 2, fig. 6, this angle is considerably greater (about 60 degrees), possibly due to mechanical distortion during sedimentation. The secondary divisions nearly always involve much narrower angles (approximately 5 degrees) at the immediate points of division, as seen in Pl. 1, figs 1-3 and Pl. 2, figs 6 and 7. Beyond the points of secondary division, the two pairs of ultimate segments usually maintain equal spatial relationships. This feature, along with the similar lengths of corresponding members of each foliar division, results in a graceful, symmetrical system of foliar segments, well-illustrated in Pl. 1, figs 1-2, and Pl. 2, fig. 7.

Relative lengths of successive segments of the leaves show a fairly high degree of consistency. As seen in Pl. 1, figs 2-3, and Pl. 2, fig. 5, the basal, undivided part of the leaf is much longer (by as much as nearly 3 times) than the two segments distal to the first dichotomy. Likewise, the ultimate segments are at least twice as long as the penultimate segments. Thus, the median segments of the leaves are by far the shortest elements in leaves of *D. readii*.

Longitudinal, parallel striations are visible on the surfaces of some specimens (Pl. 1, fig. 4) but these striations show insufficient regularity of spacing or any other features to permit their morphological or anatomical interpretation; thus one cannot speculate intelligently on the vasculature of these leaves. Likewise, the epidermal characteristics are not known, for attempts to macerate coalified flakes of the leaves for cuticular studies were unsuccessful. Notwithstanding the lack of knowledge of anatomical details, it is apparent that leaves of this species were rigid in life, for only rarely are specimens curved or otherwise distorted from a linear shape. It is likely that the laminae were well-reinforced with mechanical tissues.

The specimen illustrated in Pl. 1, fig. 4 is one of several that demonstrate the enlarged leaf base in *D. readii*. Along with its rather abrupt enlargement, this particular leaf base is smoothly truncated. It appears to have been cleanly abscised from its parent axis, and one has reason to conclude that the bark of that axis had a regular pattern of leaf scars, as noted in other species of *Dicranophyllum* (Barthel, 1977, figs 16, 18). However, there is no firm information on that point in the Kinney collection. All the leaves identifiable as *Dicranophyllum* are detached, and a few associated specimens of stem material are either devoid of surface ornamentation or clearly represent sigillarian lycopods.

Most of the leaf fragments indicate great lengths (50 cm or more) for complete leaves, but the specimen shown in Pl. 2, fig. 6, is considerably smaller; had it been unbroken, it probably would have been no more than 15 cm long. There is no way of supporting the thought that this specimen may represent a species separate from *D. readii*, characterized by smaller leaves. It is more likely a younger, smaller developmental stage of *D. readii*. It would be unsubstantiable to suggest that this leaf was shed earlier in the year than the larger ones, because it was found on the same bedding plane with large specimens. Other, even smaller linear foliar fragments occur in the collection, but they are undivided and show no convincing evidence of being early growth stages of *D. readii*.

COMPARISONS

The thirty-odd previously described species of *Dicranophyllum* show a considerable range of size, but none approaches the leaves of *D. readii* in foliar length. Leaves of *D. domini* Nemejc (1929) and *D. ? brevifolium* Kawasaki (1931) are only 17 mm or less in length, while leaves of *D. striatum* Grand'Eury (1877) and *D. latifolium* Sterzel (1907) may slightly exceed 20 cm in length.

The type species, *D. gallicum* Grand'Eury (1877), is the most common and best known member of the genus. Its leaves, however, are ordinarily no longer than 10 cm (Barthel, 1977).

The North American plants described as representatives of *Dicranophyllum* in-

clude only two species sufficiently well-preserved for comparisons with the New Mexico material. *D. glabrum* (Dawson) Stopes (1914) is based on an incomplete specimen only 9 cm long. It differs further from *D. readii* by dichotomizing three times, possibly more, and resulting in at least eight terminal segments.

D. rigidum Mamay & Read (1956) was found in abundance at one Pennsylvanian locality in central Oregon. As far as ascertainable, the leaves bifurcate only twice, as in *D. readii*. Leaves of *D. rigidum* are very small, however (from 1.5-5.0 cm in length), and their diminutive size readily distinguishes them from *D. readii*.

