

## Mesozoic Plants from Nagato and Bitchu.

By

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*With 3 plates.*

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### 1. Plants from Nagato.

Some fourteen years ago, I wrote a brief paper<sup>1)</sup> on fossil plants discovered by Dr. T. KOCHIBE at Yamanoi, in the Province of Nagato, in which I advanced the opinion that they were most probably Rhætic in age. This view is now entirely confirmed by my recent study of a later collection made by Mr. K. INOUE at the same place. This collection, although not rich in the number of species, contains specimens which are valuable both as supplementing those previously found only in an imperfect state, and as making possible a determination of the exact age of the layer in which they were obtained.

The plant-bearing formation of Yamanoi is below the so-called *Inkstone Series* with which it was formerly incorporated. The lower part of the latter has been recently proved by me to be Liassic<sup>2)</sup> from the Ammonites entombed in it. The former

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1) On Some Fossil Plants from the Coal-bearing Series of Nagato. Journal of the College of Science, Imperial University, Japan, Vol. IV, part, II, 1891.

2) Jurassic Ammonites from Echizen and Nagato. Ibid., vol. XIX, art. 20, 1904.

contains anthracite layers in its lower portion, and is underlaid by a marine limestone filled with *Fusulina*.

The species of clearly determinable plants which I can now mention from Yamanoi are the following :

1. *Cladophlebis nebbensis* (BRGNT.)
2. *Cladophlebis yamanoiensis* YOK.
3. *Dictyophyllum Nathorsti* ZEIL.
4. *Dictyophyllum japonicum* YOK.
5. *Dictyophyllum Kochibeii* YOK.
6. *Podozamites lanceolatus* (LINDL. ET HUTT.)
7. *Nilssonia Inouyei* YOK.
8. *Baiera paucipartita* NATH.

Among these, *Cladophlebis nebbensis* and *Cl. yamanoiensis* are what I formerly called *Asplenium Ræsserti* PRESL, and *Asp. Ræsserti* var. *whitbiensis* BRGNT. respectively, while *Dictyophyllum Nathorsti* is a species which I formerly compared to *D. acutilobum* BRAUN.

It may be here added, that among the plants brought back by Mr. INOUE, there are fragments which seem to be referable to the genera *Pinus* and *Phœnicopsis*, but which are at present still undetermined.

A glance at the above list shows the indubitable Rhætic nature of the florula. The three species, *Cladophlebis nebbensis*, *Dictyophyllum Nathorsti* and *Baiera paucipartita*, are forms hitherto known only from the Rhætic. *Podozamites lanceolatus* is indeed a form of wide occurrence in the Jurassic, but its first appearance seems to be in the Rhætic. The remaining species being those found only in Japan are not available for the determination of the age. But we must remember that a form like *Dictyophyllum japonicum* exhibits a great resemblance to one

already found in the Rhætic of Europe. Therefore we may safely conclude that at least the upper portion of the plant-bearing series of Yamanoi belongs to the uppermost Keuper, or Rhætic as it is generally called.

## DESCRIPTION OF THE SPECIES.

### 1. *CLADOPHLEBIS NEBBENSIS* (BRGNT.).

Pl. I. Fig. 1-3.

*Cladophlebis nebbensis* NATHORST, *Bidrag till Sveriges fossila Flora*, p. 16, pl. II, fig. 1-6, pl. III, 1-3. MÖLLER, *Bidrag till Bornholms fossila Flora, Pteridofyter*, p. 29, pl. II, fig. 22, pl. III, fig. 1. ZEILLER, *Flore Fossile des Gîtes de Charbon du Tonkin*, p. 45, pl. IV, fig. 2-4.

*Pecopteris nebbensis* BRONGNIART, *Histoire des Végét. Foss.*, p. 299, pl. XCVIII, fig. 3.

*Asplenium Ræsserti* YOKOYAMA, *On Some Fossil Plants from the Coal-bearing Series of Nagato*, p. 241, pl. XXXII, fig. 1-5.

