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Some Fossil Plants from the Jangseong Formation of the Gangweon Coal Mine, Korea

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江原炭礦 長省層에서 發見된 植物化石 數種

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ABSTRACT

Thirteen specimens, containing eleven species of fossil plants obtained from the Jangseong Formation, the upper part of the so-called Sadong Formation of Gangweon Coal Mine, are described. Some of them are well preserved to retain the finest structure of the laminae. Five of these are identical with those species which have been identified by Kawasaki; two specimens, *Asterophyllites sp.* and *Odontopteris sp.*, are not able to be identified on account of the unknown venation resulted from poor preservation. A new species, *Taeniopteris? koreanensis* is proposed here.

INTRODUCTION

Some beds of the black shales, covering the main coal-bearing cyclothem JC of the Jangseong Formation, the upper part of the so-called Sadong Formation, have been known to produce prolific plant fossils of Permo-Carboniferous. Mr. Wall Yong Ha, geologist of the Gangweon Coal Mine, Gangweon-do, found the well preserved fossils from an underground face of the mine in 1964. Many of the fossils show fine structure of venation on their carbonized impressions to reveal the clear form of original plants. Since such well preserved plant fossils have rarely been found throughout the shales overlying the main coal bed of the cyclothem JC (Cheong, 1969), it is believed, therefore, that a rather restricted portion of the shales may preserve such good fossils. The writers failed to find any more extension of the same fossil plants-bearing shales around the place. The fossil plants described here are as follows:

Sphenophyllales et Equisetales	*Sphenopyllum speciosum*(Royle)
	Asterophyllites sp.
Filicales et Pteridospermae	*Sphenopteris Nystraemii* Halle
	S. tenuis Schenk
	Pecopteris anthriscifolia(Goepp.)
	Odontopteris longifolia Kawasaki
	O. sp.
Cordaitales	*Cordaites Schenkii* Halle
Incertae Sedis	*Tingia carbonica* (Schenk)
	Plagiozamites oblongifolius Halle
	Taeniopteris? koreanensis Cheong et Lee

Taeniopteris? koreanensis n. sp. is described here as a new species. However, the same material has temporarily been named as *Serratopteris koreanensis* Cheong by one of the writers as a new genus and species (Cheong 1969).

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SYSTEMATIC DESCRIPTION

Equisetales et Sphenophyllales

Genus **Sphenophyllum** Brongniart, 1822

Sphenophyllum speciosum (Royle), 1880

Pl. III, Fig. 1, 2

1927, *Sphenophyllum speciosum* (Royle) Kawasaki, Geol. Surv. Korea Bull. Vol. VI, Pt. 1, p. 24, Pl. XIII, Figs. 68, 69

1934, *Sphenophyllum speciosum* (Royle) Kawasaki, Geol. Surv. Korea Bull. Vol. VI, No. 4, p. 85

1964, *Sphenophyllum speciosum* (Royle) Weylend, Lehrbuch der Paläobotanik, p. 158, Fig. 89

Material.— The illustrated specimens consist of two detached fragments, one of which constitutes an axis bearing five small whorls, and the other is an axis with ten whorls. Hypotypes, DGSU Coll. Cat. 00172, 00173

Description.— Axis very slender and uniform breadth, about 0.5mm across, internode 5mm long, leaflets arranged in three pairs in a whorl, more or less wedgeshaped or cuneiform with bluntly pointed smooth margin. Upper and middle pairs nearly equal size, reaching a length of 7mm and a breadth of 2mm approximately; the lower pairs much smaller, 3—4mm long and 2mm wide, margin of leaflets entire. Venation commonly distinct; usually two veins are given off from the narrow base, repeatedly forked to the apex. The upper and middle pairs of leaflets are attached to the axis at a wide angle, while the lower pairs are adhered nearly parallel to the axis. In the latter especially four veins are given off at the base, among which inner two veins are only biforked, whereas the outer ones run to the apical margin simply.

Comparison.—The illustrated specimens resemble closely to *S. oblongifolium* Germ. et Kaulf in the outline of the whorl and the size of the leaflets. But the former disagrees with the latter in the detailed habits. Leaflets of the latter are serrated into sharp teeth in the apical region and the upper pair is largest in size, whereas the distal part of the above described species is truncated smoothly, and the upper and middle pairs are almost equal in size.

Occurrence.— Cyclothem JC of the Jangseong Formation, the upper part of the so-called Sadong Series, in the Gangweon Coal Mine.

Genus **Asterophyllites** Brongniart, 1822

Asterophyllites sp.

Pl. IV, Fig. 4

Material.— The species at hand represents a poorly preserved fragment of a sheath which is composed of an incomplete whorl and a short internode. Hypotype, DGSU Coll. Cat. 00180.

Description.— Axis distinct and thick, uniform breadth, reaching a length of 30mm and a width of 7mm in the preserved sheath, longitudinally striated. A whorl consists of 6~8 leaflets in the preserved specimen, arranged more or less oppositely. Leaflets very slender, linear in shape, 10~17mm in length and 1mm or less in width.

They are given off from one node and attached to the axis at a wide angle of about 50°~60°.

Venation indistinct, but a thin midrib runs from the base to the apex.

Remarks.—It is very difficult to distingish each other between the genus *Asterophyllites* and a younger branchlet of the genus *Phyllotheca* in such an incomplete fragment as the illustrated specimen. The latter resembles closely to the former, but it differs from the *Asterophyllites* in the arrangement of the leaves. The leaves of *Asterophyllites* point upward adaxially, whereas that of *Phyllotheca* turned down abaxially.

On considering the feature of the axis, it is reasonable that the illustrated specimen might fall within *Asterophyllites*, for the width of the axis which lies parallel to the leaves is somewhat narrower than the below, so that the leaves prove to be arranged adaxially.

Occurrence.— Cyclothem JC of the Jangseong Formaton. The genus has been described from the upper Shihhotse Series in Central Shansi, China by Halle. It is described for the first time in Korea.

Filicales et Pteridospermae

Genus **Sphenopteris** Brongniart, 1822

Sphenopteris Nystraemii Halle, 1927

Pl. II, Fig. 2

1927, *Sphenopteris Nystraemii* Halle
Halle, Palaeont. Sinica, Vol. II, Fascicle I, P(II), 57, Pl. 12, Figs. 1—2

Material.—The described specimen is only a part of a frond. Hypotype, DGSU Coll. Cat. 00171.

