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SOME FOSSIL GINKGOPHYTES AND A POSSIBLE VOJNOVSKYALEAN ELEMENT FROM THE GLOSSOPTERIS FLORA OF VEREENIGING, TRANSVAAL

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ABSTRACT

A short historical review is given of previously described sites where plant fossils occur in Lower Karroo beds at Vereeniging in the Southern Transvaal. Reference is made to the importance of these sites because of the outstanding discoveries made here in the past. Some new material from the same sites is described and several unusual elements in the *Glossopteris* flora of Vereeniging are recorded for the first time.

Leaves of a plant not previously recorded from Gondwanaland are provisionally described under the term *cf.Nephropsis* on account of a strong resemblance to leaves of the Russian Permian genus *Nephropsis* Zalessky.

The remaining specimens in the assemblage are tentatively placed in the genera *Ginkgoites* Seward and *Psygmophyllum* Schimper respectively. Owing to the paucity of material, type numbers are assigned in certain cases, instead of specific names. Specific identification is attempted, however, in the case of four of the specimens, which are provisionally assigned to *Psygmophyllum kidstoni* Seward.

INTRODUCTION

The fossiliferous Lower Karroo beds occurring at Vereeniging, in the Southern Transvaal, have been for many years a rich source of plant fossils which have shed much light on the nature of the early *Glossopteris* flora in South Africa. A considerable amount of valuable new information concerning this flora became available during the past 25 years as a result of new exposures of fossiliferous deposits. This came about as a consequence of the exploitation of refractory shales by the Vereeniging Brick and Tile Company. These activities started about 25 years ago and were continued for several years. During this time some extensive excavations were made along the northern bank of the Vaal River. The locality is situated about 6 km south of the town on a portion of the original farm Leeuwkuil No. 81, and the excavations concerned are generally known as the "Leeuwkuil Quarries".

During the time when the fossil-bearing deposits were being exposed in these quarries they were intensively exploited by the present author. Collecting was subsequently continued for many years. This eventually led to numerous new discoveries, the most important of which was undoubtedly the discovery of the fructifications of the *Glossopteridae*, which were subsequently described by Dr. Edna Plumstead.

A large collection of plant fossils was built up by the author over a period of many years. The major part of the collection is now lodged in the Bernard Price Institute for Palaeontological Research of the University of the Witwatersrand, Johannesburg. The material which is described in the present paper forms part of the collection and represents the remains of some of the rarer elements of the Vereeniging fossil flora.

NATURE AND RELATIVE STRATIGRAPHIC POSITION

The plant material is preserved in the form of impressions in which there is a complete absence of material suitable for cuticular preparation. The impressions are preserved in fine-grained sediments in which the external morphological features of the specimens are often shown in fine detail.

The fossiliferous layers can be differentiated into distinctly different zones on the basis of colour and texture. These zones occur at specific levels in the sequence of strata overlying the coal in this area. The relative stratigraphic positions of the various specimens under description are described in terms of a previously published description of the different zones as initially exposed (Le Roux, 1963, pp. 1-2).

AGE

The sequence of fossil-bearing beds at Vereeniging forms an integral part of the Coal-measures in this area. These Coal-measures are referred to the Middle Ecca stage of the Karroo system. The general concensus of opinion is that the relative age of the Middle Ecca is Lower Permian. This naturally implies an age lying within very wide limits.

For more exact correlation of the strata, the application of modern methods based on palynology is essential. Investigations of this nature recently carried out by Hart (1966) have led him to the conclusion that the Middle Ecca stage could possibly be of Kungurian age. Further palynological research should be of great value in the elucidation of the question regarding the age of the Middle Ecca. This applies especially to the Vereeniging strata where the occurrence of a peculiar

mixed fossil flora has created some uncertainty regarding the true stratigraphical position of the fossiliferous beds, which are normally included in the Middle Ecca. In a recent discussion of this problem Plumstead (1966, p.6) expresses the opionion that " . . . it is probable that as a result of plant evidence adjustments will have to be made in the classification of the Lower Karroo".

When referring to the age of the Vereeniging fossil plants it is often found convenient to use the term Permo-Carboniferous. This term was derived from the fact that the Vereeniging fossil flora contains elements of both the Permian and Carboniferous periods. This rather vague age designation is of little value, however, when close age determination is demanded.

NAMING AND CLASSIFICATION OF THE FOSSILS

The material which is described in the present paper is of such a nature that the taxonomic position of the plants cannot be determined with any degree of certainty. Some of the specimens are tentatively placed in the genera *Ginkgoites* Seward and *Psygmophyllum* Schimper respectively.

In order to distinguish between the different specimens placed in the genus *Ginkgoites,* it was found to be more satisfactory to assign type numbers rather than specific names. This unusual procedure was also recently adopted by Huard-Moine (1965, p.77) and Plumstead (1967, p.13) in cases where a paucity of material did not justify the institution of a new species.

The remaining material represents impressions of leaves of a plant which has apparently not previously been recorded from Gondwanaland, but which shows a strong resemblance to the Russian Permian genus *Nephropsis* Zalessky. Since there is no conclusive evidence, however, that the new plant was actually generically identical with *Nephropsis* it is thought wiser to describe the specimens concerned provisionally under the term *cf.Nephropsis.*

DESCRIPTION OF THE MATERIAL

GINKGOALES

Genus *GINKGOITES* Seward

The generic name *Ginkgoites* was instituted by Seward (1919, pp.10-11). He motivated the institution of the new name as follows: " . . . In certain instances, for example such leaves as those from the Island of Mull and other Tertiary localities referred to *Ginkgo adiantoides,* there can be no doubt as to the generic identity with the recent species and indeed, so far as concerns form and venation, the Eocene leaves might well belong to *Ginkgo biloba.* On the other hand even in the case of *Ginkgo adiantoides* we lack the confirmatory evidence of flowers and seeds . . .I therefore propose to employ the name *Ginkgoites* for leaves that it is believed belong either to plants generically identical with *Ginkgo* or to very closely allied types . . ."

(A) *Ginkgoites* sp Type A (Plate I, fig. 1 & 1a)

(a) **Material**

Only one specimen is available for study. It is preserved in the form of two counterparts, GK/1 and GK/1a. Specimen GK/1 (Plate I, Figs. 1, 1a) is the more complete of the two counterparts and the description of the plant is therefore mainly based on this specimen.

