JOURNAL OF THE COLLEGE OF SCIENCE, IMPERIAL UNIVERSITY,
TOKYO, JAPAN.

VOL. XX., ARTICLE 8.

Mesozoic Plants from Korea.

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With 4 Plates.

Introduction.

Palæontologically speaking, Korea[1] is the least known of all the countries of Eastern Asia. The first notice on Korean fossils is found in GOTTSCHE's "Geologische Skizze von Korea", in which he mentions the occurrence of a Cambrian fauna in a limestone

1) Having arrived at Chemulpo (Inchhyön), Korea, in the end of August, 1903, the present writer was engaged in field work for about two months up to the beginning of November, when he took his way home from Fusan (Pusan). During the month of September, he made a journey along one of the main roads from Seoul to Fusan, through Tyo-ryöng on the boundary of northern Kyöng-syang-Do and Chhung-chhyöng-Do, in order to obtain a general knowledge of the various geological formations in which there was probability of the occurrence of organic remains, and especially to make a collection of the Palæozoic plant fossils at a locality close to Mun-gyöng, known since GOTTSCHE's exploration. From the 3rd to the 15th of October, he made a second tour from Fusan to Yöng-il along the eastern coast, making there a collection of plant fossils in the younger deposit of the said district. The existence of a plant deposit of a very recent age in this district was one of the important discoveries of Prof. KOTŌ. During the remaining days, the writer was able to traverse Chyol-la-Do, starting from Mok-pho, by the way of Chyang-syöng, Chin-an; thence he crossed Yuk-sim-nyöng, and traversed Kyöng-syang-Do for the third time, passing near An-eui and through Chin-jyu, Sa-chhyön, Chin-hai and Masampho.

The palæontological collections made during his first two months stay in the peninsula comprise:—

I) Plant fossils of the Palæozoic (?) from a locality near Mun-gyöng.
II) Plant fossils of a middle or upper Mesozoic age from Naktong.
III) Plant fossils of a younger Tertiary age (?) from Yöng-il.

found near Chho-san and Ui-uŏn, northern Phyŏng-ang-Do, and of plant impressions in a slate exposed near Mun-gyŏng, northern Kyŏng-syang-Do.

He also mentions indeterminable plant remains as occurring in the slates of Naktong, Northern Kyŏng-syang-Do, which are said to lie unconformably upon gneiss, and to gradually pass above to a thick complex of sandstones and shales. This formation was provisionally taken by him as synchronous with the plant-bearing slate of Mun-gyŏng, above alluded to, which he believed to be of the Carboniferous age from the presence of a species of *Neuropteris* which he compared to *N. flexuosa* STERNB. But Professor KOTŌ who has recently made extensive travels in Korea considers these two plant-bearing rocks as belonging to two distinct geological horizons, for the younger of which he proposes the name "Kyŏng-syang Formation."

The second tour in the southern part of the peninsula was made in September and October of 1904, for the purpose of tracing the extension of the Mesozoic deposists in the southwestern portion of Chyol-la-Do including Na-jyu and Nam-uŏn, and in a narrow belt of land stretching northeastward from the said district to the southeastern corner of Chhung-chhyŏng-Do, where he had previously no opportunity of observation. Consequently, this time, he traversed the Chyol-la-Do by the way of Mokpho, Yong-am, Nam-phyŏng, Koang-jyu, Tong-pok, Ok-koa, Nam-uŏn, Im-sil, Chyŏn-jyu, Chin-an, Yong-dam, Keum-san and Mu-jyu, and then entering the Chhung-chhyŏng-Do went as far as the Keifu-railway line, then in the process of construction, at Yong-dong. Thence he made a visit to Ok-chhyŏn on the west and to Hoang-gan on the east, and then went to Syang-jyu, Ham-chhyang, Po-eun and Chhyŏng-san, returning to Hoang-gan after a week. In this way, the Syong-ni-san ridge was crossed between Ham-chhyang and Po-eum from east to west. Afterward he went along the railway southeastward by Chhyu-phung-nyŏng, Keum-chhyŏn and Pu-sang, to Tol-pa. Next a few days were spent in making a research along both sides of the Nak-tong-gang between Tol-pa on the south and Nak-tong village on the north, and then going from Tol-pa to Fusan by railway, the journey came to the end.

Palæontologically, no important results were obtained from this second journey of about 50 days. Only in the Mesozoic deposits of Yong-dong and its vicinity, a few plant remains of an almost indeterminable preservation and consequently of very little or no value, were obtained in a slaty rock harder, though geologically a little younger, than the shales of the Nak-tong plant beds. From the latter, on the contrary, he got 4 or 5 additional species, not found in the collection of the preceding year.

The development of this Kyöng-syang formation is principally found in a rectangular area bounded on the east and south by the coasts of Kyöng-syang-Do, on the west by the meridian of 128° and on the north by a line roughly coinciding with lalitude 36° 30′. The region covers the main portion of the well populated Kyöng-syang-Do, with exclusions of numerous small areas composed of Tertiary and younger sediments, and also of eruptives.

There is another area in which this formation is found, but it is less extensive, lying in southern Chyol-la-Do. Like the other it is almost quadrate in outline, being bounded by the lines connecting Mokpho, Ok-koa, Ku-ryoi and Hai-nam successively, and is composed of two topographically well marked portions, the low, well cultivated southwestern plain and the more or less wooded northeastern highland.

Connecting these two separate areas, there runs a narrow belt of the same sediments, from northeast to southwest for about 200 km. through Chyol-la-Do. From Mokpho in the southwest, it runs through Chyang-syong and then north of Im-sil, west and north of Chin-an and near Mu-jyu where it disappears for a short distance in a region consisting of gneisses and biotite-schists. But it reappears at the southwest of Yong-dong in Chhung-chhyöng-Do which lies due north of Hoang-gan. It is again intercepted by the gneiss plain of Syang-jyu for a distance of about 20 km. In general, the belt has a width of about 16 km. along the road between Ok-chhyön and Hoang-gan, and between Im-sil and Chyöng-jyu.

East of Chhyön-san, in Chhyung-chhyöng-Do, there is also an isolated area composed of the same rocks, but its exact extent is at present not definitely known.

In this formation, GOTTSCHE distinguished five series of rocks which enumerated from below are as follows:

1) Dark marly shale, alternating with a fine grained, fragile sandstone.

2) Bituminous clay, partly discoloured, with small coaly flecks and obscure vegetable impressions.

3) Conglomerate, arcose near the base, with numerous, very compact layers of the same rock.

4) Marl of various grades of colour between violet and chocolate-brown, with frequent intercalations of compact limestones.

5) Thick banded sandstone, conglomerate-like near the base.

The total thickness of these series of rocks is estimated by GOTTSCHE as more than 600 m., i.e. 25 m. for the first; 15 m. for the second; 450 m. for the third; 70 m. for the fourth; and 40 m. for the last series.

According to the writer's view, the Kyöng-syang formation is a much thicker complex, with frequent intercalations of red tuffs and porphyrite sheets in the upper portion. The study of many local profiles led him to recongnize by means of the predominating rocks the following four principal divisions of the formation. The uppermost part is characterised by porphyrite sheets and a green breccia associated with them. The next part contains thick layers of several kinds of red coloured tuffs partly brecciated, together with a greenish slaty rock. The third part is mainly composed of a hard sandstone, often passing into a conglomerate and usually underlaid by a thin shale, a red tuff and an amygdaloidal sheet. The fourth part is composed of a series of thick slates, green or black in colour and often sandy,

containing a few plant remains, mostly indeterminable. Below these four parts, there is a thick conglomerate gradually passing below into a sandstone with intercalations of shales which are sometimes coaly.

As to the distribution of these parts in Kyöng-syang-Do, the uppermost shows a wide extent around Fusan, while the lowest appears along the boundary of the Mesozoic area against granite and gnesis in the west; the other two parts occur in areas between these two, although their distribution has in many cases become complicated by dislocations.

The upper conglomerate, No. 5 of GOTTSCHE, is distinguished from the lower usually by the occurrence of a red tuff and amygdaloidal rock sheet below it and also by being covered by a thick series of a red tuff above. A similar rock series also forms an extensive area in southern Chyol-la-Do and in the narrow belt between Chang-syöng and Yong-dong. In the latter, it is underlaid by thick greenish and black slates. GOTTSCHE differs from the writer in considering this conglomerate exposed near Chin-an as the equivalent of a similar rock which he calls No. 3 in his Nak-tong section, and consequently in taking the underlying complex as corresponding to No. 2 and No. 1. But the writer, from his own observation, is inclined to consider the conglomerate as representing the upper horizon, i. e. No. 5 of GOTTSCHE, while the lower series probably corresponds to his No. 4.

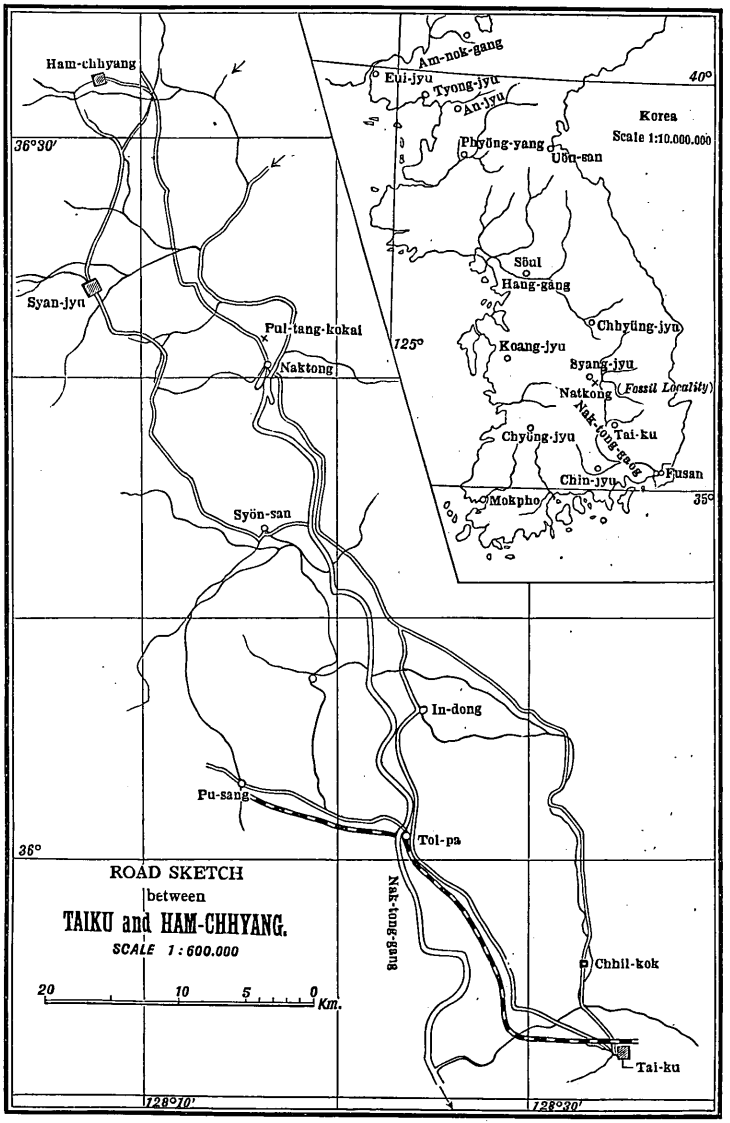
According to the writer's opinion, the lowest part of the Kyöng-syang formation is to be distinguished from the rest, under the name of the Naktong series. It seems exactly to correspond to the divisions, No. 1, No. 2, and No. 3, of GOTTSCHE. It is characterized by loose sandstones and inter-

calated seams of a coaly shale as above stated. In thickness, it is far inferior to the remaining upper portion of the Kyöng-syang formation. Its peculiarity consists in the easy destructibility of its shales and sandstones by atomospheric agencies; the hills in the region of these rocks are usually very low and undulating, except where capped with a thick conglomerate bed when they are high and steep. The scarcity of vegetation and the low mound like hills give the landscape a peculiar aspect. The upper portion of the Kyöng-syang formation is generally composed of harder rocks, aloso with frequent intercalations of conglomerate and breccia, especially near the top. The topography of the region is tolerably distinct from that described above; it consists of mountains or hills of higher elevations and where the water courses have cut into these rocks, perpendicular bluffs are presented which afford excellent opportunities for the study of the order of rock layers, and for searching for fossils, although few of the latter have been obtained and those only from the lower series in a very bad state of preservation. Ripple-marks have frequently been met with in the rocks of the upper series.

A greater regularity prevails in the arrangement of the rock-layers of the Kyöng-syang formation. They seem not to have suffered from any great subsequent disturbances except by the faulting of the Korean and Hansan systems, therefore they retain nearly their orginal horizontal position, dipping very slightly to the east (strictly speaking, the dip varies locally from NE. to SE.).

The collection of fossils to the description of which this paper is solely devoted, was made on a slope of a hill named Pul-tang-kokai, on the way from Söul to Fusan, and at about

4 km., northwest of a village called Naktong which is situated close to the river of the same name. Here the rock of the



Naktong series is typically developed. Numerous seams of coaly shale, seldom over half a meter in thickness, are found exposed

along the road; they are intercalated in a complex consisting of alternations of shales and sandstones, the latter of which often pass into a conglomerate, which is underlaid by marly shales and hard sandstones. Some of these underlying sandstones are coarse grained, and in one of them was found a large impression of a fern frond, which, however, is too badly preserved for determination. Marl nodules, rarely with Foraminifera, are found in the sandstones. In the coaly shales themselves and in the intercalated shales, vegetable remains are everywhere found, but either as indistinct impressions or as small fragments; among the former we find sometimes crowded impressions of *Nilssonia*, and in one of the latter abundant fragments of *Onychiopsis* were also observed. A locality for better preserved plants is in a valley at the eastern flank of the hill above alluded to, where a shale of a dark brown colour is very rich in fossils. This locality promises to yield an abundant harvest to future collectors.

The fossil flora, so far as the number of species is concerned, must be called a poor one, although some of the species are rich in individuals. It contains certain forms by means of which it is possible to determine with approximate accuracy the age of the strata in which they occur. There is no doubt that the flora is of the middle Mesozoic age;[1] it is therefore of considerable value, not only for the determination of the probable age of the

1) Once, Mr. Y. Ishii suspected that the coal-bearing deposit near Phyöng-yang belonged to the Cretaceous age, though, as he said, there was neither palæontological nor stratigraphical data for confirming such an opinion. More lately, Bruno Knochenhauer has said "Kretacische Gebilde treten nur inselformig an der Ostküste auf" (Korea, p. 111, 1909); but how he came to speak of the Cretaceous deposits, it is not known.

