THE RHAETIC PLANTS FROM THE NARIWA[1] DISTRICT, PROV. BITCHÛ (OKAYAMA PREFECTURE), JAPAN

By

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With 35 Plates, 4 Text-figures and 1 Table.

I. INTRODUCTION

The collection of fossil plants described in this memoir was made chiefly by the present writer in the summer of 1930 with the aid of several gentlemen in the town of Nariwa; it comprises also an added number of specimens later sent to him from people living in the town. In the following, first is offered a brief note on the geology of the Nariwa Triassic district chiefly based on the writer's own field observation and a short review of the related geological works by the previous writers. Then it follows a systematic description of the fossil plants and finally a correlation of the present flora with those of Korea and foreign countries.

The author wishes to express his indebtedness to Professor H. YABE of the Institute of Geology and Palaeontology in Sendai and Professor T. NAGAO of our Department, from whom he has received valuable suggestion and help during the course of the work. Especially Professor YABE has very kindly interested himself in no small degree in the palaeobotany, and to his wide knowledge the present writer is particularly indebted. His sincere thanks are due also to Mr. T. AKAGI of the Imperial Geological Survey in Tôkyô who kindly lent his own field geological map of this district, and to Messrs. T. FUJITA, T. TAKAMI, T. OGAWA, M. FUJISAWA, K. YAMASHITA and S. YANAI, from all of whom the writer received much assistance in collecting fossils.

(1) 成羽.

II. GEOLOGY

The Upper Triassic rocks in Province Bitchû, S.W. Japan, occupy an area of more than 5 square miles in the neighbourhood of the town of Nariwa, and are, according to the writer's own field observation in the summer of 1930, divisible into two groups of different rock-facies and geological ages, namely: the marine Jitô Bed characterised by *Pseudomonotis ochotica* (KEYS.) var. *eurhachis* TELL., and terrestrial Nariwa Bed characterised by abundance of fossil plants. The Jitô Bed consists almost entirely of dark gray, somewhat calcareous, hard sandstone, more than 800 m. in thickness. It contains remains of many *Pseudomonotis* besides a few Lamellibranchiata and Gastropoda, together with disjoined stems of *Pentacrinus*. The geological age of the Jitô Bed is believed to be the Noric by most Japanese geologists. The Nariwa Bed is also a thick complex, more than 800 m. in thickness, which consists of sandstone, shale and conglomerate in alternation, and contains thin layers of anthracite seams. Plant fossils particularly abundant in several horizons represent more than 80 species, most of which are of characteristic Rhaetic and Lower Liassic elements. It is the writer's opinion that the greater part of the fossiliferous beds of the terrestrial Nariwa Bed represent the Rhaetic, though it is probable from the occurrence of some Liassic elements in certain horizons that the upper part of this thick complex may be slightly younger than the Rhaetic.

The stratigraphical relation between the plant and the *Pseudomonotis* beds can hardly be determined in the field, because they are everywhere found put in juxtaposition to one another by severe dislocations, and it is only the fossils contained in them that give clue to the determination of their age.

The Triassic rocks are covered unconformably by a thick complex of the Inkstone Series, the age of which is probably Cretaceous; but the base has not yet been found in this district. At least the plant beds, possibly the *Pseudomonotis* beds as well are found in many places in direct contact because of the faults, with the Palaeozoic phyllitic slate, schalsteins and limestone with *Neoschwagerina globosa* YABE. AKAGI[1] mentions that the plant beds with the

(1) T. AKAGI: Explanatory Text to the Geological Map in 1/75,000; Sheet Futchû, 1930, p. 8.

basal conglomerate cover the Palaeozoic rocks unconformably, but the evidences for this conclusion are not satisfactory.

III. REVIEW OF LITERATURE BEARING ON THE PALAEOBOTANY OF THE NARIWA TRIASSIC

The fossil plants of this district were first described by Dr. M. YOKOYAMA[1] in 1905 and he determined them as follows:

Cladophlebis sp.
Sagenopteris sp.
Anthrophyopsis? sp.
Nilssonia sp.
Podozamites lanceolatus (L. and H.).

Amongst these, *Anthrophyopsis*? sp. is in all probability an imperfect pinna of *Ctenis japonica* sp. nov.; the others excepting the last one are too fragmentary to admit of their specific determination. The exact localities of these fragmental specimens are unknown, though *Anthrophyopsis*? sp. may have probably been derived from the plant-bed of Nabae where *Ctenis japonica* occurs frequently.

In 1925 AKAGI[2] reproduced a photograph of specimens of *Dictyophyllum* found in Hayama as *D.* cfr. *remauryi* ZEILLER after the determination of the late Dr. Y. OZAWA; this specimen is now believed to be specifically identical with *D. nilssoni* (BRONGN.).

Recently the present writer[3] examind some imperfect specimens of fossil plants which occurred at Eda and Hinabata (in the note mentioned only as Hina) and discriminated them as follows:

Annulariopsis inopinata ZEILLER?
Hausmannia nariwaensis ÔISHI
Dictyophyllum sp.
Dictyophyllum? sp.
Baiera sp.

(1) M. YOKOYAMA: Mesozoic Plants from Nagato and Bitchû. Journ. Coll. Sci., Imp. Univ. Tôkyô, Vol. XX, Art. 5, 1905.

(2) T. AKAGI: Preliminary Notes on the Triassic Formation of Nariwa, Prov. Bitchû. Journ. Geol. Soc. Tôkyô, Vol. XXXII, No. 378, 1925, p. 100, Pl. IV (in Japanese).

(3) S. ÔISHI: Notes on Some Fossil Plants from the Upper Triassic Beds of Nariwa, Prov. Bitchû, Japan. Jap. Journ. Geol. Geogr., Vol. VII, No. 2, 1930.

Baiera sp. cfr. *B. paucipartita* NATHORST
Podozamites sp.

Of these, *Dictyophyllum* sp. has now been clearly identified as a fragment of *Hausmannia dentata* sp. nov., and *Dictyophyllum*? sp. as a fragment of *Thaumatopteris nipponica* sp. nov. *Baiera* sp. and *B.* sp. cfr. *B. paucipartita* may probably be referable to *B. paucipartita.*

In 1931, the present writer[1] reported the occurrence of an interesting fossil plant, *Yabeiella,* from the Triassic rocks of the Nariwa district; it was, however, unfortunately not specifically determinable.

IV. LIST OF FOSSIL PLANTS DESCRIBED

I. PTERIDOPHYTA

EQUISETALES

GENUS *Equisetites* STERNBERG

Equisetites multidentatus sp. nov.
E. sp.

GENUS *Phyllotheca* BRONGNIART

Phyllotheca sp.

GENUS *Neocalamites* HALLE

Neocalamites hoerensis (SCHIMPER)
N. carrerei (ZEILLER)

GENUS *Annulariopsis* ZEILLER

Annulariopsis inopinata ZEILLER?

FILICALES

MARATTIACEAE

GENUS *Marattiopsis* SCHIMPER

Marattiopsis muensteri (GOEPPERT)

(1) S. ÔISHI: *Yabeiella* sp. from the Japanese Triassic. Jap. Journ. Geol. Geogr., Vol. VIII, No. 4, 1931, p. 257.

OSMUNDACEAE

GENUS *Todites* SEWARD

Todites roesserti ZEILLER (non PRESL)
T. williamsoni (BRONGNIART)
T. princeps (PRESL)

OSMUNDACEAE?

GENUS *Cladophlebis* BRONGNIART

Cladophlebis haiburnensis (L. and H.)
C. gigantea sp. nov.
C. bitchuensis sp. nov.
C. nebbensis (BRONGNIART)
C. raciborskii ZEILLER
C. denticulata (BRONGNIART)
C. pseudodelicatula sp. nov.

DIPTERIDACEAE

GENUS *Clathropteris* BRONGNIART

Clathropteris meniscoides BRONGNIART var. *elegans* var. nov.
C. obovata sp. nov.

GENUS *Thaumatopteris* GOEPPERT

Thaumatopteris nipponica sp. nov.
T. elongata sp. nov.
T. schenki NATHORST
Cfr. *T. brauniana* POPP

GENUS *Dictyophyllum* LINDLEY and HUTTON

Dictyophyllum spectabile NATHORST
D. nilssoni (BRONGNIART)
D. muensteri (GOEPPERT)

GENUS *Hausmannia* DUNKER

Hausmannia nariwaensis ÔISHI
H. crenata NATHORST
H. dentata sp. nov.

DIPTERIDACEAE?

GENUS *Spiropteris* SCHIMPER

Spiropteris sp.

POLYPODIACEAE?

GENUS *Sphenopteris* BRONGNIART

Sphenopteris gracilis sp. nov.

II. CYCADOPHYTA

BENNETTITALES?

GENUS *Pterophyllum* BRONGNIART

Pterophyllum schenki (ZEILLER)
P. jaegeri BRONGNIART
P. ctenoides sp. nov.
Cfr. *P. distans* MORRIS
P. spp.

GENUS *Campylophyllum* GOTHAN

Campylophyllum hörmanni GOTHAN

GENUS *Otozamites* F. W. BRAUN

Otozamites lancifolius sp. nov.
O. indosinensis ZEILLER
O. sp.

GENUS *Ptilozamites* NATHORST

Ptilozamites tenuis sp. nov.

P. nilssoni NATHORST?

GENUS *Yabeiella* ŌISHI

Yabeiella sp.

GENUS *Taeniopteris* BRONGNIART

Taeniopteris lanceolata sp. nov.
T. nabaensis sp. nov.
T. cfr. *stenophylla* KRYSHTOFOVICH
T. cfr. *carruthersi* TENISON-WOODS
T. cfr. *leclerei* ZEILLER
T. sp.
T. ? sp.
T. ? sp. nov.

NILSSONIALES

GENUS *Nilssonia* BRONGNIART

Nilssonia simplex sp. nov.
N. orientalis (HEER)
N. acuminata (PRESL)
N. muensteri (PRESL)
N. sp.
N. ? gen. et sp. indet.

GENUS *Ctenis* LINDLEY and HUTTON

Ctenis japonica sp. nov.
C. yabei sp. nov.
C. ? sp.

III. GINKGOPHYTA

GINKGOALES

GENUS *Ginkgoites* SEWARD

Ginkgoites sibirica (HEER)

GENUS *Baiera* F. W. BRAUN

Baiera muensteriana (PRESL)
B. furcata HEER
B. filiformis sp. nov.
B. taeniata F. W. BRAUN
B. paucipartita NATHORST
B. elegans sp. nov.
B. guilhaumati ZEILLER?
B. sp.

GINKGOALES?

GENUS *Czekanowskia* HEER

Czekanowskia rigida HEER

GENUS *Phoenicopsis* HEER

Phoenicopsis sp.

GENUS *Stenorachis* SAPORTA

Stenorachis bitchuensis sp. nov.
S. elegans sp. nov.

IV. CONIFERALES

GENUS *Pityophyllum* NATHORST

Pityophyllum (*Pityocladus*) *longifolium* (NATHORST)

GENUS *Elatocladus* HALLE

Elatocladus plana (FEISTMANTEL)
E. tennerima (FEISTMANTEL)
E. sp.

V. CONIFERALES?

GENUS *Podozamites* F. W. BRAUN

Podozamites schenki HEER
P. lanceolatus (LINDLEY and HUTTON)
P. sp.

GENUS *Nageiopsis* FONTAINE

Nageiopsis rhaetica sp. nov.

Problematicum

V. LOCALITIES OF FOSSIL PLANTS TREATED IN THIS MEMOIR

The following list shows the localities of fossil plants described in this memoir. The stratigraphical relation of these plant beds to one another is not yet fully settled in the field. To certain beds which are characterised by having a species or a genus dominant in common is given a bed-name only for convenience sake bearing the name of that prevailing species or genus. As to the geographical position of each locality see Pl. I.

Locality No. 1 (*Hausmannia*-bed)—Eda(1), N. W. of Nariwa.
Locality No. 10—Shirochi(2), N. of Nariwa.
Locality No. 16—Shirochi, N. of Nariwa.
Locality No. 21 (*Ctenis japonica*-bed)—Nabae(3), N. of Nariwa.
Locality No. 30 (*Dictyophyllum spectabile*-bed)—Hayama(4), N. W. of Nariwa.
Locality No. 33—Eda, N. W. of Nariwa.
Locality No. 40—Kamihina(5), S. of Nariwa.
Locality No. 44 (*Cladophlebis*-bed)—Hinabata(6), S. of Nariwa.
Locality No. 45—Hinabata, S. of Nariwa.
Locality No. 46 (*Yabeiella*-bed)—Kamihina, S. of Nariwa.
Locality No. 47 (*Otozamites*-bed)—Kamihina, S. of Nariwa.
Locality No. 48 (*Todites roesserti*-bed)—Kamihina, S. of Nariwa.
Locality No. 49 (*Dictyophyllum muensteri*-bed)—Kamihina, S. of Nariwa.
Locality No. 50 (*Ctenis yabei*-bed)—Kamihina, S. of Nariwa.
Locality No. 54—Jitô(7), S. W. of Nariwa.
Locality No. 55—Jitô, S. W. of Nariwa.
Locality No. 58—Koyagaichi(8), S. W. of Nariwa.
Locality No. 62—Nishihata(9), N. W. of Nariwa.
Locality No. 63—Yamamoto(10), N. W. of Nariwa.
Locality No. 64—Yamamoto, N. W. of Nariwa.
Locality No. 65—Hata(11), S. E. of Nariwa.
Locality No. 66—Hinabata, S. of Nariwa.
Locality No. 68—Hinabata, S. of Nariwa.
Locality No. 69—Suimyô(12), S. of Nariwa.

(1) 枝. (2) 福地. (3) 難波江. (4) 羽山. (5) 上日名. (6) 日名畑.
(7) 地頭. (8) 小谷ケ市. (9) 西畑. (10) 山本. (11) 畑. (12) 水名.

VI. DESCRIPTION OF THE SPECIES

I. PTERIDOPHYTA

EQUISETALES

GENUS *Equisetites* STERNBERG

Equisetites multidentatus sp. nov.

Pl. XX (II), Figs. 1–2.

An Equisetaceous stem of unknown length. Stem large, more than 16 cm. in length and 5 cm. in breadth, with internodes more than 10 cm. long. Surface of stem quite smooth, showing neither ridges nor grooves. Sheath about 7 mm. in height above the node, with fringed margin. Teeth numerous, more than 80 in each sheath.

Pl. XX (II), fig. 1 shows a pith-cast secured from Kamihina (Loc. No. 49) impressed on the back surface of the rock bearing *Neocalamites carrerei* (ZEILLER) figured in Pl. XXI (III), fig. 4. In the middle portion of the stem, a node is seen and a diaphragma of 15 mm. diameter is faintly visible in the lower right side of the node. Another specimen in fig. 2 shows smooth outer surface of a part of a nodal region of a stem; the faint indication of relief on the surface may possibly be due to the preservation. The leaf-sheath measures about 1 cm. high above the node and the commissual furrows continue below the node. Thirty seven teeth are counted in this portion of the node, so the whole number of teeth may be more than 74. The length of the teeth is not clear, but it seems to be not more than 2 mm.

E. multidentatus is characterised first by having numerous teeth in a leaf-sheath and secondly by the smooth surface of the stem. *E. scanicus* (STERNB.)[1] and *E. veronensis* ZIGNO[2] are somewhat comparable to the present specimens, but none of them bears such numerous teeth in a leaf-sheath.

Localities: Eda (Loc. No. 1); and Kamihina (Loc. No. 49).

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(1) T. G. HALLE: Zur Kenntnis der mesozoischen Equisetales Schwedens. Kgl. Svensk. Vet.-Akad. Handl., Bd. XLIII, No. 1, 1908, p. 22, Pls. VI, VII; Pl. VIII, figs. 1–5; Pl. IX, figs. 16–17.

(2) A. DE ZIGNO: Flora Fossilis Formationis Oolithicae. Vol. I, 1856–1868, p. 64, Pl. VI.

Equisetites sp.

Pl. XX (II), Figs. 3–6.

Some fragmental leaf-sheaths of an *Equisetites* occur somewhat commonly in the plant bed of Shirochi (Loc. No. 16), but specifically they are all indeterminable. Pl. XX (II), fig. 3 shows two imperfect leaf-sheaths impressed on a rock; the lower one (A) is more than 2 cm. broad and the length of the commissual furrows is at least 1.5 cm. The nature of the upper margin of the sheath is obscure; the breadth between two adjacent furrows is 2 mm. In the upper one (B), however, it is 3 mm. broad. No trace of internode is represented in the collection from this locality; (C) seems to show a portion of internode, the surface of which is longitudinally ridged and grooved; fig. 4 shows a sheath which is vertically compressed at the node, where the number of commissual furrows is about 22.

Specimens in figs. 5 and 6 are from Hinabata (Loc. No. 49) and represent also fragments of nodal region. These specimens differ somewhat from those in fig. 3 in having a larger number of furrows in an unit breadth.

Localities: Shirochi (Loc. No. 16); Hinabata (Loc. No. 44); Kamihina (Loc. Nos. 46 and 49); Hayama (Loc. No. 30); and Eda (Loc. No. 33).

GENUS *Phyllotheca* BRONGNIART

Phyllotheca sp.

Pl. XX (II), Fig. 10.

Pl. XX (II), fig. 10 shows a fragmental specimen of a part of leaf-sheath of an Equisetaceous plant which the writer believes to belong to the genus above cited, though its specific name is not determinable. It is vertically compressed at the node, and the leaves which are united at the base into a cup-like sheath are spread radially from the center of the node. The leaves are linear, acuminated upwards, single-nerved, and about 5 mm. long in free part; the number of leaves may be more than 10 in the present specimen.

Though fragmental, this specimen very closely resembles *Phyllotheca equisetiformis* figured and described by ZIGNO[1] from the Liassic of Italy, and may probably belong to that species.

Locality: Suimyô (Loc. No. 69).

GENUS *Neocalamites* HALLE

Neocalamites hoerensis (SCHIMPER)

Pl. XX (II), Figs. 7–9.

1869. *Schizoneura hoerensis* SCHIMPER: Traité de paléontologie végétale, Tom I, p. 283.

1878. *Schizoneura hoerensis* NATHORST: Floran vid Bjuf, p. 24, Pl. X, figs. 6–8.

1878. *Schizoneura hoerensis* NATHORST: Bidrag till Sveriges Fossila Flora. Kgl. Svensk. Vet.-Akad. Handl., Bd. XVI, No. 7, p .9, Pl. I, figs. 1–4.

? 1878. *Schizoneura hoerensis* NATHORST: Ibid., p. 40, Pl. VII, fig. 5.

? 1892. *Schizoneura hoerensis* RACIBORSKI: Flora Retyckiej Polski, p. 7, Pl. II, fig. 10.

? 1906. *Schizoneura hoerensis* YOKOYAMA: Mesozoic Plants from China. Journ. Coll. Sci., Imp. Univ. Tôkyô, Vol. XXI, Art. 9, p. 29, Pl. VII, fig. 10.

1908. *Neocalamites hoerensis* HALLE: Zur Kenntnis der mesozoischen Equisetales Schwedens. L.c., p. 6, Pls. I–II.

1915. *Neocalamites hoerensis* WALKOM: Mesozoic Floras of Queensland. Pt. I. The Flora of the Ipswich and Walloon Series. Queensland Geol. Surv. Publ. No. 252, p. 33, Pl. II, fig. 1.

1922. *Neocalamites hoerensis* JOHANSSON: Die rhätische Flora der Kohlengruben bei Stabbarp und Skromberga in Schonen. Kgl. Svensk. Vet.-Akad. Handl., Bd. LXIII, No. 5, p. 7, Pl. VI, figs. 1, 2.

1924. *Neocalamites hoerensis* WALKOM: On Fossil Plants from Bellevue, Near Esk. Mem. Queensland Museum, Vol. VIII, Pt. I, p. 79, Pl. XV, fig. 1.

1926. *Neocalamites hoerensis* HARRIS: The Rhaetic Flora of Scoresby Sound, East Greenland. Medd. om Grønland, Bd. LXVIII, p. 51, Pl. IV, fig. 8; Pl. IX, figs. 2, 5; Text-fig. 1A.