This fern which I formerly took for *Cladophlebis* (*Asplenium*) *Ræsserti* (PRESL.), a well known Rhætic form, proved to be a different, but still very closely related species of the same formation, viz. *Cladophlebis nebbensis* (BRGNT.), as has already been pointed out by ZEILLER in his excellent work on the fossil flora of Tonkin, above cited. This author who studied specimens of both species occurring in Tonkin says that the pinnules of *Cladophlebis nebbensis*, besides being denticulated at least in the posterior and middle portions of the frond, are generally larger and broader, with apex more rounded and margins more parallel than those of *Cladophlebis Ræsserti*. He adds moreover that in

the former the two basal pinnules of every pinna, one in front of the rachis and the other behind it are different either in shape or in mode of attachment to it, a character never observed in the latter. Lastly it is said that the lateral veins of the pinnules of BRONGNIART'S species are more divergent, further apart, and less divided than those of the pinnules of Presl's species.

Although none of the specimens found at Yamanoi show denticulated pinnules, yet the other characters, especially the peculiarity in the two basal pinnules, being observable in them the plant is now referred to the species first created by Brongniart.

Very frequent, but mostly fragmentary.

## 2. **CLADOPHLEBIS YAMANOIENSIS** Yok.

*Asplenium Rœsserti* var. *whitbiensis* YOKOYAMA, *On Some Fossil Plants from the Coal-bearing Series of Nagato*, p. 242, pl. XXXII, fig. 3, 3a, 4.

FronD bi-or tripinnate. Principal rachis moderately strong and rigid. Pinnæ elongated, linear, alternate, slightly inclined forward, rather widely separated so that there is more or less space left between them. Pinnules falcate, those on the posterior side of the pinnæ being especially so, and also more strongly inclined forward than those on its anterior side; alternate, close together, but separate to the base, bluntly pointed, thin in texture. Midrib distinct, but diffusing into branches toward the end. Lateral veins going off obliquely at a very wide angle, divergent, forking twice, except near the end where they are forked only once.

Although I formerly identified this fern with *Cladophlebis whitbiensis* BRONGT., the strong forward inclination of the pinnules

of the posterior side of the pinnæ compells me to treat it now as a new species. In the form and venation of the pinnules, our specimens show a close resemblance to those figured and described by HEER as *Asplenium whitbiense* var. *tenuis* (*Beitr. z. Juraflora Ostsib. u. d. Amurl.*, p. 39, pl. III, fig. 3) from Siberia, which, however, have the pinnæ so close together as to partly overlap one another. A plant described under the same name from the Jurassic of China (*Schenk* in RICHTHOFEN'S *China*, vol. IV, pl. LII, fig. 1) has the pinnæ further apart, but the veins are somewhat denser, and moreover there is not the peculiarity of the posterior pinnules before mentioned.

Specimens of this plant are not found in the collection of Mr. INOUE. Therefore the only ones which are at hand are those formerly figured by me in the work above cited. For this reason the figures are not given here.

### 3. **DICTYOPHYLLUM JAPONICUM** YOK.

Pl. II. Fig. 3.

*Dictyophyllum japonicum* YOKOYAMA, *On Some Fossil Plants from the Coal-bearing Series of Nagato*, p. 243, pl. XXX.

Among the specimens collected by Mr. INOUE, there is a fragment of a basal portion of a frond in which the more or less palmate nature of the pinnæ is well shown. As may be seen from our figure, the primary rachis is divided apparently into two very divergent branches, each carrying on its upper or front side several pinnæ which are separated from one another by a short space and assume a more less fan-shaped appearance.

Very frequent.

4. **DICTYOPHYLLUM NATHORSTI** ZEILLER.

*Dictyophyllum Nathorsti* ZEILLER, *Flore Fossile des Gîtes de Charbon du Tonkin*, p. 109, pl. XXIII, fig. 1, XXIV, 1, XXV, 1-6, XXVI, 1-3, XXVII, 1, XXIII, 3.

*Dictyophyllum* cf. *acutilobum* YOKOYAMA, *On Some Fossil Plants from the Coal-bearing Series of Nagato*, p. 242, pl. XXXII, fig. 6.

No specimen of this plants being found in the INOUE collection, I am again obliged to refer to the one previously figured by me in the work above cited.

At that time, I had called attention to the fact that the teeth in the frond of the Japanese specimen are closer together than in most of the figures of *D. acutilobum* (BRAUN), given by SCHENK and others. And now I am quite convinced that our plant is identical with *D. Nathorsti*, a species recently created by ZEILLER for specimens from Tonkin which he also formerly took for those of BRAUN's species. A glance at plate XXV of ZEILLER's work will show to a certainty that the Japanese and the Indo-Chinese plants belong to one and the same form.