E. v. Ahnert also reported the occurrence of a Jurassic coal-bearing deposit in an area along the middle course of the Tu-man-gang and its left branch the Bolohotung (布爾哈圖).

upper Kyöng-syang formation and hence of the dislocation of the Korean and Hansan systems, but also of the geographical distribution of the middle Mesozoic flora.

The study of the flora, above alluded to, was first suggested to the writer by Prof. B. Kotō, by whose encouragement the writer had the opportunity to twice visit the territory under discussion. It was first intended that this note should be included in the more comprehensive work on Korean geology by this professor; but by kind permission, it is now given an earlier publication.

The writer is also indebted to Prof. M. Yokoyama for assistance in regard to palæontological points and for a painstaking revision of his manuscript.

Acknowledgment is also due to Prof. K. Mitsukuri, Director of the Science College, and to Prof. I. Ijima, of the publication committee of the Journal.

DESCRIPTIONS.

CYCADOPHYTA Nathorst.

DICTYOZAMITES Oldham.

T. Oldham[1] speaks of the genus *Dictyozamites* as "very interesting as a fossil plant, but of no importance in the determina-

1) T. Oldham and J. Morris: Fossil Flora of the Rajamahal Series in the Rajamhal Hills. 1863.

tion of the age of the flora; only characteristic of the Rajmahal group"; but the subsequent discovery of the genus in the fossil flora of many other lands has led A. C. SEWARD[1] lately to make a short but interesting contribution on the history, time range, and distribution of the genus, accompanied by an important article upon the plant geography of the Jurassic age. Indeed, it was by the occurrence of this plant in the Naktong flora that the present writer was able to draw the conclusion that the deposit is of the Mesozoic era and most probably of the Jurassic age.

The species of the genus hitherto known, according to SEWARD, number only three:—

1. *D. falcatus* OLDHAM.
   Rajmahal series of the Rajmahal Hills, and upper Gondwana of the Madras coast, India.
2. *D. falcatus* OLDH. var. *distans* YOK.
   Tetori series of Japan.
3. *D. falcatus* OLDH. var. *grossinervis* (YOK.)
   Tetori series of Japan.
4. *D. Johnstrupi* NATH.
   Liassic or Rhaetic bed of Bornholm.
5. *D. Hawelli* SEWARD.
   Lower Estuarine of Marske, Yorkshire, England.

As is seen from the above enumeration, this genus is surely known from the Jurassic. In strata older or younger than the above, it has not yet been known to occur.

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1) A. C. Seward: Occurrence of *Dictyozamites* in England, and on European and Eastern Mesozoic Floras. 1903.

DICTYOZAMITES FALCATUS (MORRIS).

Pl. II., figs. 2–7.[1]

1863. *Dictyopteris falcata* and *D. falcata* var. *obtusifolia* OLDHAM and MORRIS: The Fossil Flora of the Rajmahal Series, Rajmahal Hills, Bengal. P. 38, pl. XXIV., figs. I, 2.

1876. *Dictyozamites indicus* FEISTMANTEL: Ueber die indischen cycadeen Gattungen *Ptilophyllum* MORRIS u. *Dictyozamites* OLDHAM. P. 18, pl. IV., figs. 7, 8; pl. V., figs. 1–4; pl. VI.

1877. *D. indicus* FEISTMANTEL: Jurassic Flora of the Rajmahal Group, in the Rajmahal Hills. P. 70, pl. XLVI., figs. 7, 8.

1877. *D. indicus* FEISTMANTEL: Jurassic Flora of the Rajmahal Group of Golapili. P. 180, pl. II., figs. 5, 6.

1879. *D. indicus* FEISTMANTEL: The Fossil Flora of the upper Gondwanas Outliers of the Madras Coast. P. 24, pls. III–V.; pl. XVI., figs. 4–7.

1889. *D. indicus* var. *distans* YOKOYAMA: Jurassic Plants from Kaga, Hida and Echizen. P. 53, pl. X., figs. 4–10; pl. XI., fig. 5.

1899. *D. grossinervis* YOKOYAMA: l. c. P. 55, pl. VII., fig. 10.

1903. *D. falcatus* SEWARD: Occurrence of *Dictyozamites* in England. P. 218, pl. XV., figs. 5–8.

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1) All the specimens, figured in the accompanying plates, are in the Sci. Coll. Mus.

Frond pinnate; pinnae closely set in two alternating rows, attached to the upper surface of the rachis by the middle of the base at an angle of about 70°. Pinnae linear, very slightly falcate, gradually tapering to the bluntly pointed apex; ranging between 5.0 × 0.2 cm. and 1.2 × 0.3 cm. in size. End pinna smaller than others. Venation very distinct, showing numerous areoles. Areoles narrow, elongate and subquadrate, parallel to the margin in the middle of the pinnae becoming shorter and diverging gradually near the margin.

This most characteristic species is quite common.

The pinnate fronds obtained in Korea are a little broader than the Indian examples figured by OLDHAM and FEISTMANTEL, but the pinnae of the former are generally narrower than those of the latter. In other respects, there are no distinctions between them.

As in *D. falcatus* from India, our examples also vary greatly in the shape of the pinnae and the size of the areoles. Thus, the basal portion of the frond shown in fig. 2, is shorter and broader than in others. But there is no example in the writer's collection in which the pinnae show areoles so coarse as in some of the Indian and Japanese specimens. *D. grossinervis* of Prof. YOKOYAMA,[1] distinguished by having a less number of coarser areoles, was reduced by SEWARD[2] to the rank of a variety of the latter. Probably the Korean examples might also better be treated as a particular variety.

Two fragments of detached pinnae drawn in the same plate (figs. 6, 7) show a somewhat different outline from the others, being considerably broader and more abruptly attenuated to the

1) YOKOYAMA: l. c. P. 55, pl. VII., fig. 10.
2) SEWARD: l. c. P. 3.

pointed apex. These are here also treated as belonging to the same species, although with doubt.

NILSSONIA BRONGN.

NILSSONIA ORIENTALIS HEER.

Pl. III., figs. 1–5.

1878. *Nilssonia orientalis* HEER: Beitr. zum Juraflora Ostsibiriens u. d. Amurlandes. P. 18, pl. IV., figs. 5–9.

1889. *N. orientalis* YOKOYAMA: l. c. P. 41, pl. XIV., figs. 4–9.

1897. *N.* cfr. *orientalis* NATHORST: Zur Mesoz. Flora Spitzbergens. P. 24, pl. I., figs. 18, 19.

Frond longly oval, entire; truncated at the apex and attenuated gradually below. Veins fine, dense, 3–4 in the space of 1 mm.; slightly curved and directed forward, especially near the apex.

None of the fronds of *Nilssonia orientalis* from Siberia figured by HEER are complete. Yet, the Korean specimens show in general a great resemblance to them and also to the Japanese specimens described by Prof. YOKOYAMA. The only difference between the Korean and the Japanese specimens is that the base of the frond in the former is not so much rounded as in the latter. The writer, however, thinks it almost certain that both belong to one and the same species. Their resemblance to the

fronds mentioned by NATHORST as *N.* cfr. *orientalis* from Spitzbergen is also striking. *N. tenuinervis* NATH. from Yorkshire and Bornholm is no doubt an ally of this oriental species, as already pointed out by NATHORST, HEER and SEWARD. Very recently, NATHORST reported the occurrence of a *Nilssonia* very much like the European species in a Jurassic deposit at Esperance Bay, Louis-Philipp land.

NILSSONIA SP.

Pl. III., fig. 6.

The fragment here figured belongs to a species decidedly different from the preceding. It shows a lower portion of a leaf, which is cut into two alternate segments. The segments are continuous at the base; the upper margin is nearly straight, the lower strongly convex, and both make an acute angle between them. In this respect it closely resembles *N. nipponensis* YOK.[1] from the Japanese Jurassic, but is distinguished from it by having very densely crowded veins (about 6 in a milimeter).

DIOONITES, BORNEM.

DIOONITES (?) SP.

Pl. III., fig. 7.

There is another fragment of a pinnate frond, 2.7 cm. in length, which appears to have been thin in texture. About

1) YOKOYAMA: l. c. p. 42, pl. VI., fig. 8d; pl. VII., figs. 2-7, 8a; pl. XLI., fig. 6.

eleven pinnae which are close together are preserved on one side of the rachis, meeting those of the other side along the median line of its upper surface; none of the pinnae are perfect; they vary in breadth from 1.5 to 2.5 mm. and are parallel sided, expanding a little near the base where they are slightly decurrent. The veins are fine, simple, and uniformly distant; 5–8 in a segment.

This fern is not unlike *Dioonites Kotōei* YOK., but its imperfect preservation renders a strict comparison impossible.

CTENOPHYLLUM, SCH.

CTENOPHYLLUM (?) SP.

Pl. IV., fig. 7.

A slab of shale with a splendid example of *Cladophlebis koraiensis* shows, besides, two fragmental impressions of pinnate cycadean fronds.

One of them bears about fourteen linear pinnae on one side of the rachis, and the other four; none of these pinnae are, however, perfect. The rachis is stout, about 1½ mm. in breadth. The pinnae attenuate but little toward the broken apex; they are very close together and alternate; the mode of insertion cannot be satisfactorily made out, the rachis showing only the dorsal side. The veins are rather thick, 5–6 of them fork shortly after leaving the rachis. The longest pinnae, also imperfect at its apex, has a length of 1.2 cm. and a breadth of ca. 3 mm.

Only two fragments of this plant have been obtained, so that exact determination is at present impossible. Though not unlike *Dioonites Kotōei* in some respects, their generic distinction is obvious, for the Japanese species has simple veins while those from Korea usually fork once.

PODOZAMITES,[1] Fr. Braun emend. Schenk.

PODOZAMITES REINII Geyler.

Pl. IV., fig. 6.

1877. *Podozamites Reinii* Geyler: Ueber Fossile Pflanzen aus der Juraformation Japans. Pp. 229–230, pl. XXXIII., fig. 4a; XXXIV., 1, 2, 3b, 4, 5a.

1899. *P. Reinii* Yokoyama: l. c. p. 50, pl. III., fig. 6a-c; IX., 12a; XII., 4.

Two detached pinnae of *Podozamites*, distinguished from the following species, by their ovate outline and more numerous veins, are to be identified with *P. Reinii* Geyler, peculiar to, and abundant in, the Japanese Tetori series, first described in detail by Geyler and then by Prof. Yokoyama. Hitherto it has not been known to occur outside of Japan; therefore it is to be looked upon as a species indicating a close relationship between the Tetori and the Naktong floras.

One of the specimens measures 2.0 cm. in breadth and has forty-two parallel veins with numerous fine interstitial ones.

1) This genus is here provisionally placed in Cycadophyta according to the customary acceptation, though its position is not certain.

PODOZAMITES LANCEOLATUS (LINDL. and HUTTON).

Pl. IV., figs. 1–5.

1877. *P. lanceolatus* GEYLER: l. c. P. 228, pl. XXXII., figs. 1, 4; XXXIII., 1–3, 4b; XXXIV., 3a, 5a.

1889. *P. lanceolatus* YOKOYAMA: l. c. P. 45, pl. IV., figs. 1a & c, 2, 3a, 4a-b; V., 1, 2b, 3, 4, 5a–d, 6, 7, 8, 9; VI., 1; VII., 8b; IX, 6; XII., 18; XIV., 12a.

1894. *P. lanceolatus* YOKOYAMA; Mesozoic Plants from Kozuke, Kii, Awa and Tosa. P. 222, pl. XIII., figs. 1, 3, 4, 5, 6, 8, 9; XIV., 1–3, 5.

1905. *P. lanceolatus* YOKOYAMA: Mesozoic Plants from Nagato and Bitchu. P. 6, pl. I., fig. 6; p. 13, pl. III., fig. 5.

For further references see SEWARD's Jurassic Flora, p. 242.

This widely spread, well known species is also present, though rare, in the Naktong flora. The few specimens obtained are all detached pinnae, mostly imperfect either in their apical or basal portions, or in both. The poor state of their preservation and the rarity of their occurrence, in contrast with the richness and excellent preservation of the associated fern fronds, seem to indicate that they belong to that kind of vegetable remains which have been drifted from a great distance.

Some of the best preserved examples are given in the accompanying plates. Figure 2 represents a broad pinna lacking its apex, but with rapidly narrowing base pierced by about thirty veins in a space 1.9 cm. in breadth. It reminds one strongly of var. *latifolia* HR. Fig. 1 is distinguished by its more lanceolate outline, gradually tapering above. It is not unlike var. *inter-*

media HR., but the veins are much more crowded. Besides, there are many other oblong pinnae (figs. 3, 5), smaller in size and with 22–25 veins. One (fig. 4) is characterized by its rounded apex and gently tapering basal portion and only 20 veins, the breadth of the pinna being about 1 cm. Therefore it may better be compared with *P. pulchellus* HR.[1]

CONIFERAE.

PINUS L.

PINUS SP.

Pl. II., figs. 9–10.

The existence of coniferous plants in the deposit of Naktong is shown by isolated linear leaves much like those of *Pinus Nordenskjoldi* and of its allied species described from the Jurassic deposits of Spitzbergen, Siberia, China, Japan etc. They are found uniformly scattered in the bed, though not numerically abundant. One can distinguish two types by their larger or smaller leaves. The larger leaves (fig. 9) usually attain 3 mm. in breadth and more than 4 cm. in length, with a midrib and numerous fine longitudinal striae on either side of it, thus being quite similar to *Pinus Nordenskjoldi* HR.[2] in every respect.

1) HEER: Beitr. zur Fossilen Flora Spitzbergens, p. 38, pl. IX., figs. 10–14. NATHORST: Zur Mesozoischen Flora Spitzbergens, p. 14, pl. I., figs. 6–11.

2) HEER: Beitr. z. Foss. Flora Spitzb., p. 45, pl. IX., figs. 1–6. Beitr. z. Juraflora Ostsib. u. d. Amurl., p. 76, pl. IV., fig. 8e; p. 117, pl. XXII., fig. 4a, b; XXVII., 4. Beitr. 1878, p. 26, pl. II., figs. 7–10. Nachtrag p. 28, pl. I., figs. 6b, 8c. YOKOYAMA: l. c. p. 63, pl. IX., fig. 12b.