? 1926. *Neocalamites hoerensis* CHAPMAN and COOKSON: A Revision of the "Sweet" Collection of Triassic Plant Remains from Leich's Creek, South Australia. Trans. Roy. Soc. S.-Australia, Vol. L, p. 165, Pl. XIX, figs. 3–5.

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(1) A. DE ZIGNO: Flora Fossilis Formationis Oolithicae. Vol. I, l.c. p. 60, Pl. VIII.

1931. *Neocalamites hoerensis* ÔISHI: Mesozoic Plants from Kita-Otari, Prov. Shinano, Japan. Journ. Fac. Sci., Hokkaidô Imp. Univ., Ser. IV, Vol. I, No. 2, p. 229, Pl. XVI, figs. 2–3.

1931. *Neocalamites hoerensis* HARRIS: The Fossil Flora of Scoresby Sound, East Greenland. Medd. om Grønland, Bd. LXXXV, No. 2, p. 22, Text-figs. 4A–B.

The genus *Neocalamites* is represented by a considerable number of specimens in the author's collection and seems to be placed in two different species, viz. *N. hoerensis* (SCHIMPER) and *N. carrerei* (ZEILLER). Three specimens which seem to belong to the former are shown in Pl. XX (II), figs. 7–9. Fig. 7 shows a pith-cast, 9.5 cm. long and 2.5 cm. broad, and having two nodes in the extreme upper and the lower ends, the internode between being 9 cm. The surface is ornamented by fine longitudinal ridges and furrows in alternation, the ridges being 15 in number per 1 cm. The associated leaves which may possibly belong to this stem but unfortunately showing no organic connection with it are pictured in fig. 8; they are more than 7 cm. long, 2 mm. broad, and traversed by a single midnerve.

Another specimen in fig. 9 shows also a portion of a stem; the scars of leaf-bases at node show that the outer surface of the stem is here impressed though the surface is pretty obliterated as if it were originally smooth. The stem is more than 7.5 cm. long and 1.5 cm. broad, the internode being 3.5 cm. long. The leaves at one node may not exceed seven in number in this specimen. The reason why the present specimen has been assigned to *N. hoerensis* is that the internode is longer in comparison with the breadth of the stem and that the leaves are broader and fewer in number, than in *N. carrerei.*

Localities: Hinabata (Loc. No. 45); and Kamihina (Loc. No. 48).

Neocalamites carrerei (ZEILLER)

Pl. XXI (III), Figs. 1–4; Pl. XXII (IV), Figs. 1–2.

1903. *Schizoneura carrerei* ZEILLER: Flore fossile des gîtes de charbon du Tonkin, p. 137, Pl. XXXVI, figs. 1, 2; Pl. XXXVII, fig. 1; Pl. XXXVIII, figs. 1–8.

1908. *Schizoneura carrerei* SEWARD: On a Collection of Fossil Plants from South Africa. Q. J. Geol. Soc., London, Vol. LXIV, p. 85, Pl. II, fig. 1.

1908. *Neocalamites carrerei* HALLE: Zur Kenntnis der mesozoischen Equisetales Schwedens. L.c., p. 6.
1920. *Neocalamites carrerei* YABE: Atlas of Fossils, Pl. I, figs. 2, 3.
1923. *Neocalamites carrerei* KRYSHTOFOVICH: Equivalents of the Lower Jurassic Beds of Tonkin near Vladivostok. Rec. Geol. Com. Russ. Far East, Vladivostok, No. 22, p. 8, Pl. I, figs. 1–3.
1925. *Neocalamites carrerei* KAWASAKI: Some Older Mesozoic Plants in Korea. Bull. Geol. Surv. Korea, Vol. IV, Pt. 1, p. 37, Pl. II; Pl. III, figs. 10–12; Pl. XLIII, fig. 117a; Pl. XLIV, fig. 118; Pl. XLV, fig. 119b; Pl. XLVI, figs. 121, 122.
1927. *Neocalamites carrerei* DU TOIT: The Fossil Flora of the Upper Karroo Beds. Ann. South African Museum, Vol. XXII, Pt. 2, p. 315, Pl. XVI, figs. 2, 3.

N. carrerei is one of the commonest plants in the collection, several specimens of which, though fragmentary, are shown in Pl. XXI (III), figs. 1–4; Pl. XXII (IV), figs. 1–2. Pl. XXI (III), fig. 1 is a portion of stem 8 cm. long, 2 cm. broad, obtained from Shirochi (Loc. No. 16). One can see four nodes in the photograph, the internode being generally 2 cm. long. The surface of the stem is alternately ridged and grooved in the longitudinal direction, about 16–20 ridges being counted in the interval of 1 cm. In the upper left side of the figure is seen a bundle of leaves, which are slightly less than 1 mm. in breadth and traversed by a single nerve. A specimen in Pl. XXI (III), fig. 2, also secured from Loc. No. 16, shows a bundle of leaves possibly arisen from certain nodes which are not clearly shown in the photograph. The rather acute angle between the leaves and the median axis of the stem may indicate that the specimen is from the upper portion of this plant. Here the breadth of the leaves is generally 1 mm. and they are traversed by a single nerve as usual.

Pl. XXI (III), fig. 3 shows a fragment of stem, 7 cm. long and 2.5 cm. broad, in which the nodes are seen in the upper and the lower ends of the specimen respectively, the internode being 5.2 cm. long. The surface of the stem is ridged and grooved alternately in the longitudinal direction just like the preceding, the ridges numbering 20 in the interval of 1 cm. The leaves are 1 mm. broad and single-nerved. Fig. 4 of this plate shows a comparatively large stem, in which two nodes are seen, one in the middle part and the other in the extreme upper end; the stem is more than 15 cm. long and 5 cm. broad and the internode is 7 cm. in length. At the node one can see scars of leaf-bases, which can be counted to about 30 in number on the impression, so the total number at the node

may be about 60. Pl. XXII (IV), fig. 2 shows a stem-fragment attaining 7.5 cm. in breadth, and more than 8.7 cm. long. The scars of the leaf-bases are clearly seen at the node in the photograph. Pl. XXII (IV), fig. 1 shows a stem-fragment obtained from Jitô (Loc. No. 54), representing the broadest stem now found in the collection; it is more than 7.5 cm. in breadth and the internode is 8.5 cm. in length. Some narrow leaves, about 1 mm. broad, often found in close association with stems are not illustrated at this place.

All the specimens described just above differ from the specimens described under the name *N. hoerensis* in having a larger number of narrower leaves and are believed to be specifically identical with the well-known Rhaetic species *N. carrerei* (ZEILLER).

N. carrerei and *N. hoerensis* are common plants in the Rhaetic rocks of the Nariwa district, often occurring almost exclusive of other species of fossil plants. *Equisetites* sp. cfr. *Neocalamites carrerei* as figured by SEWARD[1] and by YABE and ÔISHI[2] from the Jurassic rocks of Afghanistan and China respectively are fragments of stem-impression and it is impossible to determine them specifically or even generically without the indication of any leaf-sheaths or leaves.

Outside Japan, *N. carrerei* is known from Korea, China, Siberia, Tonkin, Australia and South Africa, always confined in occurrence to the Rhaetic and Liassic horizons.

Localities: Shirochi (Loc. No. 10); Koyagaichi (Loc. No. 58); Kamihina (Loc. No. 49); and Jitô (Loc. No. 54).

GENUS *Annulariopsis* ZEILLER

Annulariopsis inopinata ZEILLER?

Pl. XXI (III), Fig. 5; Pl. XXII (IV), Fig. 3.

1930. *Annulariopsis inopinata* ? ÔISHI: Notes on Some Fossil Plants from the Upper Triassic Beds of Nariwa, Prov. Bitchû, Japan. L.c., p. 51, Pl. VII, fig. 1.

In the present writer's previous notes[3] on some fossil plants from the Upper Triassic beds of Nariwa, a fragmental specimen

(1) A. C. SEWARD: Mesozoic Plants from Afghanistan and Afghan-Turkistan. Palaeont. Indica, N.S. Vol. IV, Mem. No. 4, 1912, p. 9, Pl. VII, fig. 85.

(2) H. YABE and S. ÔISHI: Jurassic Plants from the Fang-tzu Coal-Field, Shantung. Jap. Journ. Geol. Geogr., Vol. VI, Nos. 1–2, 1928, p. 4, Pl. I, fig. 1.

(3) S. ÔISHI: Notes on Some Fossil Plants from the Upper Triassic Beds of Nariwa. L.c.

was described of fossil plant secured from Eda which resembles closely *Annulariopsis inopinata* figured by ZEILLER[1] from the Rhaetic of Tonkin. The additional material at hand contains two new imperfect specimens of similar leaf whorl, but none of them is sufficient for determining definitely. One is from Shirochi (Loc. No. 16) and shown in Pl. XXI (III), fig. 5; five leaves are radially disposed from one center; they are more than 21 mm. long and about 3 mm. broad at their broken upper end thence taper gradually towards the base. As the very base of each leaf is broken it is difficult to decide whether they are free or united at the base. Though fragmentary, the present specimen resembles the specimens figured by ZEILLER from Tonkin, while it differs somewhat in respect to the narrower leaves from a specimen from Eda figured in the writer's previous notes.

Another specimen illustrated in Pl. XXII (IV), fig. 3 is from Eda (Loc. 1) and shows also a part of a whorl in which seven leaves are disposed radially from the center. The leaves are more than 17 mm. in length and 5 mm. wide at their broken upper end, and thence taper gradually towards the narrow free base. The narrow midrib is also faintly observable. The present imperfect specimen may possibly represent the same and the central part of a specimen figured in Pl. VII, fig. 1 in my previous notes.

Localities: Eda (Loc. 1); and Shirochi (Loc. No. 16).

FILICALES

MARATTIACEAE

GENUS *Marattiopsis* SCHIMPER

Marattiopsis muensteri (GOEPPERT)

Pl. XXII (IV), Figs. 4–6.

1842. *Taeniopteris muensteri* GOEPPERT: Les genres des plantes fossiles, Liv. III and IV, p. 51, Pl. IV, figs. 1–3.
1869. *Angiopteridium muensteri* SCHIMPER: Traité de pal. végét., Tom. I, p. 603, Pl. XXXVIII, figs. 1–6.
1874. *Marattiopsis muensteri* SCHIMPER: Ibid., Tom. III, p. 514.
1931. *Marattiopsis muensteri* ÔISHI: Mesozoic Plants from Kita-Otari, Prov. Shinano, Japan. L.c., p. 242, Pl. XVI, figs. 10, 10a.

For further references see ÔISHI 1931, l.c.

(1) R. ZEILLER: Flore fossile des gîtes de charbon du Tonkin, p. 132 Pl. XXXV, figs. 2–7.

Very recently the present writer[1] reported the occurrence of the well-known Rhaeto-Liassic species *Marattiopsis muensteri* in the Kuruma Bed which he considered to be of the Rhaetic. Though the specimens at hand are two small imperfect fertile pinnae one secured from Kamihina (Loc. No. 49) and the other from Hinabata (Loc. No. 44), yet they show the characteristic sori of Marattiaceae, and there is no doubt at least about their generic determination. On Pl. XXII (IV), an imperfect pinnae in fig. 4 is at least 4.5 cm. in length and 1.8 cm. in breadth and traversed by a midnerve of about 1.2 mm. in breadth. The secondary nerves, given off from the midnerve at a right angle, are simple or once forked close to the midnerve, generally numbering 12 per cm., and each one has near its end a linear synangium about 5 mm. in length, with fine transverse wrinkles on its surface. Another specimen in fig. 5 is also an imperfect pinna; it is more than 9 cm. in length and it is slightly broader than the preceding, being 2.2 cm. across and traversed by a thicker midnerve which is 2.5 mm. in breadth, though otherwise similar.

Specimens here assigned to *M. muensteri* differ somewhat from the usual type of pinnae of the species in having slightly longer synangia; in this point they should rather be assigned to *M. hoerensis*[2] which is said to be distinguishable from *M. muensteri* in having longer synangia and a more cordate base of the pinna; but, as KAWASAKI[3] pointed out, the length of synangia varies considerably even in one pinna in each of both species, and it is difficult to accertain in our present state of knowledge to what extent the limit of length of synangia is constant in one pinna or species; so the author dared provisionally to assign all the present specimens to the species above cited until better specimens are at hand. The basal character of the pinnae is obscure in ours.

Localities: This species is common in the plant-beds of Hinabata (Loc. No. 44); and Kamihina (Loc. No. 49).

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(1) S. ÔISHI: Mesozoic Plants from Kita-Otari, Prov. Shinano, Japan. L.c., p. 242, Pl. XVI, figs. 10, 10a.

(2) W. PH. SCHIMPER: Traité de paléontologie végétale, Tom. I, 1869 p. 604, Pl. XXXVIII, fig. 7. E. ANTEVS: Die liassische Flora des Hoersandsteins. Kgl. Svensk. Vet.-Akad. Handl., Bd. LIX, No. 8, 1919, p. 21, Pl. II, figs. 2–13; Pl. VI, fig. 40.

(3) S. KAWASAKI: Some Older Mesozoic Plants in Korea. L.c., p. 27.

OSMUNDACEAE

GENUS *Todites* SEWARD

Todites roesserti ZEILLER (non PRESL)

Pl. XXII (IV), Figs. 7–9; Pl. XXIII (V), Figs. 1–3.

1903. *Cladophlebis* (*Todea*) *roesserti* ZEILLER: Flore fossile des gîtes de charbon du Tonkin, p. 38, Pl. II, figs. 1–7; Pl. III, figs. 1–3.

Pl. XXII (IV), figs. 7–9 and Pl. XXIII (V), figs. 1–3 show specimens of some fagmental fern pinnae, both sterile and fertile, which can hardly be distinguished from *Cladophlebis* (*Todea*) *roesserti* figured and described by ZEILLER[1] from the Rhaetic of Tonkin. A specimen in Pl. XXIII (V), fig. 1 represents a lower portion of a pinna attached to a thick rachis which can be partly seen in the extreme left of the figure. This shows that the frond is at least bipinnate. The complete length of the pinna is not known, but it is more than 5 cm. It is about 4.3 cm. in breadth. The pinna-rachis which makes approximately 80° angle with the rachis is nearly straight and 1.5 mm. in breadth. The pinnules are closely set, slightly falcate, broadest at the base, thence narrowing gradually towards the subacute apex, and attached by their whole base at a wide angle. The midnerve which is not so much stronger than the secondary nerves dissolves into the latter at a short distance from the origin. The secondary nerves are crowded, arching, and usually twice forking; the basal upper ones bend very markedly outwards, which enhances the Alethopteroid aspect of the nervation. Pl. XXII (IV), fig. 7 shows also an imperfect pinna in which the nervation of the pinnules is clearly seen. Pl. XXII (IV), fig. 8 and Pl. XXIII (V), fig. 2 show fragmental fertile pinnae which consist of a pinna-rachis to which sori-bearing pinnules are attached suboppositely. Fertile pinnules similar in form and size to the sterile are covered by small rounded sori, the internal structure of which, however, can not be made out. Fertile pinnae in Pl. XXII (IV), fig. 9 and Pl. XXIII (V), fig. 3 are from a different locality, but agree in all respects with those in figs. 7 and 8.

The sterile and fertile specimens above described agree well with ZEILLER's *Cladophlebis roesserti* from Tonkin. But they dif-

(1) R. ZEILLER: Flore fossile des gîtes de charbon du Tonkin. L.c.

fer distinctly from the specimens described under the same designation or *Todites roesserti* from Sweden[1], Germany[2] and East Greenland[3] in respect to the more crowded, arching, more frequently forking secondary nerves into which the midnerve dissolves at a short distance from its origin. Specimens bearing the same nervation as ours have been described by HARTZ[4] in 1896 and recently by HARRIS[5] from the Rhaetic of East Greenland under the name *Todea williamsoni* and *Todites* cfr. *williamsoni* respectively. While on the other hand, *Cladophlebis roesserti* figured by NATHORST[6], ANTEVS[7], JOHANSSON[8] and HARRIS[9] are hardly distinguishable from sterile fern fronds commonly known as *C. denticulata* or *C. nebbensis* though HARRIS later renamed the Greenland specimens *C. scariosa* HARRIS. It is a matter of importance in the future to settle whether the fronds bearing crowded and arching secondary nerves should really be identified with those in which the secondary nerves are less crowded, once forking and quite indistinguishable from *C. denticulata.* If the latter should be taken as type of *C. roesserti,* then the former should be called under a distinct name.

HARRIS[10] first states that *Todites roesserti* (PRESL) figured by GOTHAN[11] may probably be distinct from PRESL's species and that *Cladophlebis* (*Todea*) *roesserti* from Tonkin is indistinguishable from *Todites williamsoni.* In his second work on Greenland flora, however, HARRIS[12] included ZEILLER's specimens from Tonkin as a

(1) A. G. NATHORST: Floran vid Höganäs och Helsingborg, 1878, p. 42, Pl. VIII, figs. 1–3. E. ANTEVS: Die liassische Flora des Hörsandsteins. L.c., p. 18, Pl. II, fig. 1; Text-fig. 2. N. JOHANSSON: Die rhätische Flora der Kohlengruben bei Stabbarp und Skromberga in Schonen. L.c., p. 18, Pl. V, figs. 4–9.

(2) W. GOTHAN: Die unter-liassische (rhätische) Flora der Umgegend von Nürnberg. Abh. naturhist. Gesell. Nürnberg, Vol. XIX, 1914, p. 9, Pl. XVIII, figs. 9, 9a.

(3) T. M. HARRIS: The Rhaetic Flora of Scoresby Sound, East Greenland. L.c., p. 57, Text-figs. 3A–D.

(4) N. HARTZ: Planteforsteninger fra Cap Stewart i Østgrønland, 1896, p. 232, Pl. XII, figs. 4, 4a.

(5) T. M. HARRIS: The Rhaetic Flora of Scoresby Sound, East Greenland. L.c., p. 55, Text-fig. 2F.

(6) A. G. NATHORST: Flora vid Höganäs och Helsingborg. L.c.

(7) E. ANTEVS: Die liassische Flora des Hörsandsteins. L.c.

(8) N. JOHANSSON: Die rätische Flora der Kohlengruben bei Stabbarp und Skromberga in Schonen. L.c.

(9) T. M. HARRIS: The Rhaetic Flora of Scoresby Sound. L.c.

(10) T. M. HARRIS: Ibid., p. 59.

(11) W. GOTHAN: Die unter-liassische (rhätische) Flora der Umgegend von Nürnberg. L.c.

(12) T. M. HARRIS: The Fossil Flora of Scoresby Sound, East Greenland. L.c., p. 31, Pl. XI, figs. 3, 8; Text-figs. 6–7.

synonym of *Todites goeppertianus* to which the present specimens also are comparable.

Lastly, *Asplenium roesserti* figured by SCHENK[1] from the Rhaetic of Persia is closely allied to *Cladophlebis nebbensis*, while *C. roesserti* figured by MOELLER[2] from Bornholm may most probably be a *C. haiburnensis*.

Localities: Kamihina (Loc. No. 48); and Eda (Loc. No. 33).

Todites williamsoni (BRONGNIART)

Pl. XXIII (V), Figs. 4–6.