Description.—Frond bipinnate, nearly triangular shape in outline. Rachis distinct, more or less slender, narrowed gradually toward the apical region. Its breadth 1mm at the apex and 2mm at base. Ultimate pinna linear to oblong, reaching a length of 8.5cm and a breadth of 2.3cm at the lower part, obtusely pointed at the distal area and attached oppositely to the rachis at a wide angle of about 60 degrees.

Lengths of the pinnae reduce somewhat rapidly toward the apex. Pinnules ovate to lanceolate, incisely lobed, bearing bluntly toothed margins. Primary nerves of the pinnules relatively strong, flexuous partially. They always die out before reaching the apex of the lamina and give off numerous secondary veins at an acute angle. Each secondary vein runs out into one of the lobes.

Comparison.— The above-described specimen approaches closely to *S. Lescuriana*. Its venation is, however, distinguished from the latter's. The lateral veins of the latter branch out palmately in comparison with the dichotomous forking of the former. The specimen is also similar to *S. hymenophylloides* Brongn., but the latter's pinnules are more deeply incised than the former.

Occurrence.—Cyclothem JC of the Jangseong Formation in the upper part of the so-called Sadong Series. Lower Shihhotse Series.

Sphenopteris tenuis? Schenk

Pl. IV, Fig. 5 (right)

1927, *Sphenopteris tenuis* Schenk
Halle, Palaeont. Sinica, Vol. II, Fascicle I. P(II) 58, Pl. 15, Figs. 15—17.

1931, *Sphenopteris tenuis* Schenk
Kawasaki, Geol. Surv. Korea Bull. Vol. VI, No. 2, Pl. XX, Figs. 21, 22.

1934, *Sphenopteris tenuis*? Schenk,
Kawasaki, Geol. Surv. Korea Bull. Vol. VI, No. 4, p. 91,

Material.—A frond of the species is somewhat poorly preserved. Hypotype, DGSU Coll. Cat. 00181.

Description.—Frond pinnate to tripinnate; linear to lanceolate in shape, reaching a length of more than 12cm. Its breadth narrows gradually toward the apex, approximately 8cm at the lower part

and 5cm at the upper.

Rachis distinct and comparatively slender, gradually tapering toward the distal region; 1mm or more at base and less than 1mm at apex, somewhat longitudinally striated.

Pinnae linear and lanceolate in shape, attached to the rachis at an obtuse angle of 50–55 degrees. Axis of pinnae distinct, about 0.5mm across.

Pinnules vary in shape; in the lower pinnae the outlines are comparatively lanceolate with incisely lobed margin, whereas those in the upper are more slender in width, and more slightly lobed. Mid-nerves are distinct. Most lateral veins are not visible owing to the poorly preserved lateral veins. However, some veins are given off dichotomously.

Remarks.— It is really difficult to identify the specimen correctly on account of the poorly preserved lateral veins. Pinnules, habit of the rachis and distinct mid-nerves, however, agree with *S. tenuis* Schenk.

Occurrence.— JC of the Jangseong Formation, and the Gobangsan Series in Samcheog district. Sadong Series in Jeongseon and Pyeongchang districts, Gangweon-do. Lower Shihhotse Series in Central Shansi, China.

Genus **Pecopteris** Brongniart, 1822

Pecopteris anthriscifolia (Goepp.), 1865

Pl. II, Fig. 1

1927, *Pecopteris anthriscifolia* (Goepp.) Halle, Palaeont. Sinica, Vol. II, Fascicle I, P(II) 98, Pl. 26, Figs. 5—8; Pl.54, Figs. 7—9.

1931, *Pecopteris anthriscifolia* (Goepp.) Kawasaki, Geol. Surv. Korea Bull. Vol. VI, No.2, Pl. 34, Fig. 72, Pl.56, Fig. 4,5.

1934, *Pecopteris anthriscifolia* (Geopp.) Kawasaki, Geol. Surv. Korea, Bull. Vol. VI, No. 4, P. 116,

1939, *Pecopteris anthriscifolia* (Goepp.) Kawasaki, Geol. Surv. Korea Bull. Vol. VI, No. 5, p. 14—15, Pl. III, Figs. 9—11.

Material.— This specimen consists of several fragments of fronds, but all the fragments are not preserved as a perfect frond.

Hypotype, DGSU Coll. Cat. 00170.

Description.—Frond bipinnate; linear to oblong in shape, reaching a length of more than 12cm and a relatively uniform breadth of about 5cm. Rachis distinct, its breadth more or less equal, 2—3mm across. Pinna comparatively lanceolate in shape and obtuse-apexed, about 3cm long, 1.2cm broad in lower ones, and attached to the rachis at a wide angle.

Pinnules entire or slightly lobed, they commonly vary in shape even in the same pinna; triangular, ovate with rounded apex or linear with slightly lobed margin, attached oppositely to the pinna axis. Somewhat confluent, usually 4×7mm in size in the lower basal pinnules.

Midrib more or less distinct, forked near the apical region, somewhat flexuous. The lateral veins mostly four pairs in number, given off obliquely forward from the midrib, and once bifurcated, but in the slender lineate pinnules they are forked thrice or more.

Comparison.— As pointed out by Halle the species is highly polymorphic. Pinnules in the obtained samples differ from each other in shape even in the same pinna.

The described specimen agrees most closely with that of Halle's from China(Pl. 26, Fig.6) and Kawasaki's specimens.

The species resembles to *P. orientalis* in the general outline. The former disagrees, however, with the latter in the venation. The midrib of *P. orientalis* is stronger than that of *P. anthriscifolia*, so that the midrib is apparently distinguished from the lateral veins, and the lateral veins are also more in number than the described species.

The shape of the pinnules in *P. orientalis* is somewhat constant in comparison with *P. anthri-*

scifolia.

Occurrence.— JC of the Jangseong Formation in the so-called upper Sadong Series of Samcheog district. Gobangsan Series in Jeongseon district, Gang weon-do, Korea. Upper ShihhotseSeries in Central Shansi, China.