Some bring *P. Nordenskjoldi* under the genus *Cyclopitys*, against which view Prof. YOKOYAMA[1] has given a short argument in his description of the Japanese examples, citing the opinion of NATHORST. POTONIE also made a remark on *Cyclopitys*.[2] But in this place, it is sufficient to mention that the Korean example lacks the transverse wrinkles, though the longitudinal striae are quite distinct.

The smaller leaves (fig. 10) are about 1 mm. broad and more than 2 cm. long with a distinct midrib; there are no other particular characters to be mentioned. *Pinus* cfr. *prodromus* HR. from Japan[3] is at least a similar plant, if not specifically identical.

Though these two fossils are not of much value either from the chronological or the botanical point of view, yet they are at least worthy of consideration as representatives of the scanty remains of Coniferae in the deposit.

PTERIDOPHYTA.

FILICINAE.

LEPTOSPORANGIATAE.

POLYPODIACEAE.

ONYCHIOPSIS, YOK. 1890.

(Jour. Coll. Sci. Japan, vol. III., 1890, p. 26. Cat. Mes. Pl. Dep. Geol. Brit. Mus. Wealden Flora I., p. 40, 1894.)

1) YOKOYAMA: l. c. p. 63.
2) POTONIE: Pflanzenreste aus der Juraformation. Futterer's Durch Asien III.
3) YOKOYAMA: l. c. p. 62, pl. XII., fig. 3.

The genus was first established by Prof. YOKOYAMA in 1890 for the reception of *Thyrsopteris elongata* GEYLER from the Japanese Jurassic, on account of the close resemblance of its fertile as well as sterile pinnae to those of the living species of *Onychium*. Immediately afterward, NATHORST[1] pointed out the great similarity of VELONOWSKY's figures of the fertile frond of *Thyrsopteris capsulifera* to the Japanese species, which fact led him to bring it under the same genus, and he further proposed to assign the well known European Wealden species—*Sphenopteris Mantelli* BRONGN.—to the same genus, which closely resembles *O. elongata*. This view was subsequently verified by SEWARD,[2] who examined fertile pinnae of *Sphenopteris Mantelli* from the British rocks and confirmed Prof. YOKOYAMA's view, that the features of the fossil fern show a closer relationship to *Onychium* than to any other living genus.

SAPORTA[3] however on examining a fertile frond from Portugal was inclined to bring the position of *Sphenopteris Mantelli* under the genus *Davallia* or at least into the group of the *Davalliae*. But, SEWARD's words[4] about this run as follows: "The comparison made by YOKOYAMA in the case of *Onychiopsis elongata* and by myself as regards *O. Mantelli*, with the recent genus *Onychium*, is, I belive, a much nearer approach to the truth than if we adopt the conclusions of SAPORTA."[5]

The genus has a wide range from Jurassic through Wealden to Cenomanian; altogether 4 species being known at present.

1) NATHORST: Beiträge z. Mesozoischen Flora Japans. 1890.

2) SEWARD: Wealden Flora I. 1894. P. 43.

3) SAPORTA: Flora Fossile du Portugal. 1894.

4) SEWARD: Wealden Flora II., p. 229.

5) The fertile fronds of *Sphenopteris Mantelli* described by SAPORTA from the lower Cretaceous of Portugal appear to the writer somewhat different from those of the same species from Yorkshire and also of *Onychiopsis elongata*.

Of these four, *O. elongata* seems to have been abundant in the fossil floras of the Japanese Mesozoic. In the Tetori and Ryoseki series, a great many specimens are found from many localities, and the occurrence of the same in the somewhat older strata of Nagato has also been very recently pointed out by Prof. YOKOYAMA.

Another Japanese species—*O. elegans* YOK.—is known only by one specimen from the Ryoseki series of Tosa.

Outside of Japan, the genus also possesses a very wide geographical distribution. Particularly worldwide is the distribution of *O. Mantelli* which is a common fossil in the Wealden rocks of England, and also appears in the deposits of the corresponding age in Germany, Portugal, Austria and Belgium. Besides, the species is reported from the upper Jurassic of Portugal, though the identification of Saporta is doubted by SEWARD ;[1] otherwise it is an exclusively Wealden species. In North America, this species has been described from the Potomac formation of Virginia,[2] and in South Africa from the Uitenhage Series[3] of Cape Town. According to the recent publication of SEWARD,[4] *Trichomanites laxum* and *T. spinifolium* from Australia are mere synonyms of this species.

From the lower Cretaceous of Bohemia, another species is described under the name of *Thyrsopteris capsulifera.*[5] Besides, some of the specimens from England[6] and Bohemia[7] are referred

1) SEWARD: Wealden Flora II., p. 229.

2) Some of the numerous species of the genus *Thyrsopteris* described by FONTAINE from the Potomac of Virginia, are believed by SEWARD to be *O. Mantelli.*

3) SEWARD: Fossil Floras of Cape Colony, p. 5.

4) l. c.

5) VELENOWSKY: Die Farne der Böhmischen Kreideformation, p. 10, pl. I., figs. 6–12. KRASSER: Beiträge z. Kenntniss der fossilen Kreideflora von Kunstadt, p. 121. ANT. FRIC u. E. BAYER: Perucer Schichten, 1900, p. 44, fig. 12.

6) SEWARD: Wealden Flora, I., p. 55.

7) KRASSER: Beiträge, p. 121, pl. VII., fig. 1.

to *O. elongata.* All of these species closely resembling one another, it is sometimes questioned whether *O. elongata* is really distinct from *O. capsulifera* on the one hand or from *O. Mantelli* on the other. More recently, SEWARD[1] has united *O. elongata* with *O. Mantelli.*

In short, *Onychiopsis* is a genus ranging from the Jurassic to the oldest part of the upper Cretaceous and is of a wide geographical distribution, and of the 4 species known, *O. elongata* seems to have the greatest chronological range.

ONYCHIOPSIS ELONGATA (GEYLER).

Pl. I., figs. 9–14; pl. III., fig. 15.

1871. *Sphenopteris Geopperti* SCHENK (in part): Palæontographica vol. XIX., pl. XXX., figs 2 and 2a.

1877. *Thyrsopteris elongata* GEYLER: Ueber Foss. Pflanzen a. d. Juraform. Japans. P. 224, pl. XXX., fig. 5; pl. XXVI., figs., 4 and 5.

? 1883. *Thyrsopteris elongata* SCHENK: Richthofen's China. Vol. IV., pt. X., p. 263, pl. LIV., fig. 1.

1886. *Dicksonia elongata* YOKOYAMA: On the Jurassic Plants of Kaga, Hida and Echizen. Bull. Geol. Soc. Japan. Pt. B. Vol. I., no. I., p. 6.

? 1889. *Thyrsopteris rarinervis* FONTAINE: The Potomac or Younger Mesozoic Flora. P. 124, pl. XXVI., figs. 6, 7; pl. XLIII., figs. 4–6; pl. XLIV., figs. 1, 2 and 5; pl. XLIX., fig. 2; pl. CLXIX., figs. 6, 7.

1) SEWARD: Fossil Flora of Cape Colony, 1903, p. 5.

1890. *Onychiopsis elongata* YOKOYAMA: Jurassic Plants from Kaga, Hida and Echizen. P. 27, pl. II., figs. 1–3; pl. III., fig. 6d; pl. XII., figs. 9. 10.

1890. *Onychiopsis elongata* NATHORST: Beiträge z. Mesozoische Flora Japans. P. 4, pl. I., figs. 1–3, pp. 8, 10, 13, 14, pl. VI., fig. 5.

1894. *Onychiopsis elongata* YOKOYAMA: Mesoz. Plants from Kozuke, Kii and Tosa. P. 215, pl. XX., fig. 8; pl. XXI., figs. 1 and 4.

?1884. *Onychiopsis elongata* SEWARD: Wealden Flora I. P. 55, pl. II., fig. 2.

?1896. *Onychiopsis elongata* KRASSER: Beitr. z. Kenntniss d. Foss. Kreideflora v. Kunstadt. P. 121, pl. VII, fig. 1.

This elegant fern is exceedingly common in the plant bearing beds of Naktong, although it is not easy to obtain specimens sufficiently large and well preserved to show the entire frond. Not seldom, large blocks of shales are found containing innumerable fragments of pinnae frequently bearing fructification. On pl. I. and II., some of the specimens are figured; all of them show the characteristic features of the species, quite agreeing with the description and figures of the Japanese specimens in Prof. YOKOYAMA's works.

Prior to YOKOYAMA's publication, Mr. S. MATSUSHIMA, in his "Geological Report of the Eastern Part of Echizen including the Upper Tetorigawa Region" 1883 (MS.), described a fern under the name of *Sphenopteris Mantelli*, much like *Thyrosopteris elongata* GEYLER but more slender in appearance. This specimen is reproduced here in pl. I., fig. 12, from which we know that it is almost indistinguishable from the drawings of European

Sphenopteris Mantelli given in various publications. As in the Japanese and the Korean examples, the foreign specimens seem equally variable so that SEWARD once distinguished a form with broader pinnules from those with narrower.

SEWARD also referred some of the ferns described as *Sphenopteris Goepperti* by SCHENK to *Onychiopsis elongata*, which was subsequently verified by KRASSER's reëxamination of the original specimen of SCHENK. Besides, KRASSER added that there was a great probability that the specimen referred to the Japanese species was a narrow leaved form of *O. capsulifera* (VELONOWSKY). SEWARD is also of the opinion that the distinguishing characters given of *O. Mantelli* and *O. elongata* are not of sufficient importance to render them separate species.

In the collection from Korea, there are many pinnae with fructification; the fertile pinnules agree with the Japanese specimens both in their dimensions and in their mode of arrangement on the axis. They are arranged on the axis sometimes quite distant from one another as in the figures of the present work, sometimes very close as in the GEYLER's drawings. SEWARD described the fertile pinnules of *O. Mantelli* as sessile or short-stalked, and VELONOWSKY's illustration of *O. capsulifera* also clearly shows the same character. A specimen of *O. elongata* which GEYLER figured, belongs to the upper portion of pinnae with fertile pinnules which are crowded together and furnished with short stalks. Specimens from Korea differ from those above mentioned in having, "the sori placed two at the end of each pinnule, which is considerably narrowed looking like a winged stalk", as Prof. YOKOYAMA aptly expressed it in his description of the Japanese specimens.

A comparison of the fertile pinnules of *O. Mantelli* with

those of *O. elongata* shows a slight difference in form. In the former, the apical portion is more elongated while, in the latter, it is usually rounded instead of being acuminated.

However great the resemblance may be between the oriental and the European species, the writer considers it at present proper to keep them as two distinct species, as there are slight differences in the form of the fertile pinnules and in the general habits of the sterile pinnae.

An examination of numerous figures of the species of *Thyrsopteris* described by FONTAINE from the Potomac formation of Virginia,[1] shows many forms more or less closely allied to the Japanese species. This fact was already pointed out by the author of the Wealden Flora who placed *T. rarinervis* FONTAINE among the synonyms of *O. elongata*. However, until a direct comparison of the specimens from both sides is made, the question must be left unsettled. SEWARD also compared *Asplenium dicksonianum* HEER[2] from the Kome-beds of Greenland with the present species, their external resemblance at least being very striking. HEER placed the fossil under the genus *Asplenium*, because he was convinced of its relation to the living *Asplenium nigrum* L.. But there is no fructification to decide the question.

Schenk[3] determined a specimen from Japan in one of RICHTHOFEN's collections of fossil plants, as *Thyrsopteris elongata* GEYLER, to which Prof. YOKOYAMA and SEWARD also seem to agree although the pinnules are apparently too broad to allow this identification to pass unquestioned. It reminds some of

1) FONTAINE: Potomac Flora p. 123, pl. XXVI., figs. 6 & 7; pl. XLIII., figs. 4–6 pl. XLIV., figs. 1, 2, 5; pl. XLIX., fig. 2; pl. CLXIX., figs. 6, 4, 7.

2) HEER: Fl. Foss. Arct., III., p. 31, pl. I.

3) SCHENK: Fossilen Pflanzen (RICHTHOFEN's China IV.), p. 263, pl. LIV., fig. 1.

what HEER, Prof. YOKOYAMA and others described as *Thyrsopteris*; and it is also in some respects not unlike *O. capsulifera.*

In this connection, the present writer figured (pl. I., fig. 12) a specimen from Shimamura, Prov. Kaga, one of the localities in Japan which are prolific of Jurassic plants. It shows a character very much like SCHENK's *Thyrsopteris elongata,* and at first it was taken for the same. But on making a thorough examination of the fertile portion of the frond, it was found not to belong to the genus *Onychiopsis* but in all probability to *Coniopteris.* Although the plant will not be described here, the above fact forces the present writer to doubt SCHENK's determination above alluded to.

CYATHEACEAE.

CONIOPTERIS *Brongniart.*

(Tableau Foss. Veg. p. 26).

In agreement with to SAPORTA, SOLMS LAUBACH and SEWARD, the following fossils are described below under the generic name of *Coniopteris,* on account of the external resemblance of their fructification to that of some recent genera of Cyatheaceae (especially of *Dicksonia* and *Thyrsopteris*). For such forms, some authors are accustomed to use the generic names of the living ones, even when the real nature of the sori and sporangia is unknown.

CONIOPTERIS HEERIANUS (YOKOYAMA).

Pl. II., fig. 8; pl. III., figs. 9, 14.

1889. *Adiantites Heerianus* YOK.: l. c. p. 28, pl. XII., figs. 1, 1a, 1b, and 2.

Frond bipinnate, ovate; principal rachis slender, but stout and straight, partly winged; pinnae oblique (making an angle of about 40°–50° with the principal rachis), rather distant from one another, long, rapidly becoming shorter toward the anterior portion of the frond; pinnules rather distant, alternate, oblongly rhomboidal, gradually tapering below, and lobed; lobes small, acutely directed forward, acute at apex; venation very fine and indistinct, median vein sending off alternately into the lobes branches which fork once or twice. Leaf substance coriaceous?

The pinnae of the anterior part of the frond are simple-lobed. The sori which are found on these pinnae are reniform, fixed to the margin of each lobe, at the end of the vein; usually there is one sorus on the inner margin of the lobe, but sometimes many along the inner as well as the outer margin. Each anterior portion of the posterior pinnae is also simple-lobed, without being cut so as to form separate pinnules.