(b) **Zone**

Buff-coloured silty clay layer (Le Roux, 1963, Plate I, Fig. 2, Layer A, Quarry no. 2).

(c) **Description** (See Plate I, Figs. 1-1a)

The impression is in fine-grained sediment and is that of a single leaf which was evidently torn before preservation. This is clearly indicated by the position of the right-hand lateral lobe.

The original shape of the leaf could have been broadly triangular. The lamina is deeply dissected and divided into 3 primary lobes which converge towards the bases. The lobes have radii of 2,5–3,5 cm and their lateral margins are nearly straight. The lobes are divided into wedge-shaped segments with truncated apices which are repeatedly incised. There is a distinct petiole which is 5 mm long by 2 mm wide. The venation is inconspicuous. Several primary bundles appear to enter each lobe, and by repeated forking give rise to the formation of a number of more or less sub-parallel veins. The veins are spaced about 1 mm apart. The venation is not preserved in sufficient detail to determine whether anastomosis took place or not. The leaf was evidently comparatively thin judging from the faint impression left on the fine-grained sediment. The epidermal features are not preserved and no indication of resin bodies can be detected between the veins.

(d) **Comparisons and discussions**

(i) *General.*

The superficial features of the leaf described here clearly indicate a ginkgoalean origin. The generic identification is based on Dorf's (1958, p.3) modification of a key originally proposed by Florin (1936, p.44) for the identification of ginkgoalean leaves. Any attempt at specific identity would have to be based on the external morphology of a single leaf. Considering the perplexing variability in size and shape of ginkgoalean leaves, this is regarded as an impossible task.

(ii) *Comparisons with Palaeozoic ginkgophytes.*

As far as is known the fossil record of the ginkgophytes beyond the Mesozoic does not include any foliage which could be compared with the new plant from Vereeniging. According to Andrews (1961, p.340) " . . .The most ancient fossil that may with some confidence be attributed to the ginkgophyte line, and which offers some significant clues concerning the evolution of the

living species, is *Trichopitys heteromorpha* from the Lower Permian of Lodeve in southern France.

The latter plant does not show any superficial resemblance to the new plant from Vereeniging, however. Unlike *T. heteromorpha,* the Vereeniging plant shows a remarkable resemblance to the living species. The existence of a plant in Permo-Carboniferous times showing such distinctive ginkgoalean features as *Ginkgoites* sp Type A, is of great phylogenetical interest. It seems to indicate that the earliest ancestors of *Ginkgo biloba* should be sought even farther back in time than was previously thought.

(iii) *Comparisons with Mesozoic ginkgophytes.*

Many of the numerous Mesozoic species show some resemblance to *Ginkgoites* sp Type A. A brief comparison between *G.* sp Type A and similarly deeply lobed leaves from different geological horizons and localities may be of interest.

Of the Mesozoic species the foliage of the widely-spread *Ginkgoites digitata* is certainly the best known. Typical variations in the shapes and sizes of the leaves of this species are illustrated by Seward (1919, Fig. 635, p.17). *G. digitata* is also one of the few species previously recorded from South Africa. It is known to occur in Upper Karroo beds (Upper Triassic) and was first described by du Toit (1927, Text-fig. 16B, p.370).

The lamina of both *G. digitata* and *G.* sp Type A are deeply lobed and the lobes are divided into segments. In the former species the segments are linear oblong with curved margins and obtuse apices. In the latter, however, the segments are wedge-shaped and have straight margins and truncated apices. The petiole of the latter is also much shorter than that of *G. digitata.* The possibility is not excluded, however, that part of the petiole of *G.* Type A was broken off prior to preservation. No marked difference is evident in the venation of the two plants.

The Indian species *G. rajmahalensis* described by Sah & Jain (1965, Text-figs. 3-9, p.156) has, like *G.* sp Type A, deeply incised laminae. Although there seems to be some resemblance between the two plants under discussion as regards their distinctive ginkgoalean features, no close comparison is possible.

Among Triassic species, *G. acosmia* and *G. taeniata,* described by Harris (1935, Fig. 4, p.11 and Fig. 9, p.20) from Greenland, seem to bear some resemblance to the Vereeniging species. This resemblance is of a very superficial nature, however, and consequently it has little or no diagnostic value.

In the Austrian Triassic species *G. lunzenses* described by Kräusel (1943) the leaves were very much larger in size than those of *G.* sp Type A. There is also a marked difference in the mode of division of the laminae of the two plants.

In comparing the leaf of *G.* Type A with those of the Lower Cretaceous species *G. tigrensis* and *G. ticoensis* described by Archangelsky (1965, Plate I, Figs. 1-6, Text-fig. 7, pp.122-128) from Santa Cruz, Argentina, the venation of the latter species appears to be more conspicuous and denser than that of the Vereeniging species.

(iv) *Comparison with* Ginkgo biloba.

The striking resemblance between *Ginkgoites* sp Type A and a leaf of a one year old plant of *Ginkgo biloba* is clearly reflected in Plate I, Figs. 1-2. When the leaves of older specimens of *Ginkgo biloba* are compared with that of *Ginkgoites* sp Type A, the general resemblance becomes less striking, however. This seems to be in agreement with Shaparenko's view (1935, p.5) that primitive characters are more strongly in evidence in the leaves of young ginkgoaceous plants than in older ones. Shaparenko makes an important point in the following statement: "...This matter has to be taken into consideration in describing the fossil *Ginkgo* in order to avoid confusion of the leaf with leaves of other genera and species..."

(d) **Conclusions**

With the meagre evidence available it is impossible to relate *Ginkgoites* sp Type A to any of the known species of this genus. Considering the position of the new plant in time and space, it seems to be more closely related to *Ginkgoites digitata* than to any of the other species with which it has been compared, however.

(B) *Ginkgoites* **sp Type B** (Plate II, figs. 1 & 2.)

(a) **Material**

Two specimens, marked GK/2 and GK/3 respectively, are available for study (Plate II, Figs. 1-2).

(b) **Zone**

Specimen GK/2—Buff-coloured silty clay layer (Le Roux, 1963, Plate I, Fig. 2, Layer A, Quarry No. 2).

Specimen GK/3—Beige-coloured sandy shale layer (Le Roux, 1963, Plate 1, Fig. 1, Layer C, Quarry No. 1).