Genus **Odontopteris** Brongniart, 1822

Odontopteris longifolia Kawasaki, 1934
Pl. III, Fig. 4

1934, *Odontopteris longifolia* Kawasaki
Kawasaki, Geol. Surv. Korea Bull. Vol. VI, No. 4, p. 137, Pl. CX, Fig. 20.
1939, *Odontopteris longifolia* Kawasaki
Kawasaki, Geol. Surv. Korea Bull. Vol. VI, Pt. 3, No. 5, p. 16, Text Fig. 3

Material.— This specimen consists of several fragments of an ultimate pinnae. They bear a perfect several pinnules and show extraordinarily well preserved venation.

Hypotype, DGSU Coll. Cat. 00176.

Description.— Habit of frond unknown, probably pinnate to tripinnate. Ultimate pinnae linear to oblong in outline with a comparatively uniform breadth of about 3cm and a length of 4cm or more, though its whole length may not be measured. Pinnae axis more or less distinct, 1mm across, and finely longitudinally striated.

Pinnules entire, deltoid or slightly falcate with an obtusely pointed apex in outline. It reaches a length of 20mm and a breadth of 10mm, attached to the pinna axis with the whole base at a wide angle, confluent.

Venation distinct, of *Odontopteris* type. Midrib more or less distinct at the proximal region, however, it dies out in the basal part of the lamina, so that it is forked dichotomously toward the apex. The anadromous vein is given off from the base of the markedly decurrent midrib, forking repeatedly, and the catadromous ones rise directly from the pinna axis and also repeatedly bifurcated, running parallel to the midrib, and they are more or less arcuated, forming a convexity toward the central part. All lateral veins are also forked repeatedly.

Comparison.— The illustrated specimen is well identified with the original specimen which has been described by Kawasaki. It also resembles to *Neuropteridium? yongwolensis* described by Kawasaki from the Sadong Series in Yeongweol district. However, the former is more slender and falcate in outline of the pinnule than the latter, and the posterior area of the pinnule is almost straight, whereas the latter's is curved toward midrib.

Occurrence.— JC of the Jangseong Formation in the upper part of the so-called Sadong Series of Samcheog district, Gangweon-do. Gobangsan Series in Danyang district, North Chungcheong-do, Kor ea.

Odontopteris sp.
Pl. IV. Fig. 3

Material.— The specimen is a fragment of a frond with poorly preserved ten pinnules. Hypotype, DGSU Coll. Cat. 00179.

Description.— Frond probably pinnate, oblong in shape. Rachis comparatively distinct, 7mm across at the basal part, longitudinally striated.

Pinnules entire or slightly lobed, ovate to oblong in outline, reaching a length of 35mm and a breadth of 15mm, and subcircular in its apical region, attached by the whole base to the rachis nearly at a right angle.

Venation somewhat distinct and of *Odontopteris* type. Midrib indistinct. Several catadromous veins given off directly from the rachis. Lateral veins forked repeatedly. The innermost branch of the lateral vein reaches near the apex of pinnules and the other branches are slightly arcuated at the margin.

Comparison.—Although this specimen bears the feature of *Odontopteris* type in the general habit, it is not correctly identified into specific rank owing to the poor preservation. It is closely similar to *Neuropteris* and *Neuropteridium*, but the former is distinguished from the latter in which only a midportion of the base is attached to the rachis. In the former the whole base of the pinnules are adhered,

It also resembles to *O. longifolia*, but the described specimen differs from the species in the rounded apical region of the pinnules. *O. longifolia* is more slender and fulcate in outline in comparison with the rounded subcircular apex of the illustrated form.

Occurrence.—JC of the Jangseong Formation, the Sadong Series in Jeongseon, and Yeongweol district, Gangweon-do, Korea and in Deogcheon, Gaecheon and Daedong districts, S. Pyeongan-do, northern Korea. Gobangsan Series in Samcheog district, Gangweon-do, Korea.

Genus **Cordaites** Unger, 1850

Cordaites Schenkii Halle, 1927

Pl.III. Fig. 3(left), Pl. IV. Fig. 5(left)

1927, *Cordaites Schenkii* Halle
Halle, Palaeont. Sinica, Vol. II. Fas. I, p. 185, Pl. 50, Figs. 1-4, Pl. 52, Figs. 2-5.

1931, *Cordaites Schenkii* Halle
Kawasaki, Geol. Surv. Korea Bull. Vol. VI. No 2, Pl. XLII. Fig. 106B, Pl. XLVII, Fig. 120D. LXXX, 229-232, LXXX, Fisg. 233-236, LXXXII, Figs. 237-239, LXXXIV, Fig. 246C

1934, *Cordaites Schenkii* Halle
Kawasaki, Geol. Surv. Korea, Bull. Vol. VI, No. 4, p. 205.

Material.—The illustrated form is composed of two fragments of the lamina. Both of which are not preserved perfectly. Hypotype, DGSU Coll. Cat. 00175, 00182.

Description.— Lamina broadly linear in shape, reaching a uniform breadth of 1.8cm, and a length of more than 10cm. Close-set parallel ribs more or less distinct, mostly equal size, but in the lower part the stouter ribs or veins separated one another by two or three finer ribs or interstitial veins. Generally numbering 16-18 per centimeter. Interspace of main ribs irregular.

Comparison.— It is difficult to distinguish *C. Schenkii* from *C. principalis*. Halle(1927) illustrated in his description "In the number of interstitial ribs *Cordaites Schenkii* agrees with *C. principalis*. In that species, however, the interstitials are relatively much finer, appearing only as a very faint and close striation, whereas in *C. Schenkii* they are often difficult to distinguish from the thicker rib. The latter, too, are more distant than in *C. principalis*."

Considering this explanation, the specimen at hand is identified as *C. Schenkii*. The interstitial ribs of the specimen vary in thickness. They are clearly distinguished from the main ribs on the lower part, whereas on the upper part there is no difference between them and the thicker ribs. In addition to this feature, the interspace of the main ribs is also somewhat distant. The illustrated specimen is distinguished from *C. parvifolius* described by Kawasaki from the Sadong Series of North Korea in outline and their ribs. The latter is more slender in shape of the lamina and bears finer uniform veins than the former.

Occurrence.—JC of the Jangseong Formation. Sadong Series in Jeongseon and Yeongweol district, Gangweon-do, Korea and in Deogcheon, Gaecheon and Daedong districts, S. Pyeongan-do, northern Korea. Gobangsan Series in Samcheog district, Gangweon-do, Korea.