After a careful study, the writer was convinced of the identity of the examples with a Japanese species, very rarely found in the plant-bed of Shimamura, prov. Kaga. The Korean and the Japanese examples are precisely similar in characters, but it is necessary to note that the type specimens from Japan consist of but four fragmental pinnae, for which Prof. YOKOYAMA gave the following diagnosis:

"Pinnae elongated; pinnules alternate, acutely directed forward, rhomboidal, attenuated below, acute at apex, acutely lobed; veins equal, fine, repeatedly dichotomous."

Prof. YOKOYAMA brought two pinnae, which differ from each other in the size and form of the last segments, under the species in question and quite rightly, as the Korean material shows that the pinnae of the posterior portion of a frond possess broad segments while those of the anterior portion present narrow ones. As to the identity of the Korean and Japanese forms, a comparison of a specimen shown in fig. 8, pl. II., with fig. 1a in pl. XII of Prof. YOKOYAMA will place it beyond all doubt.

In one of the Japanese examples, all of the pinnules show dark dots around their margin borne on the tip of each lobe; the fructified example from Korea, fig. 9, pl. III., being distinctly the apical portion of a frond, shows pinnae which are simple-lobed instead being deeply divided into pinnules; and the lobes which sometimes bear more than one sorus along the inner margin are only the posterior ones. From this, it is highly probable that the fructified example from Japan figured by Prof. YOKOYAMA is from the posterior portion of a frond.

The writer has brought this species under the genus *Coniopteris* for its fructification obviosuly resembles, at least in its external appearrance, some of the recorded cases of fossil *Dicksonia* and of the living representatives of the same genus. Yet it must be admitted that with the material at the writer's disposal it has been impossible to examine in any way either the real nature of the sori, indusium and sporangia, or the anatomical characters of the stem. Prof. YOKOYAMA placed his species in the genus *Adiantites*, although he admitted the resemblance of its fructifica-

tion also to *Dicksonia* ; SEWARD,[1] however, brought it within the synonyms of *Coniopteris hymenophylloides* with a query.

The sterile pinnae of this species are so much like those of *Dicksonia acutiloba*,[2] *D. concinna*[3] and *D. Saportana*[4] from the Jurassic Deposits of eastern Siberia, that the writer at first hesitated to separate it from any of those species. But the distinctly contracted base of the pinnules and other minute differences led him to make it separate from the Siberian species. Among the Potomac plants, there are also many species allied to the Japanese, such as *Thyrsopteris elliptica* FONTAINE,[5] *T. varians* FONTAINE[6] and *T. crenata* FONTAINE,[7] none of which however seems to be quite identical with it.[8]

CONIOPTERIS HYMENOPHYLLOIDES (BRONGNIART) ?

Pl. II., fig. 8 ; pl. III., fig. 8.

1851. *Sphenopteris nephrocarpa* BUNBURY : On Some Fossil Plants from the Jurassic Strata of the Yorkshire Coast. Quart. Jour. Geol. Soc. London. Vol. VII., pl. XII., figs. 1a, b, p. 179.

1) SEWARD : Jurassic Flora, p. 100.

2) HEER : Beiträge z. Jura-flora Ostsibiriens u. d. Amurlandes, p. 92, pl. XVIII., fig. 4.

3) HEER : l. c. p. 34, pl. XIV., fig. 6 ; p. 87, pl. XVI., figs. 1-9.

4) HEER : l. c. p. 89, pl. XVII., figs. 1, 2 ; pl. XVIII., figs. 1-3.

5) FONTAINE : Potomac Flora, p. 133, pl. XXIV., fig. 3 ; pl. XLVI., fig. 1 ; pl. L., figs. 6, 9 ; pl. LI., figs. 4, 6, 7 ; pl. LIV., fig. 6 ; pl. LV., fig. 4 ; pl. LVI., figs. 6, 7 ; pl. LVII., fig. 6 ; pl. LVIII., fig. 2.

6) FONTAINE : l. c. p. 137, pl. LII., figs. 2-4 ; pl. LII., figs. 1-3 ; pl. LIV., fig. 10 ; pl. LVII., fig. 2.

7) FONTAINE : l. c. p. 127, pl. XXXIX., figs. 1-2.

8) In a piece of shale with a sterile frond of the species, there is an impression which looks as if it were a portion of a tree fern stem 3.5 cm. in length and 2.5 cm. in breadth. It shows an obliterated surface only, the vascular bundles being not quite recognizable. The petiole bases are arranged in close spirals.

1863. *Hymenophyllites Bunburyanus* FEISTMANTELL: Jurassic Flora of the Raymahal Group. P. 78, pl. XXXII., figs. 5–7.

1864. *Tympanopora racemosa* et *simplex* LECKENBY: On the Sandstones and Shales of the Oolithes of Scarborough. Quart. Jour. Geol. Soc. London. Vol. XX., p. 79, pl. XI., fig. 2.

1876. *Thyrsopteris Murrayana* HEER: Beiträge z. Jura Flora Ostsibiliens u. des Amurlandes. P. 30, pl. I., fig. 4; pl. II., fig. 4; pl. VIII., fig. IIb.
Thyrsopteris Maakiana HEER: l. c. P. 31, pl. I., fig. 1; pl. II., fig. 5.
Dicksonia clavipes HEER: l. c. P. 33, pl. II., fig. 7.

1878. *Thyrsopteris Murrayana* HEER: Nachträge z. Juraflora Sibiriens. P. 6, pl. I., fig. 1.

1889. *Dicksonia nephrocarpa* YOKOYAMA: l. c. P. 25, pl. I., figs. 1, 1a.

1895. *Thyrsopteris* (?) *Murrayana* RACIBORSKY: Flora Kopalna. P. 180, pl. X., figs. 15, 16; XII., 17–21.
Dicksonia (*Eudicksonia*) *Heerii* RACIBORSKY: l. c. P. 174, pl, X., figs. 5, 6a, 7–11a, 12–14.
Dicksonia Zarecznyi (par.) RACIBORSKY: l. c. P. 175, pl. XII., figs. 8, 9, 11, 12.

1900. *Coniopteris hymenophlloides* SEWARD: The Jurassic Flora. Yorkshire. P. 99, pl. XVII., figs. 6 and 8; pl. XXI., figs. 2–4.

Two fertile pinnae are referred by the writer with doubt to the well known, and widely distributed species, *C. hymenophylloides*, whose fertile pinnae have been described under various names from different localities, for example, *Sphenopteris nephro-*

carpa, *Tympanopora racemosa* and *T. simplex* from Yorkshire, *Dicksonia clavipes*, *Thyrosopteris Murrayana*, *T. Maakiana* from Siberia and *Dicksonia* (*Eudicksonia*) *Heerii*, *D. Zarecznyi* from Cracow. What are known under these different names have subsequently been proved to be simple modifications of the fertile segments of *Coniopteris hymenophylloides*, and the presence of a gradual transition in these fertile pinnae from forms with a few broad and round lobes to those with narrow, deeply dissected segments, has been traced by SEWARD in materials found at Scarborough.

NATHORST united *Dicksonia clavipes* HEER, from Kaja in Siberia, with *Sphenopteris nephrocarpa* BUNBURY; then, Prof. YOKOYAMA described a fertile pinna from Japan of precisely similar nature as *Dicksonia nephrocarpa*. *Sphenopteris* (*Hymenophyllites*) *Bunburianus*[1] from India is also no doubt a close ally, if not identical.

One of the fructified examples from Korea, being quite similar to *Sphenopteris nephrocarpa* figured by BUNBURY from the Yorkshire Jurassic, is a bipinnatified fragment with an almost straight and slender rachis about 2.5 cm., and alternate pinnae (4 on one side) attached to the rachis at a wide angle. The pinnae are but slightly flexuous and are furnished with alternate pinnules. A round sorus is on the dilated margin of each pinnule or lobe, which is contracted below and at the end of the vein.

In an other example, the lamina of the segments is much more reduced; each pinnule has usually a single cup-shaped (?) sorus; some of the lower portion however have the lamina less reduced and bear 2 or more sori.

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1) OLDHAM and MORRIS: Pal. Indica, pl. XXXII., p. 54. HEER took it to be *Thyrsopteris Maakiana*; and SEWARD referred it with some doubt to *Coniopteris hymenophylloides*.

Genera of Uncertain Systematic Position.

CLADOPHLEBIS, Brongniart.

CLADOPHLEBIS cfr. **DENTICULATA** (Brongniart).

Pl. III., fig. 11.

The only specimen obtainable being fragmentary, it has been impossible to make an exact specific determination. Only the apical portion of a pinnae is shown, about 4 cm. in length, bearing seven pinnules on one side of the slender rachis. The pinnules are more or less falcate, rapidly narrowing forward to the acute apex, and show a few serrations along the margin; they are separate, but are set close together, being attached by the whole base. The venation is fine but quite distinct; the median vein is somewhat flexuous, and the lateral veins are distant, opposite, directed acutely forward and forked once near the base.

Fragmentary as the specimen is, its resemblance to *Cladophlebis denticulata* (Brongn.) is considerable, all the characters seen in it being quite similar to those of this well known Jurassic species.

The full account of *C. denticulata* is given in the Jurassic Flora Pt. I., p. 134.

CLADOPHLEBIS KORAIENSIS sp. nov.

Pl. II., fig. 1; pl. III., figs. 12, 13.

Frond tripinnate in the anterior portion and quadripinnate in the posterior; main stalk longitudinally striated, rather broad

and strong. Pinnae usually linear, subopposite, leaving the rachis at an angle of about 45° or more; or, as is sometimes the case, standing perpendicular to the rachis; close together so as to overlap in the posterior portion of the frond. Pinnules vary considerably in size and form; those in the posterior part being generally very narrow, linear, often finger-shaped and falcate; decurrent at base, giving the rachis a slightly winged aspect; they are usually close together but sometimes quite remote from one another; serrate along the margin, the teeth gradually changing into numerous small trigonal segments. Anterior pinnules close together, varying in form from a short and more or less trigonal one to lanceolate, with the front margin usually straight and the back more or less strongly covex and with a bluntly pointed apex; attached by the whole of the broad base to the rachis. Median vein well preserved, scarcely reaching to the summit of the pinnule; lateral veins very obscure, somewhat distant, oblique and with single bifurcation. Sori large in proportion to the pinnules, nearly round, very prominent, appearing as pustular elevations on the upper surface; crowded, arranged in a single row on each side of the median-vein; fertile pinnules somewhat rolled up along the margin, with lateral veins quite obscure. Even by SCHULZE's method, it is not possible to determine the character of the sporangia or the spores.

Among the Japanese fossils, there are many forms, more or less closely related to this Korean species. First of all, there is *Pecopteris exiliformis*[1] of GEYLER, who pointed out its close resemblance to *P. exilis*. Subsequently, however, Prof. YOKOYAMA[2] considered this Scarborough species as itself represented in the

1) GEYLER: Pflanzen a. d. Juraform. Japans, p. 226, pl. XXX., fig. 1a.
2) YOKOYAMA: Jurassic Plants, p. 35, pl. I., figs. 8, 10.

Japanese Jurassic flora and believed *P. exiliformis* to be in reality no other than this species; but subsequently, he expressed the opinion that the Tetori form might possibly belong either to *P. Browniana* or *P. Geyleriana*; NATHORST also pointed out the great resemblance existing between *P. exiliformis* and his *P. Geyleriana*;[1] and SEWARD[2] is of the opinion that *P. exilis* from Japan is probably identical with, or at least very close, to *P. Browniana*; and *P. exiliformis* also does not suggest a plant with a well marked specific difference.

According to BUNBURY[3] and RACIBORSKY[4] who described the fertile pinnules of *P. exilis*, the sporangia possess an apical annulus, and are in a single row on each side of the median vein; hence the latter author was led to propose the new generic name *Klukia* for the above fossil, which shows a decided affinity to Schizaeaceae.

The round dots in the Korean examples are in all probability of a different nature from those of *Klukia exilis*, though there is a great resemblance between them. The present writer does not regard this resemblance as an evidence of relationship.

At any rate, fig. 9, pl. I. in Prof. YOKOYAMA'S work exhibits a greater likeness to the Korean form than figs. 8 and 10 in the same plate. The example figured by GEYLER also resembles it.

The writer has examined some specimens of the *P. exilis* type from Hakogase, collected by Mr. S. MATSUSHIMA and now deposited in the Science College Museum. One of them is pre-

1) NATHORST: Mesoz. Flora Japans, p. 48.
2) SEWARD: Fossil Flora of Cape Colony.
3) BUNBURY: Quart. Jour. Geol. Soc. 1851. VII. P. 188, pl. XIII., fig. 5.
4) RACIBORSKY: Ueber die Osmundaceen u. Schizaeaceen d. Juraformation.

cisely similar to GEYLER's drawing, and hence also like figs. 8 and 10 in Prof. YOKOYAMA's work. The other examples show much resemblance to fig. 9 of the latter and evidently belong to the terminal and middle portions of the same fern.

The Japanese fern, so well illustrated by Prof. YOKOYAMA possesses oblong pinnules, in general differing from the Korean by a decidedly obtuse outline, often broader and rising from the rachis at a wider angle.

A similar fern was described by Prof. YOKOYAMA from Japan under the name of *Asplenium argutulum*; among the figures referred to this species, in pl. III., fig. 1, agrees well with the Chinese examples described by SCHENK; while those represented in fig. 9, pl. XIII. and fig. 22, pl. XIV., show a great resemblance to the Korean. Prof. YOKOYAMA had already made the remark that the latter two examples have a great resemblance to some forms of *P. Phillipsi* BRGT. (*P. exilis*). It is by no means improbable that some of these figures represent plants which are really identical with the Korean species. In the Ryoseki flora of Japan, there is *Cladophlebis Browniana*,[1] a Wealden species of world wide distribution, associated with *C. Geyleriana* NATH.,[2] a hitherto solely Japanese form.

When NATHORST first described *P. Geyleriana*, he was unable to trace out the lateral veins of the pinnules, and therefore, though he possessed the fertile pinnae provided with round sori on each side of the median vein, he took it to be simply a species of *Pecopteris*. Its relation to *Lonchopteris* which he then suspected, was subsequently made impossible by Prof. YOKOYAMA's exami-

1) YOKOYAMA: Mesoz. Plants from Kozuke, Kii, Awa and Tosa, p. 218, pl. XXIV., figs. 2 & 3; XXVII., 1–4, 5c, d.