(c) **Description** (See Plate II, Figs. 1-2)

The leaf is broadest towards the apex. It is distinctly spatulate with the apical portion more or less rhombic in outline. The length of specimen GK/2 is approximately 13 cm and its maximum width is 5,5 cm. The broad distal portion is elongated proximally into a gradually tapering petiole-like structure which is not completely preserved. The distal margins converge to form a bluntly pointed apex. In the case of specimen GK/2 the margin is entire, but there appears to be a median incision in the blade of specimen GK/3. There is no distinct midrib. There are several strong median veins in the proximal half of the leaf. The veins are more or less parallel in the petiolate portion and these veins bifurcate repeatedly, at the same time spreading out fan-wise over the broader

portion of the leaf. Bifurcation was continued up to within 5 mm from the apical margin. Anastomosis of veins appears to have taken place occasionally (see Plate II, Fig. 2).

Generally speaking the two specimens included here under the same name are superficially very similar. There is a distinct difference in the density of the veins, however. In specimen GK/2 there are 13-14 veins per cm but only 6-7 veins per cm in the case of specimen GK/3. At present it is uncertain whether this difference has any important diagnostic value. Two specimens are, therefore, provisionally described together.

(d) **Comparison and discussions**

(i) *General*

In spite of the admittedly meagre evidence available at present, it is believed that the leaves described here were those of a plant related to the genus *Ginkgo.* The specimens are, therefore, assigned to *Ginkgoites* the form genus instituted by Seward (1919, p.11) for extinct members of the Ginkgo family whose epidermal features or other anatomical characters are not preserved.

(ii) *Comparisons with previously recorded ginkgophytic plants with a similar type of foliage.*

Specimen GK/3 described in the present paper (Plate II, Fig. 2) closely resembles a specimen previously recorded from Vereeniging by Plumstead (1961, Plate VIII, Fig. 3, p.548) and which was named *Ginkgoites* sp. Although there is a slight difference in the shapes of the two specimens referred to above, the venation is identical, and it seems probable that the two specimens represent the foliage of a single species. No other South African fossil plant is known which bears any resemblance to *Ginkgoites* sp. Type B.

The foliage of the Devonian plant *Enigmophyton superbum* from Spitsbergen shows some resemblance to the Vereeniging plant in that the leaf also developed from a narrow base into a fan-shaped structure. Unlike the Vereeniging plant the lamina of *E. superbum* is much dissected, however.

The leaf of an American Devonian plant described by Beck (1963, Fig. 1a, p.432) under the name of *Ginkgophyton* sp. has more or less the same shape as that of the Vereeniging plant. A detailed comparison is impossible, however, owing to the fragmentary nature of the leaves described by Beck.

? GINKGOALES

Genus *PSYGMOPHYLLUM* Schimper

This generic name was instituted by Schimper (1870, p.192) for large cuneate leaves of Upper Carboniferous and Permian age. He defined it as follows: "Folia pinnatisecta, pinnis erecto patentibus, e basi valde angustata flabelliformibus, longitudinaliter flabellatim plicatis, plus minus profunde pinnatisectis, vel margine lobatis sen crenatis; nervis plusies dichotomis, erecto-radiatibus. Vernatio foliorum verticaliter involuta".

Seward (1919, p.81) gave the following revised definition of the genus: "The name *Psygmophyllum* is adopted both for entire and deeply divided leaves of larger dimensions than the similar leaflets of fronds included in such genera as *Palaeopteris* and *Adiantites.* Specimens usually occur as detached leaves, but when the leaves are attached to an axis the lamina is usually contracted into a fairly long, decurrent, basal portion. There is no true petiole. The veins spread from the base of the lamina and are repeatedly forked; they may be very numerous in some forms occasionally anastomose, as in *P. flabellatum,* or much farther apart, as in *P. majus* Arb. and *P. brownii* (Daws)."

(A) *Psygmophyllum kidstoni* Seward (Plates III & IV)

(a) **General**

This species was first described from Vereeniging by Seward (1903, Plate XII, Fig. 1, p.93), who defined it as follows: "Vegetative shoots woody, bearing spirally disposed leaves. Leaves wedge-shaped, reaching a length of 13 cm, usually divided by a deep median sinus into two narrow wedge-shaped lobes, truncate distally and tapering gradually to the proximal end of the lamina. Leaves sessile, attached to the axis by a narrow base. The lamina is traversed by numerous spreading and occasionally forked veins following a course parallel to the edge of the leaf. Organs of reproduction unknown."

The specimens described in the present paper came from a different stratigraphical zone from that in which Seward's type specimen was found. Reference was recently made by Plumstead (1961, p.548) to the occurrence of *P. kidstoni* in the new zone mentioned above, but no description was given.

(b) **Material**

The descriptions are based on the following specimens:

PS/1—(Plate III, Fig. 1),

PS/2—(Plate III, Fig. 2),

PS/3 and PS/3a (counterparts) (Plate IV, Figs. 1-1a).

(c) **Zone**

Specimen PS/1-2—Buff-coloured silty clay layer (Le Roux, 1963, Plate, I. Fig. 2, Layer A, Quarry No. 2).

Specimen PS/3-3a—Red ferruginous layer (Le Roux, 1963, Plate I, Fig. 1, Layer B, Quarry No. 1).

(d) **Description of the specimens**

(i) Specimen PS/1 (Plate III, Fig. 1)—This fossil consists of an impression of a strong woody axis bearing spirally arranged leaves. The leaves are rather fragmentary and bear signs of having been damaged prior to preservation (according to Plumstead, 1963, p.148, Plate A, damage of this nature

could have been done by insects). The central terminal leaf, although incomplete, is the best preserved. It is fan-shaped and is divided into two wedge-shaped lobes by a median incision. This leaf has a length of approximately 9 cm and a maximum width of 5 cm. The lamina tapers towards its proximal end and terminates in a decurrent, petiole-like basal portion, which is inserted at an acute angle to the axis. The axis is more or less uniform in width in the region where it is exposed. The specimen described here strongly resembles Seward's type specimen of *Psygmophyllum kidstoni,* and the new specimen is, therefore, referred to the same species.