Incertae Sedis

Genus **Tingia** Halle, 1925

Tingia carbonica (Schenk)

Pl. IV, Figs. 1, 2

1925, *Tingia carbonica* (Schenk) Halle, Bull. Geol. Surv. China. No. 7, p. 5, Pl. 1

1927, *Tingia carbonica* (Schenk) Halle, Palaeont. Sinica, Vol. II, Fascicle I, P(II). 231, Pl. 62, Figs. 1—6, Pl. 63, Fig. 3—5.

1931, Kawasaki, Geol. Surv. Korea Bull. Vol. VI, No. 2, Pl. XCIII, Figs. 287, Pl. XCN, Figs. 288—290

1934, *Tingia carbonica* (Schenk) Kawasaki, Geol. Surv. Korea Bull. Vol. VI, No. 4, p. 179—180

Meterial.—This specimen is described with two well preserved frond-like fragments. Hypotype, DGSU Coll. Cat. 00177, 00178.

Description.— Shoot frondlike, ovate to oblong in outline. Axis comparatively thick, 3—6mm across, gradually tapering to the apex.

Leaves arranged pinnately, oblong to broadly linear in shape, reaching a length of about 5.5cm and a breadth of 8mm, inserted over into the axis, forming an angle of 40—50° with the axis, closely set each other.

Each lamina is truncated and deeply dissected at the apex thrice or more, attaining a maximum length of 8—12mm, so that it appears as if many slender leaflets might set closely each other and bear a strongly accuminated apex.

Lateral margin entire, slightly contracted at the base. Venation relatively distinct; veins fine, bifurcating in the lower part of the leaves, each running in parallel, 13—15 in number.

Two or three parallel grooves from the base to distal incised region are observed.

Remarks.—The characteristic feature in *Tingia*, which shows the leaves arranged in four raws, two on the upper and two on the lower side of the axis, is not confirmed owing to the inappropriate preparation of the material, so that the description was only limited on the observable upper surface of the leaves.

Comparison.—The illustrated specimens well agree with the description of original specimens of China, described by Halle and the specimens found by Kawasaki from the upper Sadong Series in Korea. As Halle pointed out, the leaves vary greatly. Two specimens at hand differ from each other in ap-pearance, one broadly linear, another oblong, and they are somewhat more deeply dissected than the Chinese specimens. The species is distinguished from the related *T. crassinervis*, *T. Hamaguchii* in the habit of the dissection and the veins. In the former the apical region of the lamina is usually deeply dissected and their veins are finer than those of the latters. The axis of *T. Hamaguchii* is more stouter in comparison with the above described species. This differs also from *T. partita*, in which lamina is wider and shorter than *T. carbonica*.

Occurrence.— JC of the Jangseong Formation. Sadong Series in Jeongseon district, Gangweon-do, Korea, and Daedong and Deogcheon districts, S. Pyeongan-do, northern Korea. Lower Shihhotse Series in Central Shansi, China.

Genus **Plagiozamites** Zeiller, 1894

Plagiozamites oblongifolius Halle, 1927

Pl. III, Fig. 3(right)

1927, *Plagiozamites oblongifoli* Halle Halle, Palaeont. Sinica, Vol. II, Fascicle I, p(II) 227, Pl. 60, Figs.. 1—9, Pl. 63, Figs. 6—7

1934, *Plagiozamites oblongifolius* Halle Kawasaki, Geol. Surv. Korea Bull. Vol. VI, No. 4, p. 270

Material.—The specimen is composed of well preserved several fragments of fronds. Hypotype, DGSU Coll. Cat. 00174.

Description.— Shoot frondlike, oblong to ovate in outline. Leaves arranged in two rows on the flanks of the axis, but not exactly above each other; some attached a little more on the upper side, others a little more on the lower. Axis moderately thick, uniform in width, 4mm across, longitudinally striated. Leaves entire or slightly lobed, elongated ovate to oblong in shape,gradually tapering to an acuminate or rounded apex, about 40—45mm in length, 12—14mm in maximum width, attached to the axis almost at a right angle with a contracted base. The apical region of leaves is not dissected. Some leaves are slightly serrated, but it seems that the serration is due to secondary detachment after sedimentation.

Veins numerous, bifurcated, running nearly parallel to the margin, converging slightly towards the base and apex of the lamina, about 24—26 in number in middle part of leaves.

Comparison.— The illustrated specimen agrees most closely with the original Chinese specimen described by Halle (1927), particularly with that of Pl. 60, Fig. 1, though the latter has generally more numerous veins(25—40 in number) than this specimen (24—26).

It seems, however, that this difference may not be of an importance to warrant specific separation.

The above-described specimen resemble also to the genus *Tingia*, but the former bears more or less pointed unsegmented apex, whereas the latter is obtusely truncated.

Occurrence.— JC of the Jangseong Formation, Gangweon Coal Mine, Samcheog district, Korea. Lower and Upper Shihhotse Series, China.

Genus **Taeniopteris** Brongniart, 1832

Taeniopteris? koreanensis Cheong et Lee nov. sp.

Pl. I, Figs. 1-3

Material.—The present specimens are two well preserved fragments, though their distal parts are not obtained.

Holotype, DGSU Coll. Cat. 00167, 00168.
Paratype, DGSU Coll. Cat. 00169.

Description.—Frond probably unipinnate, broadly linear to oblong in shape, rounded at the base of the lamina. Original length unknown, total length of preserved fragment 63mm, width of pinna about 15mm, midrib distinct, uniform breadth; about 10mm throughout its length, faintly longitudinally striated. Petiolate.

Pinna margin deeply serrated, as if the lamina might consist of numerous pinnately confluent pinnules whose apices are acuminated, but in the distal region of the paratype dentation is not observed.

Lateral veins relatively distinct, simple or sometimes dichotomously bifurcated near the midrib, generally given off at wide angle from the pinna axis, straight or slightly arcuated, each running in parallel, loosely separated.

The concentration of veins at the margin about 8 per centimeter. No reproductive organs found.