1828. *Pecopteris williamsoni* BRONGNIART: Hist. vég. foss., I, p. 324, Pl. CX, figs. 1, 2.
1828. *Pecopteris whitbiensis* BRONGNIART: Ibid., p. 321, Pl. CIX, figs. 2–4.
1828. *Pecopteris tenuis* BRONGNIART: Ibid., p. 322, Pl. CX, figs. 3, 4.
1833. *Neuropteris recentior* LINDLEY and HUTTON: Fossil Flora of Great Britain, Vol. I, Pl. LXXVIII.
1833. *Pecopteris williamsoni* LINDLEY and HUTTON: Ibid., Vol. II, Pl. CXXVII.
1835. *Pecopteris dentata* LINDLEY and HUTTON: Ibid., Vol. III, Pl. CLXIX.
1835. *Pecopteris recentior* PHILLIPS: Geology of Yorkshire, Pt. I, 2nd Ed., p. 119, Pl. VIII, fig. 15.
1868. *Acrostichites williamsoni* EICHWALD: Lethaea Rossica, p. 17, Pl. II, fig. 3.
1885. *Todea williamsoni* SCHENK: Die waehrend der Reise des Grafen Bela Széchenyi in China gesammelten fossilen Pflanzen. Palaeontogr., Vol. XXXI, p. 168, Pl. III, fig. 3.
1889. *Asplenium whitbiensis* YOKOYAMA: Jurassic Plants from Kaga, Hida, and Echizen. Journ. Coll. Sci., Imp. Univ. Tôkyô, Vol. III, Pt. I, p. 31, Pl. III, fig. 3; Pl. X, figs. 1, 1a.
1890. *Todea williamsoni* RACIBORSKI: Ueber die Osmundaceen und Schizaeazeen der Juraformation. Engler's Bot. Jahrb., Bd. XIII, Heft 1, p. 1, Pl. I, figs. 7–10.
1900. *Todites williamsoni* SEWARD: Notes on Some Jurassic Plants in the Manchester Museum. Mem. Proc. Lit. Phil. Soc. Manchester, Vol. XIV, Pt. 3, Pl. I, figs. 1, 2.
1900. *Todites williamsoni* SEWARD: Jurassic Flora, Pt. I, p. 87, Pl. XIV, figs. 2, 5, 7; Pl. XV, figs. 1–3; Pl. XXI, fig. 6; Text-fig. 12.

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(1) A. SCHENK: Fossile Pflanzen aus der Albourskette. Bib. Bot., Heft No. 6, 1887, p. 2, Pl. I, figs. 2–4; Pl. II, figs. 8, 10; Pl. IV, fig. 19; Pl. VI, fig. 33; Pl. VII, fig. 36.

(2) H. MOELLER: Bidrag till Bornholms Fossila Flora. Pteridofyter. Lunds Univ. Årsskrift, Bd. XXXVIII, Af. 2, No. 5, 1902, p. 27, Pl. II, fig. 21.

1911. *Todites williamsoni* SEWARD: The Jurassic Flora of Sutherland. Trans. Roy. Soc. Edinburgh, Vol. XLVII, Pt. IV, p. 667, Pl. II, figs. 27, 27A; Pl. 1V, fig. 57; Pl. VII, fig. 15.

1913. *Todites williamsoni* HALLE: The Mesozoic Flora of Graham Land. Wiss. Ergebn. schwed. Suedpolar-Exped., 1901-1903, Bd. III, Lief. 14, p. 11, Pl. III, figs. 1–5; Pl. VIII, fig. 1b.

1914. *Todites williamsoni* ANTEVS: Die liassische Flora des Hoersandsteins. L.c., p. 20, Pl. I, figs. 20, 21, 22?

1925. *Cladophlebis* (*Todites*) *williamsoni* forma *whitbiensis* KAWASAKI: Some Older Mesozoic Plants in Korea. L.c., p. 21, Pl. IV, fig. 13.

1925. *Cladophlebis* (*Todites*) *williamsoni* KAWASAKI: Ibid., p. 24, Pl. XXXVI, fig. 101.

This species occurs more or less in fragmentary state in the plant-bed of Hinabata (Loc. No. 66). Pl. XXIII (V), fig. 4 shows three pinnae arranged in parallel probably attached to the main rachis unfortunately not seen in the photograph. The pinnae are nearly parallel-sided, more than 5 cm. in length, 1.7 cm. in breadth and seem to be nearly parallel-sided throughout their whole length. The pinnules, which make a wide angle with the pinna-rachis, are closely set, broadest at the base, attenuating gradually towards the apex, slightly falcate, lateral margins sometimes overlapping each other laterally and attached to the pinna-rachis by the whole base. The midnerve sends off secondary nerves at an acute angle which are curving and usually twice dichotomising. The margin of the pinnules seems to be almost entire. Another specimen in fig. 5 shows fragments of pinnae in which the nervation is very clearly seen. Fig. 6 shows a fertile pinna, which is more than 5.5 cm. in length and uniform in breadth throughout the whole length or very slightly narrowing towards the apex. The sori-bearing pinnules which are somewhat distantly attached to the axis, are smaller in size than the sterile pinnules and very obscure in nervation. The margin seems to be irregularly lobed, but this feature is not clearly recognizable. The sori are densely distributed on the surface, possibly the lower, of the pinnules, but their internal structure can not be made out because of the unsatisfactory preservation of the specimen.

The sterile specimens here illustrated agree in all respects with those of *Todites williamsoni* hitherto recorded from several localities in the world. But the fertile pinnae differ somewhat from those previously recorded in the smaller size of the pinnules, though such difference may be of too minute importance to separate the

present form specifically from the ordinary pinnae with typical larger sori-bearing pinnules. SEWARD[1] believes the specific identity of the type specimen of *Todites williamsoni, Pecopteris williamsoni* BRONGN., and *P. whitbiensis* BRONGN., all derived from the Jurassic of Yorkshire coast; while KAWASAKI, laying too much stress on the form of sterile pinnules, retained the name *williamsoni*[2] for short ovoid pinnules and proposed to apply the name *williamsoni* forma *whitbiensis*[3] for pinnules which are shortly triangular in shape and slightly falcate, ending in an obtusely pointed apex. In the present writer's opinion, however, KAWASAKI's *Cladophlebis williamsoni* forma *whitbiensis* agrees very well with the sterile pinnae of BRONGNIART's *Pecopteris williamsoni* from Yorkshire, and it seems that there is no need of calling the Korean specimen under a new designation. On the contrary, KAWASAKI's *Cladophlebis williamsoni* has pinnules which are shortly ovoid in outline, and the present writer has a feeling that the Korean specimen might more correctly have been referred to some other species.

Todites williamsoni is known from many Middle and Lower Jurassic rocks in the Northern Hemisphere, and the occurrence of this species in the present district is particularly interesting, as it is geologically the oldest occurrence in the world. *Todea williamsoni* described by HARTZ[4] from the Rhaetic beds of East Greenland and subsequently by HARRIS[5] as *Todites* cfr. *williamsoni* is quite identical with the specimens which have been referred to *Todites roesserti* in the present work, the account of which was given in the descriptive part of the latter species. From Japan some sterile fronds were figured as *Cladophlebis whitbiensis* by YOKOYAMA[6] from the Tetori Series of Central Japan and by KAWASAKI[7] from Korea.

Localities: Hinabata (Loc. Nos. 44 and 66).

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(1) A. C. SEWARD: Jurassic Flora, Pt. I, 1900, p. 87.

(2) S. KAWASAKI: Some Older Mesozoic Plants in Korea. L.c., p. 24.

(3) S. KAWASAKI: Ibid., p. 21.

(4) N. HARTZ: Planteforsteninger fra Cap Stewart i Østgrønland, 1896, p. 232, Pl. XII, figs. 4, 4a.

(5) T. M. HARRIS: The Rhaetic Flora of Scoresby Sound, East Greenland. L.c., p. 55, Text-fig. 2F.

(6) M. YOKOYAMA:—Jurassic Plants from Kaga, Hida, and Echizen. L.c., p. 31, Pl. III, fig. 3; Pl. X, figs. 1, 1a.

(7) S. KAWASAKI: Some Older Mesozoic Plants in Korea. L.c., pp. 21 and 24.

Todites princeps (PRESL)

Pl. XXIII (V), Fig. 7.

1833. *Sphenopteris princeps* PRESL: In STERNBERG's Versuch einer geognostisch-botanischen Darstellung der Flora der Vorwelt, II, Fasc. V & VI, p. 126, Pl. LIX, figs. 12, 13.
1838. *Pecopteris obtusa* PRESL: In STERNBERG's Versuch, II, Fasc. VII, p. 155, Pl. XXXII, figs. 2, 4.
1842. *Sphenopteris princeps* GOEPPERT: Les Genres des Plantes Fossiles, Liv. III & IV, p. 72, Pl. X, figs. 3–7.
1842. *Sphenopteris patentissima* GOEPPERT: Les Genres des Plantes Fossiles, Liv. III & IV, p. 73, Pl. X, fig. 8.
1850. *Sphenopteris princeps* UNGER: Genera et Species, p. 119.
1869. *Pecopteris* (*Acrostichites*) *princeps* SCHIMPER: Traité de paléontologie végétale, Tom. I, p. 529.
1890. *Sphenopteris princeps* RACIBORSKI: Ueber die Osmundaceen und Schizaeaceen der Juraformation. L.c., p. 4, Pl. I, figs. 11–15.
1902. *Acrostichites princeps* MOELLER: Bidrag till Bornholms Fossila Flora. Pteridofyter. L.c., p. 26, Pl. II, fig. 19.
1903. *Sphenopteris princeps* ZEILLER: Flore fossile des gîtes de charbon du Tonkin, p. 23, Pl. I, figs. 1, 2.
1914. *Todites princeps* GOTHAN: Die unter-liassische (rhaetische) Flora der Umgegend von Nürnberg. L.c., p. 95, Pl. XVII, figs. 3, 4.
1926. *Todites* cfr. *princeps* HARRIS: Rhaetic Flora of Scoresby Sound, East Greenland. L.c., p. 56, Pl. XII, fig. 5; Text-figs. 2A–E.
1931. *Todites princeps* HARRIS: The Fossil Flora of Scoresby Sound, East Greenland. L.c., p. 35, Pl. XI, figs. 1, 2, 4, 9; Pl. XII, fig. 3; Text-figs. 8, 9.

A slender fern. Frond bipinnate at least; frond or penultimate pinna more than 6 cm. in length, nearly uniform in breadth, breadth being about 4 cm. Axis or rachis narrow and slender, 1 cm. in breadth measured on the impression. Ultimate pinnae opposite, perpendicular to the axis, straight, broadly lanceolate, not touching each other laterally, broadest at the base, thence narrowing gradually towards the blunt apex. Pinna-rachis narrow. Pinnules closely set, ovate to elliptical in outline, attached by a slightly contracted and decurrent base like a *Coniopteris*. Nervation of *Cladophlebis*-type. Midnerve decurrent at the base, dissolving to secondary nerves at the apex. Secondary nerves 2–3 in number on each side of midnerve, forking once, the basal upper one forking twice. Margin entire or roughly lobed; in well-developed pinnules the margin being often deeply pinnatified.

Pl. XXIII (V), fig. 7 shows the best specimen of this species in the collection, on which the above description is based. There is often dispute on the specific identity of this Rhaetic species with the Middle Jurassic species *Sphenopteris modesta* LECKENBY. SEWARD[1] once had an opinion that both the species are specifically identical and adopted on several occasions PRESL's names for Jurassic specimens. The same opinion was held also by ZEILLER[2] and recently by HARRIS[3]. Having examined some Dzungarian specimens collected by OBRUTSCHEW, and having them compared with PRESL's species figured by SCHENK, SEWARD[4] found that LECKENBY's species is distinct from *S. princeps* of PRESL, and enumerated the following differences existing between the two species: "In the Rhaetic species the pinnules are more symmetrical along the long axis of the lamina and are characterised by a median vein which gives off forked lateral veins as in *Cladophlebis*. The lamina of the pinnules in LECKENBY's specimen and in the Dzungaria fern is markedly asymmetrical, the abaxial side being straighter than the adaxial margin: moreover the vascular supply enters the lamina near the adaxial edge and subdivides into lateral veins which frequently fork more than once. The edge of the lamina in *S. modesta* is irregularly notched, whereas in *S. princeps* the lobing is more regular." It is by no means clear to us to what extent the differences pointed out above by SEWARD are constant between *S. modesta* and *S. princeps*, unless the comparison is based on the examination of original specimens or more correctly on fertile specimens, yet the present writer wishes to refer the Japanese specimens to PRESL's species on the ground that (a) the bed from which the specimens are derived is believed by the writer to be the Rhaetic, and (b) one of the characteristics, pointed out by SEWARD of this species (margin of pinnules is regularly lobed), is found in our specimens. The lamina of the pinnules of the present specimens is not very asymmetrical, though the midnerve enters the pinnules near the adaxial edge.

The sterile pinnae of *Sphenopteris princeps* here figured resemble, more than any other, *S.* (*Todites*) *princeps* described by

(1) A. C. SEWARD: Jurassic Flora, Pt. I, 1900, p. 151. Seward: Jurassic Plants from Caucasia and Turkestan. Mém. Com. Géol., St.-Pétersbourg, N.S., Liv. 38, 1907, p. 27.

(2) R. ZEILLER: Flore fossile des gîtes de charbon du Tonkin, p. 23.

(3) T. M. HARRIS: The Fossil Flora of Scoresby Sound. L.c., p. 35.

(4) A. C. SEWARD: Jurassic Plants from Chinese Dzungaria. Mém. Com. Géol., St.-Pétersbourg, N.S., Liv. 75, 1911, p. 42.

PRESL[1], GOEPPERT[2], GOTHAN[3] and HARRIS[4]. The species enumerated above in the synonym table do not indicate their belonging to one species, but have been so arranged only for the sake of convenience in reference.

Locality: Kamihina (Loc. No. 49).

OSMUNDACEAE?

GENUS *Cladophlebis* BRONGNIART

Cladophlebis haiburnensis (L. and H.)

Pl. XXIV (VI), Figs. 1–3; Pl. XXVI (VIII), Figs. 1–2.

1837. *Pecopteris haiburnensis* LINDLEY and HUTTON: Fossil Flora of Great Britain, Vol. III, p. 97, Pl. 187.
1931. *Cladophlebis haiburnensis* ÔISHI: Mesozoic Plants from Kita-Otari, Prov. Shinano, Japan. L.c., p. 237, Pl. XVII, fig. 2.

For further references see ÔISHI, 1931, l.c.

A number of impressions of sterile fern fronds agreeing closely in form with those which have been included under this species have been found in several localities in the Nariwa district. The frond is large, attaining at least 40 cm. in length. It is bipinnate at least and bears a thick axis which sometimes attains a breadth of 1 cm. ornamented by a series of longitudinal striations on the surface. The pinnae are long, more than 13.5 cm. in length, touching each other laterally, linear, nearly parallel-sided, the breadth being about 3 cm. throughout the entire length, each traversed by a pinna-rachis which is nearly 1.5 cm. in breadth, and attached at a wide angle to the axis subopppositely, sometimes nearly at a right angle. The pinnules are broadly linear, the length being generally as much as 1.5 to 2 times the breadth, closely set, and are provided with obtusely rounded apex; the pinnules are often characterised by the basal curvature of the adaxial side of each pinna. In texture the pinnules are very thin. The midnerve is distinct but delicate, and persists to the apex assuming a

(1) C. G. VON STERNBERG: Versuch. L.c.
(2) H. R. GOEPPERT: Genres des Plantes Fossiles. L.c.
(3) W. GOTHAN: Die unter-liassische (rhätische) Flora der Umgegend von Nürnberg. L.c.
(4) T. M. HARRIS: Rhaetic Flora of Scoresby Sound, East Greenland. L.c.

straight course. The secondary nerves are fine, crowded, and twice dichotomising.

Pl. XXIV (VI), figs. 1–3 show imperfect fronds derived from Hinabata (Loc. No. 44); they were when first found one large frond finely impressed on a single slab of rock, but the difficulty of splitting off the rock with impression from the mother rock as a large single specimen resulted in its being unavoidably broken into many smaller specimens upon which the writer is now under the necessity of describing them. Of three specimens of fronds here illustrated, the one in fig. 1 corresponds to the upper, fig. 2 to the middle, and the last, fig. 3, to the lower position, if they were restored; this is easily understood from the fact that the breadth of the axis becomes thicker gradually from one to another. From the present material it is highly suggestive that this plant may have attained to nearly 1 meter high at least when the frond is assumed to be bipinnate. Another specimen in Pl. XXVI (VIII), fig. 2 is a small portion of a bipinnate frond, which though imperfect, agrees closely to the preceding specimens.

C. haiburnensis is a common Jurassic plant of the northern hemisphere; in Asia it is known from the Jurassic rocks of Siberia(1), China(2), Korea(3) and Japan(4), and recently the writer described this species from the Rhaetic rocks of Kita-Otari, Prov. Shinano(5).

Localities: Hinabata (Loc. No. 44); Kamihina (Loc. Nos. 40, 48, and 50).

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(1) A. Kryshtofovich: Equivalents of the Lower Jurassic Beds of Tonkin near Vladivostok. L.c., p. 12. A. Kryshtofovich: Contribution to the Jurassic Flora of Middle Siberia. Bull. Com. Géol. Léningrad, Vol. XLVI, 1927, p. 560, Pl. XXXI, figs. 3, 4.

(2) H. Yabe and S. Ôishi: Jurassic Plants from the Fang-tzu Coal-Field, Shantung. L.c., p. 5, Pl. I, fig. 2; Pl. III, fig. 1. H. Yabe: Mesozoic Plants from Japan, Korea and China. Sci. Rep., Tôhoku Imp. Univ., 2nd Ser., Vol. VII, No. 1, 1922, p. 18, Text-fig. 12. *Todites williamsoni* figured by M. Yokoyama from several localities in China (M. Yokoyama: Mesozoic Plants from China. L.c.) seems to contain more than one different form: the present writer is of the opinion that Yokoyama's *T. williamsoni* from Nien-tzu-kou should be included in *C. haiburnensis*; on this point, it may be discussed in H. Yabe and S. Ôishi: Mesozoic Plants from Manchuria, in preparation.

(3) S. Kawasaki: Some Older Mesozoic Plants in Korea. L.c., p. 18, Pl. V, figs. 16–20; Pl. VI, figs. 21, 22. H. Yabe: Notes on Some Mesozoic Plants from Japan, Korea and China. L.c., p. 16, Text-figs. 13, 14; Pl. II, fig. 9.

(4) H. Yabe: Mesozoic Plants from Japan, Korea and China. L.c., p. 19, Text-figs. 15, 16; Pl. II, fig. 10 (non fig. 11; this is a form very similar to *Cladophlebis raciborskii*. Cf. S. Ôishi: Mesozoic Plants from Kita-Otari, Prov. Shinano. L.c., p. 237).

(5) S. Ôishi: Mesozoic Plants from Kita-Otari. Op. cit.

Cladophlebis gigantea sp. nov.

Pl. XXV (VII), Fig. 2.

Frond at least bipinnate; frond or penultimate pinna more than 20 cm. in length, bearing a thick axis which is about 7 mm. in breadth measured on the compressed surface; surface of the axis ornamented by a series of longitudinal striations. Ultimate pinnae more than 10 cm. in length and 5 cm. in breadth at the base, thence attenuate towards the apex, touching or overlapping each other laterally, and attached to the axis subopposite making an angle of about 50° with it. Pinna-rachis about 2 mm. in breadth. Pinnules, with lamina of delicate texture, subopposite, broadest at the base, thence attenuating gradually towards the bluntly rounded apex, straight, closely set, and attached to the pinna-rachis by their whole base nearly at right angle. Nervation delicate and very crowded; from the well-defined midnerve which is straight and persistent to the apex of pinnule are sent off secondary nerves at a wide angle which are slightly arching, and forked three times, first close to the midnerve, secondly midway and lastly near the margin of pinnules, thus making a bundle of nervelets. Margin of pinnules sometimes shallowly crenulated or lobed, each marginal lobe corresponding to a bundle of nervelets. Fructification not known.

So far as the writer knows, there is no known species with which the present form should be identified. Judging from the thick axis of frond or penultimate pinna, this fern may attain a considerable size in its whole length. The distance between two adjacent pinnae on each side of the axis is nearly 5 cm., and accordingly the pinnae always overlap each other laterally. The margin of pinnules seems to be not always crenulated; the lower pinnules of a pinna usually have crenulated margin, while they become gradually entire towards the apex of the pinnae. The large size of pinnules which often have crenulated margins and the crowded secondary nerves are the characteristic features of this species.

Recently the present writer[1] reported a fern fragment under the name *Cladophlebis* sp. a which was also characterised by hav-

(1) S. Ôishi: Mesozoic Plants from Kita-Otari, Prov. Shinano. L.c., p. 238, Pl. XVII, fig. 3.

ing large pinnules and crowded secondary nerves just like the present specimen from the Rhaetic beds of Kita-Otari, Prov. Shinano; it differs from this only in having larger pinnules with entire margin. Otherwise both are very closely allied to each other.

Locality: Hinabata (Loc. No. 44).

Cladophlebis bitchuensis sp. nov.