5. **DICTYOPHYLLUM KOCHIBEI** YOK.

Pl. I. Fig. 5, 7. Pl. II. Fig. 1, 2.

*Dictyophyllum Kochibei* YOKOYAMA, *On Some Fossil Plants from the Coal-bearing Series of Nagato*, p. 244, pl. XXIV, fig. 1, 1a.

The diagnosis formerly given of this species may be revised as follows :

Primary pinnæ elongated, deeply pinnatifid. Secondary pinnæ elongated, mostly inclined a little forward, but sometimes going off from the rachis nearly at right angles, rigid or slightly bent forward or even a little flexuous, mostly separated from one another by a greater or less interval, alternate or subopposite, gradually diminishing in length toward the front, until at last they become mere lobes of the primary pinnæ, lobed. Lobes in the posterior pinnæ ovate or ovately lanceolate with very deep incisions between them, crenate at margin, obtusely pointed at apex, while those in the anterior pinnæ become shorter, with shallower incisions, entire and more blunt, so that in the most anterior ones they change into mere crenations and then finally disappear. Rachis of the primary as well as of the secondary pinnæ slender. Midrib of the lobes distinct, but weak, somewhat zigzag, evanescent. Lateral veins forming polygonal nets within which there are still smaller ones. Veins in the lobed wings similar to those of the lobes of the pinnæ. Fertile pinnæ like sterile ones, with numerous, crowded, more or less rounded sori on the finer veins.

When I first described this species, I had only a single piece of stone on which was preserved a part of two consecutive pinnæ which I then took for the primary ones. But now on examining the excellent specimens collected by Mr. INOUE, I find them to be the secondary pinnæ which belong to the posterior portion of the frond. Figs. 5 and 7 in pl. I represent secondary pinnæ probably belonging to the middle portion of a primary pinna, while fig. 1, pl. I shows its terminal portion.

This plant seems to be not so rare, as was at first supposed.

6. **PODOZAMITES LANCEOLATUS** (LINDL. ET HUTT.)

Pl. I. Fig. 6.

*Podozamites lanceolatus* YOKOYAMA, *On Some Fossil Plants from the Coal-bearing Series of Nagato*, p. 245, pl. XXXIV, fig. 3, 4.

*Podozamites distans* ZEILLER, *Flore Foss. d. Gîtes d. Charb. d. Tonkin*, p. 159, pl. XLII, fig. 1-4. *Nathorst, Beitr. z. foss. Flora Schwedens*, p. 23, pl. XIII, fig. 1-6, XV, 20.

*Zamites distans* SCHENK, *Flora der Grenzschichten*, pl. XXXV, fig. 10, XXXVI.

Specimens belonging to this well known form of *Podozamites* are quite frequent at Yamanoi, though mostly in a fragmentary state. The one shown in our figure has the leaflets attached to the rachis. Judging from their shape, the plant seems to belong to the variety genuina of HEER.

ZEILLER is of opinion that the Rhætic *Podozamites distans* (PRESL) should be kept separate from *P. lanceolatus* (LINDL.) of the Middle Jurassic, on the ground that they belong to two different geological horizons. Indeed it is quite true that, similar as they are, they may possibly be two different species. But in a case like this, in which the determination must be based upon the leaves alone in which the two species present no marked differences, their union is not at all unjustifiable, especially when we consider that some of the plant fossils are remarkable for their longevity. One instance of this is found in our *Onychiopsis elongata* (GEYL.) which is not only abundant in our Lower Oolite, but also in our Neocomian. Recently it has even been suspected that it occurs also in the Lias.



7. **NILSSONIA INOUYEI** YOK.

Pl. I. Fig. 4. Pl. II. Fig. 4.

Leaf elongated, narrow, sides nearly parallel, 8–12 mm broad, entire, bluntly pointed at apex. Midrib more or less straight, moderately strong. Lateral veins fine, straight, parallel, dense, slightly inclined forward.

This species first found by Mr. INOUYE is represented by only a few specimens. Fig. 4, pl. II shows one which, though not quite complete, illustrates the general character of a leaf. It is about 12 mm at the broadest part, tapering very slightly toward front and back. Fig. 4, pl. I represents a part of a narrower leaf.