Comparison of holotype and paratype
[(H) : Holotype (P) : Paratype]

	Length (mm)	Width(mm)	Remarks
Lamina	(H)50+	14~17	oblong or broadly linear
	(P)63+	8~10	oblong or broadly linear
Leaflet	(H)6~7	1~1.5	linear
	(P) 5	1	shape linear
Axis	(H)50+	1	distinct
	(P)63−	0.5	distinct
Midrib	(H)9~10	0.2	angle 70°~80°
	(P) 7~8	0.1	angle 70°

Remarks.—The illustrated specimen is the most interesting form of the specimens at hand. It resembles to the genus *Taeniopteris*, *Marattiopsis* in general shape, but it is clearly distinguished

from the latters by the deep serration in the margin of the lamina. No species of both genera attain the feature of deep marginal serration.

Asama and Kon'no (oral communication, 1968) have given the authors valuable suggestions about the information of this specimen.

Asama has inquired if the specimen is a fragment of pinnule of *Alethopteris* sp. whose margin is secondarily dissected by the deformation. It can be, however, verified that the serration is of original character on the ground of the constant habit of the serration in both preserved specimens. Each of the lateral veins is also regularly inserted in each leaflet. Kon'no expressed the opinion that the specimen might be a new species of *Taeniopteris* or *Marattiopsis* on consideration of the general habit of the lamina, even if the characteristic serration on the margin of the leaves is quite distinguishable from those of both genera. The writers believe that the specimen should be distinguished from *Taeniopteris* and *Marattiopsis*, and it could be a new generic rank. But it was not clarified in this study whether the serration is only limited on the proximal region of the lamina or extended to the apex. Therefore they hesitate to give the specimen a new generic name till the habit of the frond is thoroughly known. It is here described as *Taeniopteris*? nov. sp. provisionally.

THE GEOLOGIC AGE OF THE FOSSIL FLORA

It has been well known that the boundary between the Carboniferous and the Permian Systems, as far as the fossil flora are concerned, could not been clarified. In addition, the illustrated specimens are so meagre that they do not provide any suggestion about the distinct age of the related sequence. The writers' interest, however, is focussed on the fact that the flora is more closely related with the flora of Gobangsan Series rather than that of the Sadong Series, both of which were studied by Kawasaki (1927, 1934).

Sphenopteris tenuis and *Cordaites Schenkii* were recorded as common species from the lower Shihhotse Series in Central Shansi of China. The series is roughly correlated with the Sadong Series in Korea. But they were described by Kawasaki from both the Sadong and Gobangsan Series ranging from his D to G zones. So that their stratigraphic ranges are not definite.

Sphenopteris Nystraemii is not also a good indicator for the age determination, because it was reported from the lower and upper Shihhotse Series in China, and it has not been yet described in Korea.

Tingia carbonica occurs commonly in the Sadong Series in Korea and in the correlated Lower Shihhotse Series in China. Kodaira (1930, p. 13) reported, however, that the species was found with *Plagiozamites oblongifolius* in the lower part of the Gobangsan Series in the Goweon Coalfield, northern Korea. Therefore any of the described species do not indicate the typical flora of the Sadong Series.

On the other hand, *Sphenopteris speciosum* and *Odontopteris longifolia* have been recorded from G and E zones of the lower part of the Gobangsan Series in Korea, and *Pecopteris anthriscifolia* was also described from the G zone of the same series in Korea and from the Upper Shihhotse Series in China.

On the consideration of these facts it seems that the flora is younger than the D zone of Sadong Series, the uppermost zone of the Series, and older than the H zone of the Gobangsan Series, both of which were established by Kawasaki.

On the basis of the fossil flora Kawasaki expressed that the age of the Gobangsan Series might be early Mesozoic than late Paleozoic, whereas Halle considered that the Gobangsan

Series contains a flora which is undoubtedly equivalent to that of the Upper Shihhotse Series which has been correlated with the lower Permian by him.

One of the writers (Cheong, 1969, p. 39) has suggested that the lower part of the Gobangsan Series (Hambaeg Formation) may fall within Permian. Although the described fossils are poor to determine the age of the fossil-bearing sequence, it seems that the fossil flora indicate the Permian because these fossil plants contain no Mesozoic element. The following table shows the occurrence of the described species in the related series in Korea and China.

Table. I.

Fossils \ Series	Yuen-menkou	L. Shi.	U.Shi.	Sad.	Gob.
Sphenophyllum speciosum					×
Sphenopteris Nystraemii		×	×		
Sphenopteris tenuis		×		×	×
Pecopteris anthriscifolia			×		×
Odontopteris longifolia					×
Cordaites Schenkii	×	×		×	×
Tingia carbonica		×		×	×
Plagiozamites oblongifolius		×	×		×
Taeniopteris? koreanensis				×	

Note: Shi.···Shihhotse Series.
Sad.···Sadong S. and Jangseong Formation
Gob.···Gobangsan Series

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EXPLANATION OF PLATES

PLATE I

Figs. 1-3—*Taeniopteris? koreanensis* Cheong et Lee, Jangseong Formation.
1a—×1, 1b—×2. Holotype, DGSU 00167
2a—×1, 2b—×2. Counterpart of the holotype, DGSU 00168
3—×2, Paratype, DGSU 00169