(ii) Specimen PS/2 (Plate III, Fig. 2). This is a detached leaf having characters similar to those of the leaf described under specimen PS/1. The venation is better preserved in specimen PS/2, however. Three strong veins appear to enter the leaf at the base and by repeated forking produce numerous secondary veins which spread out through the lamina. The veins are approximately 1 mm apart in the region of greatest concentration. The general direction of the veins is more or less parallel to the edge of the leaf. The venation is not distinct enough to determine with certainty whether lateral anastomosis of the veins took place or not. There are several scars in the leaf. They are of the same type as those regarded by Plumstead (1963) to have been produced by insects.

(iii) Specimen PS/3-3a (Plate IV, Figs. 1-1a). This fossil is preserved somewhat differently from the others. Fossilization is due to mineralization, the original organic matter having been completely replaced by red ochre. The red fossil produced stands out in vivid contrast against a lighter background. The lamina is broadly fan-shaped and is divided into two equal lobes by a deep median incision. The lobes are wedge-shaped and truncated distally. The width of each lobe is 6 cm and the radius is about 8 cm. The maximum dimensions inferred for the complete leaf are approximately 11 cm for the width and 10 cm for the length. The lamina tapers proximally and terminates in a petiolate structure which is not completely preserved. Three strong veins enter each lobe and spread across the lobes by repeated dichotomous branching. The veins are about 1 mm apart in the region where they are closest together. The veins run parallel to the lateral margins of the lobes. This specimen is considered to be an exceptionally large leaf of the same identity as the central terminal leaf of specimen PS/1 and is, therefore assigned to *Psygmophyllum kidstoni.*

(B) *Psygmophyllum* sp (Plate V)

(a) **General**

This fossil differs from *P. kidstoni* in respect of its venation and the long petiole-like basal portion. It seems justifiable, therefore, to describe it separately.

(b) **Material**

Only one specimen, PS/4, is available for study.

(c) **Zone**

Beige-coloured sandy shale layer (Le Roux, 1963, Plate I, Fig. 1, Layer C, Quarry No. 1).

(d) **Description of specimen**

The leaf is incomplete and apparently distorted, so that the true shape is unknown. The lamina was evidently torn or lobed and several segments appear to be overlapping. The specimen has a length of 19 cm. It consists of a broad apical portion, 5 cm wide, which is elongated proximally. It is contracted by gradual tapering into a long narrow basal portion which is strongly suggestive of a petiole. The veins are fine, repeatedly forked and lateral anastomosis appears to have taken place. The maximum concentration of the veins is about 12 per cm.

(e) **Comparisons and discussions**

The leaf described above seems to conform to the definition of the genus *Psygmophyllum.* The specimen is, therefore, provisionally placed in this highly artificial genus. No species of this genus is known, however, which shows any resemblance to the fossil described here.

THE UNCERTAIN TAXONOMIC POSITION OF THE GENUS PSYGMOPHYLLUM

Psygmophyllum is essentially a Devonian and Carboniferous genus, but if the identification of certain flabelliform and cuneiform leaves occurring in Permian strata is correct, the range of the genus must be extended into the Permian.

Leaves of the *Psygmophyllum* type have a wide geographical distribution. The classical Gondwana, Cathaysian, Angara and Euramerican floras each contains the genus *Psygmophyllum* as a minor constituent. As pointed out by Seward (1932, p.226), however, it is a disputable question as to whether all the fossils included in *Psygmophyllum* actually belonged to one genus or even to one family.

In spite of the wide-spread occurrence of these leaves, the reproductive organs remain unknown and consequently the true taxonomic position of *Psygmophyllum* cannot be determined with certainty. This has been a most perplexing palaeobotanical problem for nearly a century.

In the present paper the genus is tentatively placed in the Ginkgoales. This is done mainly on the basis of the superficial resemblance of the fossils concerned to ginkgoalean plants. It must be admitted, however, that no valid evidence exists for assuming relationship between *Psygmophyllum* and the Ginkgoales.

? VOJNOVSKYALES

Genus *NEPHROPSIS*-Zalessky

The generic name *Nephropsis* was proposed by Zalessky (1912, p.28, Foot-note) for Permian leaves previously described by Schmalhausen

(1879) and Renault (1888) under the genus *Ginkgo.*

cf. Nephropsis (Plate VI, figs. 1 & 2)

(a) **Material**

Five specimens, marked NP/1-5, are available for study. Specimens NP/1 and NP/4 have counterparts marked NP/1a and NP/4a respectively. Specimens NP/1-2 were selected for illustration because they are the best preserved and show typical variations in characters.

(b) **Zone**

All specimens–Buff-coloured silty clay layer (Le Roux, 1963, Plate I, Fig. 2, Layer A, Quarry No. 2).

(c) **Description** (see Plate VI, Figs. 1-2)

The specimens on which this description is based are very similar to each other and vary only slightly in size and shape. The leaves are bract-like and are flabelliformic to rhomboid in shape. The blade is distally expanded and elongated proximally into a broad stalk-like structure. The expanded distal portion has a width of 20-25 mm and the stalk-like basal portion is approximately 5 mm wide at the point of connexion. The total length of the leaf is 25-32 mm. The lateral margins curve outwards from the base to meet the arched apical margin at an angle. The margin is entire in the case of specimens NP/2, 3 and 5. Shallow incisions are present, however, on each side of the blades of specimens NP/1 and NP/4, thus giving rise to the formation of narrow lateral lobes. The leaves appear to have been of a fleshy nature and were probably much thicker in the central region of the blade than near the peripheral region. Two primary veins enter the leaf at the base. Dichotomous forking of the veins takes place 5 times, dividing up to 3 mm from the distal margin. The densest concentration of the veins is 16-18 per cm. The veins diverge from the base and are strong and prominent in the basal and central regions of the blade, becoming finer and indistinct towards the distal margin.

(d) **Comparisons and discussions**

Plant fossils of the type described here have not previously been recorded from Southern Africa. They do show some resemblance, however, to leaves of *Sphenophyllum,* a genus which is well represented in the Wankie flora of Southern Rhodesia. The venation of the species *Sphenophyllum thonii* Mahr is remarkably similar to that of the new plant. There is also a general resemblance with regard to the shape and size of the leaves of the two plants. The new plant differs from *S. thonii,* however, in the distinctly bract-like nature of the leaves of the former as well as in the stalk-like basal portion and the pronounced curvature of the margins.

The leaves described here are reminiscent of ginkgoalean leaves. They do show some resemblance to the specimens described elsewhere in this paper under the name *Ginkgoites* sp. Type B. The new plant is separated from the Ginkgoales, however, on the basis of the plural nerves entering the leaf as well as on the nature of the branching of the veins.