2) YOKOYAMA: l. c. p. 219, pl. XXI., figs. 1, 2; XXIII., 1a, 1; XXVIII., 5.

nation of better material which showed the pinnules with bifurcating lateral veins. Therefore, SEWARD[1] thinks that possibly the fertile pinnae described by NATHORST should be kept as a species distinct from the sterile examples, and referred to *Weichselia* (*Lonchopteris*) *Mantelli*. In a more recent publication, SEWARD[2] has placed the specimens represented in figs. 2–6 of NATHORST'S paper under *C. Browniana*, considering them as distinct from the others for which he retains the name of *P. Geyleriana*.

The present writer has mentioned above that the *P. exilis* of Prof. YOKOYAMA (*P. exiliformis* GEYLER) shows some slight differences from *C. koraiensis*, on account of which the Japanese species approaches to, or more likely is identical with, *C. Browniana*, as YOKOYAMA and SEWARD had already pointed out.

The fertile pinnae of *P. Browniana* figured by Prof. YOKOYAMA and those of *P. Dunkeri* of FONTAINE[3] from the Potomac, strongly suggest those of the living *Aspidium* in the form and mode of attachment of the sori, so that the latter author even went so far as to bring his *P. Dunkeri* under the genus *Aspidium*, although according to the writer's opinion these characters not seem to justify such an assumption.

Comparing the fertile pinnules of *C. koraiensis* with those of the two above mentioned, some differences still remain; also it is not wholly impossible, that the form belongs to a genus entirely different from the latter two.

To sum up, at present it seems advisable to treat the Korean form, as a new species of *Cladophlebis*, a genus created for the

1) SEWARD: Wealden Flora, I, p. 116.
2) SEWARD: Fossil Flora of the Cape Colony, p. 12.
3) FONTAINE: Potomac Flora, p. 101, pl. XXII., fig. 9.

reception of sterile fronds of ferns whose real relation to the living forms is unknown.

CLADOPHLEBIS cfr. **DUNKERI** (SCHIMPER).

Pl. IV., fig. 9.

Among numerous examples of fronds of the *Cladophlebis* type, there is one which closely resembles the Wealden species called *C. Dunkeri*. Possibly it may turn out to be an extremely modified form of the preceding species; but at present it is better treated as a differrent fossil.

The specimen shows a bipinnate fragment of a frond, with a stout principal axis from which the pinnae branch off at a wide angle. The pinnae are opposite and close; the pinnules are small, oblong, often slightly falcate, very close, attached to the rachis with a broad base.

It is almost impossible to draw a distinction between this fern and *C. Dunkeri* from the Potomac flora (Fontaine, Pl. XXVI., fig. 3.).

CLADOPHLEBIS sp. indet.

Pl. IV., fig. 8.

There are several fragments of isolated pinnae of a *Cladophlebis* which though too imperfect for specific determination, may be briefly described as follows:—

Pinnae lanceolate, rapidly tapering to an acuminate apex; pinnules elongated, gradually becoming oval toward the anterior part of the pinna; slightly pointed at apex and somewhat decurrent at base which is auriculate on the posterior side; margin slightly

undulating. Median vein thick, evanescent near the apex; lateral ones obsolete, remote, subopposite, oblique and single-forked.

One of the pinnae measure 3 cm. in length and bears nine pinnules on one side of the rachis.

This species is evidently distinct from the foregoing two.

SPHENOPTERIS, BRONGN.

SPHENOPTERIS NAKTONGENSIS sp. nov.

Pl. IV., figs. 10, 11.

Frond tripinnate, deltoid; principal rachis slender, flexuous; primary pinnae subopposite, rather remote, attached to the rachis at a wide angle, linearly oblong, pinnatifid; ultimate pinnae alternate, very short, passing anteriorly into lobed pinnules; pinnules oblong or cuneiform, alternate, oblique, decurrent on the slightly winged rachis, more or less deeply lobed; lobes denticulated; venation indistinct, veins very close, flabelately dichtomous.

Among the hitherto described ferns, there is none which is identical with this Korean fossil. *Ruffordia Geopperti*[1] is the only one which more or less closely approaches it.

SPHENOPTERIS sp.

Pl. I., fig. 15.

Frond bipinnate, rachis slender; pinnae linear, springing almost at right angles from the rachis, pinnately lobed; lobes

1) SEWARD Wealden Flora, I., p. 75.

obtuse, acuminate with entire margin; somewhat falcate; venation of a Sphenopteris type, that is to say, with a distinct median vein sending off an obsolete secondary vein into each lobe. Sori in two rows, one on each side of the median vein, placed near the base of each lobe and on the summit of the uppermost branch of the vein.

At a first glance, this form comes near to *Dicksonia Bindrabunensis* FEISTMANTEL[1] from the Jurassic of the Rajmahal Hills, India, and *Alsophila polonica* RACIBORSKY[2] from the neighbourhood of Cracow. But, no detail of the fructification being observable in the only specimen at hand, its generic position is not certain.

ADIANTITES, GOEP.

ADIANTITES SEWARDI sp. nov.

Pl. I., figs. 1–8.

1888. *Rhacopteris*? sp. MATSUSHIMA: A Geol. Rep. of the East. Part of Echizen including the Upper Tetorigawa region, in Kaga. (MS.) P. 188, pl. VII., fig. 5.

Frond bipinnate, rachis thin and straight; pinnules alternate to subopposite, close but rarely imbricated; rounded at the upper margin and attenuated below to a narrow base, with a short de-

1) FEISTMANTEL: Jurassic Flora of the Rajmahal group in the Rajmahal Hills. P. 23, pl. XXXVII., figs. 2, 2a.

2) RACIBORSKY: Flora Kopalna ognitrawalych glinek Krakowskich. Archaegoniatae. P. 29, pl. IX., figs. 3, 4.

current petiole. Lateral pinnules generally inequilateral, varying from subquadrilateral to fan-shaped, with inner margin parallel and very close to the rachis. Apical pinnules nearly equilateral, being broader than the others. Upper margin irregularly crenulated. Veins numerous, fine, uniform and distinct, united below at the base, widely spreading and dichotomously divided upward.

According to the general usage, this elegant fern is referred to the provisional genus *Adiantites* on account of its undoubted resemblance to some living species of *Adiantum* or *Lindsaya*.

Among the recorded species referred to *Adiantites* or sometimes to *Adiantum* itself, there are three species more or less allied to the present species; *Adiantites Tietzi* SCHENK[1] from the Rhaetic of the Albours-chain, *Adiantum Szechenyi* SCHENK[2] from the middle Jurassic of China and *Adiantites yuasensis* YOK.[3] from the Ryoseki series of Yuasa in Japan. The resemblance of the Korean frond to the last species has already been pointed out by Mr. MATSUSHIMA.

In the first of these three species, the pinnules are more densely crowded and deeply imbricated; the other two species exhibit a somewhat different venation.

A species which is nearer to the Korean than any of the above three is *Adiantites longiquuis* SAPORTA (Nouvelles Contributions a la Flore Mesozoique 1894. p. 40, pl. X., fig. 1.) from the Neojurassic deposit of Portugal. This species was founded by SAPORTA on a few fragmental pinnae with subopposite pinnules; however, so far as one can judge from the characters revealed

1) SCHENK: Fossile Pflanzen aus der Albours-kette, gesammelt von E. TIETZE. 1887, p. 3, pl. II., fig. 9.

2) SCHENK: Fossile Pflanzen (Graf. Szecheny's Reise Vol. III.) P. 168, pl. I., fig. 3.

3) YOKOYAMA: Mesoz. Plants from Kozuke, Kii, Awa and Tosa. P. 216, pl. XXI., fig. 15.

by the figures, the species so much resembles the Korean in form, size and the venation of the pinnules, that these two are no doubt very closely allied to each other, if not identical. The only distinction lies in a slight difference in venation.

The Japanese examples of this species have been obtained by Mr. MATSUSHIMA from Kinebashi, Uchinami and Otani, Onogori, prov. Echizen.

FILICES?

SAGENOPTERIS, PRESL.

SAGENOPTERIS BILOBATA sp. nov.

Pl. III., figs. 16a, b, c.

There are two forms of *Sagenopteris* hitherto described from the Jurassic deposists of Yorkshire and others, which are usually found together. The pinnules in the one are lanceolate in outline, while those of the other are cuneate at base; and these had been kept for a long time as two distinct species, but at present the cuneate form is considered to be an imperfect or abnormal state of the frond of the same species; thus in the case of the Yorkshire flora, SEWARD[1] distinguished these two forms under the names of *S. Phillipsii* var. *cuneata*, and var. *major*.

In the Korean specimens, there are two types; the one represented by three examples, shows an outline precisely similar to *S. cuneata* or *S. Phillipsii* var. *cuneata*, while the other three slightly differ from var. *major*.

1) SEWARD: Jurassic Flora, I. P. 162.

The first of them consists of two obcuneate pinnules, in contact, borne on a stipe; the pinnules bear no median vein, but are traversed by spreading anastomosing veins. The second is a linear pinna, apically cleft into two symmetrical lobes, with a median vein. Its lateral veins are very fine, anastomosing, leaving the median vein at an acute angle.

Though at first the writer took the latter type as specifically identical with *S. Phillipsii* var. *major*, the bilobed nature of the pinnules of the Korean plant led him at last to regard it as a different species. Such being the case, he believes it best to treat the two types of the Korean examples as a single species, but calling them for distinction, var. *cuneata* and var. *major* directly after the example of *S. Phillipsii*.

Another point of distinction of some value between *S. Phillipsii* and *S. bilobata* is found in the outline ef the pinnules which are lanceolate in the former and linear in the latter.

Another allied species which merits mention is *S. tasmanica* FEISTMANTEL[1] from the Carbonaceous beds (upper Mesozoic) of the Jerusalem basin, Tasmania. The species was founded by FEISTMANTEL on a single example which shows a portion of two lobes of a three-lobed frond as he understood it. Each lobe is linear, attenuated above and provided with a median vein, quite distinct in the greater part of the length though disappearing in the apical portion, and with lateral, veins passing out from the median vein at an acute angle and forming a single anastomosis.

A comparison of this species with the Korean is rendered, however, almost impossible so far as the outline is concerned,

1) FEISTMANTEL: Geological and Palæontological Relations of the Coal- and Plant-bearing Beds of Palæozoic and Mesozoic age in Eastern Australia and Tasmania, p. 135, pl. XXIX., fig. 6.

owing to the want of the basal portion of the frond in the former and of the apical portion in the latter; but if FEISTMANTEL'S explanation is correct, then their relationship is only a slight one, for he understands his specimen to be a probably three-lobed frond while the Korean species is only two-lobed, the resemblance being solely due to the mode of preservation.

A similar dichotomization of the frond is also well shown by *Phlebopteris* (?) *dichotoma* SHIRLEY[1] from the Denmark Hill, Ipswich, Queensland.

EQUISETALES.

EQUISETUM, L.

EQUISETUM USHIMARENSE YOK.

Pl. III., fig. 10.

1889. *Equisetum ushimarense* YOK.: l. c. p. 39, pl. XI., figs. 1–3.

A few fragments of rhizomes of an equisetaceous plant are in the writer's collection. Their breadth varies between 2.5 mm. and 6 mm., with three to four, strong ribs and internodes, 2.0–2.5 cm. apart. Tubercles rarely found are ovate in form, measuring 1.8 cm. in length and with no surface markings visible on thier surface.

A comparison between the present examples and the figures of Prof. YOKOYAMA's species leaves no doubt about their specific identity.

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1) J. SHIRLEY: Additions to the Fossil Flora of Queensland, p. 24, pl. XV., fig. 2.

The Japanese species is so much like *E. Burchardi* SCHENK from the European Wealden formation, that there is a doubt that they are really different plants. However, their identity being not yet fully verified, the above name has been here adopted.

GENERAL REMARKS AND CONCLUSIONS.

Constitution of the fossil flora :—Though sufficient material has not yet been collected to warrant an exhaustive discussion of the fossil flora, yet there are some points of importance with regard to the geological age of the Naktong series and its floral constitution, which call for a brief statement in this place. Indeed, the geological importance of these fossils lies in the circumstance that they are derived from the base of a very thick complex which affords no other reliable organic remains for determining its geological age.

As will be seen from the above description, the writer was enabled to distinguish the following twenty-one species of plants, of which 3 are new, and 7 of doubtful affinity.

Dictyozamites falcatus (MORRIS)	common.
Nilssonia orientalis HR.	abundant.
N. sp.	rare.
Dioonites (?) sp.	rare.
Ctenophyllum (?) sp.	rare.
Podozamites Reinii GEYLER	rare.

P. lanceolatus (LINDLE. & HUTTON)	rare.
Pinus sp.	common.
Pinus sp.	common.
Onychiopsis elongata (GEYLER)	abundant.
Coniopteris Heerianus (YOKOYAMA)	common.
C. hymenophylloides (BRONGN.) (?)	rare.
Cladophlebis cfr. *denticulata* (BRONGN.)	rare.
C. koraiensis sp. nov.	abundant.
C. cfr. *Dunkeri* (SCHIMHER)	rare.
C. sp.	rare.
Sphenopteris naktongensis sp. nov.	common.
S. sp.	rare.
Adiantites Sewardi sp. nov.	abundant.
Sagenopteris bilobata sp. nov.	rare.
Equisetum ushimarense YOK.	common.

In the constitution of the flora, Filices form of the most important part, being represented by 6 genera and 11 species. Among these, three species are found in great abundance. Cycadophyta, though fairly common, are less frequent than the ferns, being represented by 5 genera and 7 species. Equisetaceae and Coniferae, though not rare, are all not clearly determinable. It is very striking that the fern fronds are generally in a fertile state, just as in the fire-clay of Cracow, described by Raciborsky. Such are *Onychiopsis elongata*, two species of *Coniopteris*, and one species of *Sphenopteris*; likewise the pinnae of *Cladophlebis koraiensis* mostly show the fructification.

Geological relation of the fossil flora:—From the above list it is quite evident that the flora is Jurassic, for neither typically Rhaetic nor Cretaceous forms are found in it; the form which may be assigned with hesitation to the Wealden type is but a single

one, that is, *Cladophlebis* cfr. *Dunkeri*.[1] As usually accepted by palæophytologists, the vegetative character of the world from the upper Triassic to the Wealden seems to have been remarkably uniform and constant in its main features.[2] Hence it is a very difficult task to make out the exact age of a given plant-bed if it is poor in fossil contents, as in the present case. Though we have now twenty-one species in all, many are not available for this purpose.