PLATE II

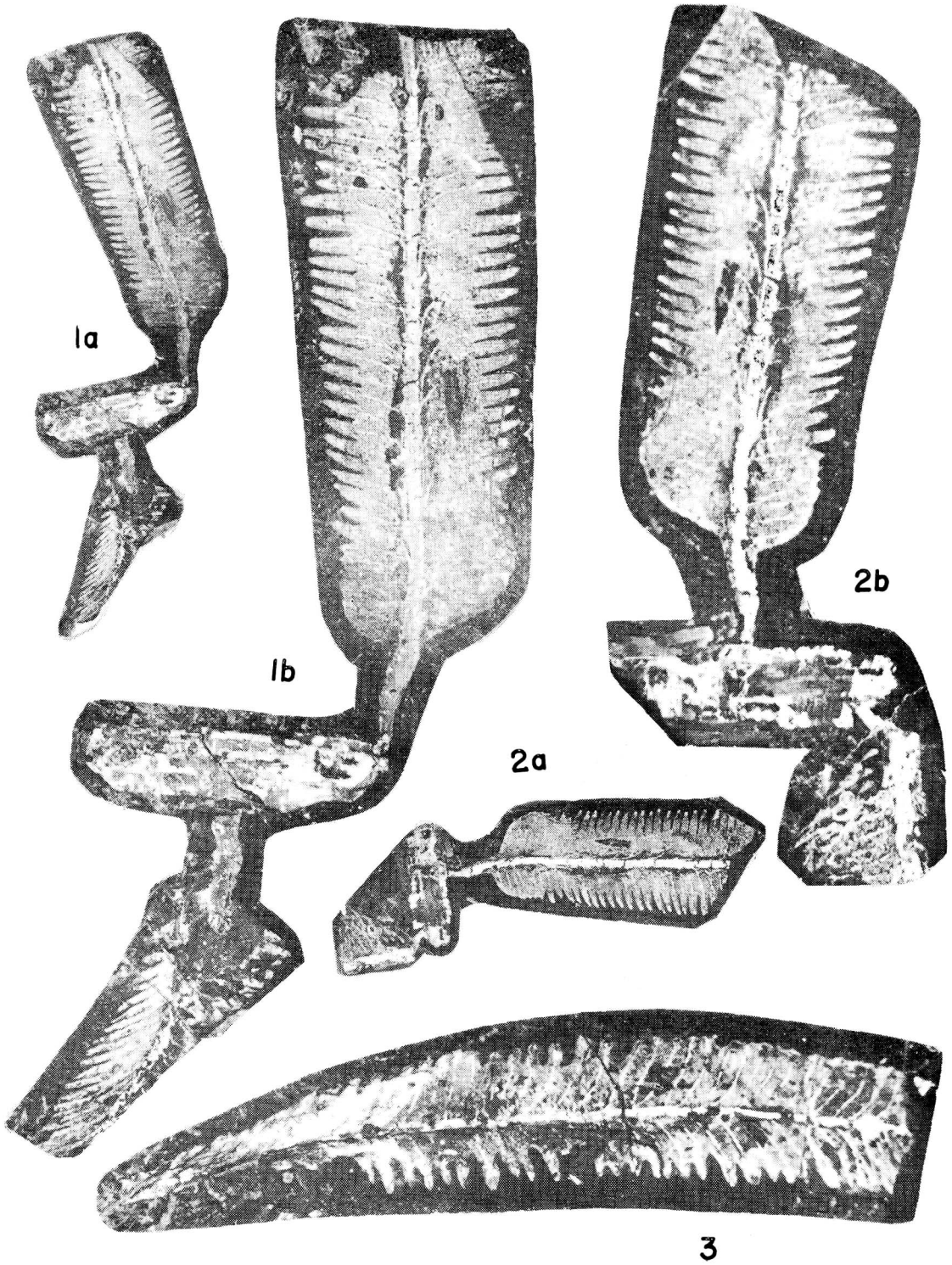
Fig. 1—*Pecopteris anthriscifolia* (Goepp.), ×2, Jangseong Formation. Hypotype, DGSU 00170
Fig. 2—*Sphenopteris Nystraemii* Halle, ×1, Jangseong Formation. Hypotype, DGSU 00171

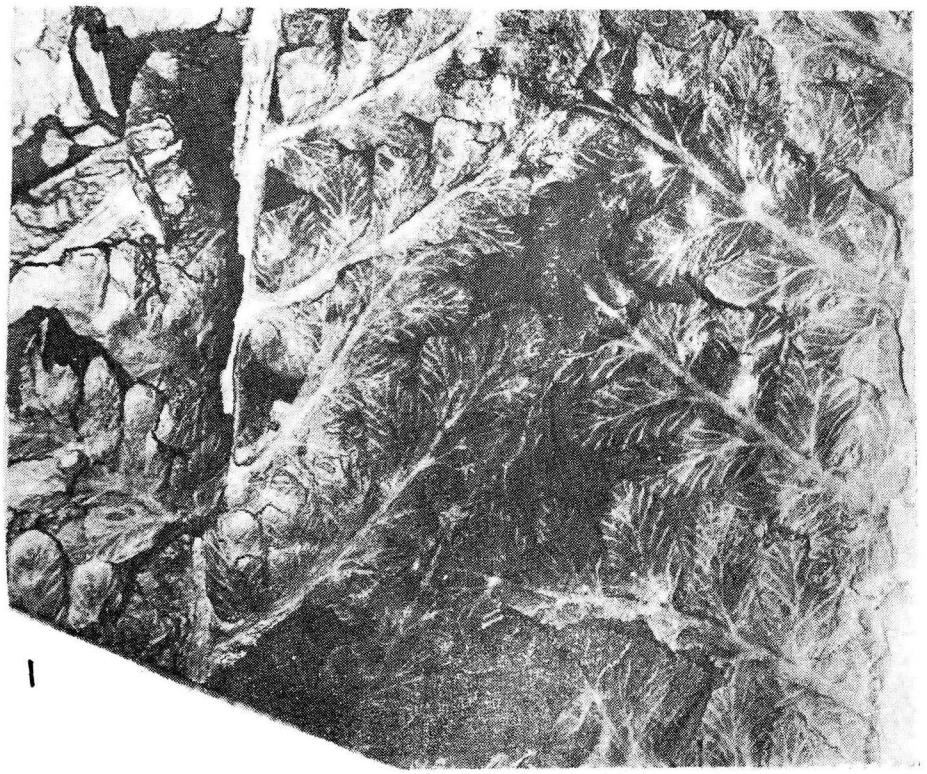
PLATE III

Figs. 1-2—*Sphenophyllum speciosum* (Royle), Jangseong Formation. Hypotypes, DGSU 00172, 00173
Fig. 3—*Plagiozamites oblongifolius* Halle, ×2/3 (right), *Cordaites Schenkii* Halle, ×2/3 (left). Both from the Jangseong Formation. Hypotypes, DGSU 00174, 00175
Fig. 4—*Odontopteris longifolia* Kawasaki, ×2. Jangseong Formation. Hypotype, DGSU 00176

PLATE IV

Figs. 1-2—*Tingia carbonica* (Schenk), ×2/3, Jangseong Formation. Hypotypes, DGSU 00177, 00178
Fig. 3—*Odontopteris* sp., ×1, Jangseong Formation. Hypotype, DGSU 00179
Fig. 4—*Asterophyllites* sp., ×2, Jangseong Formation. Hypotype, DGSU 00180
Fig. 5—*Sphenopteris tenuis?* Schenk, ×1 (right). *Cordaites Schenkii* Halle, ×1 (left). Both from the Jangseong Formation. Hypotypes. DGSU 00181, 00182