Pl. XXV (VII), Fig. 1.

A single specimen in Pl. XXV (VII), fig. 1 does not agree with any known species of fossil plants. Description follows: Frond large, at least bipinnate; frond or penultimate pinna more than 40 cm. in length and 30 cm. in breadth. Rachis or axis comparatively delicate, being generally 5 mm. in breadth; the surface finely striated in the longitudinal direction. Ultimate pinnae alternate or subopposite, long and narrow, linear-lanceolate in outline, touching each other laterally and of nearly the same breadth througout their whole length. Pinna-rachis also delicate, being 1–1.5 mm. in breadth, and sometimes flexuous possibly due to the preservation. Pinnules, with lamina of delicate texture, broadly linear in outline, the sides being nearly parallel or in short pinnules slightly converging, closely set, and attached to the pinna-rachis by the whole base making a wide angle with it, generally 70° or sometimes a right angle. Apex of pinnules bluntly pointed or obtusely rounded. Midnerve distinct but delicate; in smaller pinnules not much thicker than the secondary nerves, decurrent at the base, often bending slightly forwards in the upper half of the pinnules. Secondary nerves slightly arching and dividing three times.

This species is of the type of *Cladophlebis haiburnensis* (L. and H.) and the general habit of the frond and the shape and size of pinnules recall that species strongly to mind; but the careful examination of the nervation has revealed that the secondary nerves are always thrice dichotomising in ours, though in the young and smaller pinnules they are often twice forking; and as the mode of branching of the secondary nerves occurs so constantly in the large specimen at hand, the author decided to treat the present specimen as a new species.

Locality: Hinabata (Loc. No. 44).

Cladophlebis nebbensis (BRONGNIART)

Pl. XXIV (VI), Figs. 4–5; Pl. XXVII (IX);
Pl. XXIX (XI), Fig. 1; Pl. XXX (XII), Fig. 1;
Pl. XXXIX (XXI), Fig. 5C.

1833. *Pecopteris nebbensis* BRONGNIART: Hist. végét. foss., I, p. 299, Pl. 98, fig. 3.

1931. *Cladophlebis nebbensis* ÔISHI: Mesozoic Plants from Kita-Otari, Prov. Shinano, Japan. L.c., p. 231, Pl. XVI, figs. 4, 4a.

For further references see ÔISHI, 1931, l.c.

Pl. XXVII (IX) shows the largest specimen of this species in the collection; it is at least bipinnate, narrowing gradually towards the apical region, more than 19 cm. in length, traversed by a slender but rigid rachis to which the pinnae are attached subopositely. The outline of the frond is not known. The ultimate pinnae are more than 9 cm. in length and 1.8 cm. in breadth, linear in outline, or tapering very gradually from the base upwards to a blunt apex, closely set or touching each other laterally and making a wide angle with the rachis. It is noteworthy that the pinna-rachis is nearly of the same strength as the rachis. The pinnules are alternate, closely set, nearly parallel-sided or tapering towards the obtusely rounded apex, nearly straight or very slightly falcate with apex directed forwards and making a wide angle with the pinna-rachis. The midnerve is distinct, persisting to the apex of the pinnules and sends off once forking secondary nerves at an angle of 45°. The margin is entire.

The apex of frond or penultimate pinna is seen in a specimen in Pl. XXIV (VI), fig. 4, though the very tip is broken. The ultimate pinnae are usually closely set or slightly touching each other laterally, but they are sometimes slightly distant. Such specimens are shown in Pl. XXIV (VI), fig. 4 and Pl. XXX (XII), fig. 1. The most remarkable thing is that the pinnules vary in considerable degree in different specimens. While the pinnules in Pl. XXVII (IX) are about 9 mm. long and 2.5–3 mm. broad, the length thus being about 3 times the breadth, the pinnules in Pl. XXIV (VI), fig. 5 are much shorter, generally 7 mm. long and 5 mm. broad making the length only 1.4 times the breadth.

Some Swedish specimens figured by JOHANSSON from the Rhaetic of Stabbarp as *C. nebbensis*[1] seem to differ somewhat from the ordinary type of this species, the pinnules bearing twice forking secondary nerves, while *C. svedbergii*[2] also from Stabbarb is very similar to a form of *C. nebbensis* though the pinnules are slightly more acuminated than those in the present specimens.

Recently HARRIS[3] gave a new specific name, *Todites hartzi* HARRIS, for *Cladophlebis roesserti groenlandica* HARTZ from Greenland which has generally been considered to be identical with *C. nebbensis*. HARRIS distinguished *T. hartzi* from *C. nebbensis* in the former's having a larger sterile frond and further mentioned that "the pinnules of the two species have somewhat different venation and the marginal teeth, which are distinct in *T. hartzi*, are absent in *C. nebbensis* as described by JOHANSSON." As I have mentioned, the pinnules of *C. nebbensis* are often toothed and the secondary nerves are once forking just as in *T. hartzi*. Thus the only possible distinction between these two species lies in the future comparison of the fertile examples, which have hitherto been studied by HARRIS only in *T. hartzi* from Greenland.

Localities: *C. nebbensis* is rather common in the plant-bed of Eda (Loc. No. 1); it occurs also at Eda (Loc. No. 33); Hinabata (Loc. No. 44); Suimyô (Loc. No. 69); and Jitô (Loc. No. 55).

Cladophlebis raciborskii ZEILLER

Pl. XXVI (VIII), Fig. 3; Pl. XXVIII (X), Figs. 1–4.

1903. *Cladophlebis raciborskii* ZEILLER: Flore fossile des gîtes de charbon du Tonkin. L.c., p. 49, Pl. V, fig. 1.

We have a number of imperfect specimens of fern fronds which are hardly distinguishable from *Cladophlebis raciborskii* figured by ZEILLER from the Rhaetic of Tonkin. Pl. XXVIII (X), fig. 1 shows four ultimate pinnae arranged in parallel suggesting their arising from a common axis. The pinnae are more than 7 cm. in

(1) N. JOHANSSON: Die rhätische Flora der Kohlengruben bei Stabbarp und Skromberga. L.c., p. 14, Pl. II, figs. 1–3; Pl. VII; fig. 7; Text-figs. 2, 3.

(2) N. JOHANSSON: Ibid., p. 19, Pl. I, figs. 37, 38; Pl. VII, figs. 1–6.

(3) T. M. HARRIS: The Fossil Flora of Scoresby Sound, East Greenland. L.c., p. 44, Pl. X, figs. 1–6; Text-figs. 13–14.

length, about 3 cm. in breadth, touching each other laterally, nearly parallel-sided throughout their whole length and narrow rather abruptly to an obtuse apex. The pinnules are alternate, closely set, slightly falcate, broadest at the base, thence they narrow gradually to an acuminate apex. The midnerve making approximately 70° with the slender pinna-rachis is distinct, persisting to the apex of the pinnules, and sends off twice forking secondary nerves at an angle of about 45°. The upper half of the margin of the pinnules is finely dentate. Another specimen in fig. 2 shows also an imperfect specimen of pinnae arranged in parallel and all the features available agree well with the preceding one.

A specimen in Pl. XXVI (VIII), fig. 3 differs slightly from ZEILLER's specimens in having entire margin and is of the same type as some pinnae which the present writer recently described from the Rhaetic of Kita-Otari under the name *Cladophlebis* cfr. *raciborskii*. Specimens in Pl. XXVIII (X), figs. 3 and 4 closely resemble ZEILLER's specimens in the general habit of pinnae, especially in the shape of pinnules which are provided with dentate margin, while they differ from them in having once forked secondary nerves. As the writer has already stated[1], it is not certain to what extent the dentation of the pinnules occurs constantly or whether it is limited to a certain portion in a frond, and the same is to be said also on the secondary nerves which in some specimens are once forking while in the others twice. Under these considerations the writer wishes to hold such specimens as in Pl. XXVI (VIII), fig. 3 and Pl. XXVIII (X), figs. 3–4 as *C.* cfr. *raciborskii* without referring them directly to *C. raciborskii* from Tonkin.

Cladophlebis haiburnensis (L. and H.) from Afghanistan[2] and *C. ingens* HARRIS from Greenland[3] show a striking resemblance to *C.* cfr. *raciborskii* here illustrated.

Localities: *C. raciborskii*:—Hinabata (Loc. No. 44); *C.* cfr. *raciborskii*:—Hinabata (Loc. No. 44); and Kamihina (Loc. Nos. 47, 48 and 49).

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(1) S. ÔISHI: Mesozoic Plants from Kita-Otari, Prov. Shinano. L.c., p. 235.

(2) A. C. SEWARD: Mesozoic Plants from Afghanistan and Afghan-Turkistan. Palaeont. Indica, N.S., Vol. IV, Mem. No. 4, 1912, p. 19, Pl. II, figs. 31–35.

(3) T. M. HARRIS: The Fossil Flora of Scoresby Sound. L.c., p. 55, Text-figs. 17A–D.

Cladophlebis denticulata (BRONGNIART)

Pl. XXIX (XI), Figs. 3–7.

1833. *Pecopteris denticulata* BRONGNIART: Hist. végét. foss., I, p. 301. Pl. XCVIII, figs. 1, 2.
1931. *Cladophlebis denticulata* ÔISHI: Mesozoic Plants from Kita-Otari, Prov. Shinano, Japan. L.c., p. 233, Pl. XVI, figs. 5, 5a.

Pl. XXIX (XI), fig. 3 shows a portion of a bipinnate frond which may be referable to this species commonest in the Mesozoic rocks. The rachis is rather thin, being less than 2 mm. in breadth measured on the impression. The pinnae are attached oppositely at an angle of approximately 45°. The pinnae are linear and straight, and narrow gradually towards an acuminate apex. The pinnules are alternate, triangular in form, slightly falcate, and attached by their whole base to the pinna-rachis at an angle of 45°. The midnerve, whose base is close to the lowest base of the pinnule, sends off once forking secondary nerves.

Some fragmental pinnae bearing pinnules, characterised by falcate and triangular form but somewhat larger than those in the preceding specimen are shown in figs. 4–7; they all have once forking secondary nerves.

It is often very difficult to distinguish *C. denticulata* from *C. nebbensis* on the basis of a sterile specimen, especially when the example is very small. At his place, however, I prefer to assign the specimens here illustrated to the species above named taking the falcate and deltoid to triangular form of the pinnules into consideration, features not often met with in *C. nebbensis*.

Localities: Kamihina (Loc. No. 49); Hayama (Loc. No. 30); Shirochi (Loc. Nos. 10 and 16); and Suimyô (Loc. No. 69).

Cladophlebis pseudodelicatula sp. nov.

Pl. XXIX (XI), Fig. 2.

1931. *Cladophlebis* sp. b. ÔISHI: Mesozoic Plants from Kita-Otari, Prov. Shinano. L.c., p. 238, Text-fig. 2.

Frond probably bipinnate. Ultimate pinnae very slender, more than 5 cm. in length, linear-lanceolate in outline, touching each other laterally, tapering very gradually from the base upwards to an acuminate apex, and traversed by a thin and slender pinna-rachis. Pinnules linear to elongate-lanceolate in outline,

closely set, and attached to the pinna-rachis perpendicularly by their whole base. Apex of pinnules subacutely pointed. Margin entire. Midnerve distinct and straight. Secondary nerves giving off from the midnerve at an angle of approximately 45°, forking once, branches forming a narrow angle.

The frond is possibly bipinnate at least, but as the principal axis has not been preserved, the mode of attachment of the pinnae to the axis is not clear. The pinnae are very slender and often flexuous, possibly by preservation. The pinnules are long and narrow, the length being generally five times as great as the breadth; they are usually perpendicular to the pinna-rachis, but they become oblique towards the apex.

C. pseudodelicatula is closely akin to *C. argutula* (HEER) originally described by HEER[1] and later by I. NOVOPOKROVSKIJ[2] from Siberia as *Asplenium argutulum,* but the pinnae in our specimens are more markedly delicate and slender than those of the Siberian species. An imperfect pinna which the present writer[3] described recently from the Rhaetic rocks of Kita-Otari as *Cladophlebis* sp. b. belongs possibly to the present species. A most comparable species is *C. delicatula* YABE and ÔISHI[4] from the Jurassic of Manchuria, from which, however, ours is distinguished by the secondary nerves, branches of which subtend a narrower angle than in the Manchurian species.

Locality: Hinabata (Loc. No. 44).

DIPTERIDACEAE

GENUS *Clathropteris* BRONGNIART

Clathropteris meniscoides (BRONGN.) var. *elegans* var. nov.

Pl. XXIX (XI), Fig. 8; Pl. XXX (XII), Figs. 3–4;
Pl. XXXI (XIII), Figs. 1–2; Pl. XXXIII (XV), Fig. 1.

Frond petiolate, petiole being characterised by an equal dichotomy at the top. Pinnae 7–9 in number to each arm, disposed

(1) O. HEER: Beitraege zur Juraflora Ostsibiriens und des Amurlandes. Mém. l'Akad. Sci. St.-Pétersbourg, Ser. VII, Vol. XXII, No. 12, 1876, Pl. XIX, fig. 3.

(2) I. NOVOPOKROVSKIJ: Beitraege zur Kenntnis der Jura-Flora des Tyrma-Thal, 1912, p. 20, Pl. I, figs. 5, 5a.

(3) S. ÔISHI: Mesozoic Plants from Kita-Otari, Prov. Shinano. L.c., p. 238, Text-fig. 2.

(4) H. YABE and S. ÔISHI: Mesozoic Plants from Manchuria. Sci. Rep. Tôhoku Imp. Univ., 2nd Ser., Vol. XIV, No. 2B (in preparation).

flabellately, reaching a length of about 10 cm. and a breadth of 2 cm., nearly parallel-sided, and characterised by subacutely or obtusely pointed marginal lobes. Lamina fused basally for a distance generally of 2–5 cm. Midnerve distinct, straight or slightly curved. Secondary nerves making an angle of approximately 60°–70° with the midnerve, distinct, each ending at the tip of marginal lobe. Tertiary nerves at right angle to the secondaries, forming characteristic rectangular meshes. Quarternary nerves not visible. Fused area of lamina filled with irregular polygonal meshes, without sending off secondary nerves from the midnerve. Sori rounded, numerous, covering the lower surface of pinna; their inner structure not known.

Pl. XXXI (XIII), fig. 1 shows an imperfect pinna consisting of nine pinnae disposed flabellately from an arm. In fig. 2 one may see two groups of imperfect pinnae which partly overlapping each other, each group suggesting its springing up from an arm which unites together below to a common petiole. Pl. XXX (XII), fig. 4 represents a portion of a fertile frond; the sori marked as a circular impression elevated somewhat from the surface of the lamina are numerously distributed all over the surface, probably the lower, of the lamina, but their detailed character can not be made out.

Compared with the typical specimens of *Clathropteris meniscoides* hitherto illustrated from several Rhaetic and Lower Jurassic localities in the world, the present form is distinguished first by the decidedly smaller size and elegant nature of the frond, secondly by the indistinct nature of tertiary and quarternary nerves, and lastly by the more or less linear and parallel-sided pinnae. Examining the rich material now at hand, the size of the fronds is always constant and one can not consider them to be young fronds of *C. meniscoides*. The tertiary nerves which form the reticular meshes between the secondary nerves ar always indistinct and very faintly visible by the aid of a magnifier, while the midnerve and the secondaries are delicate but distinct.

In size and form, the following specimens resemble ours more or less: certain specimens of *Clathropteris platyphylla* BRONGN. by SAPORTA[1] and ZEILLER[2]; *Dictyophyllum nilssoni* SCHENK? by

(1) M. DE SAPORTA: Plantes Jurassiques, Tom. I, 1873, p. 333, Pl. XXXVII, figs. 1, 2.

(2) R. ZEILLER: Flore fossile des gîtes de charbon du Tonkin, p. 119, Pl. XXXIV, fig. 1.

BARTHOLIN[1]; *D. acutilobum* BRAUN by JOHANSSON[2]; and *D. davidi* WALKOM by WALKOM[3].

Locality: Eda (Loc. No. 1).

Clathropteris obovata sp. nov.

Pl. XXX (XII), Fig. 2; Pl. XXXII (XIV), Fig. 1.

Pinnae crowded, closely set, overlapping each other laterally, obovate in outline, more than 12 cm. long, and 6–8 cm. broad at a short distance below the apex to which the pinnae narrow abruptly, and more gradually towards the fused base. Margin subacutely and deeply lobed, a lobe being triangular in outline, with the upper margin straight or slightly concave and the lower margin convex below. Nervation distinct. Midnerve lightly undulating and slightly curved. Secondary nerves also lightly undulating, making an approximately 70° angle with the midnerve, each ending at a tip of a marginal lobe. Tertiary nerves nearly perpendicular to the secondaries, forming reticular meshes of *Clathropteris*-type.

The present form is very similar to *Clathropteris meniscoides* BRONGN., and seems to be almost referable to that well-known species; in the Japanese form, however, the pinnae are obovate in outline, the length being short compared with the breadth, and the marginal lobes are much larger and more deeply cut, than in *C. meniscoids.*

A similar form is reported by YABE[4] and KAWASAKI[5] from the Lower Jurassic of Korea as *Clathropteris meniscoides*, but these two authors are probably correct in referring the Korean specimens to that species, though HARRIS[6] bears a distinct opinion.

Localities: Hinabata (Loc. No. 44); Nishihata (Loc. No. 62); and Suimyô (Loc. No. 69).

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(1) C. T. BARTHOLIN: Nogle i den bornholms. Juraformation forekomm. Planteforsteninger. I. Bot. Tidskr., Bd. 12, 1892, p. 25, Pl. X, figs. 5 and 7 (non 6).

(2) N. JOHANSSON: Die rhätische Flora der Kohlengruben bei Stabbarp und Skromberga in Schonen. L.c., p. 9, Pl. IV, fig. 10.

(3) A. B. WALKOM: Mesozoic Floras of Queensland. Pt. I-cont. The Flora of the Ipswich and Walloon Series. Queensl. Geol. Surv. Pub. No. 257, 1917, p. 10, Pl. III, fig. 2.

(4) H. YABE: Notes on Some Mesozoic Plants from Japan, Korea and China. L.c., p. 11, Text-fig. 8.

(5) S. KAWASAKI: Some Older Mesozoic Plants in Korea. L.c., p. 10, Pl. XIII, fig. 45; Pl. XIV, figs. 46–49; Pl. XV, figs. 50–52.

(6) T. M. HARRIS: The Fossil Flora of Scoresby Sound, East Greenland. L.c., p. 89.

GENUS *Thaumatopteris* GOEPPERT

The genus *Thaumatopteris* was instituted by GOEPPERT[1] in 1841, but the genotype *Thaumatopteris muensteri* GOEPP. was later transferred to *Dictyophyllum* by NATHORST[2], and the last named author proposed to keep the generic name *Thaumatopteris* for the species which POPP called *T. brauniana* without illustration.

Thaumatopteris, in the general habit of the frond, closely resembles *Dictyophyllum,* and some authors believe in their generic identity. NATHORST[3], who made valuable contribution on GOEPPERT's genus mentioned in his "Ueber *Thaumatopteris schenki* NATH." that this genus was distinguishable from *Dictyophyllum* in the thin texture of the lamina of frond, regular deep lobing of pinnae up to the pinna-rachis, less distinct nervation, and the smaller dimension of sporangium. HALLE[4] also found a difference in the soral structure in both genera. A more important difference is, as already noted by NATHORST, the mode of disposition of pinnae: in *Dictyophyllum,* the top of the petiole is divided into two arms, to each of which pinnae are attached palmately; while in *Thaumatopteris,* on the other hand, the arms, if any, are very short or more usually the pinnae are disposed in funnel-shape at the top of a vertical petiole indicating no special division of the petiole into two arms. In this last mentioned point, *Thaumatopteris* closely resembles *Laccopteris.* POTONIÉ and GOTHAN[5] mention that it is just an intermediate form between *Laccopteris* and *Dictyophyllum.*

If *Thaumatopteris muensteri* should, after NATHORST, really be transferred to *Dictyophyllum,* there yet remain known two species of *Thaumatopteris,* viz., *T. schenki* NATHORST and *T. brauniana* POPP. However, the *Thaumatopteris* fronds are rather common in the Rhaetic plant-beds of the Nariwa district. Amongst them the writer distinguished three different species, two new and one already known species, *T. brauniana.* The descriptions of each follow.