Ovuliferous appendages have been reported for *D. gallicum* (Seward, 1919, p. 97), and Barthel (1977) has illustrated the epidermal features of undesignated species of the genus. Such characters are not generally known for the plants grouped in *Dicranophyllum*, however, so that gross foliar habit must suffice for species differentiation. In the case of *D. readii*, the type of foliar division is such that it would be difficult to justify a separation of this material from the concept of *Dicranophyllum* on a qualitative basis. However, the leaves of the New Mexico plant are so spectacularly large in comparison to previously described species that a new specific assignment appears to be justified.

The name *Dicranophyllum readii* is proposed in honour of my late colleague, Charles B. Read, who led me to the Kinney clay pit and instructed me in many aspects of the geology and paleontology of New Mexico and Texas. *D. readii* is diagnosed herewith:

SPECIFIC DIAGNOSIS

Dicranophyllum readii n. sp.

Leaves linear, long (to 75 cm), thin, and narrow (to 1.2 cm wide), with broadened bases (to 1.7 cm wide); bases appearing cleanly abscised. Laminae consistently twice-bifurcate in one plane, bifurcations usually describing narrow angles; basal (primary) bifurcations 20-30 degrees wide, secondary bifurcations less than 10 degrees wide. Ultimate foliar segments of equal length, less than 2 mm wide. Median

foliar segments usually much shorter than either basal or terminal segments. Faint, closely spaced, parallel striations apparent on surfaces of some basal segments.

Parent axes, epidermal features, vasculature, and fructifications unknown.

Holotype — U.S.N.M. 267277.

Paratypes — U.S.N.M. 267278-267283.

Geographic Location — Kinney clay pit; SE $\frac{1}{4}$, sec. 18, T 9 N, R 6 E, Bernalillo Co., New Mexico, U.S.A. (U.S.G.S. PB Locality 10087).

Stratigraphic Source — Wild Cow Formation, Madera Group, Virgilian Provincial Series, Pennsylvanian System.

DISCUSSION

Unfortunately, *D. readii* contributes nothing to amplify our knowledge of the natural affinities of *Dicranophyllum*. The genus has been regarded as cordaitan, ginkgoalean, and taxaceous, while most recently Barthel (1977, p. 73) has suggested that *Dicranophyllum* is the "origin group for conifers; the furcate leaves with apex growth point to Pteridosperm origin."

Associated with *D. readii* are abundant platyspermic seeds, but they are all isolated specimens whose presence in the plant-bearing beds need have no bearing on the relationships of *D. readii*. Nonetheless, the huge size of these leaves constitutes a striking example of size variation within the leaves of a fossil plant genus, and points up the probability that many new and interesting plant forms yet remain to be discovered by the paleobotanists. Experience has shown me that the southwestern United States is a particularly promising area in which to expand our understanding of Late Paleozoic floras.

The biota of which *D. readii* is a part, is remarkable in its diversity. The associated flora is rich in ferns, pteridosperms, walchian conifers, and arthropytes, while lycopods are rare. The Kinney clay pit also contains a variety of animal remains, including foraminifers, brachiopods, pelecypods, gastropods, eurypterids, insects, crustaceans, fishes, and amphibians, some of which have been described (insects: Carpenter, 1970; crustaceans: Schram & Schram, 1979; fishes: Zidek, 1975; an amphibian: Berman, 1973). I have collected neuropterid frond fragments with

juvenile pelecypod shells attached, apparently preserved in originally adherent associations. Clark (1978) noted similar circumstances at this locality and interpreted the sediments as a lagoonal deposit; in this interpretation Clark agrees with Carpenter (1970), Schram and Schram (1979), Berman (1973) and Zidek (1975). This would most logically explain the large variety of terrestrial and aquatic organisms present in the same sedimentary beds.

This biotic association suggests vegetation growing along sluggish watercourses

emptying into lagoons such as that represented by the Kinney clay pit. In most aspects, the vegetation was a typical Late Pennsylvanian association, yet it differed by the presence of *Dicranophyllum readii*. Nothing is known about the gross growth habit of this plant, but its frequency of occurrence in the collection suggests it to have been a dominant plant. With its long, slender and gracefully twice-forked leaves, it adds an interesting element to the "usual" spectrum of lowland Pennsylvanian vegetation.

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EXPLANATION OF PLATES

PLATE 1

1. Distal portion of leaf, showing four terminal, nearly equal, slender segments, with secondary bifurcation at bottom of photograph. Scale equals 5.0 cm. Paratype, U.S.N.M. 267278.
2. Nearly complete leaf, showing enlarged base and two successive bifurcations. Scale equals 10.0 cm. Paratype, U.S.N.M. 267279.
3. Large, nearly complete leaf, showing two successive bifurcations. Scale equals 10.0 cm. Holotype, U.S.N.M. 267277.
4. Proximal, undivided portion of leaf, showing enlarged base, natural size. Paratype, U.S.N.M. 267280.