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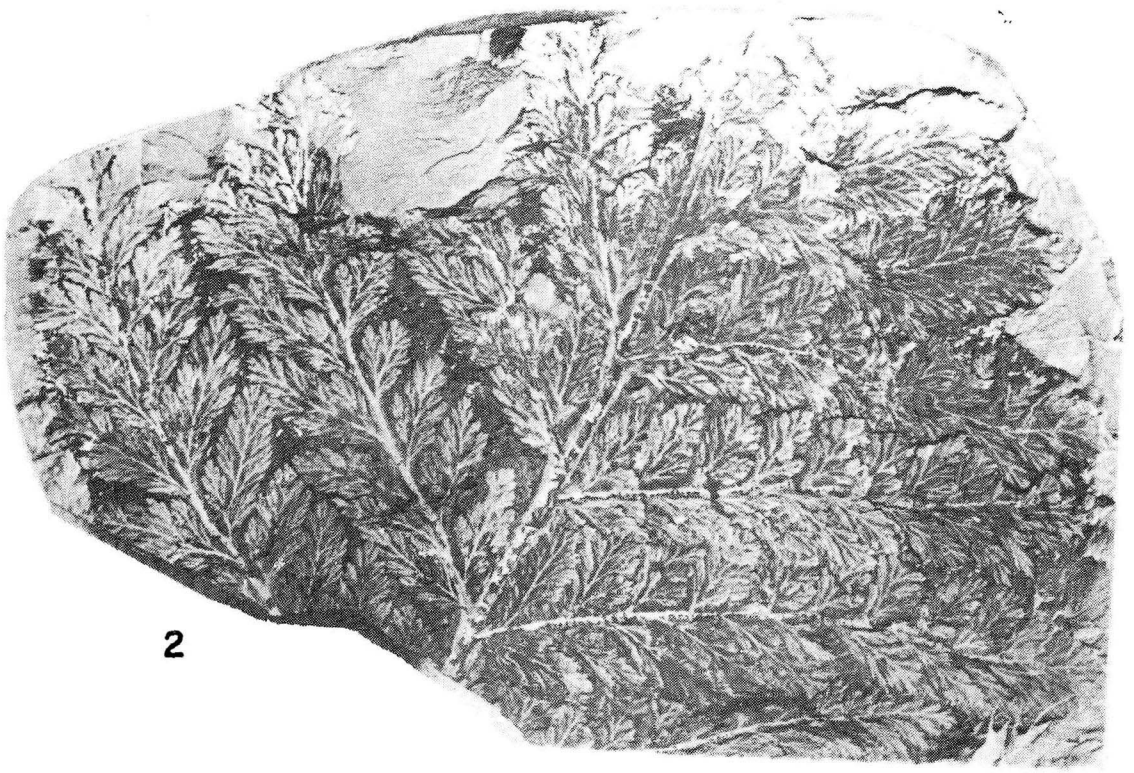

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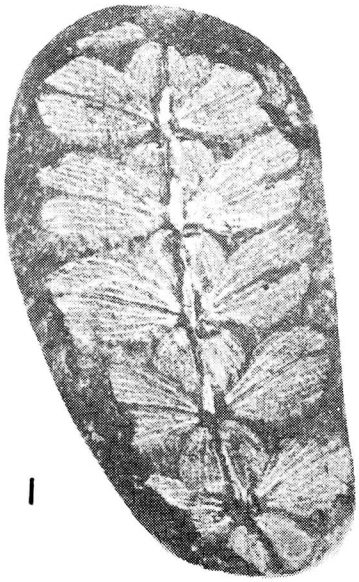

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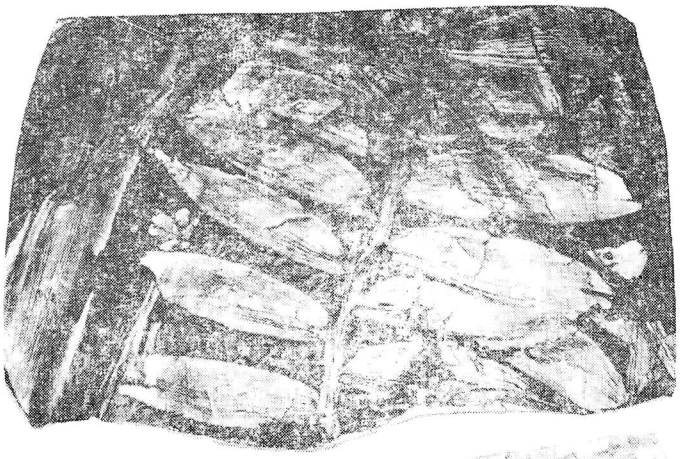

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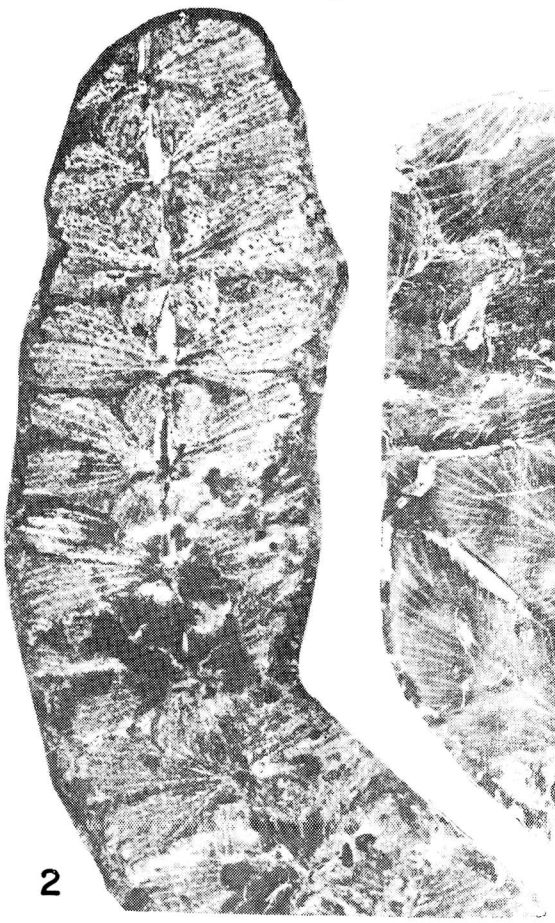