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(1) H. R. GOEPPERT: Les genres des plantes fossiles, Liv. I & II, 1841, p. 2, Pls. I–III.

(2) A. G. NATHORST: Bidrag till Sveriges Fossila Flora. I. L.c., p. 29, Pl. XVI, figs. 17–18.

(3) A. G. NATHORST: Ueber *Thaumatopteris schenki* NATH. Kgl. Svensk. Vet.-Akad. Handl., Vol. XLII, No. 3, 1907.

(4) T. G. HALLE: On the Sporangia of Some Mesozoic Ferns. Arkiv för Botanik, Vol. XVII, No. 1, 1921, p. 23.

(5) POTONIÉ-GOTHAN: Lehrbuch der Palaeobotanik, 1921, p. 47.

Thaumatopteris nipponica sp. nov.

Pl. XXX (XII), Figs. 5–6; Pl. XXXIII (XV), Figs. 2–3; Pl. XXXIV (XVI), Fig. 1; Pl. XXXIX (XXI), Fig. 5B; Text-Fig. 1.

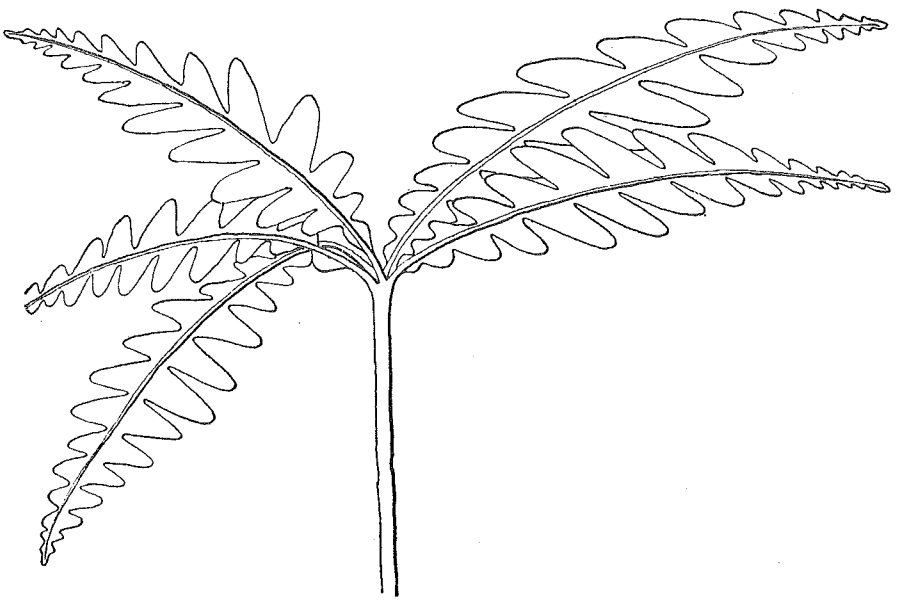
1930. *Dictyophyllum* ? sp. ÔISHI: Notes on Some Fossil Plants from the Upper Triassic Beds of Nariwa. L.c., p. 55, Pl. VII, figs. 4, 5.

Pinnae generally 5 in number, disposed in funnel-shape at the top of the petiole, about 13 cm. in length, elongate-ovate in outline, broadest at the middle portion, which is about 4–8 cm. in breadth, thence narrowing gradually towards both ends, and free at the base. Pinnules making a wide angle with the delicate pinna-rachis, long and narrow, alternate, subopposite or opposite, narrowing gradually from the base towards an obtuse apex, lamina being contiguous laterally at the base; pinnules at the proximal part deltoid, with rounded apex. Midnerve distinct, persisting to the tip of pinnules. Secondary nerves, occasionally bifurcating at a short distance from their origin, dissolve themselves into finer nerves forming polygonal meshes. Margin of pinnules entire or lightly undulating. Fructification not known.

Pl. XXXIII (XV), fig. 2 shows five pinnae disposed in funnel-shape from one center to which the petiole is attached vertically. It is also obvious from the specimen that the pinnae are spread out from the petiole top more or less in funnel-shape, and not in one horizontal bedding-plane. This character often causes the filling up of the hole of the central depression by matrix and makes the mode of disposition of pinnae obscure. Such specimen is shown in fig. 3; in this one can see at least three pinnae disposed from one center to which also a petiole might have been attached.

The pinna-rachis seems to be rather slender, and it does not exceed 1.7 mm. in breadth on the impression among so many specimens examined. The length of pinnae is naturally not constant, and it varies from 7–15 cm. according to the stage of growth of the frond. The pinnae are usually fusiform or elongate-ovate in outline and broadest at their middle portion, ending in an obtuse apex.

The pinnules are usually regular in shape, being elongated triangular in form, and provided with obtuse apex; towards the proximal portions of the pinnae they rather rapidly reduce their



Text-fig. 1. Restored figure of *Thaumatopteris nipponica*; slightly reduced.

size and become shortly deltoid in shape with rounded apex (Pl. XXXIII (XV), figs. 2–3). They usually make a wide angle with the pinna-rachis, and are straight or very slightly falcate directing the apex forwards. The margin of the pinnules is usually lightly undulating as clearly seen in Pl. XXXIV (XVI), fig. 1, while in the young frond it is almost entire (Pl. XXX (XII), fig. 5). The mid-nerve and the secondary nerves are generally distinctly impressed.

It is quite beyond doubt that the present specimens belong to the genus *Thaumatopteris* and not to *Dictyophyllum* from the characteristic mode of disposition of the pinnae at the top of the petiole. In general habit, the pinnae of *T. nipponica* closely resemble *Dictyophyllum remauryi* ZEILLER[1] from the Rhaetic of Tonkin, and the present writer first thought that ZEILLER's species should be transferred to the genus *Thaumatopteris,* and has provisionally called the Japanese specimens *Dictyophyllum* (*Thaumatopteris* ?) *remauryi* ZEILLER in his list of the Rhaetic plants from the Nariwa district[2]. Now, having examined more carefully the additional

(1) R. ZEILLER: Flore fossile des gîtes de charbon du Tonkin, p. 101, Pl. XIX, figs. 1, 2; Pl. XX, figs. 1–4; Pl. XXI, figs. 1, 2.

(2) S. ÔISHI: On the Upper Triassic Formation in Nariwa District, Bitchû. L.c., p. 6.

material, the author finds that the pinnae in the Japanese specimens are always arranged in funnel-shape, each pinna having a free base, and that in *D. remauryi* the pinnae are said to be fused laterally at the base and the mode of disposition of pinnae is quite *Dictyophyllum*-like (ZEILLER: Flore fossile des gîtes de charbon du Tonkin, p. 101, Pl. XX, fig. 2).

Thaumatopteris nipponica resembles *T. schenki* NATHORST[1], but is distinguished from it chiefly in that the fronds have a less number of pinnae, slightly narrower pinnules, and lastly in the less deeply crenulated margin of the pinnules; NATHORST states that frond of *T. schenki* bears 7–9 pinnae; while in ours they are only 5. From *T. brauniana* POPP the present species is distinguished in that the pinnules of the former have entire margin.

Some fern fragments which the present writer[2] once described from Eda as *Dictyophyllum* ? sp. are now revealed to be fragments of the distal portion of pinnae of *T. nipponica*. A certain specimen of *Dictyophyllum nilssoni* SCHENK ? described by BARTHOLIN[3] from the Liassic of Bornholm which was later named *D. bartholini* by MOELLER[4] may be either *D. remauryi* or *T. nipponica*.

Locality: Eda (Loc. No. 1).

Thaumatopteris elongata sp. nov.

Pl. XXXIV (XVI), Fig.2; Pl. XXXV (XVII), Figs. 1–2.

An incomplete pinna shown in Pl. XXXIV (XVI), fig. 2 does not agree with any known species of *Thaumatopteris* yet described. It shows a distal portion of a pinna, more than 17 cm. in length which is traversed by a rather thin pinna-rachis. The pinnules are long and narrow, forming an angle of approximately 60° with the pinna-rachis, about 1 cm. in breadth at the base which is slightly contiguous laterally, narrowing gradually towards a blunt apex; the lowest pinnule preserved measures 9 cm. in length, and the

(1) A. G.NATHORST: Ueber *Thaumatopteris schenki* NATH. L.c.

(2) S. ÔISHI: Notes on Some Fossil Plants from the Upper Triassic Beds of Nariwa. L.c., p. 55, Pl. VII, figs. 4, 5.

(3) C. T. BARTHOLIN: Nogle i den bornh. Juraform. forekommend. Planteforsteninger. I. Bot. Tidskr., Bd. 18, 1892, p. 16, Pl. X, fig. 6.

(4) H. MOELLER: Bidrag till Bornholms Fossila Flora. Pteridofyter. L.c., p. 44, Pl. IV, figs. 10–12.

pinnules seem to shorten gradually towards the apex. The mid-nerve is distinctly impressed on the matrix, elevated as a ridge, while the secondary nerves are faint and indistinct, and dissolve into a reticulum consisting of very small meshes which are often overlooked by the naked eyes. The distal margins of the pinnules are lightly crenulated. The fertile pinnae are similar to the sterile; the sori are circular in outline, approximately 1 mm. in diameter and distributed on the whole surface, possibly the lower, of the pinnules; unfortunately the inner structure of the sori can not be made out on account of the unsatisfactory preservation of the fertile specimens.

There is no satisfactory evidence for referring the present specimen to the genus *Thaumatopteris* other than that the general habit of the pinna resembles closely that of *Thaumatopteris* rather than that of *Dictyophyllum* or any other allied genera; the size of a sorus which in *Thaumatopteris* (*T. schenki*) is usually of twice the diameter of a single sporangium of *Dictyophyllum* which is about 0.4–0.6 mm. diameter, is another clue in bringing the present specimen to *Thaumatopteris*.

In general appearance, *T. elongata* resembles closely *T. brauniana* figured by HARRIS[1] from East Greenland, but has finer meshes than his.

Localities: Kamihina (Loc. Nos. 48 and 49).

Thaumatopteris schenki NATHORST

Pl. XXXV (XVII), Figs. 3–4; Pl. XXXVI (XVIII), Fig. 1.

1907. *Thaumatopteris schenki* NATHORST: Ueber *Thaumatopteris schenki* NATH. L.c.
1921. *Thaumatopteris schenki* HALLE: On the Sporangia of Some Mesozoic Ferns. L.c., p. 22, Pl. II, figs. 25–26.
1931. *Thaumatopteris schenki* ÔISHI: Mesozoic Plants from Kita-Otari, Prov. Shinano. L.c., p. 239, Pl. XVI, figs. 7, 7a, 8, 8a.
1931. *Thaumatopteris schenki* HARRIS: The Fossil Flora of Scoresby Sound, East Greenland. L.c., p. 93, Pl. XVII, figs. 6–8; Pl. XVIII, figs. 1–2; Text-fig. 35.

For further references see ÔISHI, 1931, l.c.

(1) T. M. HARRIS: The Fossil Flora of Scoresby Sound, East Greenland. L.c., p. 94, Pl. XVII, fig. 5; Pl. XVIII, figs. 4, 6–11, 13; Text-fig. 36.

Recently, the present writer[1] reported the occurrence of the species above referred to from the Rhaetic beds of Kita-Otari, Prov. Shinano. Now, he has here a number of specimens of fronds, obtained from the plant-bed of Hayama (Loc. No. 30), which are in all respects indistinguishable from *T. schenki*.

Specimen shown in Pl. XXXVI (XVIII), fig. 1 is particularly interesting because the frond itself is preserved in the matrix in the natural state of growth of its life time. The petiole which is more than 4 cm. in length is vertical to the plane of stratification, and the pinnae numbering seven are disposed in funnel-shape at the top of the petiole. The angle made by a pinna and the petiole is about 120°–150°. The petiole is circular in its cross section and 3 mm. in diameter measured a short distance below its top. Pl. XXXV (XVII), fig. 3 shows a portion of a pinna, consisting of some incomplete pinnules attached to a slender pinna-rachis. The pinnules are 4 cm. in length, and 4 mm. in breadth at the base, attenuating gradually towards the blunt apex; at the base the lamina is slightly contiguous laterally and narrowly spaced between any two adjacent ones. The nervation is very similar to that of *T. elongata;* the midnerve is distinct and persists to the apex of the pinnule. The secondary nerves which are less distinct than the midnerve form a reticulum, the meshes being very small and polygonal.

It is because of the specimen being a young pinna that the margin of the pinnules seems to be almost entire. In fig. 4 on the same plate is shown another small specimen of a distal portion of a pinna, in which the pinnules are much reduced and the uppermost pinnule preserved measures only 1.2 cm. in length.

The specimens above described agree essentially with *T. schenki* figured by NATHORST[2].

Locality: Hayama (Loc. No. 30).

Cfr. *Thaumatopteris brauniana* POPP

Pl. LIII (XXXV), Fig. 4.

Compare:

1867. *Thaumatopteris brauniana* SCHENK (pars): Die fossile Flora der Grenzschichiten des Keupers und Lias Frankens, p. 73, Pl. XIX, fig. 1.

(1) S. ÔISHI: Mesozoic Plants from Kita-Otari, Prov. Shinano. L.c.
(2) A. G. NATHORST: Ueber *Thaumatopteris schenki* NATH. L.c.

1869. *Thaumatopteris brauniana* SCHIMPER: Traité de paléontologie végétale, Tom. I, p. 630, Pl. XL, figs. 13, 13a.

1892. *Thaumatopteris brauniana* RACIBORSKI: Flory Retyckiej Polski, p. 4, Pl. II, fig. 23.

1931. *Thaumatopteris brauniana* HARRIS: The Fossil Flora of Scoresby Sound, East Greenland. L.c., p. 94, Pl. XVII, fig. 5; Pl. XVIII, figs. 4, 6–11; Text-fig. 36.

A pinna in Pl. LIII (XXXV), fig. 4, though fragmental, closely resembles a certain specimen figured by SCHENK[1] as *Thaumatopteris brauniana*.

The pinna is more than 9 cm. in length and traversed by a slender pinna-rachis which hardly exceeds 1 mm. in breadth. The pinnules are subopposite, long and narrow, 5 cm. in length at least, 7–9 mm. in breadth, being almost uniform in breadth throughout their whole length, slightly expanded at the base, and they make an oblique angle with the pinna-rachis. The midnerve is distinct. The secondary nerves make a reticulum, consisting of the polygonal meshes. The margin of the pinnules seems to be almost entire or very lightly wavy.

Thaumatopteris brauniana resembles *T. schenki* NATH., but differs from it in having entire pinnules.

Comparable forms are *Dictyophyllum dunkeri* NATHORST[2] and *Thaumatopteris exilis* SAPORTA[3].

Locality: Hinabata (Loc. No. 68).

GENUS *Dictyophyllum* BRONGNIART

Dictyophyllum spectabile NATHORST

Pl. XXXV (XVII), Figs. 5–6.

1906. *Dictyophyllum spectabile* NATHORST: Ueber *Dictyophyllum* und *Camptopteris spiralis*. Kgl. Svensk. Vet.-Akad., Handl., Bd. XLI, No. 5, p. 4, Pl. I.

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(1) A. SCHENK: Die fossile Flora der Grenzschichten des Keupers und Lias Frankens. L.c. See also W. Ph. Schimper: Traité de paléontologie végétale. L.c.

(2) A. G. NATHORST: Bidrag till Sveriges Fossila Flora. II. L.c., p. 45, Pl. V, fig. 17.

(3) M. DE SAPORTA: Plantes jurassiques, Tom. I, 1873, p. 320, Pl. XXXV, figs. 2, 2a.

We have two imperfect pinnae which may possibly be referable to the species above cited. This species has been known only from the Hoersandston of Sweden, and a large specimen was illustrated by NATHORST in 1906(1). NATHORST writes as follows: "Wie aus der Abbildung hervorgeht, liegen Teile von fünf Fiedern eines anscheinend fussförmig geteilten Blattes vor, von denen jedoch eine sehr fragmentarisch ist. Die Fiedern gehen von einem kurzen Gabelast des Blattstiels aus und waren wahrscheinlich an der Basis durch einen schmalen Rand der Blattlamina mit einander verbunden. Der Blattstiel scheint einen beinahe rechten Winkel mit der Blattspreite gebildet zu haben, und das vollständige Blatt muss wenigstens (denn nur die eine Hälfte liegt ja vor) zehn Fiedern getragen haben. Dieselben sind tief fiederteilig, mit nicht weit voneinander gestellten wechselständigen linearen, stumpfen Segmenten, die von schmalen parallelseitigen Einbuchtungen getrennt sind. Die Segmente scheinen am Rande verdickt gewesen zu sein (etwas umgebogen ?), ihr hinterer Rand ist etwas wellig gekerbt, der vordere mehr ganzrandig. Der Mittelnerv ist stark und setzt sich bis zu Spitze des Segmentes fort, die Secundärnerven und Nerven der folgenden Ordnung sind in gewöhnlicher Weise zu Maschen verbunden; doch scheinen die Sekundärnerven die Tendenz zu haben, den Blattrand zu erreichen, und zwar besonders, wenn dieser gekerbt ist."

Pl. XXXV (XVII), figs. 5 and 6 show two incomplete pinnae obtained from the plant-bed of Hayama; they are more than 9 cm. in length and traversed by a rather slender pinna-rachis which is nearly 2 mm. in breadth in the lowest broken end. The entire length of the pinnules is not known, but they are 4 cm. long at least, markedly falcate with their lower margin slightly undulating. The midnerve is distinct and the secondary nerves are divided into a reticulum.

D. spectabile resembles *D. remauryi*, but is distinguished from it in that the pinnules of the former are usually markedly falcate, less elongated, and the space between any two adjacent pinnules is broader, than in the latter.

Locality: Hayama (Loc. No. 30).

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(1) A. G. NATHORST: Ueber *Dictyophyllum* und *Camptopteris spiralis*. L.c.

Dictyophyllum nilssoni (BRONGNIART)

Pl. XXXV (XVII), Figs. 7–8; Pl. XXXVI (XVIII), Fig. 2.

1906. *Dictyophyllum nilssoni* NATHORST: Ueber *Dictyophyllum* und *Camptopteris spiralis*. L.c., p. 5, Pl. II; Pl. III, figs. 2–8.
1924. *Dictyophyllum nilssoni* CHOW: The Lower Liassic Flora of Sofiero and Dompäng in Scania. Arkiv för Botanik, Bd. XIX, No. 4, p. 3, Pl. II, fig. 1.
1925. *Dictyophyllum* cfr. *remauryi* AKAGI: Preliminary Notes on the Triassic Formation of Nariwa, Prov. Bitchû. L.c., p. 100, Pl. IV.
1928. *Dictyophyllum* cfr. *remauryi* AKAGI: On the Triassic Formation of Nariwa, Bitchû. Proc. Third Pan-Pacific Sci. Congr., Tôkyô, 1926, p. 1726.
1931. *Dictyophyllum remauryi* ÔISHI: *Yabeiella* sp. from the Japanese Triassic. L.c., p. 359.
1931. *Dictyophyllum nilssoni* HARRIS: The Fossil Flora of Scoresby Sound, East Greenland. L.c., p. 81, Pl. XIV, fig. 4; Pl. XV, figs. 3, 5–6, 8; Pl. XVI, figs. 1–5, 7–8, 11–12; Pl. XVII, fig. 9; Text-figs. 29–30.

For further references see HARRIS, 1931, l.c.

In 1906, NATHORST[1] subdivided *Dictyophyllum nilssoni* from the Hoersandstone into three varieties, viz., var. *brevilobatum*, var. *genuinum*, and var. *hoerensis*; the first two of which seem to be represented in our collection.

(a) var. *brevilobatum* NATHORST (Pl. XXXVI (XVIII), Fig. 2).