The species exhibits a great resemblance to *Nilssonia ozoana* YOK. (*Jurassic Plants from Kaga, Hida and Echizen*, p. 42, pl. X, fig. 2b, 11–14). But the veins are coarser, there being 2–3 to a millimeter, while in the latter we can count 4 such in the same space.

8. **BAIERA PAUCIPARTITA** NATH.

Pl. II. Fig. 5.

*Baiera paucipartita* NATHORST, *Om Floran i Skanes Kol-förande Bildningar I. Floran vid Bjuf*, p. 94, pl. XX, fig. 7–13, XXI, XXII, 1–2.

*Baiera* ? sp. YOKOYAMA, *On Some Fossil Plants from the Coal-bearing Series of Nagato*, p. 246, pl. XXXIV, fig. 6.

What I had formerly suspected to be a *Baiera* proved, not only to belong to that genus, but also to a form already

known from the Rhætic of Sweden. The specimen shown in our figure is the best we have. It is a leaf composed of several, narrow, parallel-sided lobes which are obtuse at apex and arranged in a fan-shaped manner. The breadth of the lobes reaches 5 mm, in which space we can count 7 or 8 fine, parallel veins.

Not rare, but mostly in small fragments.

## 2. Plants from Bitchu.

The neighbourhood of Nariwa, a little town in the province of Bitchu, has long been known as one of the localities of *Pseudomonotis ochotica* KEYS., a bivalve peculiar to the Alpine facies of the Upper Triassic.

The order of rock-layers observed at this place and believed to belong to the Mesozoic formation, when counted from below, is as follows :

1. *Sandstone*, grey, fine-grained, often argillaceous and then darker-coloured, containing innumerable remains of *Pseudomonotis ochotica* which is almost the only fossil ever found in this layer.

2. *Sandstones and Shales*, alternating with each other. The former is similar in character to No. 1, while the latter is often coaly and black, and contains impressions of vegetable remains. In this complex, there are two anthracite layers near Nariwa, each a foot in thickness.

3. *Schalstein*, red to dark red, very fine-grained and looking like shale. In the lower part of this stratum, there is intercalated a layer of conglomerate consisting of pebbles of a light grey Fusulina-limestone and of red and green tuffites, cemented by a green tufaceous matter, while in its upper part we find a stratum

of limestone-breccia between, the limestone being similar to that of the conglomerate. The whole bed is pierced here and there by dykes of porphyrites and quartz-porphyrines, often causing contact metamorphism.

The whole complex of strata from No. 1 to No. 3 rests on a Palæozoic formation whose upper part at least is attributable to the Carboniferous.

The *Pseudomonotis* bed (No. 1) in Japan is now generally accepted as an equivalent of the Noric stage of the Alpine Keuper. Therefore I once thought that the plant-bed which is immediately above it at Nariwa might belong also to the same stage; but a closer examination of the fossil plants, though fragmentary and not clearly determinable, gives one the impression that they belong to a somewhat higher horizon. The species of plants which I have been able to distinguish in them are as follows:

1. **CLADOPHLEBIS** SP.

Pl. III. Fig. 2, 4, 7.

Fragments of the pinnæ of a *Cladophlebis* with pinnules which show a close resemblance to those of *C. nebbensis* (BRGNT.), occurring in the Rhætic of Nagato. The fine lateral veins of the pinnules are not always clearly observable, but when distinct, they are forked only once.

2. **SAGENOPTERIS** SP.

Pl. III. Fig. 3.

A segment of a *Sagenopteris* lacking the apex. It has an elongated shape, broadest near the middle and tapering toward

both ends, being cuneate at base. The broadest part measures 21 mm; the length may be estimated at about 55 mm. The midrib is rather weak, becoming very weak towards the apex. The lateral veins are very fine, rise at acute angles from the midrib and are divergent, although anastomosing with one another to form elongated nets.

That this fragment belongs to the above named genus can hardly be doubted. It is very likely that it represents a form which, if not quite identical with, is at least closely akin to, *Sagenopteris Phillipsi* PRESL (MÖLLER, *Bidrag till Bornholms Fossila Flora, Pteridofyter, pl. V, fig. 1-7*) and *S. rhoifolia* PRESL (SCHENK, *Die Fossile Flora der Grenzsichten des Keupers and Lias Frankens, pl. XII*), both from the Rhætic of Europe.