The specimens under discussion seem to resemble the Russian Permian genus *Nephropsis* Zalessky more closely than any other plant previously described. The new Vereeniging plant conforms to the characteristics of this genus in that it has a transversely elongated blade on a broad stalk-like basal portion and forked veins spreading through the lamina.

The transverse elongation of the leaves is less marked in the new plant than in *Nephropsis integerrima* (Schmal.) Zalessky, the type species of the genus. (Seward's reproductions, 1919, p.78 of Schmalhausen's original figures, 1879, Pl. XVI, Figs. 12-15, were used for comparison because the original publication was not available.) The former plant shows a much closer resemblance to *Nephropsis ubojensis* Schved., figured by Shvedov (1961, Pl. XL, Fig. 1 and Pl. XLI, Fig. 1) than to *N. integerrima* with regard to the distal portions of the leaves. In comparing the Vereeniging plant with Neuburg's figures (1965, Pl. XXIII, Figs. 1-6) of *N. rhomboidea,* similar variations in shape and size seem to occur in both plants. The leaves of the latter are more distinctly rhomboidal, however, than that of the former. There also appears to be a difference in the venation of the two plants.

The occasional lobation of the leaves of the new plant seems to be a distinctive character which has not been observed in any of the known species of *Nephropsis.*

(e) **Conclusions**

In spite of the strong superficial resemblance of the Vereeniging leaves to leaves of the *Nephropsis* type, generic identity can not be inferred in the absence of confirming evidence.

In her description of *Vojnovskya paradoxa,* Neuburg (1955) draws attention to the fact that the foliage leaves associated with this fructification are of the *Nephropsis rhomboidea* type. She points out, however, that all leaves of the *Nephropsis* type cannot be attributed to the Vojnovskyales with certainty. This applies especially to the Vereeniging leaves which are consequently referred to the Vojnovskyales with hesitation.

It seems most remarkable, however, that this new element of the Vereeniging *Glossopteris* flora should show such a close resemblance to an element of the Russian Angara flora. This once again focuses the attention on the unique nature of the Vereeniging fossil flora.

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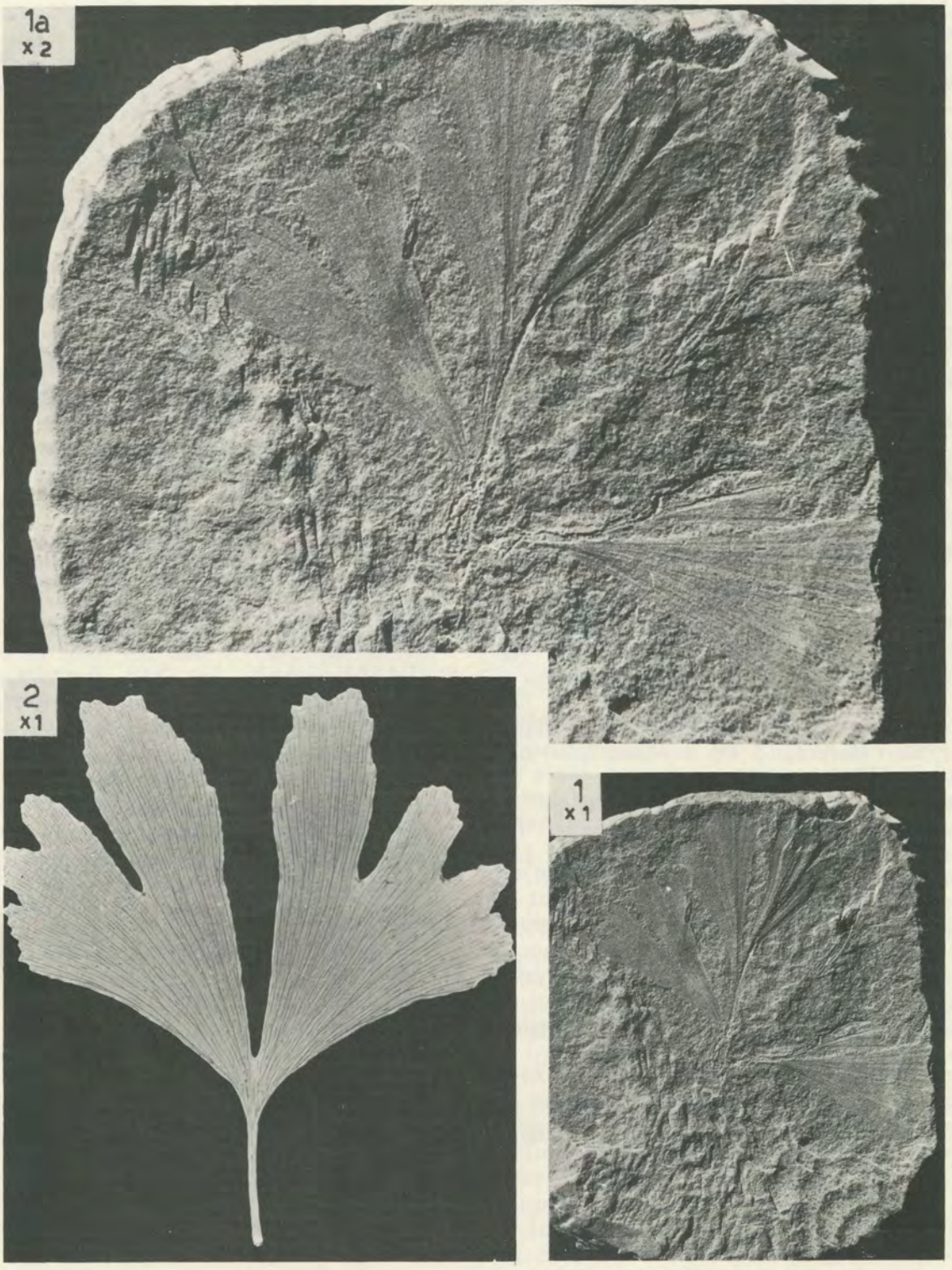


PLATE I

Ginkgoites **sp Type A**

Fig. 1 Foliage leaf, showing shape and lobation of the segments. Specimen GK/1 (Natural size)

Fig. 1(a) The same specimen as shown in Fig. 1 enlarged twice to show more detail of venation.