Pl. XXXVI (XVIII), fig. 2 shows an imperfect frond, in which five pinnae are seen disposed palmately. Each pinna is 13 cm. in length at least, and the pinna-rachis is comparatively thick, being 2 mm. in breadth on the impression near the base. The pinnules are mostly imperfectly preserved, but those in the upper broken end of the pinnae show that they are short triangular in shape, about 2 cm. in length, with the upper margin concave and the lower convex, and are slightly falcate; distally they merge gradually into a broad lamina and are contiguous laterally at the very base for a distance of about 2 cm. The midnerves are distinct, persisting to the apices of the pinnules, and they are about 1.5 cm. apart on each side of the pinna-rachis. The secondary nerves make a reticulum of usual *Dictyophyllum*-type.

(1) A. G. NATHORST: Ueber *Dictyophyllum* und *Camptopteris spiralis*. L.c.

The specimen above described and illustrated in fig. 2 agrees well with *D. nilssoni* var. *brevilobatum* figured by NATHORST (NATHORST: Ueber *Dictyophyllum,* etc., l.c., Pl. II; Pl. III, fig. 3).

(b) var. *genuinum* NATHORST (Pl. XXXV (XVII), Figs. 7–8).

This variety differs from the preceding in the more elongated triangular shape of the pinnules. In Pl. XXXV (XVII), figs. 7–8 are shown some imperfect pinnae which may probably be identical with the form *genuinum.* The pinnules are elongate-triangular in form, 3.5 cm. in length, and falcate, with concave upper and the convex lower margins which are not undulating.

Dictyophyllum nilssoni from the Nariwa district was first mentioned by AKAGI in his "Preliminary Notes on the Triassic Formation of Nariwa" as *Dictyophyllum* cfr. *remauryi* ZEILLER after the determination of the late Dr. Y. OZAWA. Having gathered later some additional material from Hayama (Loc. No. 30) where AKAGI collected "*D.* cfr. *remauryi*" and examined more carefully AKAGI'S collection in Tôkyô, the present writer found that the Japanese form was distinct from *D. remauryi* from Tonkin in several points and that it agrees more closely with *D. nilssoni* (BRONGN.).

Localities: Kamihina (Loc. No. 49); and Hayama (Loc. No. 30).

Dictyophyllum muensteri (GOEPPERT)

Pl. XXXVI (XVIII), Figs. 3–7; Pl. XXXVII (XIX), Figs. 1–7.

1841. *Thaumatopteris muensteri* GOEPPERT: Les genres des plantes fossiles, Liv. I & II, p. 2, Pl. I; Pl. II, figs. 1–6; Pl. III, figs. 1–3.

1869. *Thaumatopteris muensteri* SCHIMPER: Traité de paléontologie végétale, Tom. I, p. 629, Pl. XL, figs. 7–12.

1873. *Thaumatopteris muensteri* SAPORTA: Plantes jurassiques, Tom. I, p. 320, Pl. XXXV, fig. 1.

1876. *Dictyophyllum muensteri* NATHORST: Bidrag till Sveriges Fossila Flora. I. L.c., p. 29, Pl. VI, fig. 1 ?; Pl. XVI, figs. 17, 18.

1878. *Dictyophyllum muensteri* NATHORST: Bidrag till Sveriges Fossila Flora. II. L.c., p. 45, Pl. V, figs. 14–16; Pl. VIII, figs. 8–10.

1902. *Dictyophyllum muensteri* MOELLER: Bidrag till bornholms fossila flora. Pteridofyter. L.c., p. 41, Pl. IV, figs. 6, 7.

1913. *Dictyophyllum muensteri* MOELLER and HALLE: The Fossil Flora of the Coal-bearing Deposits of South-Eastern Scania. Arkiv för Botanik, Bd. XIII, No. 7, p. 15, Pl. II, figs. 5–8.

? 1927. *Dictyophyllum acutilobum* HIRMER: Handbuch der Palaeobotanik, Bd. I, p. 651, fig. 788.

1931. *Dictyophyllum muensteri* HARRIS: The Fossil Flora of Scoresby Sound, East Greenland. L.c., p. 85, Pl. XIV, fig. 3; Pl. XVII, figs. 1–4, 10; Pl. XVIII, fig. 14; Text-fig. 31.

Dictyophyllum muensteri is represented by two forms in the collection: var. *abbreviata* GOEPPERT and var. *pusillum* NATHORST, both occurring in two different localities.

(a) var. *abbreviata* GOEPPERT (Pl. XXXVI (XVIII), Figs. 3–6; Pl. XXXVII (XIX), Figs. 1–3).

The pinnae are linear-lanceolate, broadest near the middle, tapering gradually towards both ends, 10 cm. in length at least, and the lamina is contiguous laterally for a short distance at the base, probably about 1–2 cm. The lobes into which the lamina is dissected are narrowly triangular in shape, dissection not reaching the pinna-rachis, usually strongly falcate, with the upper margin concave and the lower convex, and provided with acute or subacute apex. The midnerve is distinct, gently curving and persisting to the apex of each lobe. The secondary nerves are also distinct, forming a coarse reticulum, the meshes of which are polygonal. The tertiary nerves are very fine, and make a fine reticulum within each mesh formed by the secondary nerves.

In Pl. XXXVII (XIX), fig. 1 is shown a portion of frond, in which a petiole is seen. In which is seen the lamina of pinnae basally contiguous. Pl. XXXVI (XVIII), figs. 3–6 and Pl. XXXVII (XIX), figs. 2–3 show imperfect pinnae in various portions with strongly falcate and acute lobes, except one specimen in Pl. XXXVI (XVIII), fig. 5 which has less falcate lobes. A specimen of an apical pinna is shown in Pl. XXXVII (XIX), fig. 3.

Dictyophyllum muensteri was first described by GOEPPERT[1] as *Thaumatopteris muensteri,* which later was considered by NATHORST[2] to be a *Dictyophyllum.* GOEPPERT subdivided *D. muensteri* into three varieties, namely, *abbreviata, elongata,* and *longissima.* To the first of these the present specimens have the greatest resemblance.

Dictyophyllum japonicum YOKOYAMA described by YOKOYAMA[3]

(1) H. R. GOEPPERT: Les genres des Plantes fossiles. L.c.

(2) A. G. NATHORST: Bidrag till Sveriges Fossila Flora. I. L.c., p. 29.

(3) M. YOKOYAMA: On Some Fossil Plants from the Coal-bearing Series of Nagato. Journ. Coll. Sci., Imp. Univ. Tôkyô, Vol. IV, Art. 2, 1890, p. 234, Pl. XXXIII. M. YOKOYAMA: Mesozoic Plants from Nagato and Bitchû. Ibid., Vol. XX, Art. 5, p. 5, Pl. II, fig. 3.

from the Rhaetic of Yamanoi, Prov. Nagato, resembles this variety more or less, but in YOKOYAMA's species the midnerve of the lobe is "crooked or zigzag" instead of being simply curved as in the present form.

(b) var. *pusillum* NATHORST (Pl. XXXVI (XVIII), Fig. 7; Pl. XXXVII (XIX), Figs. 4–7).

The pinnae are lanceolate, nearly 6 cm. in length, broadest near the base which is about 3–4 cm. in breadth and are provided with obtuse apex. The lobes into which the lamina of pinna is divided are long and narrow, 2–3 mm. in breadth, nearly parallel-sided, or slightly swollen near the obtusely rounded apex, lightly contracted near the fused base, opposite or subopposite, distant, and make a wide angle with the pinna-rachis. A characteristic feature is the abrupt reduction of the lamina near the base of pinna (Pl. XXXVI (XVIII), fig. 7; Pl. XXXVII (XIX), fig. 5). The midnerve is rather distinct and persists to the apex of pinna, while, on the contrary, the secondary nerves forming a reticulum are very obscure. The margin of the lobe is usually entire or sometimes lightly undulating. The sori are very small, being approximately ¼ mm. in diameter and distributed densely on the surface, possibly the lower, of the lamina. As the sori are badly preserved, the number of sporangia in each sorus is not clear.

Pl. XXXVII (XIX), fig. 4 shows a sterile pinna, while others represent the fertile. In general habit of pinnae, both sterile and fertile, the figured specimens agree well with the Swedish specimens described by NATHORST[1] as *Dictyophyllum muensteri* var. *pusillum*.

D. muensteri is one of the characteristic elements of the Rhaeto-Liassic flora of Europe, and it has been reported from Franconia, Sweden and Bornholm.

Localities: Kamihina (Loc. No. 49); and Yamamoto (Loc. No. 63).

GENUS *Hausmannia* DUNKER

Hausmannia nariwaensis ŌISHI

Pl. XXXVIII (XX), Figs. 1–10.

1930. *Hausmannia nariwaense* ÔISHI: Notes on Some Fossil Plants from the Upper Triassic Beds of Nariwa, Prov. Bitchû, Japan. L.c., p. 52, Pl. VII, figs. 2, 2a.

(1) A. G. NATHORST: Bidrag till Sveriges Fossila Flora. II. L.c.

Though the chief characteristics of this species have already been mentioned in the writer's previous notes in 1930[1], a more detailed description based on the additional rich material may be given in the following lines:

The frond is probably petiolate, the petiole being attached perpendicularly to the plane of lamina. The lamina is broadly reniform in outline, and varies considerably in diameter between 3–10 cm. At the base, the lamina makes a deep narrow sinus reaching to the center, where the petiole might have been attached. Both edges of the sinus are convex outwards and often overlap each other. Seven to twelve primary nerves radiate through the lamina from the bottom of the sinus or the top of the petiole, branching, dichotomously once or twice, and reach to the margin of the lamina. From such primary nerves finer nervelets are given off approximately at right angles, the latter subdivide and unite into numerous small square or polygonal meshes arranged more or less regularly. The margin of the lamina is almost entire in the young and small fronds, while it is broadly and regularly undulating in the larger and well-developed ones. The outer central margin is sometimes markedly crenulating. The sori are circular, about 0.5 mm. in diameter, and densely distributed on the lower surface of the lamina, possibly one in each mesh. Unfortunately the inner features of the sori can not be made out.

Pl. XXXVIII (XX), figs. 1–4 show several specimens of more or less well-developed laminae, in which the characteristic kidney-shaped lamina, the marginal broad undulation and the nervation are clearly observable. Fig. 7 shows a small lamina with a crenulation in its outer central margin, though otherwise entire. An imperfect fertile lamina is shown in fig. 6; numerous small circular dots on the lamina represent the sori.

The comparable species are *Protorhipis* (*Hausmannia*) *asarifolia* ZIGNO[2], *P.* (*H.*) *crenata* NATHORST[3], and *Hausmannia ussuriensis* KRYSHTOFOVICH[4], but neither of them is, the writer believes,

(1) S. ÔISHI: Notes on Some Fossil Plants from the Upper Triassic Beds of Nariwa, Prov. Bitchû. L.c.

(2) A. DE ZIGNO: Flora Fossilis Formationis Oolithecae, Vol. I, 1856–1868, p. 180, Pl. IX, figs. 2, 2a.

(3) A. G. NATHORST: Floran vid Bjuf, 1879, p. 57, Pl. XI, fig. 4.

(4) A. KRYSHTOFOVICH: *Pleuromeia* and *Hausmannia* in Eastern Siberia, with a Summary of Recent Contributions to the Palaeobotany. Amer. Journ. Sci., Ser. V, Vol. V, No. 27, 1923, p. 204, figures.

specifically identical with *H. nariwaensis*. Comparison with those foreign species has already been made in the writer's previous notes.

Localities: *Hausmannia nariwaensis* is rather common in the plant-bed of Eda (Loc. No. 1); it is also not uncommon in the grayish sandstone at Yamamoto (Loc. No. 63).

Hausmannia crenata NATHORST

Pl. XXXVII (XIX), Fig. 8.

1879. *Protorhipis crenata* NATHORST: Floran vid Bjuf, p. 57, Pl. XI, fig. 4.

1902. *Hausmannia* (*Protorhipis*) *crenata* MOELLER: Bidrag till Bornholms Fossila Flora. Pteridofyter. L.c., p. 50, Pl. V, figs. 5, 6.

1927. *Hausmannia crenata* PRINADA: Sur des restes de plantes des dépôts mésozoiques de la Samarskaya Louka. Bull. Com. Géol. Léningrad, Tom. XLVI, No. 8, p. 970, Pl. XLVIII, figs. 1, 2.

The frond is petiolate, the petiole being at least 3.5 cm. in length and very narrow and slender. The top of the petiole merges gradually to the fan-shaped lamina, which is 3 cm. in breadth and 2.5 cm. in height, with shallowly crenulated outer margin. Three or four primary nerves radiate through the lamina from the top of the petiole, once or twice forking, and reach the margin of the lamina. Finer nervelets given off from the primary nerves at an oblique angle are united to each other to form a reticulum, meshes of which are polygonal or sometimes rhomboidal.

Hausmannia crenata resembles *H. nariwaensis*, but is distinguished from it in having characteristic fan-shaped lamina and the coarse meshes, instead of being always kidney-shaped and bearing finer meshes like the latter.

We have only one figured specimen of this species derived from Eda. Outside Japan, *H. crenata* is known from the Rhaetic of Sweden(1) and the Lower Jurassic of Bornholm(2) and European Russia(3).

Locality: Eda (Loc. No. 1).

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(1) A. G. NATHORST: Floran vid Bjuf, 1879. L.c.

(2) H. MOELLER: Bidrag till Bornholms Fossila Flora. Pteridofyter. L.c.

(3) V. PRINADA: Sur des restes de plantes des dépôts mésozoiques de la Samarskaya Louka. L.c.

Hausmannia dentata sp. nov.

Pl. XXXIX (XXI), Figs. 1–4, 5A; Pl. LIII (XXXV), Figs. 2–3; Text-Fig. 2.

1930. *Dictyophyllum* sp. ÔISHI: Notes on Some Fossil Plants from the Upper Triassic Beds of Nariwa, Prov. Bitchû. L.c., p. 54, Pl. VII, figs. 3, 3a.

Frond petiolate, petiole being perpendicular to the plane of lamina. Laminae semi-orbicular or broadly reniform in outline, measuring 6–12 cm. in breadth and 5–11 cm. in height, with deep sinus at the base reaching to the center where petiole attached. Both edges of the sinus are convex outwards and sometimes overlapp each other. Outer margin strongly sinuate-dentate, with generally 14 teeth which are also slightly undulated along the margin. Primary nerves radiating through the lamina from the bottom of the sinus, correspond in number with the marginal teeth, and end at the tip of each tooth. Secondary nerves spring up from the midnerve at an acute angle uniting with each other to form a reticulum, each mesh of which is again subdivided into finer meshes. Sori densely distributing on the lower surface of the lamina, each sorus being circular in outline, approximately 1 mm. in diameter, with 6–12 (?) sporangia.

We have a number of beautifully preserved specimens of this species, mostly in fertile condition. The frond is certainly petiolate, the petiole being perpendicular to the general plane of the lamina. Pl. XXXIX (XXI), fig. 2 is the back view of a frond, and a portion of the petiole is fairly seen projected obliquely from the general surface of the lamina. The margin of the laminae is very strongly sinuate-dentate as the figures show, but the number of the teeth can not be counted, no specimens being preserved perfectly. However, the approximate number of teeth in one lamina is counted from the number of primary nerves which converge at the center of the lamina and correspond in number to the marginal teeth. Thus the number of the teeth in different laminae seems to be constant as a whole, and one can see from the number of the primary nerves that there are 14 teeth in figs. 1 and 4, and 15 teeth in fig. 2. Each tooth is slightly undulated along the margins. The primary nerves are not perfectly straight, but slightly sinuous, and persist to the tip of each tooth. The secondary nerves, which

are less prominent than the primaries are given off at an angle of approximately 45°–50°, and are united to each other to form coarse polygonal, somewhat elongated meshes, the longitudinal axis of which is usually 0.7 mm. in length. Each mesh is again subdivided into finer meshes, but their outline is usually not clearly seen without the aid of a magnifier. The sori are circular in outline, diameter being about 1 mm. They are densely distributed over the lower surface of the lamina. Each sorus seems to correspond to a single finer mesh. It is very difficult to make out the exact number of sporangia in each sorus, as the preservation of the sori is not very satisfactory; under the microscope, however, the author could count approximately 6–12 sporangia in a single sorus. The sporangia seem to have been rounded and their outline almost circular, but their whole circumference can not be traced, though the diameter is approximately 0.18–0.2 mm.

The annule is distinctly seen in some cases, but it is very difficult to trace entirely around the sporangium, on account of the crowded state of the sporangia. In certain sporangia, the annule seems to be almost complete, and about 15 cells can be counted in the semicircle of the annule preserved.

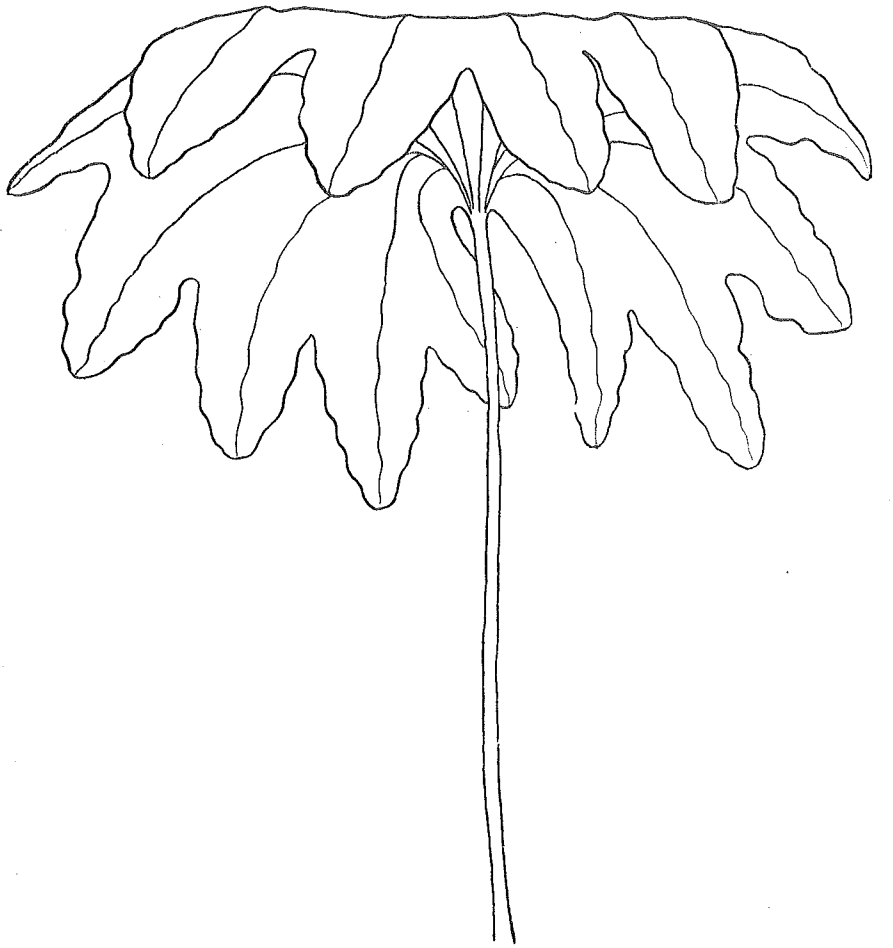
The investigation of sporangia of *Hausmannia forchammeri* BARTH. spp. *dentata* by HALLE(1) led him to the conviction that *Hausmannia* belongs also to the group of Dipteridaceae, though the reference of this genus to that group has already been recognised by several authors as founded merely on the habit and the nervation of the fronds. The soral characters available in the present specimens show also that they are nearer to the Dipteridaceae than to any other groups of fossil and living fern.

Hausmannia dentata resembles greatly in its form and habit *Dipteris conjugata* now living in the Palaeotropic floral zone of Formosa, Riukiu Islands, Malay Peninsula, Polynesia, and Fiji. For comparison of morphology of the living and the fossil species a photograph of *Dipteris conjugata* from Formosa and a restored figure of *H. dentata* are shown in Pl. LIII (XXXV), fig. 1 and Text-fig. 2 respectively.

This species resembles *Protorhipis buchii* figured and described by ANDRAE(2) from the Liassic beds of Steierdorf of the Banat in

(1) T. G. HALLE: On the Sporangia of Some Mesozoic Ferns. L.c., p. 20.

(2) K. J. ANDRAE: Beitraege zur Kenntnis der fossilen Flora Siebenbürgens und des Banates. Abhandl. k. k. geol. Reichsanst., Wien, Bd. I, Abth. III, 1855, p. 35.