### 3. **ARTHROPHYOPSIS ? SP.**

Pl. III. Fig. 6.

A small fragment of a fern-frond (?), having distinct, equal, and more or less parallel veins which here and there unite to form long nets. According to this mode of venation, it bears a close resemblance to what Nathorst has given the name of *Arthrophyopsis Nilssoni* (*Floran vid Bjuf, pl. VII, fig. 5, VIII, 6. Floran vid Höganäs und Helsingborg, pl. I. fig. 6*) from the Rhætic of Sweden.

### 4. **NILSSONIA SP.**

Pl. III. Fig. 1, 8.

There are two specimens of a *Nilssonia*, which, though somewhat different in appearance, probably belong to the same

species. Fig. 1 shows the back-side of a leaf while fig. 8 shows the upper or front side of the same. The midrib, though not very strong, is rigid with lateral veins, either at nearly right angles to it, or slightly inclined forward. The leaf seems to have been either entire or only partly segmented.

The already known form of *Nilssonia* which can be compared to the present one is *Nilssonia polymorpha* SCHENK (Nathorst, *Beitr. z. foss. Flora Schwedens, pl. XI*) from the Rhætic of Europe.

5. **PODOZAMITES LANCEOLATUS** (LINDL. ET HUTT.)

Pl. III. Fig. 5.

A leaf lacking the apical portion. The general outline and fine parallel longitudinal veins, numbering about 25, show that it belongs to the above named species of *Podozamites*, widely distributed in the Rhætic as well as in the Jurassic.

Although the above five plants are by no means decisive in determining the age of the bed in which they occur, yet their general character indicates that they belong most likely to the Rhætic. This is supported, not only by the occurrence of anthracite layers as in the Rhætic of Nagato, but also by the presence of a schalstein above, a rock which exhibits a great similarity to the so-called *Inkstone* (schalstein) of the *Inkstone Series* of the latter place. And as the lower part of this series has already been proved to be Liassic, the schalstein of Nariwa, if not entirely, at least its lower part may also be looked upon as belonging to the same age.



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**MESOZOIC PLANTS FROM NAGATO AND BITCHU.**

**PLATE I.**

**Plate I.**

(Plants from Nagato).

Figs. 1, 2, 3. *Cladophlebis nebbensis* (BRGNT.).

Fig. 4. *Nilssonia Inouyei* YOK.

Figs. 5, 7. *Dictyophyllum Kochibeii* YOK.

Fig. 6. *Podozamites lanceolatus* (LINDL.).

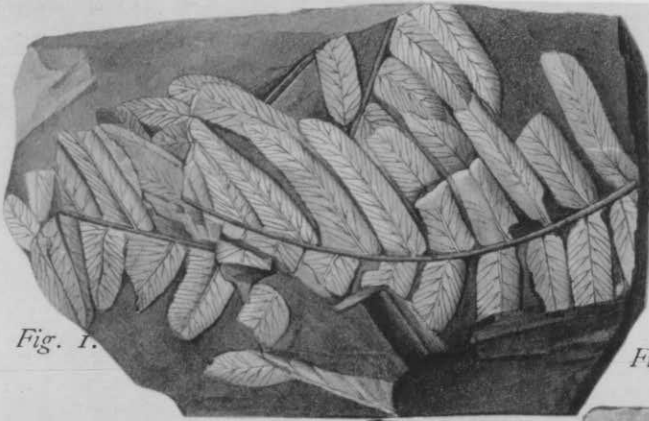


Fig. 1.

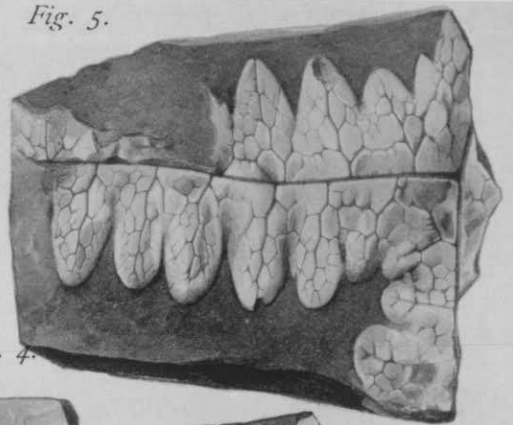


Fig. 5.