Ginkgo biloba **Linne**

Fig. 2 Foliage leaf of a one year old plant, showing similarity to leaf illustrated in Fig. 1. (Natural size)

PLATE II

Ginkgoites **sp Type B**

Fig. 1 Almost complete leaf, showing shape and venation. Note entire margin. Specimen GK/2. (Natural size)

Fig. 2 Apical portion of a leaf, showing incision in lamina. Note more open venation as compared with Fig. 1. Arrow indicates a region in which anastomosis of veins appears to have taken place. Specimen GK/3. (Natural size)

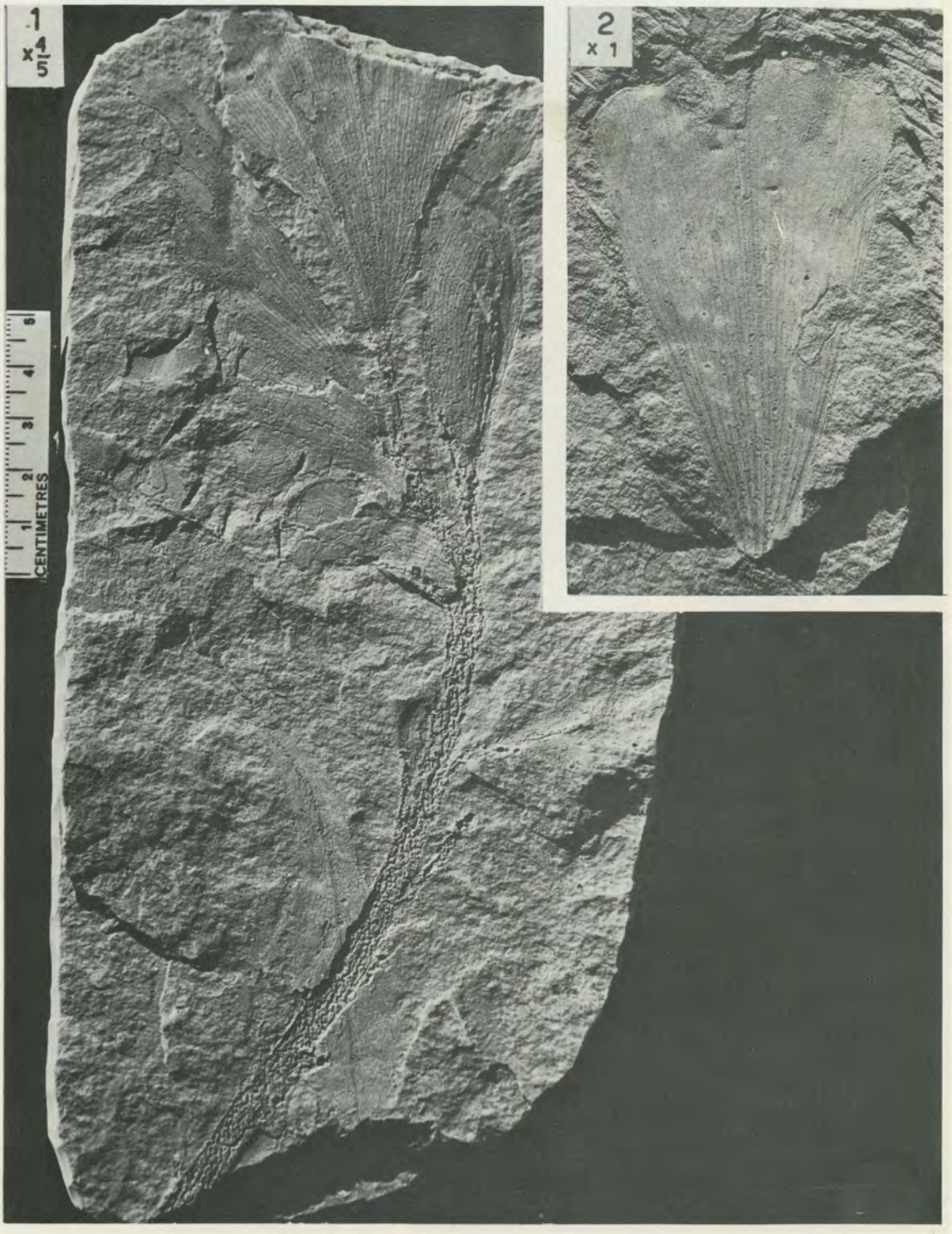
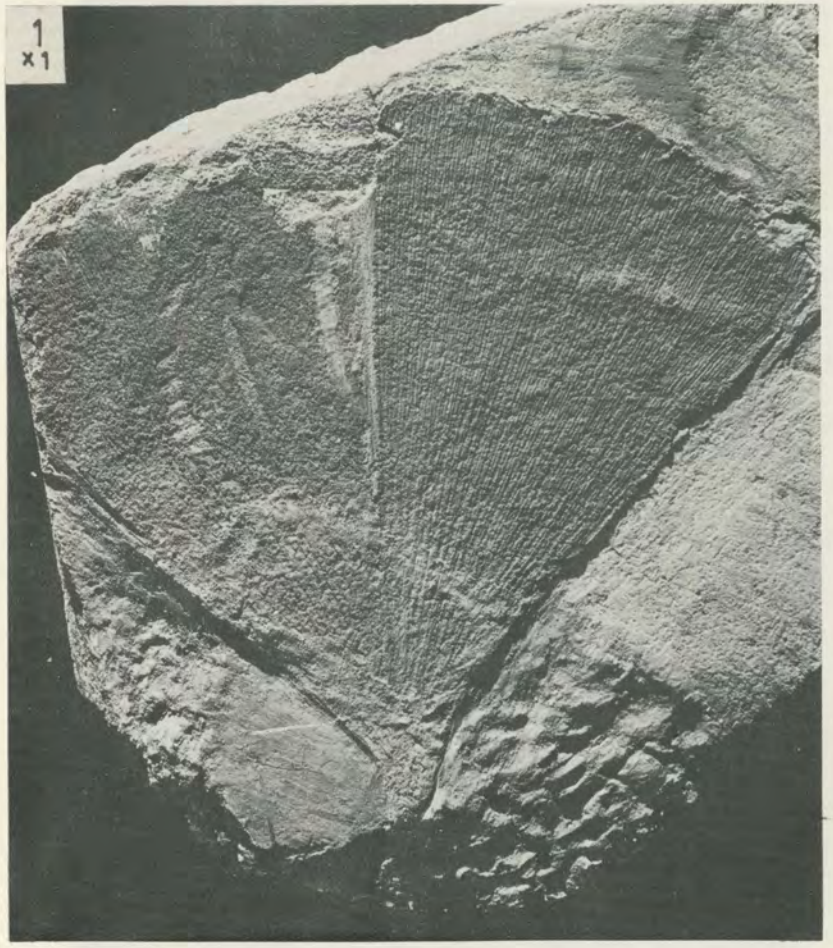