Even of specifically determinable forms, *Onychiopsis elongata* seems to be of no value in settling this question, for it is a fern type of decidedly east Asiatic origin, thence becoming widely diffused in other lands after the Jurassic age. The fern with fronds of the *Cladophlebis denticulata* type is not only exclusively Jurassic, but is found also in the older as well as in the younger strata. The two fertile pinnae which the writer has compared with *Coniopteris hymenophylloides*, and the detached leaves of Coniferae also afford us no sure basis for a chronological correlation, because a determination based on such fragments must always be uncertain. *Podozamites lanceolatus* and equisetaceous remains seem equally of little value in this respect.

Excluding the above species and such as are new or doubtful, there remain only five species, viz. *Adiantites Sewardi*, *Coniopteris Heerianus*, *Dictyozamites falcatus*, *Nilssonia orientalis*, and *Podozamitas Reinii*, which are available for determining the age of the strata.

According to Mr. S. MATSUSHIMA,[3] *Adiantites Sewardi* occurs at Kinebashi, Uchinami and Ōtani, Ōnogōri, prov. Echizen,

1) SEWARD: took *Equisetum Ushimarense* as a Wealden type.
2) SEWARD: Floras of the Past: their Composition and Distribution. Pp. 13–22.
3) MATSUSHIMA: A Geol. Rep. of the East. Part. of Echizen etc. (MS.), p. 188.

associated with *Podozamites lanceolatus*, *Cladophlebis* sp. (*C.* aff. *Dunkeri*) and *C.* sp. (*C.* aff. *distans*).

Coniopteris Heerianus and *Podozamites Reinii* are exclusively Japanese Korean species; the latter is especially widely spread in the Japanese Tetori series; Prof. YOKOYAMA[1] described it from Okamigō, prov. Hida, Tanimura, prov. Echizen, Ozō, Yanagidani and Shimamura, prov. Kaga; at the last locality it is found together with *Coniopteris Heerianus*. The other fossils found in association with these species are, according to the above author, at Shimamura, *Thyrsopteris prisca*, *T. kagensis*, *Dicksonia gracilis*, *D. acutiloba*, *D. nephrocarpa*, *Onychiopsis elongata*, *Adiantites Kochibeanus*, *Asplenium Whitbiense*, *A. argutulum*, *A. distans*, *Pecopteris exilis*, *P. Saportana*, *Macrotaeniopteris* cfr. *Richthofeni*, *Anomozamites* sp., *Nilssonia nipponensis*, *Dioonites Kotōei*, *Zamitis parvifolius*, *Podozamites lanceolatus*, *P. tenuistriatus*, *Dictyozamites grossinervis*, *Cycadospermum japonicum*, *Ginkgodium Nathorsti*, *Ginkgo sibirica*, *Taxites* sp., *Pinus prodromus*, *P. Nordenskjoldi*, *Palissya* sp., and *Vallisnerites jurassicus* (?); at Yanagidani, *Onychiopsis elongata*, *Asplenium Whitbiense*, *A. distans*, *Taeniopteris* (?), *Sagenopteris* sp., *Nilssonia ozoana*, *N.* (?), *Dictyozamites falcatus*, *Czekanowskia rigida*, *Taxites* sp., *Vallisnerites jurassicus* (?) and *Carpolithes ginkgoides;* from Tanimura *Thyrsopteris kagensis*, *Onychiopsis elongata*, *Dioonites Kotōei*, *Podozamites lanceolatus*, *Pinus.* cfr. *prodromus;* from Okamigō, *Thyrsopteris Murrayana*, *Dicksonia gracilis*, *Onychiopsis elongata*, *Asplenium argutulum*, *Equisetum* sp., *Nilssonia nipponensis*, *Podozamites lanceolatus*, *P. tenuistriatus*, *P.* sp., *Ginkgodium Nathorsti*, *Ginkgo digitata*, *Czekanowskia rigida* and *Taxites* sp.

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1) YOKOYAMA: Jurassic Plants from Kaga, Hida and Echizen.

Nilssonia orientalis is also known from Japan and Siberia. According to Prof. YOKOYAMA, it seems to be abundant in a plant-bed exposed at Hakogase, Ōnogōri, prov. Echizen, where *Dicksonia Glehniana, Onychiopsis elongata, Adiantites lanceus, Asplenium argutulum, A. distans., Sphenopteris* sp., *Podozamites lanceolatus* and *Ginkgo* cfr. *lepida* are also found. The Jurassic deposit of Ajakit on the Lena[1] whence the species was first recorded, contains, besides, *Dicksonia gracilis, D. borealis, Rhizocarpites singularis, Anomozamites angulatus, Nilssonia comtula, Podozamites lanceolatus, P. gramineus, Phoenicopsis angustifolia, Ginkgo Huttoni, G. sibirica, G. integriuscula, Czekanowskia cretacea, C. rigida* and *Pinus Nordenskjoldi.* Recently, NATHORST[2] described an identical or closely allied form from the southern side of Sassen Bay, Spitzbergen; the only other fossil associated is *Ptilozamites* sp.

According to present knowledge, the distribution of the species of the genus *Dictyozamites* is confined to India, Japan, Korea, Bornholm and Yorkshire. A full account of the genus has been very recently written by SEWARD[3] who has pointed out the uniformity of the general features of the Jurassic floras of these widely distant places.

From these localities, three or four species are already known. The Korean and the Japanese fossils make a closer approach to *D. falcatus* from India than to those from other countries. In Japan, the species is found in the plant-bed of Ozō, prov. Kaga and Ushimaru, prov. Hida; the associated fossils at the former place have already been given above; those at the latter are *Asplenium distans* and *Podozamites lanceolatus.*

1) HEER: Beitr. z. Juraflora Ostsibiriens u. d. Amurlandes, p. 18.
2) NATHORST: Zur Mesoz. Flora Spitzbergens, p. 24.
3) SEWARD: Occurrence of *Dictyozamites* in England.

In the Rajmahal group of India, *Dictyozamites falcatus* is found associated with the following species:—at Amrapara, *Angiopteridium Mc. Clellandi, Ptilophyllum cutchense, Williamsonia* sp., *Echinostrobus rajmahalensis;* at Murrero, *Angiopteridium spathulatum, Macrotaeniopteris crassinervis, Pterophyllum Medlicottianum, Zamites proximus* and *Zamiostrobus;* at Godavari, *Palissya conferta, P. indica, Cheilolepis* cfr. *Münsteri, Araucarites macropterus, Angiopteridium ensis, A. spathulatum, Ptilophyllum acutifolium, P. cutchense, Pterophyllum Morrisianum, P. Kingianum, P. distans, P. Carterianum* and *Williamsonia gigus, Alethopteris indica* and *Asplenites macrocarpus.* A similar association is also observed in the Sripermatur group and in the Vema varam beds of the Madras coast.[1)]

It has been above pointed out that there are five species surely common to the Japanese and Korean floras. But there are, besides, seven less certain or simply allied forms, so that the total number which admits comparison is twelve. They are the following:—

Japan.	Korea.
Dictyozamites falcatus (MORRIS)	*Dictyozamites falcatus* (MORRIS)
Nilssonia orientalis HR.	*Nilssonia orientalis* HR.
Dioonites Kotōei YOK.	*Dioonites* sp. *Ctenophyllum* (?) sp.
Podozamites lanceolatus LINDL. and HUTTON.	*Podozamites lanceolatus* LINDL. and HUTTON.
P. Reinii GEYLER	*P. Reinii* GEYLER.
Pinus Nordenskjoldi HR.	*Pinus* sp.

1) FEISTMANTEL: Jurassic Flora of the Rajmahal Group, in the Rajmahal Hills.—Jurassic Flora of the Rajmahal group of the Golapili.—The Fossil Flora of the Upper Gondwanas Outliers of the Madras Coast.

Pinus cfr. *prodromus* HR.....*Pinus* sp.
Coniopteris Heerianus (YOK.) ...*Coniopteris Heerianus* (YOK.)
Onychiopsis elongata (GEYLER)...*Onychiopsis elongata* (GEYLER)
Dicksonia nephrocarpa (BUNB.)...*C. hymenophylloides* (BRONGN.)
Asplenium distans HR.
A. argutulum HR. } .....*Cladophlebis koraiensis*
A. argutulum HR.
Pecopteris exilis PHILL. } .....*C.* cfr. *denticulata* (BRONGN.)
Adiantites Sewardi .....*Adiantites Sewardi*
Equisetum ushimarense YOK.....*Equisetum ushimarense* YOK.

As may be seen from the above, the general features of the two floras are essentially the same, so that their contemporaneity is quite evident.[1]

Prof. YOKOYAMA,[2] in his elaborate work on the Jurassic plants from Kaga, Hida and Echizen, assigned most of the fossiliferous beds to the Bathonian age, which view was subsequently accepted by NATHORST[3] and others. However, WARD[4] and SEWARD[5] among others point out the presence in the flora of many plants of Wealden types, suggesting that the plant-beds are of the lower Cretaceous age.

In a paper recently written on the Ammonites from Echizen, Prof. YOKOYAMA[6] states his conclusion that at least a part of the Tetori series is younger than the Bathonian and must be of the Malm age.

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1) In this place, it should also be borne in mind that the Jurassic districts of Kaga, Hida and Echizen in Japan and of Kyŏng-syang-Do in Korea are nearly in the same latitude.
2) Page 19.
3) NATHORST: Beitr. z. Mesoz. Flora Japans.
4) WARD: Geographical Distribution of Fossil Plants, p. 789.
5) SEWARD: Wealden Flora, I., p. 32.
6) YOKOYAMA: Jurassic Ammonites from Echizen and Nagato, p. 3.

As it appears from previous writings on the geology of the said region, the plant bed of Kinebashi, Uchinami and Ōtani with *Adiantites Sewardi*, and that of Hakogase with *Nilssonia orientalis* lie immediately upon the Ammonites-bed of propably the lower Malm age, and Prof. YOKOYAMA, in his paper, suspects that the plant bed of Ozō, prov. Kaga, with *Dictyozamites falcatus*, may possibly be somewhat older than the Bathonian; taking it as a whole, the Tetori series seems to represent a phase of the Jurassic in the narrowest sense of the word (i.e. Malm and Dogger).

The resemblance of the Japanese flora to the Siberian was pointed out by GEYLER;[1] HEER[2] also mentioned that *Thyrsopteris elongata* of GEYLER is a type of fern very common in the Siberian Jurassic. Prof. YOKOYAMA's renewed examination of the rich material of the Tetori flora revealed that 16 out of 36 species are found in Siberia.[3]

Beside *Nilssonia orientalis*, there are other forms common to Siberia and Korea, such as *Coniopteris hymenophylloides*, *Cladophlebis denticulata*, *Pinus Nordenskjoldi*, *P. prodromus* and *Podozamites lanceolatus*. These, however, are cosmopolitan forms, also found in Japan and China.

From China and Mongolia, NATHORST,[4] SCHENK,[5] ZEILLER,[6]

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1) GEYLER: Ueber Fossile Pflanzen aus der Juraformation Japans.—Ueber Einige Palæontologische Fragen, insbesondere uber die Juraformation Nordostasiens.

2) HEER: Nachträge z. Jura-flora Sibiriens, p. 4.

3) YOKOYAMA: l. c. p. 16.

4) NATHORST: Om forekomsten af *Dictyophyllum Nilssoni* BRONGN. sp. i. Kinas Kolorando bildningen. (By review.)

5) SCHENK: Pflanzlich Versteinerungen (RICHTHOFEN's China IV.).—Die während der Reise des Grafen BELA SZECHENYI in China gesammelten fossilen Pflanzen.

6) ZEILLER: Remarques sur la Flora Fossile de l'Altai, à propose des dernieres decouvertes Palæobotanique de M.M. les Drs. Bodenbender et Kurtz dans le république Argentine.

SCHMALHAUSEN,[1] NEWBERRY[2] and BRONGNIART[3] have described many Jurassic and Rhaetic plants but there is relatively little resemblance between these and the Korean flora. The identical or closely allied forms are restricted to those fern types of a very wide vertical and horizontal distribution. Among the Mesozoic plants, now in Prof. YOKOYAMA's possession, brought from various parts of Northern and Southern China, there are also no particular forms which indicate the presence of a close floral relationship with the Korean fossils.

The Oroville flora[4] of California is the best known of the Mesozoic vegetations in the Pacific border of North America. It is assigned to the Oolitic age. The predominance of *Pterophyllum*, *Ctenis* and *Ctenophyllum* consititutes a peculiar feature more or less like that of the Jurassic flora of India. But between this North American and the Japanese Tetori floras, there is only a slight resemblance though they are nearly contemporaneous; the distinction between the former and the Korean flora is more striking, apparently none of the species being either allied or identical. If what FONTAINE calls *Pinus Nordenskjoldi* is really identical with the plant so named from Korea, then it is the only species which shows any relation between the two floras.

In some respects, the Jurassic flora of India, seems to be more closely related to the Korean. There is in common the important species, *Dictyozamites falcatus*, above alluded to. It is

1) SCHMALHAUSEN: Pflanzen aus der nordwestlichen Mongolei.

2) NEWBERRY: Notes on Some Fossil Plants from Northern China. Description of Fossil Plants from the Chinese Coal-bearing Rocks in R. PUMPELLY's Geological Researches in China, Mongolia and Japan.

3) BRONGNIART: Note sur les Plantes fossiles de Tinkiako envoyes en 1875 par M. l'Abbl. A. David.

4) WARD: Status of the Mesozoic Floras of the United States. The Older Mesozoic. P. 340.

very noteworthy, however, that the species is absent in the Oolitic flora of Kach, though common in the older Rajmahal group.

On the whole, so far as evidence goes, the writer has little hesitation in announcing the *contemporaneity of the Naktong flora of Korea with that of the Japanese Tetori series, the affinity of the former to those of the corresponding age in Siberia, China, India and California being apparently more distant.*

Nature of the plant-bed of Naktong:—Next the question arises whether the plant bed is a fresh water deposit or not. In this connection, the following facts must be taken into consideration.

1) There are very few animal remains; a very incomplete bivalve and few Foraminifera with perforated calcareous shells were found in the same deposit.

2) There is no trace of marine plants.

3) Plant impressions of a more or less large size are generally arranged in the plane of stratification, often heaped one upon another.

4) In some parts, however, only crumbled pieces of plants are accumulated.

From the above facts, it is to be inferred that the deposition took place at least not far from the sea coast and there is a probability that the deposit was a beach formation in very shallow brackish water.