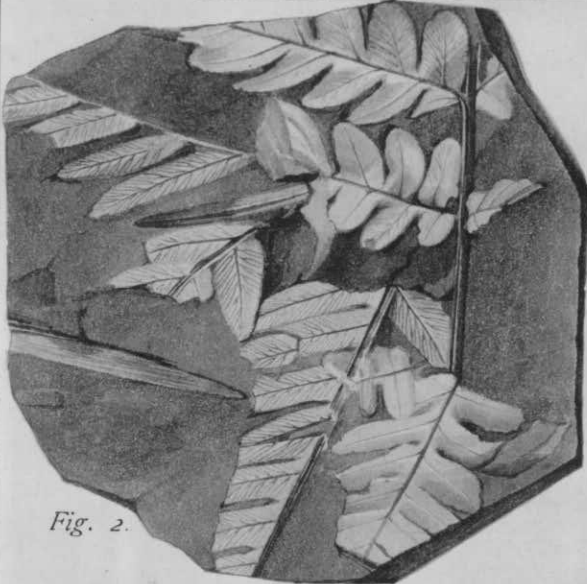


Fig. 2.



Fig. 4.



Fig. 6.



Fig. 3.

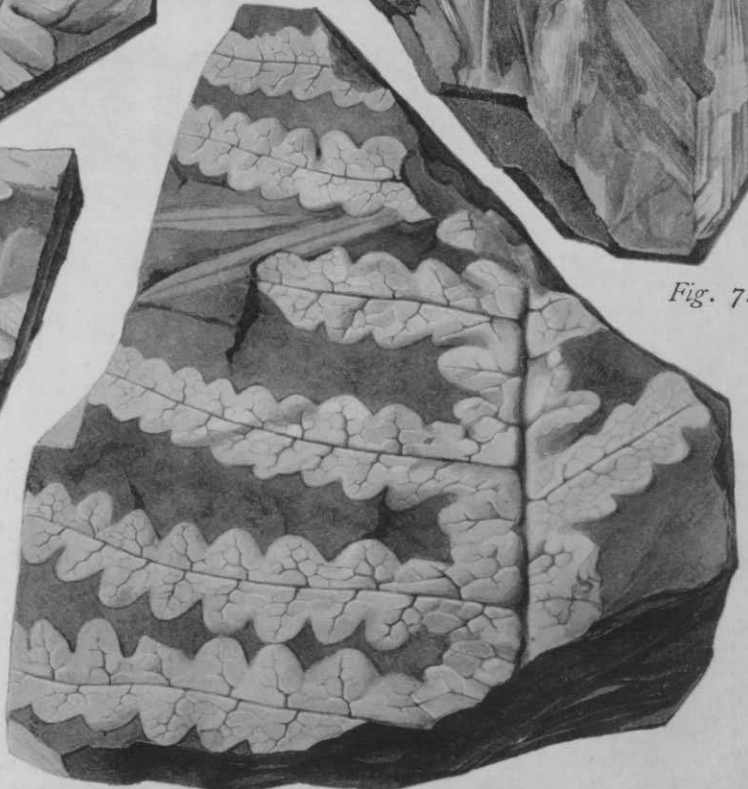


Fig. 7.