PLATE III

Psygmophyllum kidstoni **Seward**

Fig. 1 Portion of a woody axis with spirally disposed leaves. Note scars presumably produced by insects. Specimen PS/1. (Magnification X 4/5)

Fig. 2 Detached leaf, showing lobation of lamina and dichotomously-branched veins. Specimen PS/2. (Natural size)



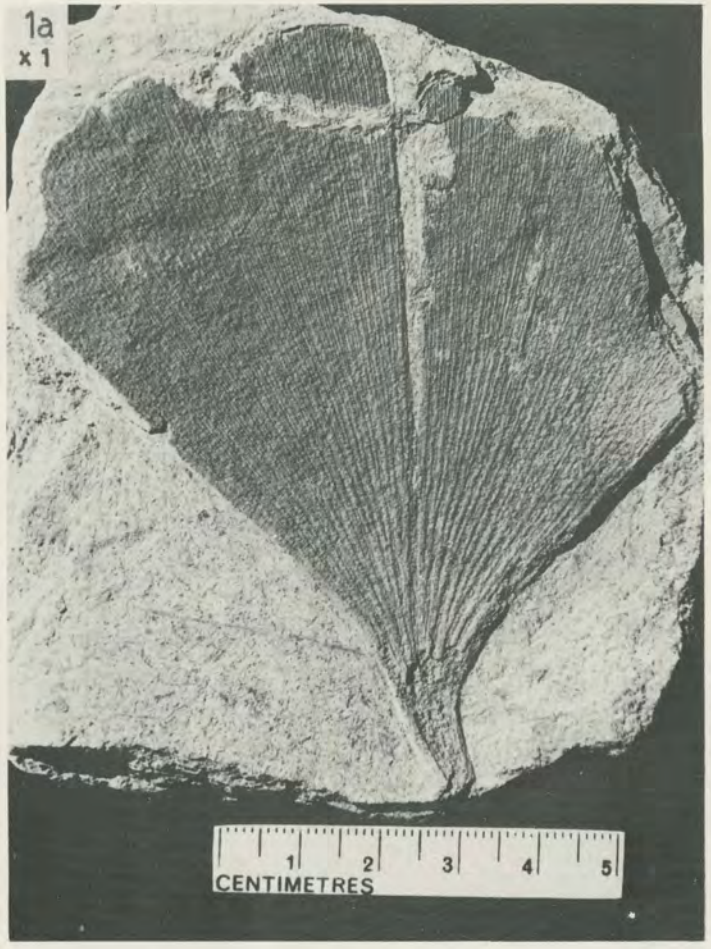


PLATE IV

Psygmophyllum kidstoni **Seward**

Figs. 1-1a Counterparts of an almost complete leaf, showing shape of the lamina and lobes, and details of venation. Specimens PS/3 and PS/3a respectively. (Natural size)