Text-fig. 2. Restored figure of *Hausmannia dentata* after Pl. XXXIX(XXI), fig. 2; slightly reduced.

Hungary, but there is a certain distinction between them. In ANDRAE's specimen the primary nerves are dichotomous in a fairly regular manner, and give off secondary nerves almost at right angles, which, together with the tertiary nerves, make polygonal or rather rectangular meshes. In the present species, however, the primary nerves run straight to the tip of each tooth without regular dichotomy and the secondary nerves arise always at an oblique angle from the primary nerves.

In his previous notes on the fossil plants from Nariwa[1] the present writer figured a curiously shaped lamina which seemed at that time to be an undeveloped or an abnormally rolled leaf of a *Dictyophyllum*. He called the specimen *Dictyophyllum* sp. In examining additional material it is found that the specimen was neither an undeveloped nor abnormally rolled lamina of *Dictyophyllum*, but represents in itself an imperfect lamina of *Hausmannia dentata*.

Locality: *Hausmannia dentata* is particularly abundant in the plant-bed of Eda (Loc. No. 1), and occurs in intimate association with *Thaumatopteris nipponica, Hausmannia nariwaensis, H. crenata,* and *Cladophlebis nebbensis*.

DIPTERIDACEAE?

GENUS *Spiropteris* SCHIMPER

Spiropteris sp.

Pl. XXXIX (XXI), Fig. 6.

In Pl. XXXIX (XXI), fig. 6 is shown a *Spiropteris*. It is common in the plant-bed of Kamihina (Loc. No. 49) and occurs frequently in close association with *Dictyophyllum muensteri*, a very common fern in the bed. The *Spiropteris* is thus considered to belong to *D. muensteri*.

Locality: Kamihina (Loc. No. 49).

POLYPODIACEAE?

GENUS *Sphenopteris* BRONGNIART

Sphenopteris gracilis sp. nov.

Pl. XL (XXII), Fig. 1.

So far as the writer knows, an incomplete frond in Pl. XL (XXII), fig. 1 does not seem to be identical to any specimen ever described. It is more than 6 cm. in length, and is very slender in general habit, traversed by a delicate axis which is about 0.5 mm. across on the impression. The pinnae are alternate or subopposite, linear-lanceolate in outline, and make an angle of approximately 50° with the axis. The lowest pinna preserved is 4 cm. in length.

(1) S. ÔISHI: Notes on Some Fossil Plants from the Upper Triassic Beds of Nariwa, Prov. Bitchû. L.c., p. 54.

The pinnules are closely set, triangular in form, narrowing from a broad base to an acute apex, and they are very oblique to the pinna-rachis. Towards the end of pinnae and higher up on the frond, the pinnules become smaller and fused laterally, and the pinnae merge gradually to pinnules, the margin of which is only lightly crenulated. The texture of lamina is very thin. The nervation is of rather *Cladophlebis*-type than of *Sphenopteris*, a delicate midnerve sending off acutely once-forking secondary nerves which are in the same strength with the midnerve. The margin of the pinnules is entire.

It is somewhat doubtful whether the present specimen should be considered as belonging to the genus *Sphenopteris* or to *Cladophlebis*. In the delicate habit of the frond it is *Sphenopteria*-type, while in the nervation it is rather *Cladophlebis*-type. It is only provisionally, however, that the writer preferred here to use the former designation, taking the general habit of the frond into consideration.

An allied form is *Sphenopteris currani* ? figured by ARBER[1] from New Zealand, and it seems to be almost identical with the present form.

Locality: Hinabata (Loc. No. 44).

II. CYCADOPHYTA

BENNETTITALES ?

GENUS. *Pterophyllum* BRONGNIART

Pterophyllum schenki (ZEILLER)

Pl. XL (XXII), Figs. 2–7.

1886. *Anomozamites schenki* ZEILLER: Note sur les empreintes végétaux recueillies par M. JOURDY au Tonkin. Bull. Soc. Géol. France, Sér. III, Vol. XIV, p. 460, Pl. XXIV, fig. 9.

1903. *Pterophyllum* (*Anomozamites*) *schenki* ZEILLER: Flore fossile des gîtes de charbon du Tonkin, p. 181, Pl. XLVIII, fig. 7.

1926. *Pterophyllum schenki* HARRIS: The Rhaetic Flora of Scoresby Sound, East Greenland. L.c., p. 88, Text-figs. 16A-H.

ZEILLER's description of *Pterophyllum schenki* runs as follows: "Frondes à contour linéaire-lancéolé, larges de 40 à 50 millimètres,

(1) E. A.N. ARBER: The Earlier Mesozoic Floras of New Zealand. New Zeal. Geol. Surv. Palaeont. Bull. No. 6, 1927, p. 41, Pl. II. figs. 7, 8.

atteignant sans doute 20 centimètres, de longueur et peut-être davantage; rachis large de 2 à 3 millimètres, marqué à la fois de stries longitudinales et de rides transversales plus ou moins serrées. Folioles généralement subopposées, partant du rachis sous un angle presque droit, deux fois à deux fois et demie plus longues que larges, à bords antérieur et postérieur légèrement divergents, un peu élargies à la base et au sommet, tronquées à leur extrémité suivant un arc à faible courbure, longues de 18 à 25 millimètres sur 7 à 9 millimètres de largeur dans leur région la plus étroite, larges de 10 à 12 millimétres à leur sommet. Nervures nombreuses, partant presque normalement du rachis, bifurquées plus ou moins près de leur origine, à branches simples ou elles-mêmes dichotomes, divergeant légèrement sur la seconde moitié ou les doux derniers tiers de leur parcours, espacées de 0.25 mm. à 0.40 mm."

The present specimens agree well with *Pterophyllum schenki* figured and described by ZEILLER[1] from Tonkin and by HARRIS[2] from East Greenland, though there is a slight difference in the size of fronds, the Japanese ones being a little smaller than ZEILLER's. None of our specimens, however, show the complete length of the frond. The frond is more than 6 cm. in length, and the breadth varies between 3–4 cm. It is nearly parallel-sided and contracts abruptly to a rounded apex. The rachis is rather slender, the breadth being 1–1.5 mm. generally; the transverse wrinkles on the rachis noted by ZEILLER and HARRIS can not be recognized in the Japanese specimens. The segments into which the lamina is divided are generally closely set, enlarged distally, a feature which often causes the lateral overlapping of the segments at the distal portion, normal to the rachis, truncated at the outer margin, with the upper and the lower distal corners rounded; the breadth of the segments is not constant even in a single frond, and it varies sometimes between 0.4–1 cm. at the base which is slightly expanded. The lateral nerves, numbering about 10–13 per 1 cm. in their origin, fork once or twice, first near the origin and secondly in their middle portion or near the outer margin of segments; they run parallel to the lateral margins of segments, thus somewhat divergently, and end at the outer margin; they are usually normal to the rachis, but sometimes they are markedly decurrent downwards at their base.

(1) R. ZEILLER: Note sur les empreintes végétaux recueillies par M. JOURDY au Tonkin. L.c. ZEILLER: Flore fossile des gîtes de charbon du Tonkin. L.c.

(2) T. M. HARRIS: The Rhaetic Flora of Scoresby Sound, East Greenland. L.c.

HARRIS succeeded in preparing the cuticles of this species in the specimens from East Greenland. According to him, the epidermis of the lamina has the sinuous cells characteristic to the Bennettitalean frond; the slit of the stomata is transverse to the nerves and the subsidiary cells are smaller and less sinuous than the other epidermal cells.

ZEILLER compared this species with *Pterophyllum inconstans* F. BRAUN, *P. balli* (FEISTMANTEL), and *Anomozamites loczyi* SCHENK. It is indeed true that *P. schenki* has a great resemblance to *P. balli*, originally described by FEISTMANTEL[1] as *Platypterygium balli* from the Lower Gondwana of India, which later was believed by SEWARD and SAHNI[2] to be a *Pseudoctenis*, and the present writer[3] once provisionally compared the Japanese specimens to FEISTMANTEL's species, *Pterophyllum balli*. Careful examination of the example, however, has shown that the Japanese specimens differ distinctly from *P. balli*, the Indian species having segments more elongated and the lateral nerves being markedly undulating.

P. schenki resembles more closely *Anomozamites loczyi*, described by SCHENK[4] from the beds in Kouang-Yuen-Shien, China, which SCHENK regarded to be the Middle Jurassic. However, ZEILLER distinguished *A. loczyi* from *P. schenki* on the grounds that in the latter species the segments are shorter and broader, the lateral margins of segments are strongly curved anteriorly and posteriorly, the lateral nerves are less in number in a unit length, and for some other reasons, an opinion which the present writer followed.

Locality: Eda (Loc. No. 1); and Jitô (Loc. No. 55).

Pterophyllum jaegeri BRONGNIART

Pl. XL (XXII), Figs. 8–12.

1850. *Pterophyllum jaegeri* UNGER: Genera et Species, p. 287.
1851. *Pterophyllum jaegeri* BRONN and ROEMER: Lethea Geognostica, Pt. III, p. 37, Pl. XII, fig. 1.

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(1) O. FEISTMANTEL: The Fossil Flora of Some of the Coalfields in Western Bengal. Palaeont. Indica, Ser. XII, Vol. IV, Pt. 2, 1886, p. 37, Pl. IIA, figs. 4–8; Pl. IIIA, fig. 2.

(2) A. C. SEWARD: Fossil Plants, Vol. III, 1917, p. 586. SEWARD and B. SAHNI: Revision of Indian Gondwana Plants, p. 14.

(3) S. ÔISHI: On the Upper Triassic Formation in Nariwa District. L.c., p. 6.

(4) A. SCHENK: Die waehrend der Reise des Grafen Bela Széchenyi in China gesammelten fossilen Pflanzen. L.c., p. 172, Pl. XIV (II), figs. 1–4.

1865. *Pterophyllum jaegeri* HEER: Urwelt der Schweitz, p. 52, Pl. III, fig. 2.
1872. *Pterophyllum jaegeri* SCHIMPER: Traité de paléontologie végetale, Tom. II, p. 134, Pl. LXX, fig. 7.
1875. *Pterophyllum jaegeri* SAPORTA: Plantes jurassiques, Tom. II, p. 43, Pl. LXXX, fig. 1.
1877. *Pterophyllum jaegeri* HEER: Flora Fossilis Helvetiae, p. 79, Pl. XXXI, figs. 1–4; Pl. XXXII, figs. 1, 2.
1903. *Pterophyllum jaegeri* LEUTHARDT: Keuperflora von Neuewelt bei Basel. Abhandl. d. schweitz. palaeont. Gesell., Vol. XXX, p. 14, Pl. V, figs. 1–3; Pl. VI, figs. 1–2; Pl. X, fig. 1.
1929. *Pterophyllum jaegeri* YABE and ÔISHI: Notes on Some Fossil Plants from Korea and China Belonging to the Genera *Nilssonia* and *Pterophyllum*. Jap. Journ. Geol. Geogr., Vol. VI, Nos. 3–4, p. 95, Pl. XIX, fig. 4; Pl. XX, fig. 4.
1931. *Pterophyllum jaegeri* ÔISHI: Mesozoic Plants from Kita-Otari, Prov. Shinano, Japan. L.c., p. 246, Pl. XVIII, fig. 3.
1931. *Pterophyllum jaegeri* ÔISHI: On the Upper Triassic Formation in Nariwa District. L.c., p. 6.

We have a number of specimens of this species in the collection, but none of them are complete. Pl. XL (XXII), fig. 8 shows an incomplete frond, more than 5 cm. in length, with a rachis which is about 3 mm. in thickness. The pinnae are long and narrow, nearly parallel-sided, more than 4 cm. in length and about 3 mm. in breadth, or widening gradually towards the apex from near the base. At the very base they are sometimes slightly expanded: in this case the pinnae are distant, and the space between two adjacent pinnae is nearly as broad as the breadth of a pinna itself. The nerves are very fine, and about 12 nerves can be seen in each pinna.

The Japanese specimens, though incomplete, agree well with *Pterophyllum jaegeri* figured by HEER(1) and LEUTHARDT(2) from the Swiss Keuper beds. In the Swiss specimens illustrated by the above named authors, the frond is far larger in size and is said to attain sometimes nearly 1 meter in length and 16 cm. in breadth, provided with a very thick rachis. Though his example is fragmentary, yet the present writer believes in the existence of this Keuper plant in the Japanese Rhaetic rocks. Some other small specimens are figured in figs. 9–11; they differ somewhat from specimens in figs. 8 and 12. In the former the pinnae are more closely set, the expansion at the base being less prominent. They agree well, how-

(1) O. HEER: Flora Fossilis Helvetiae, p. 79.
(2) F. LEUTHARDT: Keuperflora von Neuewelt bei Basel. L.c.

ever, with the second form of *P. jaegeri* mentioned by HEER[1] as illustrated in HEER's Pl. XXXI, figs. 1 and 2. A similar specimen has been also figured by the present writer[2] from the Rhaetic bed of Kuruma, Kita-Otari.

Localities: Hinabata (Loc. No. 44); and Kamihina (Loc. No. 47).

Pterophyllum ctenoides sp. nov.

Pl. XLI (XXIII), Figs. 1–3; Pl. XLII, (XXIV), Fig. 1.

Frond of unknown size, being more than 15 cm. in length and 12 cm. in breadth. Rachis nearly 1 cm. across in the lower portion of frond, measured on the flattened surface, narrowing gradually upwards to 1 mm. breadth near the apex; surface of rachis with longitudinal striations. Pinnae attached to the lateral side of the rachis, nearly at right angles at the distal and oblique at the apical portion of the frond, closely set, nearly uniform in breadth, which is 1 cm. as a whole, or narrowing gradually towards the base but expanding slightly just before joining the rachis. Nervation coarse; nerves, about 1 mm. apart, forking occasionally near the rachis but never anastomosing, lamina between the nerves elevated as a ridge directing convex side upwards.

Unfortunately, none of the specimens are complete in both the upper and the lower ends and even at lateral margins, but they may attain a considerable size in the complete frond. Pl. XLII (XXIV), fig. 1 shows an apical portion of a frond, in which the rachis is thin and the pinnae are obliquely and laterally inserted making approximately an angle of 45° with the rachis. The pinnae, though it is not always so, has generally a tendency of contracting slightly near the base, which feature is prominent in the specimen in Pl. XLI (XXIII), fig. 3. The most characteristic feature of this species is the coarse nervation and the prominent elevation of the laminae between the nerves so as to make the nerves appear very strong.

At first sight of the specimens, they strongly remind one of *Pterophyllum medlicottianum* OLDHAM and MORRIS[3] from the

(1) O. HEER: Flora Fossilis Helvetiae, p. 79.

(2) S. ÔISHS: Mesozoic Plants from Kita-Otari, Prov. Shinano. L.c.

(3) O. FEISTMANTEL: Jurassic (Liassic) Flora of the Rajmahal Group, in the Rajmahal Hills. Palaeont. Indica, Ser. II, Vol. I. Pt. 2, 1877, p. 111, Pl. XLIII, fig. 2; Pl. XLIV, fig. 1.

Rajmahal Group of India, and the author has once provisionally referred the specimens to the Indian species[1]. On a more careful scrutiny, however, one finds that there exists an important distinction between the Japanese and the Indian forms, and the writer is now convinced that the former belongs to a new species. SEWARD and SAHNI[2], in examining the original specimens of *P. medlicottianum* by OLDHAM and MORRIS, state that the nerves in the Indian species, which apparently seem very coarse, are in reality the folds or corrugations as described by NATHORST on the lamina of *Nilssonia brevis* BRONGN. and other species. They replaced the generic name *Pterophyllum* with *Nilssonia*. Though the true Nilssonian evidence of the Indian species is not satisfactorily expressed in SEWARD and SAHNI's description, it is now quite certain that the nervation of our species does not agree with that figured by these authors, the former being truly coarse and the interveining lamina elevated as a ridge, instead of being fine and the lamina folded independently of the nerves themselves as in the latter. HALLE[3] substituted the generic name *Pseudoctenis* for the generic designation of *Pterophyllum medlicottianum*.

Our specimens resemble also a frond figured by HALLE[4] from the Middle Jurassic beds of Graham Land as *Pseudoctenis ensiformis* HALLE, which, however, differs from ours in having shorter and broader and sword-shaped pinnae.

Locality: Common in the plant-bed of Kamihina (Loc. No. 46).

Cfr. *Pterophyllum distans* MORRIS

Pl. XLI (XXIII), Fig. 4.

Compare:

1877. *Pterophyllum distans* FEISTMANTEL: Jurassic (Liassic) Flora of the Rajmahal Group from Golapili (near Ellore), South Godavari District. Palaeont. Indica, Ser. II, Vol. I, Pt. 3, p. 176, Pl. V, fig. 1; Pl. VI, fig. 1.

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(1) S. ÔISHI: On the Upper Triassic Formation in Nariwa District. L.c., p. 6.

(2) A. C. SEWARD and B. SAHNI: Indian Gondwana Plants: A Revision. Palaeont. Indica, N.S., Vol. VII, Mem. No. 1, p. 31, Pl. V, figs. 43, 43a.

(3) T. G. HALLE: Mesozoic Flora of Graham Land. Wiss. Ergebn. d. schwed. Suedpolar-Expedition, 1901–1903, Bd. III, Lief. 14, 1913, p. 53, Pl. VI, figs. 9, 10.

(4) T. G. HALLE: Ibid, p. 51, Pl. VI, fig. 8.

Pl. XLI (XXIII), fig. 4 represents an incomplete frond, doubtlessly of a *Pterophyllum,* which resembles somewhat *Pterophyllum distans* not uncommon in the beds of the Rajmahal Stage in India. It is a portion of a frond, 4 cm. in length, traversed by a rachis which measures about 3 mm. across on the impression and possesses a longitudinal ridge along its median line. The pinnae or segments which are attached laterally to, and make a wide angle with the rachis are long and narrow, 6.5 cm. in length and 1 cm. in breadth near the slightly expanded base, thence tapering gradually to a narrow apex, flexuous possibly due to the preservation, and distantly placed on each side of the rachis, the distance being nearly 3 mm.

It is only provisionally and tentatively that the writer compares the incomplete specimen to the Indian species, awaiting the supply of further material available for the more precise comparison of the Japanese form.

Locality: Nishihata (Loc. No. 62).

Pterophyllum spp.

Pl. XLII (XXIV), Figs. 2–4.

We have a number of specimens of incomplete *Pterophyllum*-fronds which can be neither specifically nor even generically determind. Pl. XLII (XXIV), fig. 2 shows a portion of frond which consists of a rachis 2 mm. broad on the flattened surface. The pinnae are long and narrow, about 3 cm. long and 4 mm. broad at the base, closely set, attached by the whole base nearly at a right angle, tapering gradually from the base towards the obtusely pointed apex. The nerves are forking in their origin and there are about 13 of them in the middle of each pinna.

A specimen in Pl. XLII (XXIV), fig. 3 is also an imperfect frond of a *Pterophyllum*-like plant. It resembles the preceding specimen in general, but differs from it in having a narrower and more slender rachis. The whole length of the pinnae is not known in this, but there is nearly the same number of nerves, as in the preceding, in each pinna.

Another specimen in Pl. XLII (XXIV), fig. 4 shows more fragmental pinnae which are more than 5.5 cm. long, 5 mm. broad in their broken proximal end, slightly falcate, upper margin being lightly concave and the lower convex, and set closely. The nerva-

tion is a little coarser than any of the preceding two specimens, and there are about 8–9 of them in the middle of each pinna.

Locality: Kamihina (Loc. No. 50).

GENUS *Campylophyllum* GOTHAN

Campylophyllum hörmanni GOTHAN

Pl. XLII (XXIV), Fig. 5.

1914. *Campylophyllum hörmanni* GOTHAN: Die unter-liassische (rhaetische) Flora der Umgegend von Nürnberg. L.c., p. 53, Pl. XXXI/XXXII, fig. 4; Pl. XXXIII, fig. 2; Pl. XXXIX, fig. 4.