**YOKOYAMA.**

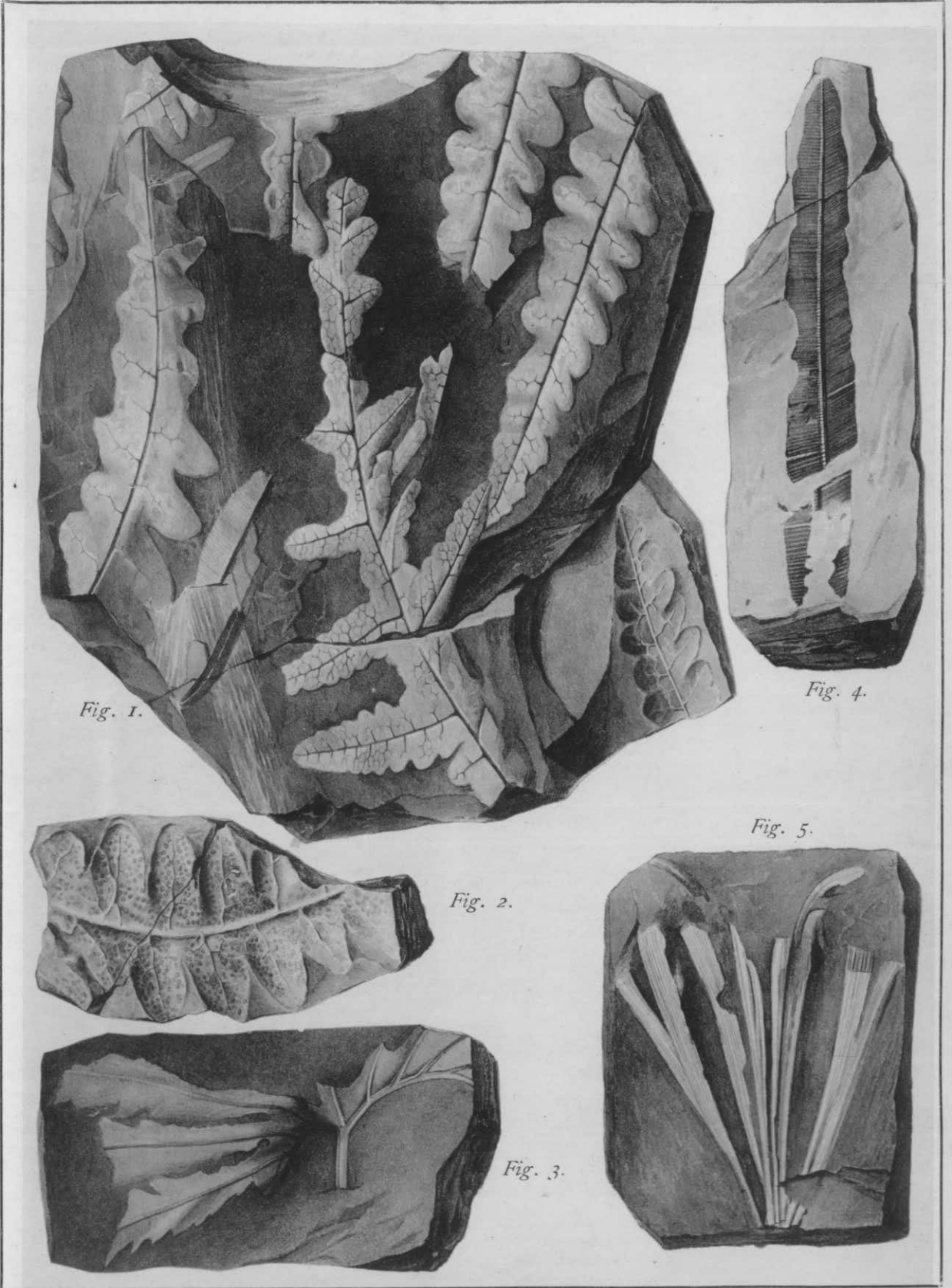
**MESOZOIC PLANTS FROM NAGATO AND BITCHU.**

**PLATE II.**

**Plate II.**

(Plants from Nagato).

- Fig. 1. *Dictyophyllum Kochibei* YOK.  
Fig. 2. *do.* Fertile pinna.  
Fig. 3. *Dictyophyllum japonicum* YOK.  
Fig. 4. *Nilssonia Inouyei* YOK.  
Fig. 5. *Baiera paucipartita* NATH.



M. YOKOYAMA.

MESOZOIC PLANTS FROM NAGATO AND BITCHU.

PLATE III.

**Plate III.**

(Plants from Bitchu).

Figs. 1, 8. *Nilssonia* sp.

Figs. 2, 4, 7. *Cladophlebis* sp.

Fig. 3. *Sagenopteris* sp.

Fig. 5. *Podozamites lanceolatus* (LINDL.).

Fig. 6. *Arthrophyopsis* ? sp.

*Fig. 1.*



*Fig. 6.*



*Fig. 4.*



*Fig. 2.*



*Fig. 7.*



*Fig. 5.*



*Fig. 3.*



*Fig. 8.*