PLATE 2

5. Large leaf, showing enlarged base and relatively short median segments. Secondary bifurcations occur slightly below broken upper edge of slab. Scale equals 10.0 cm. Paratype, U.S.N.M. 267281.
6. Relatively small, nearly complete leaf specimen, showing both primary and secondary bifurcations; an unusually broad angle is included in the primary bifurcation. Scale equals 5.0 cm. Paratype, U.S.N.M. 267282.
7. Part of leaf, showing both primary and secondary bifurcations, each describing typically narrow angles. Scale equals 5.0 cm. Paratype, U.S.N.M. 267283.

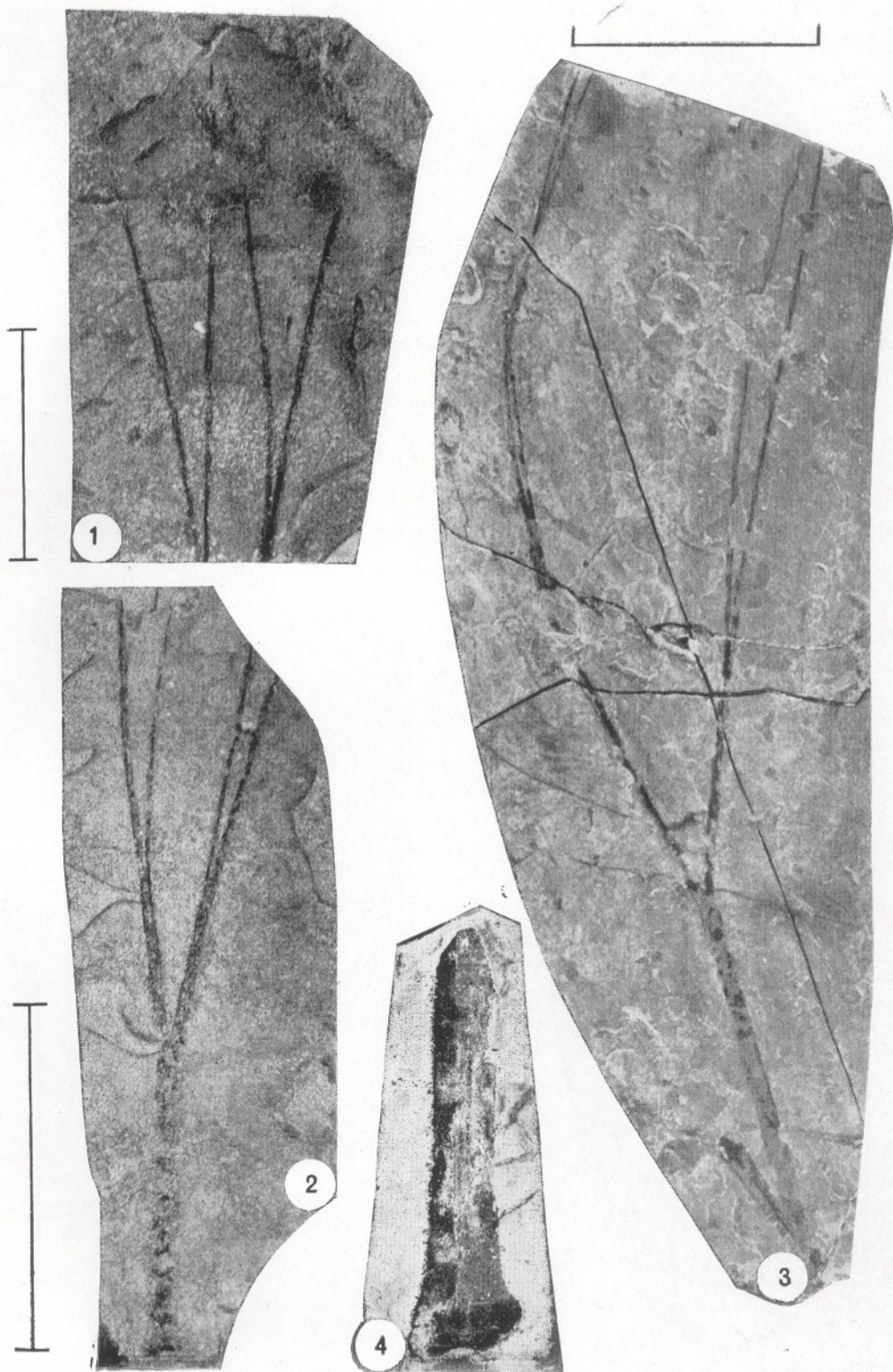


PLATE 1

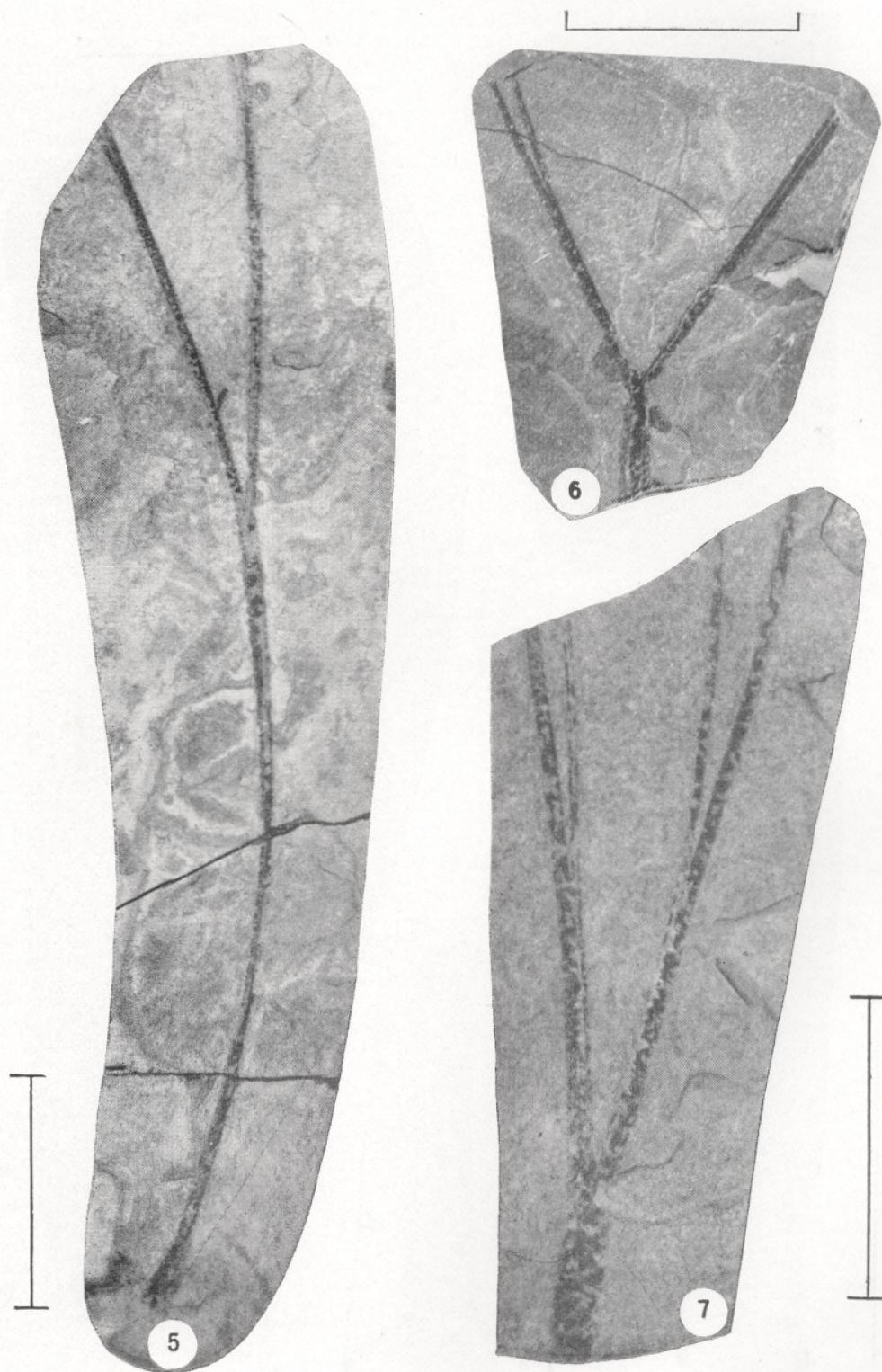


PLATE 2