Glossary of Korean Geographical Names Found in the Text.[1]

An-eui.	安義	Mun-gyöng.	聞慶
Chhyön-san.	青山	Na-jyu.	羅州
Chhyüung-chhyong-Do.	忠淸道	Nak-tong.	洛東
Chhyu-phung-nyöng.	秋風岺	Nak-tong-gang.	洛東江
Chin-an.	鎭安	Nam-phyöng.	南平
Chin-hai.	鎭海	Nam-uön.	南原
Chin-jyu.	晋州	Ok-chhyön.	沃川
Chyan-syöng.	長城	Ok-ka.	王果
Chyol-la-Do.	全羅道	Phyöng-yang.	平壤
Chyöng-jyu.	全州	Po-eun.	報恩
Fusan (Pu-san).	釜山	Pul-tang-kokai.	佛堂峴
Hai-nam.	海南	Pu-sang.	扶桑
Ham-chhyang.	咸昌	Sa-chhyon.	泗川
Hoang-gan.	黃澗	Söul.	京城
Im-sil.	任實	Syan-jyu.	尙州
In-chhyön.	仁川	Syong-ni-san.	俗離山
Keum-chhyön.	金泉	Tol-pa.	石田
Keum-san.	錦山	Tong-pok.	同福
Koang-jyu.	光州	Tu-man-gang.	豆滿江
Ku-ryoi.	求禮	Yong-am.	靈岩
Kyöng-syang-Do.	慶尙道	Yong-dam.	龍潭
Masampho.	馬山浦	Yong-dong.	永同
Mokpho.	木浦	Yong-il.	迎日
Mu-jyu.	茂朱	Yuk-sim-nyöng.	六十岺

1) Kotō and Kanazawa: A Catalogue of the Romanized Geographical Name of Korea. 1903.

Bibliography.

E. v. AHNERT: Reisen in der Mandschrei. Ber. d. k. Russ. Geogr. Ges. Bd. XXXV. (By review.)

A. BRONGNIART: Histoirê des Végétaux Fossiles. 1838.

„ : Note sur les Plantes fossiles de Tinkiako (Schensi meridional) envoyes en 1875 par M. l'Abble A. David. Bull. Geol. Soc. France. Seris 3, vol. III.

C. J. F. BUNBURY: On Some Fossil Plants from the Jurassic Strata of the Yorkshire Coast. Q. J. G. S. Vol. VII. 1851.

W DUNKER: Monographie der Norddeutschen Wealdenbildungen. 1846.

C. v. ETTINGSHAUSEN: Beiträge zur Flora der Wealden Periode. Abh. d. K. Geol. Reichsanst. I. Bd., 3 Abth., No. 2. 1852.

O. FEISTMANTEL: Ueber die Indischen Cycadengattungen *Ptilophyllum*, MORR. u. *Dictyozamites* OLDH. Palaeontographica, Supplement III. 1876.

„ : Jurassic (Liassic) Flora of the Rajmahal Group in the Rajmahal Hills. Mem. Geol. Surv. India, Pal. Indica, ser. 2, vol. I., pt. 2. 1877.

„ : Fossil Flora of the Gondwana System. Jurassic (Oolitic) Flora of Kach. 1876. Ditto, vol. II., pt. 1. Flora of the Jabalpur Group (upper Gondwana) in the Sonnerbad Region. 1877. Ditto, vol. II., pt. 2.

„ . Jurassic (Liassic) Flora of the Rajmahal Group from Golapili. 1877. Ditto, Series 2, vol. I., pt. 3.

„ : Outliers of the Madras Coast. 1879. Ditto, vol. I., pt. 4.

W. M. FONTAINE: The Potomac or Younger Mesozoic Flora. U. S. Geol. Surv. Mon., vol. XV. 1879.

T. GEYLER: Ueber Einige Palæontologische Fragen, insbesondere ueber die Juraformation Nordasiens. Bericht ueber die Senckenbergische Naturforschende Gesellschaft. 1878.

„ : Ueber Fossile Pflanzen aus der Juraformation Japans. Palæontegraphica. Vol. XXIV. 1877.

C. GOTTSCHE: Geologische Skizze von Korea. 1886.

O. HEER: Flora Fossilis Arctica. Vol. I., part. 2, Die Fossil Flora der Polarlander, 1868. Vol. III., pt. 2, Die Kreideflora der Arctischen Zone, 1875. Vol. IV., pt. 1, Beitr. zur Fossilen Flora Spitzbergens, 1877. Pt. 2. Beitr. z. Jura. Flora Ostsibiriens u. d. Amurlandes, 1877. Vol. V., pt. 2, Beitr. z. Fossilen Flora Sibiriens u. d. Amurlandes, 1878. Vol. VI., pt. 2, Nachtrage z. Fossilen Flora Sibiriens, 1880. Pt. 3, Nachtr. z. Fossilen Flora Gronlands, 1880.

B. KNOCHENHAUER: Korea. Verhandl. d. Abtheil. Berlin-Charlottenberg d. Deutschen Kolonial Ges. 1901.

B. KOTŌ: An Orographic Sketch of Korea. Jour Sci. Coll. Tokyo, vol. XIX., no. 1. 1903.

B. KOTŌ and S. KANAZAWA: A Catalogue of the Romanized Geographical Names of Korea.

F. KRASSER: Beiträge z. Kenntniss der Fossilien Kreideflora von Kunstadt in Maehren. Beitr. Palæont. u. Geol. Osterr.-Ungarns u. Orients. X. 1896.

„ : Die von W. A. Obroutschew in China u. Centralasien 1893–94 gesammelten Fossilen Pflanzen. Denkschrift d. k. Akad. d. Wiss. Wien. 1901.

J. LECKENBY: On the Sandstone and Shales of the Oolites of Scarborough, with Descriptions of Some New Species of Fossil Plants. Q. J. G. S. XX.

H. MÖLLER: Bidrag till Bornholms Fossila Flora, Pteridofyter. Kongl. Fysiogr. Sallsk. Handl., vol. XIII. 1902. Gymnosperum.

„ : K. Svenska Vet. Ac. Hndl., vol. XXXVI., No. 6. 1903.

A. G. NATHORST: Om Floran i Skanes Kolforande Bildinger. Floran vid. Bjuf. 1878–86. Floran vid. Hoganas och. Helsingborg. 1878.

„ : Beiträge z. Mesoz. Flora Japans. Denkschrift d. k. Akad. Wiss. LVII. 1890.

„ : Om forekomsten af *Dictyophyllum Nilssonia* BROGN. sp. i Kinas Kolforande Bildninger. Ofversizt af Kongl. Vet. Akad. Forhandl. 1890.

A. G. NATHORST: Zur Mesoz. Flora Spitzbergens. Kongl. Svenska Vetenskap Akademieus Händlinger. 1897.

„ : Sur la Flore Fossiles des Regiòns Antarctiques. C. R. Ac. Sc. CXXXVIII. 1904.

J. S. NEWBERRY: Notes on Some Fossil Plants from Northern China. Amer. Journ. Sci. 3rd series, vol. XXVI. 1883.

„ : Description of Fossil Plants from the Chinese Coal-bearing Rocks (in R. PUMPELLY's Geol. Researches in China etc.) 1866.

T. OLDHAM and J. MORRIS: Fossil Flora of the Rajmahal Series in the Rajmahal Hills. Pal. Indica. Ser. 2, vol. I., pt. 1. 1863.

H. POTONIE: Pflanzenreste aus der Juraformation. (FUTTERER's Durch Asien III.) 1903.

M. RACIBORSKI: Flora Kopalna Ognitrwalych Gelinsk Krakowskich. I. Archaegoniatae. Abh. d. Wiss. Krakow. XVIII. 1894.

„ : Ueber die Osmundaceen u. Schizaceen d. Juraformation. Bot. Jahrb., vol. XIII. 1891.

G. ROMANOWSKI: Geol. Palæont. Uebersicht d. Nordostl. Thian-schan. 1881.

G. DE SAPORTA: Plantes Jurassiques. Pal. Francaise. Ser. II, vols. I–IV. 1873–91.

„ : Flore Fossile de Portugal. 1894.

A. SCHENK: Die Fossilen Pflanzen d. Wernsdorfer-schichten in den Nord-Karpathen. Palæontographica XIX. 1863.

„ : Die Fossile Flora der Nordwestdeutchen Wealden-formation. Ditto. 1871.

„ : Jurassische Pflanzen. (RICHTHOFEN's China, vol. IV.) 1883.

„ : Fossile Pflanzen aus der Albours-kette, gesammelt von E. TIETZE. 1887.

„ : Fossile Pflanzen (SZECHENYI's Reise, vol. III.) 1899.

J. SCHMALHAUSEN: Beiträge z. Jura Flora Russlands. Mem. Akad. Imp. Sci. St. Petersb. Ser. VII, Vol. XXVII., No. 4. 1879.

„ : Pflanzenpaleontologische Beiträge. (Melanges Bio-

logiques. Bull. d. l'Acad. Imper. d'Sci. d. St. Petersburg. T. XI.) 1883.

A. C. SEWARD: The Wealden Flora. Pt. I., 1894; pt. II., 1895.

„ : Notes on Some Jurassic Plants in the Manchester Museum. 1900.

„ : The Jurassic Flora. Vol. I., 1900.

„ : On the Occurrence of *Dictyozamites* in England, with Remarks on European and Eastern Flora. Geol. Mag., no. 466. 1903.

„ : Fossil Flora of Cape Colony. Annals of the South African Museum. Vol. IV., pt. 1. 1903.

J. SHIRLEY: Additions to the Fossil Flora of Queensland. Bull. of the Dep. of Mines of Queensland No. 7. 1898.

J. VELONOWSKY: Die Farne der Böhmischen Kreideformation. Abh. K. Böhm. Ges. Wiss, VII. folge, vol. II. 1888.

L. F. WARD: The Geographical Distribution of Fossil Plants. U. S. Geol. Surv., Annual Rep. VIII. 1887–88.

„ : Status of the Mesoz. Floras of the United State. U. S. Geol. Surv., 20th Ann. Rep. 1898–99.

M. YOKOYAMA: Jurassic Plants from Kaga, Hida and Echizen. Journ. Sc. Coll., vol. III., pt. 1.

„ : Mesoz. Plants from Kozuke, Kii, Awa and Tosa. Ditto, vol. VII. 1895.

„ : On Some Fossil Plants from the Coal-bearing Series of Nagato. Ditto, vol. IV. 1891.

A. DE ZIGNO: Flora Fossilis Formationis Ooliticae. 1856–85.

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PLATE I.

Plate I.

(All the figures are in natural size.)

Adiantites Sewardi sp. nov. P. 39.

Figs. 1–7. Specimens from Korea.

Fig. 8. A better specimen from Kami-uchinami, Onogori, prov. Echizen in Japan.

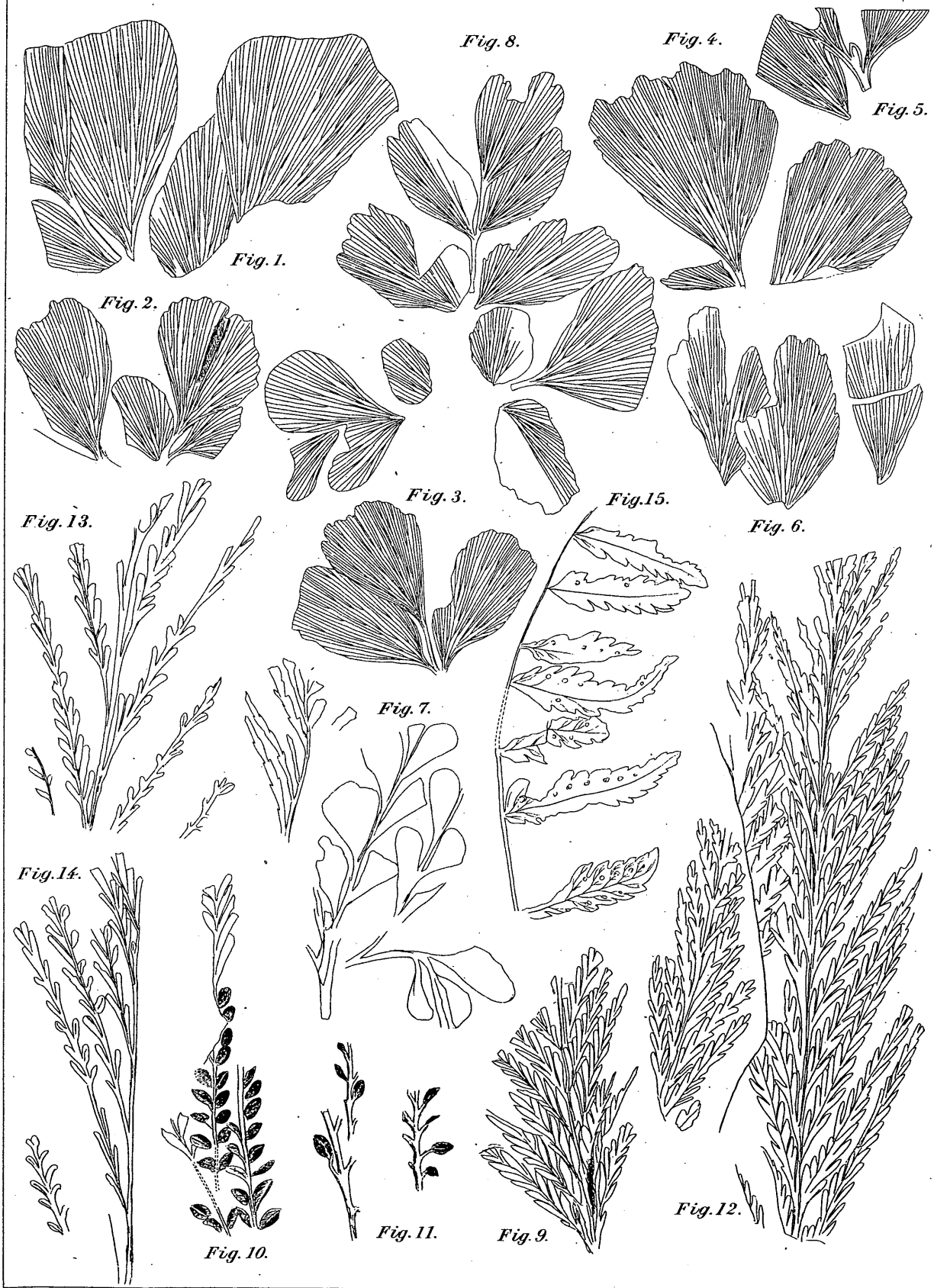
Onychiopsis elongata (Geyler). P. 22.

Figs. 9–11. Specimens from Korea; fig. 9 is a sterile pinna, while the others are fertile ones.