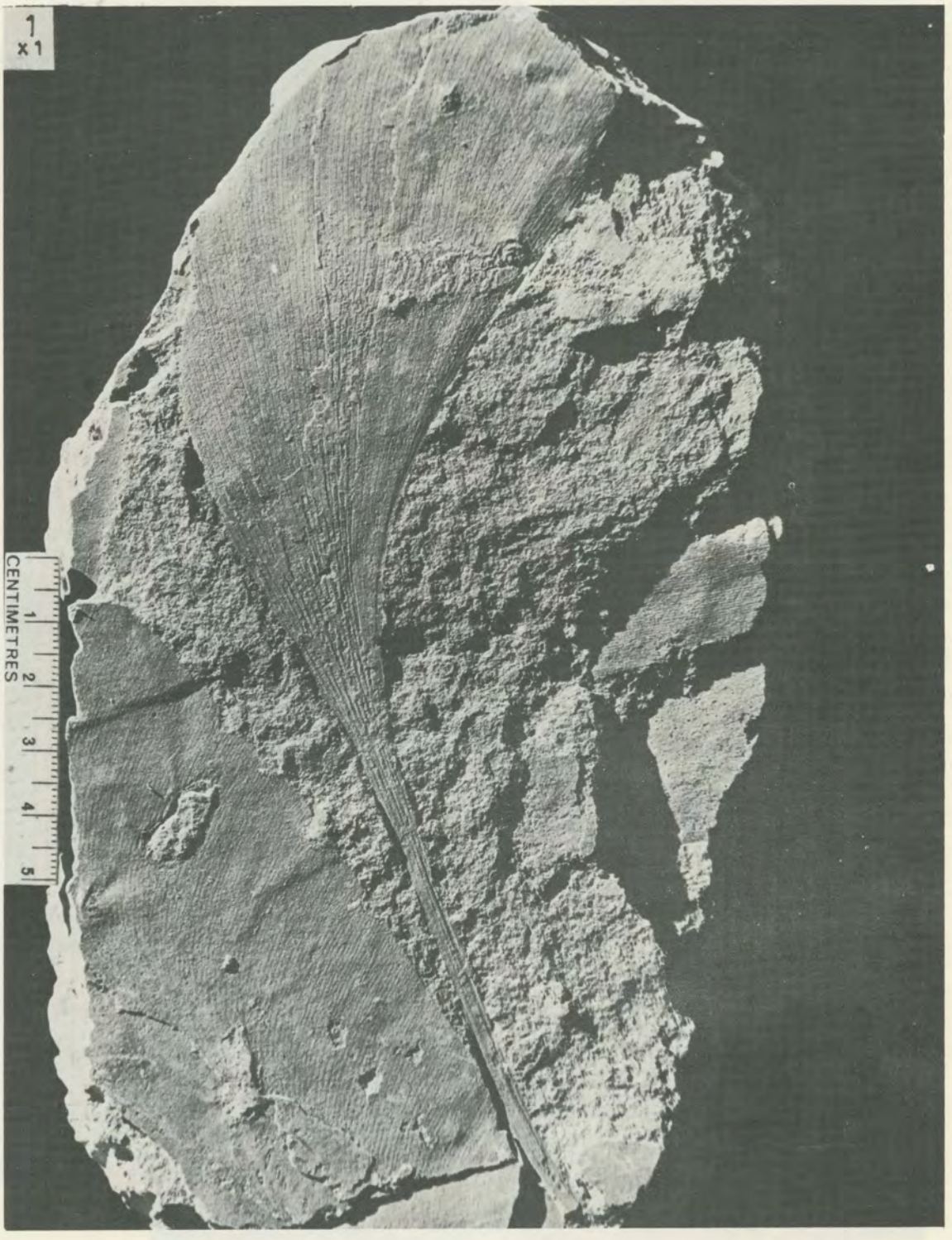
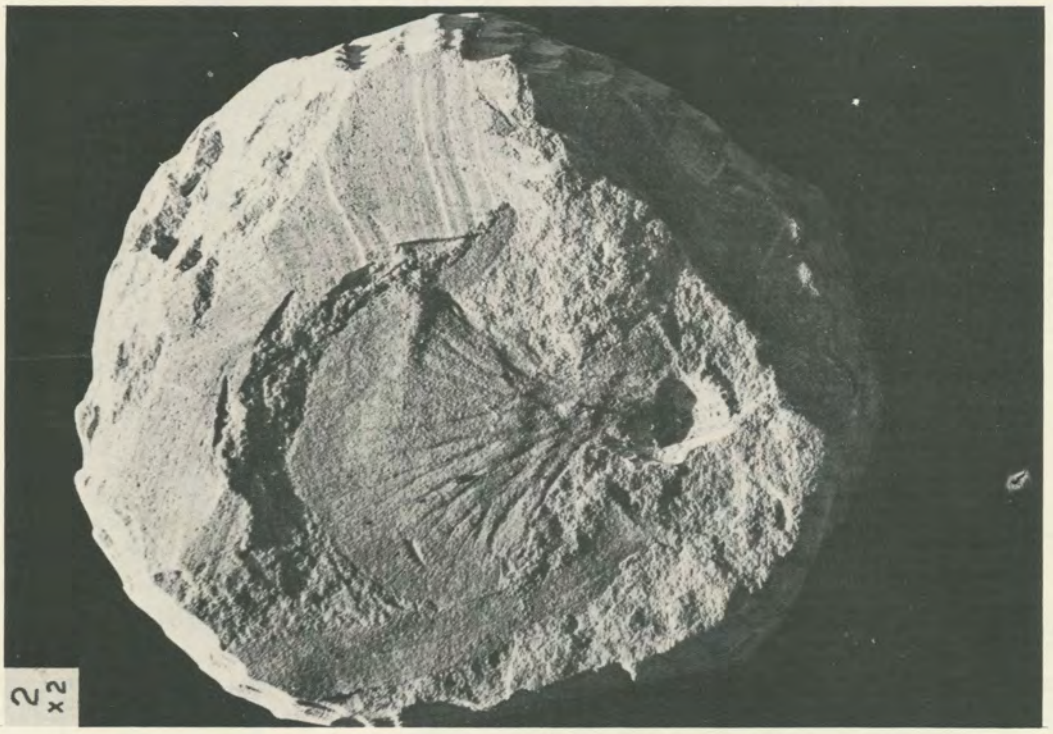


PLATE V

Psygmophyllum sp

Fig. 1 An incomplete leaf, showing the long narrow petiole-like proximal portion and forked veins with lateral connexions. Specimen PS/4. (Natural size)



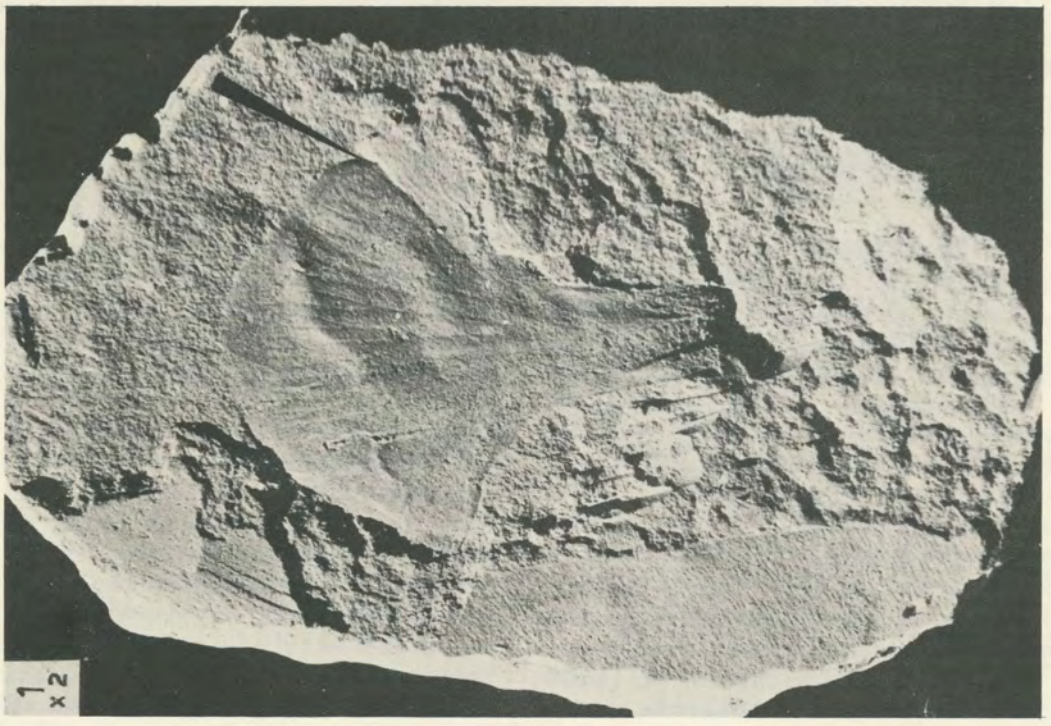


PLATE VI

cf. Nephropsis

Fig. 1 Leaf showing typical shape. Note the broad stalk-like proximal portion and the general bract-like appearance. Arrow indicates incision in the lamina. (Magnification X 2)

Fig. 2 Leaf showing fan-shaped lamina with entire margin. Note strong, repeatedly-forked veins in central and proximal regions of the lamina. (Magnification X 2)