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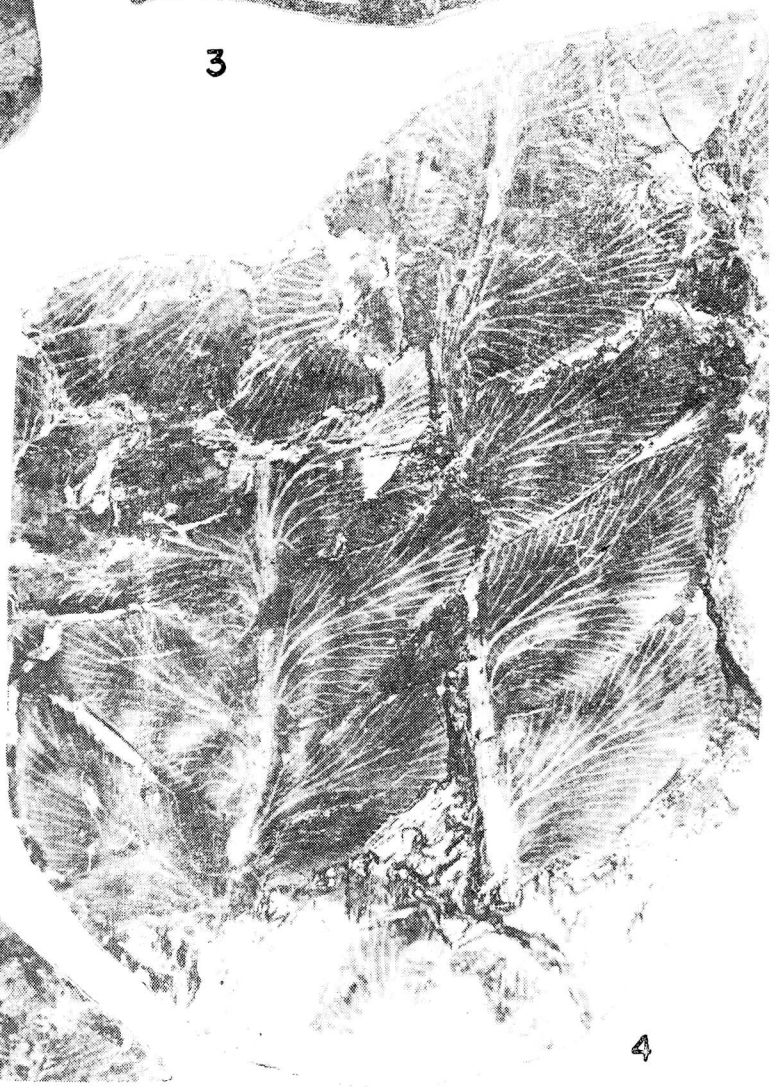

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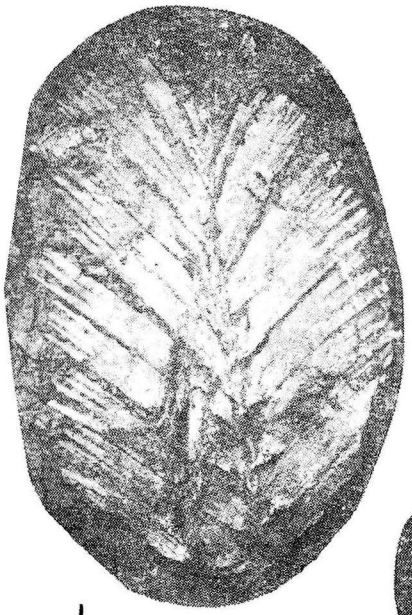

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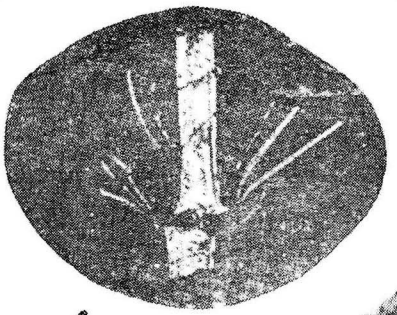

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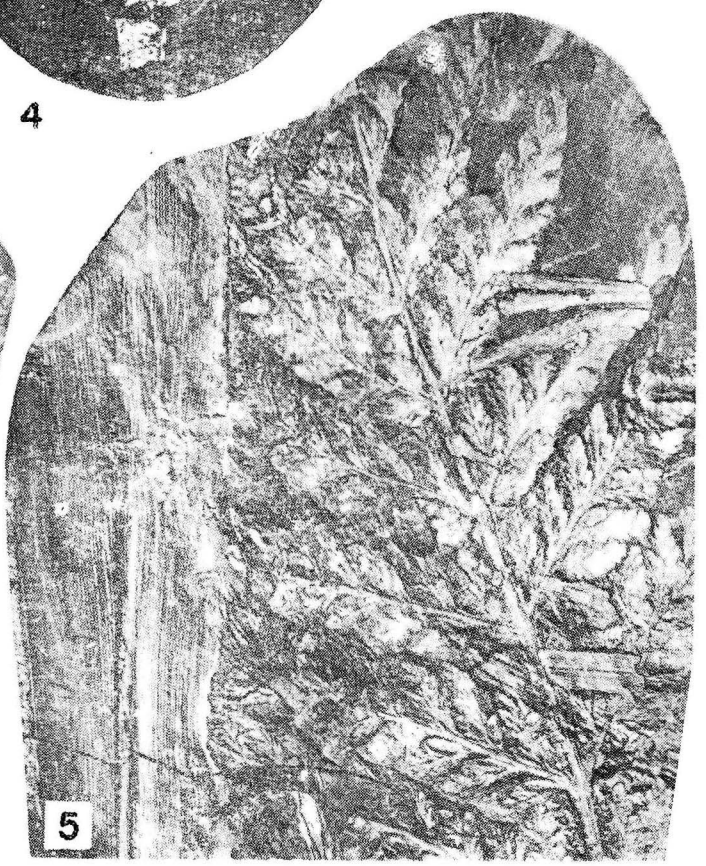

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