Figs. 12–14. Specimens from Japan; fig. 12 shows a specimen from Kami-uchinami, Onogori, which was referred by Mr. MATSUSHIMA to *Sphenopteris Mantelli*; and figs. 13 and 14 are fertile ones from Shimamura, prov. Kaga.

Sphenopteris sp. P. 38.

Fig. 15. A fertile pinna.



H. Yabe: Mesozoic Plants from Korea.

PLATE II.

Plate II.

(All the figures are in natural size.)

Cladophlebis koraiensis sp. nov. P. 32.

Fig. 1. A sterile frond.

Dictyozamites falcatus (Morris). P. 11.

Figs. 2–4. All pinnae show the reticulated venation, though not represented on the figures.

Fig. 5. A pinna, figured specially to show the venation.

Figs. 6–7. Two detached pinnae shorter and broader than others.

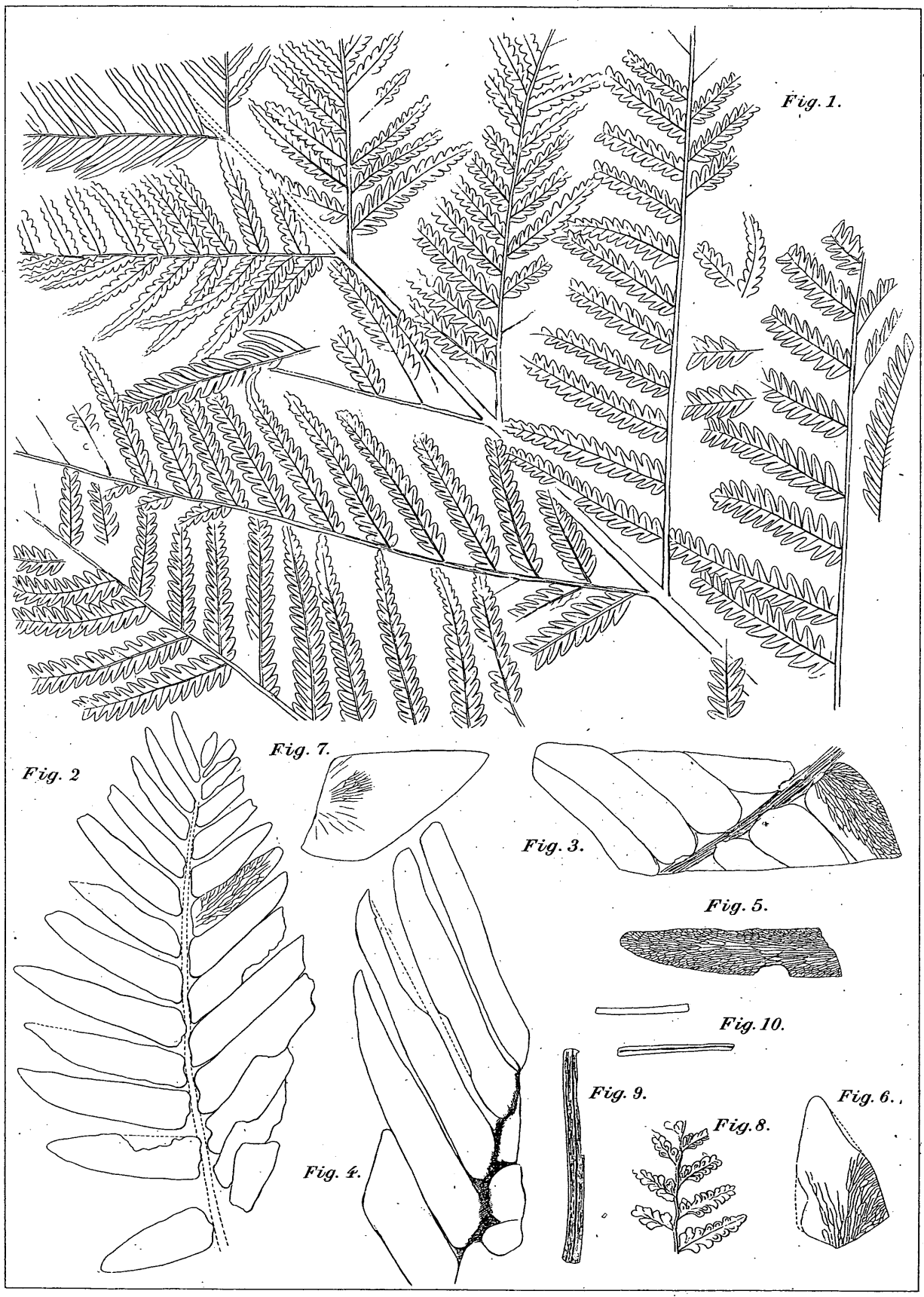
Coniopteris hymenophylloides Brongn. ? P. 29.

Fig. 8. A fertile pinna.

Pinus sp. P. 18.

Fig. 9. *P.* cfr. *Nordenskjoldi* Hr.

Fig. 10. *P.* cfr. *prodromus* Hr.



H. Yabe: Mesozoic Plants from Korea.

PLATE III.

Plate III.

(All the figures, except fig. 14, are in natural size.)

Nilssonia orientalis HR. P. 13.
Figs. 1–5.

Nilssonsia sp. P. 14.
Fig. 6.

Dioonites (?) sp. P. 14.
Fig. 7.

Coniopteris hymenophylloides BRONGN. ? P. 29.
Fig. 8.

Coniopteris Heerianus (YOK.) P. 27.
Fig. 9. A fertile pinna.
Fig. 4. A pinnule, magnified two diameters.

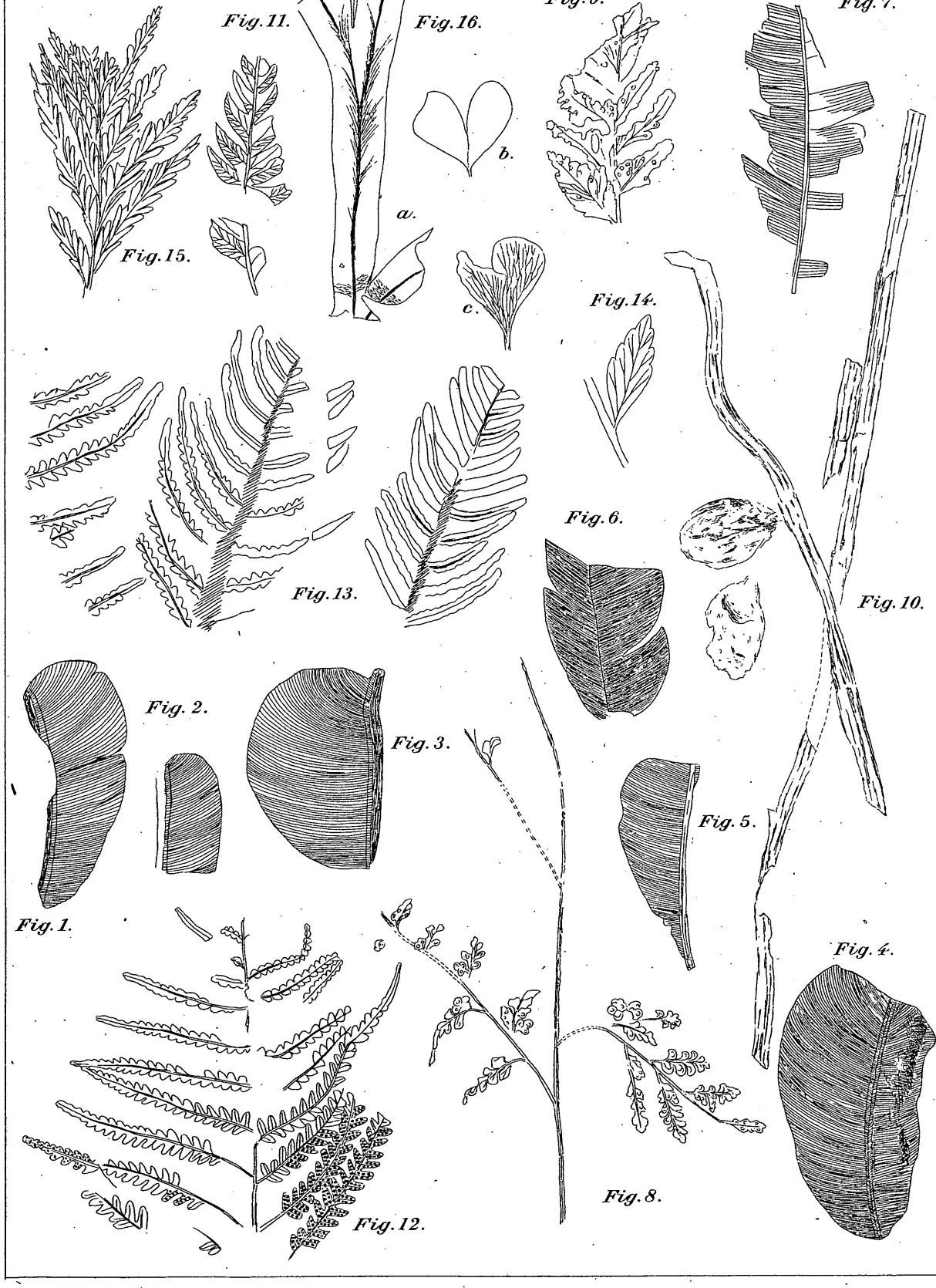
Equisetum ushimarense YOK. P. 43.
Fig. 10.

Cladophlebis cfr. *denticulata* BRONGN. P. 32.
Fig. 11.

Cladophlebis koraiensis sp. nov. P. 32.
Figs. 12–13. Both represent the fertile pinnae; on fig. 13, the round dots are omitted.

Onychiopsis elongata (GEYLER). P. 22.
Fig. 15.

Sagenopteris bilobata sp. nov. P. 41.
Fig. 16. a, var. *major*; b, c, var. *cuneata*.



H. Yabe: Mesozoic Plants from Korea.

PLATE IV.

Plate IV.

(All the figures are in natural size.)

Podozamites lanceolatus (LINDL. and HUTTON). P. 17.
Figs. 1–5.

Podozamites Rheinii GEYLER. P. 16.
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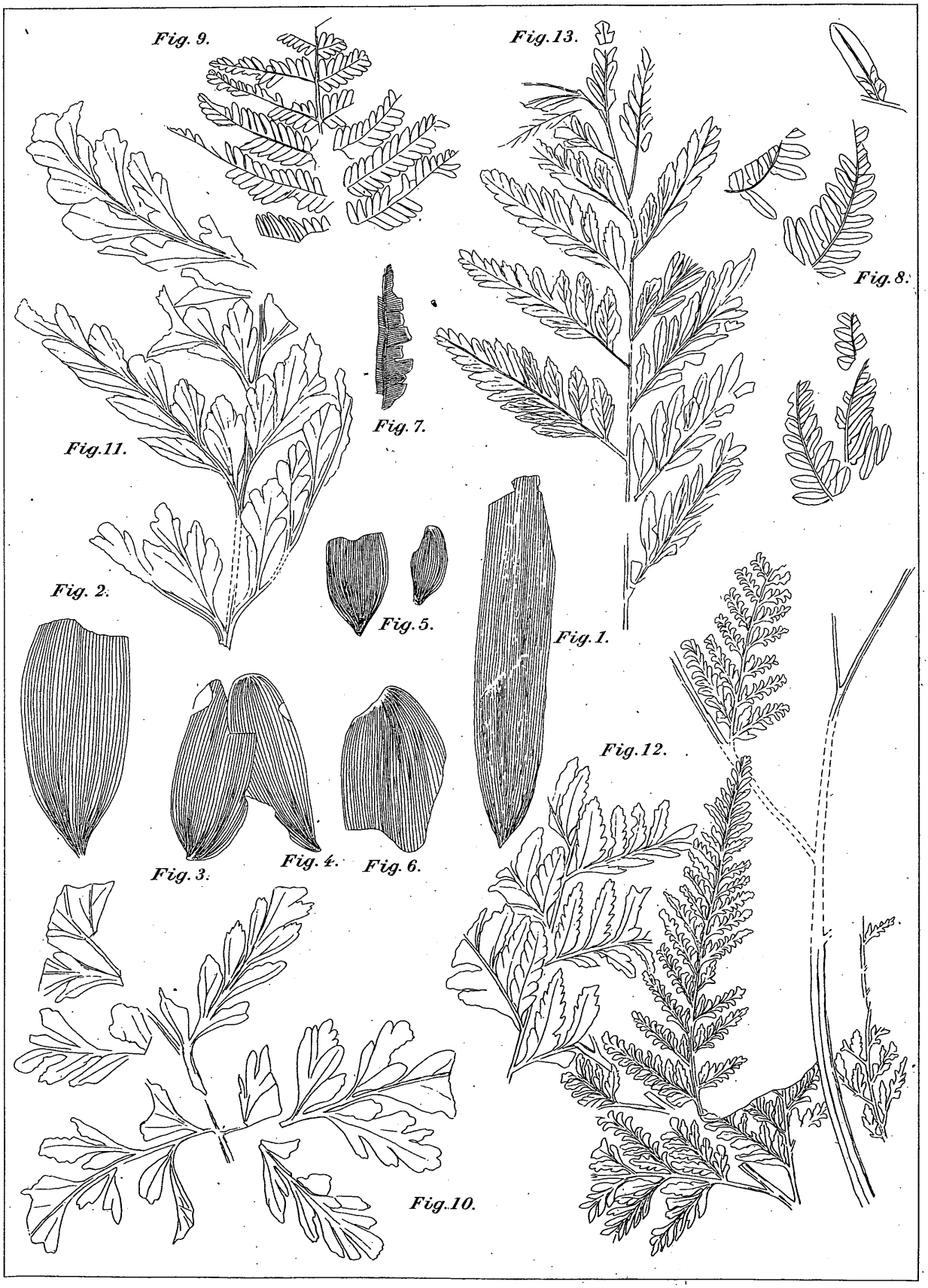
Ctenophyllum (?) sp. P. 17.
Fig. 7.

Cladophlebis sp. P. 37.
Fig. 8.

Cladophlebis cfr. *Dunkeri* (SCHIMPER). P. 37.
Fig. 9.

Sphenopteris naktongensis sp. nov. P. 38.
Figs. 10–11.

Coniopteris sp. P. 26.
Fig. 12. A specimen with fertile pinnae, from Shimamura, prov. Kaga in Japan.



H. Yabe: Mesozoic Plants from Korea.