After considerable hesitation the author decided to identify a single imperfect specimen in Pl. XLII (XXIV), fig. 5 to a form described by GOTHAN[1] as *Campylophyllum hörmanni*. It shows following characteristics: the frond (or leaf) is pinnate, more than 4 cm. in length, with thick axis. The axis is 8 mm. across measured on its compressed surface, with fine longitudinal striations. The pinnae which attached apparently to the lateral sides of the axis at a right angle are about 2.5–3 cm. in length, thick in texture, narrow, sometimes sickle-shaped, gradually increasing in breadth from a narrow base towards an obtuse apex. There seem to be 5–6 simple nerves in each pinna, but the exact number is not certain.

GOTHAN mentions that the lower base of the pinnae is decurrent downwards to, and that the upper makes a sinus with, the axis; but such features are obscure in the present specimen. GOTHAN first compared the German specimen with *Pterophyllum*, but distinguished his from the latter chiefly by the sickle-shaped pinna and the unusually thick-walled epidermal cells.

Although, without cuticular preparations, it is not yet certain that the Japanese specimen is the same plant as the German one, and although it is also not impossible that our specimen may represent a lower portion of a frond which has been described as Cfr. *Pterophyllum distans* MORRIS in this memoir, yet it is recognisable that both the German and the Japanese specimens are very similar to each other. For these reasons the present writer provisionally identified the specimen at hand to the German form.

Locality: Nishihata (Loc. No. 62).

(1) W. GOTHAN: Die unter-liassische (rhaetische) Flora der Umgegend von Nürnberg. L.c.

GENUS *Otozamites* F. W. BRAUN

Otozamites lancifolius sp. nov.

Pl. XLII (XXIV), Figs. 6, 6a.

Frond elongate-obovate in outline, broadest at a short distance below the apex, towards which it contracts rather abruptly and towards the base gradually. Pinnae closely set, alternate, elongate-lanceolate in outline, straight or slightly falcate, with the upper margin concave and the lower proximally straight and distally convex, ending at a subacute apex. Base of pinnae asymmetrical, inserted on the upper side of the rachis by a part of base, sometimes with callosity, that of opposite and lateral pinnae overlapping. Anterior basal part markedly auriculate, with its inner side nearly straight and the upper margin gently curved upwards; posterior basal part gently subacutely rounded. Nerves densely crowded, divergent, forking frequently at variable distances from the base, numbering approximately 14 per ½ cm. at the middle of pinnae.

We have only one figured specimen in the collection, which is, however, believed to represent a new form. It is more than 19 cm. in length, and probably may have attained 24 cm. in length in its complete state. The thickness of the rachis is not clear, as the pinnae cover the upper side of the rachis so as to conceal its surface entirely. But at the extreme proximal broken end, it is 3–4 mm. in thickness measured on the compressed surface. Each pinna, so far as the single frond at hand is concerned, is almost uniform in shape, being elongate-lanceolate in outline, slightly falcate, and subacutely pointed at the apex. The pinnae in the middle portion of the frond make an angle of approximately 45° with the rachis, while they become more oblique towards both proximal and apical ends. The nature of the pinna-base is typically of an *Otozamites*-type, the base being strongly asymmetrical and anterior basal margin auriculated. The detailed outline of the basal region is somewhat difficult to explain, and a sketch of it is reproduced in fig. 6a. A callosity at the pinna-base is certainly seen in certain pinnae, but it is not so clear in others on account of the strong overlapping at the base. The nerves are divergent as is usually the case in this genus, and accordingly they end at the lateral margin as well as the distal end of the pinna. The nerves are very fine and the bifurcation is very frequent.

We are now aware of far more than a dozen species of *Otozamites* from the Mesozoic strata of the world, but with none of them is the present specimen identical.

A characteristic feature of this species is the elongate-obovate shape of the frond, which in most species is linear or more elongated. Habitually it resembles a group of fronds which are usually called under the name *Otozamites obtusus* (L. and H.) or *O. bechei* BRONGN.[1], a Jurassic form. But it differs from that group in that the frond of the latter tapers gradually towards the narrow apical end and not abruptly as in our specimen, moreover the pinnae are more parallel-sided and obtusely pointed at the apex.

Locality: Kamihina (Loc. No. 47).

Otozamites indosinensis ZEILLER

Pl. XLII (XXIV), Fig. 7.

1903. *Otozamites indosinensis* ZEILLER: Flore fossile des gîtes de charbon du Tonkin, p. 168, Pl. XLIII, fig. 1.

To the Tonkin Rhaetic species *Otozamites indosinensis* ZEILLER is referred here, with some hesitation, a single fragmentary specimen illustrated in Pl. XLII (XXIV), fig. 1. It is a portion of a frond, 4 cm. in length at least and 2.2 cm. in breadth, traversed by a thin rachis. The pinnae are opposite, closely set, inserted on the upper side of the rachis with an angle of about 45°, and the opposite ones are lightly overlapping at the base. The pinnae are ovate-oblong, tapering gradually from the base to the apex, slightly falcate, with the upper margin concave and the lower proximally broadly convex, near the apex curving rather abruptly to the rounded or obtusely rounded apex. The nerves are distinct, diverging, bifurcating, and end at the margin of the pinnae.

This form seems to agree closely with *Otozamites indosinensis* figured by ZEILLER[2] from the Rhaetic of Tonkin. ZEILLER compared this species with *O. mandeslohi* KURR[3] on the one hand and *O. obtusus* L. and H. on the other, but distinguished it from KURR's

(1) A. C. SEWARD: Fossil Plants, Vol. III, 1917, p. 539.

(2) R. ZEILLER: Flore fossile des gîtes de charbon du Tonkin, p. 168, Pl. XLIII, fig. 1.

(3) J. G. KURR: Beiträge zur fossilen Flora der Juraformation Würtenberg, 1846, p. 10, Pl. I, fig. 3.

species in the less developed pinna-base, more parallel lateral margins and more divergent nerves; from LINDLEY and HUTTON's species, especially from the specimens figured by BARTHOLIN[1] from the Liassic beds of Bornholm, ZEILLER distinguished this species chiefly in the less developed and less imbricated pinna-base, more broadly rounded apex, absence of the inferior ear, and in some other points.

Locality: Kamihina (Loc. No. 47).

Otozamites sp.

Pl. XLII (XXIV), Fig. 8; Pl. L (XXXII), Fig. 2B.

Specimens shown in Pl. XLII (XXIV), fig. 8 and Pl. L (XXXII), fig. 2B are small portion of fronds which are specifically indeterminable, though their belonging to the genus *Otozamites* is far from doubtful. In both specimens the pinnae are long and narrow, slightly falcate, tapering gradually from the base to the apex, and inserted obliquely on the upper side of the rachis. The pinna-base is pretty well developed, but the imbrication seems to be not very remarkable. The nature of the apex is not known. The nerves are fine, and less divergent than any species of *Otozamites* described in the foregoing lines.

Comparable species are *Otozamites bucklandi* BRONGN. figured by SCHENK[2], which, according to GOTHAN[3], is specifically identical with *O. brevifolius* BRAUN and a Wealden species *O. goeppertianus* (DUNKER) figured by DUNKER[4] as *Pterophyllum goeppertianum*. Without a larger specimen bearing complete pinna, especially its apex, it is difficult to determine the specimens specifically.

Locality: Kamihina Loc. No. 47).

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(1) C. T. BARTHOLIN: Nogle i den bornholmske Juraformation forekommende Planteforsteninger. II. Bot. Tidskr., Bd. XIX, 1894, p. 93, Pl. II, figs. 6, 9b: Pl. III, fig. 2.

(2) W. Ph. SCHIMPER: Traité de paléontologie végétale, Tom. II, 1870–1872, p. 172, Pl. XLV, figs. 10–12.

(3) W. GOTHAN: Die unter-liassische (rhaetische) Flora der Umgegend von Nürnberg. L.c., p. 136, Pl. XXVIII, fig. 1.

(4) W. DUNKER: Monographie der norddeutschen Wealdenbildung, 1846, p. 14, Pl. II, figs. 5, 5a.

GENUS *Ptilozamites* NATHORST

Ptilozamites tenuis sp. nov.

Pl. XLIII (XXV), Figs. 1–3.

1931. *Pterophyllum contiguum* ÔISHI (non SCHENK): *Yabeiella* sp. from the Japanese Triassic. Jap. Journ. Geol. Geogr., Vol. VIII, No. 4, p. 359.

Frond pinnate, slender; its rachis also thin and delicate, with transverse wrinkles, and forking once at least. Pinnules alternate, closely set or slightly spaced, attached at a wide angle by their whole base, parallel-sided, with obtuse to rounded apex. Nerves parallel, forking, and numbering 4–5 in each pinnule.

Unfortunately, the writer has carelessly misplaced a slab of rock with certainly a forked rachis which proves the belonging of the specimens to the genus *Ptilozamites*. The pinnae shown in Pl. XLIII (XXV), figs. 1–3 in themselves resemble closely a Bennettitalean species *Pterophyllum aequale* BRONGN. and an allied species *P. contiguum* SCHENK. The author has once provisionally assigned the specimens to the latter species. But having procured a specimen of pinna with forked rachis, it was proved that the specimens are a *Ptilozamites*.

Ptilozamites is one of the characteristic Rhaetic and Lower Jurassic plants in northern Europe, and about half a dozen species of it have been known. However, with neither of them are the present specimens identical. Most species of *Ptilozamites* have pinnules characterised by the strong upward curving of the posterior margin and usually with divergent nerves, but such features are not well exhibited in our specimens. *Ptilozamites nilssoni* NATH.[1] may be somewhat comparable with our species, but in that the pinnules are more acutely pointed.

Locality: Kamihina (Loc. No. 50).

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(1) Cfr. E. ANTEVS: The Swedish Species of *Ptilozamites* NATHORST. Kgl. Svensk. Vet.-Akad. Handl., Bd. LI, No. 10, 1914, p. 8, Pl. I, figs. 1–7; Pl. II, figs. 8, 9; Pl. III, figs. 4–9. N. JOHANSSON: Die rhaetische Flora der Kohlengruben bei Stabbarp und Skromberga in Schonen. Ibid., Bd. LXIII, No. 5, 1922, p. 35, Pl. I, figs. 18–21; Pl. VI, figs. 9–11; Pl. VIII, fig. 19.

Ptilozamites nilssoni NATHORST?

Pl. XLIII (XXV), Fig. 4.

Compare:

1878. *Ptilozamites nilssoni* NATHORST: Floran vid Höganäs och Helsingborg. L.c., p. 23, Pl. III, figs. 1–5, 8.
1878. *Ptilozamites nilssoni* var. *longior* NATHORST: Floran vid Höganäs och Helsingborg. L.c., p. 23, Pl. III, figs. 6, 7.
1878. *Ctenopteris* ? *falcata* NATHORST: Floran vid Bjuf. L.c., p. 52, Pl. VII, figs. 7, 9.
1879. *Ptilozamites falcatus* NATHORST: Floran vid Bjuf. L.c., p. 63, Pl. XI, fig. 14; Pl. XII, fig. 9.
1914. *Ptilozamites nilssoni* ANTEVS: The Swedish Species of *Ptilozamites*. L.c., p. 8, Pl. I, figs. 1–7; Pl. II, figs. 8, 9; Pl. III, figs. 4–9.
1922. *Ptilozamites nilssoni* JOHANSSON: Die rhaetische Flora der Kohlengruben bei Stabbarp und Skromberga in Schonen. L.c., p. 35, Pl. I, figs. 18–21; Pl. VI, figs. 9–11.

In the collection, was found a single incomplete specimen which was believed to belong to the characteristic Rhaetic species, *Ptilozamites nilssoni* NATH. It consists of a rachis nearly 1 mm. across, to which pinnules are attached. The pinnules preserved are 1.3 cm. in length, 3 mm. in breadth at the base, closely set, attached at an angle of about 55° by their whole base, with the upper margin nearly straight and the lower convex with the broad curve, both the margins meeting in an obtuse apex. The nerves are prominent, forking in their origin, parallel to the lateral margins and converging to the apex of the pinnules, numbering usually 10 in the middle of each pinnule.

There is at hand no positive proof of forking rachis for referring the present specimen to the genus *Ptilozamites*, but the shape of the pinnules which are characterised by the gentle upward curving of the lower margin seems to bring it nearer *Ptilozamites* than any related genera such as *Pterophyllum*, *Thinnfeldia*, *Ctenopteris*, etc. Among the known species of fossil plants, *Ptilozamites nilssoni* NATH. from Sweden[1] may be comparable, though there is a slight difference in shape of the pinnules, those of the former being broader compared with the length, and the lower

(1) E. ANTEVS: The Swedish Species of *Ptilozamites* NATH. L.c. N. JOHANSSON: Die rhaetische Flora der Kohlengruben bei Stabbarp und Skromberga in Schonen. L.c.

margin being more strongly curved upwards. From the foregoing species, *P. tenuis,* the present specimen is also distinguished in the more acute apex of the pinnules.

Locality: Nishihata (Loc. No. 62).

GENUS *Yabeiella* ŌISHI

Leaf Taeniopteroid; midnerve strong, generally with minute pittings; lateral nerves simple or forked and occasionally two adjacent ones joining or connected with cross-bars; at their outer extremities lateral nerves joining to form a distinct marginal nerve. Fructification unknown.

The generic name *Yabeiella* was established by the present writer[1] on certain specimens of Taeniopteroid frond from the Lower Mesozoic strata of Argentina, South Africa, Australia, and India, which have been generally assigned to the genus *Taeniopteris.* As the above diagnosis shows, *Yabeiella* is characterised by the occasional reunion of the lateral nerves and the presence of marginal nerve, though the latter feature is sometimes obscure.

Seven species of *Yabeiella* are known, though two of them are doubtfully assigned to that genus by the present writer, viz. *mareyesiaca* (GEINITZ), *brackebuschiana* (KURTZ), *wielandi* ÔISHI *spatulata* ÔISHI, ? *dutoiti* ÔISHI and ? *crassinervis* (FEIST.). To these the writer should like now to add also some incomplete specimens from the Nariwa district which have been called *Yabeiella* sp.[2] and some specimens figured and described by NATHORST[3] from the Upper Jurassic deposits of the Advent Bay under the name *Taeniopteris lundgreni* NATH.

Yabeiella is particularly interesting, its occurrence being mostly confined to the older Mesozoic strata, though some specimens occur also in somewhat upper horizons in the Mesozoic. The geological and geographical distribution of the known species of *Yabeiella* are shown as follows:

Yabeiella mareyesiaca.. Rhaetic of Argentina; Ipswich (Rhaetic ?) Series of Queensland.

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(1) S. ÔISHI: On *Fraxinopsis* WIELAND and *Yabeiella* ÔISHI, gen. nov. Jap. Journ. Geol. Geogr., Vol. VIII, No. 4, 1931, p. 259.

(2) S. ÔISHI: *Yabeiella* sp. from the Japanese Triassic. Ibid., p. 357.

(3) A. G. NATHORST: Zur mesozoischen Flora Spitzbergens. Kgl. Svensk. Vet.-Akad. Handl., Bd., XXX, No. 1, 1897, p. 50, Pl. III, figs. 1–5.

Y. brackebuschiana... Rhaetic of Argentina and South Africa.
Y. wielandi..... Rhaetic of Argentina.
Y. spatulata..... Rhaetic of Argentina.
Y. sp..... Rhaetic of Japan.
Y. lundgreni..... Upper Jurassic of Spitzbergen.
Y. ? *dutoiti*..... Rhaetic of South Africa.
Y. ? *crassinervis*..... Rhaetic of South Africa; Liassic of India; ? Jurassic of Queensland and New Zealand; ? Triassic of North America.

Besides the above enumerated, *Taeniopteris eurychoron* (SCHENK) originally described by SCHENK[1] from China as *Oleandridium eurychoron* and later by KAWASAKI[2] as *Taeniopteris eurychoron* from Korea and a specimen figured by DU TOIT[3] from the Upper Karroo Beds of South Africa as *Taeniopteris* cfr. *immersa* NATHORST present, in the presence of frequent reunion of any two adjacent lateral nerves, the possibility of their belonging to the genus *Yabeiella*.

It is highly interesting that *Yabeiella* occurs in Argentina in close association with a type of alate fruiting bodies which WIELAND called *Fraxinopsis*. Very recently the present writer received interesting information from Dr. F. R. WHITEHOUSE[4] of the University of Queensland, Brisbane, noting that *Yabeiella* was found in association with *Fraxinopsis* also in the Upper Triassic rocks in Queensland. The only problem of the day is the nature of the seed-like bodies in *Fraxinopsis*, whether they are dicotyledonous as WIELAND considered or Gymnospermous as SEWARD[5] and the present writer suggested. This is to be settled only by the anatomic study of the seed-like bodies. The settlement of this problem may at the same time throw light on the closer affinity of *Yabeiella*.

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(1) A. SCHENK: Die waehrend der Reise des Grafen Bela Széchenyi in China gesammelten fossilen Pflanzen. L.c., p. 168, Pl. XIII (I), figs. 3–5; Pl. XV (III), fig. 2.

(2) S. KAWASAKI: Some Older Mesozoic Plants in Korea. L.c., p. 31, Pl. XX, fig. 61.

(3) A. L. DE TOIT: The Fossil Flora of the Upper Karroo Beds. Ann South African Museum, Vol. XXII, Pt. 2, 1927, p. 352, Text-fig. 10D.

(4) F. R. WHITEHOUSE: Some Problems of Queensland Palaeobotany. Abstracts of Proceedings of the Royal Society of Queensland, held on October 25th, 1931.

(5) A. C. SEWARD: Plant Life through the Ages. Cambridge, 1931, p. 328.

Yabeiella sp.

1931. *Yabeiella* sp. ÔISHI: *Yabeiella* sp. from the Japanese Triassic. L.c., p. 357.

The occurrence of this interesting genus in the plant-bed of Kamihina has already been reported by the present writer(1), and there is no need of describing more of it. It is unfortunate that the Japanese specimens are all fragmentary and can not be determined specifically. The writer has one more imperfect specimen possibly of a *Yabeiella* derived from the black sandy slate of Koyagaichi, the Nariwa District, but it is not illustrated at this place.

Localities: Kamihina (Loc. No. 46); and ? Koyagaichi (Loc. No. 58).

GENUS *Taeniopteris* BRONGNIART

Taeniopteris lanceolata sp. nov.

Pl. XLIII (XXV), Figs. 5–9.

1931. *Taeniopteris* cfr. *vittata* ÔISHI: *Yabeiella* sp. from the Japanese Triassic. L.c., p. 359.

Leaf simple, shortly-petiolate, linear-lanceolate, broadest at the portion slightly above the middle, thence tapering gradually to the acuminate or blunt apex and more gradually towards the base. Midnerve distinct, moderately strong, with a longitudinal median groove. Lateral nerves making an angle of 60°–80° with midnerve, not decurrent at the base, straight, once or twice forking at variable distances from the base, 25–30 in number per cm. at the margin.

No specimens show the complete length of the leaf, but, a specimen in Pl. XLIII (XXV), fig. 5 is nearly complete. It is more than 8 cm. in length, and a little broken at the very tip. It increases in breadth from the narrow base gradually upwards and tapers distally at the portion 6 cm. above the base. The proximal portion of the leaf is shown in the specimen in figs. 6–8; in these the leaf is well seen characterised by the gradual tapering of the lamina towards the base without abrupt contraction or rounding of the lamina in its proximal end. The nature of the apex is shown in fig. 9 a. The lateral nerves are neither too oblique nor

(1) S. ÔISHI: *Yabeiella* sp. from the Japanese Triassic. L.c.

are they perpendicular to the midnerve, but make an angle of generally 60° or occasionally slightly more. It is one of the characteristics of this species that the lateral nerves are not decurrent at the base. The lateral nerves fork frequently at variable distances from the base, but the forking occurs mostly at the middle of the course.

The comparable species are as follows: *T. jourdyi* ZEILLER from the Rhaetic of Tonkin(1); *T. tenison-woodsi* ETHERIDGE JR. from the Ipswich and Walloon Series of Queensland(2); *T. spatulata* MACCLELLAND from the Jurassic of Korea(3) and India(4), the Walloon Series of Queensland(5), the Upper Karroo Beds of South Africa(6), and the Rhaetic of Tonkin(7); *T. vittata* BRONGN. from Europe(8) and North America(9); *T. tenuinervis* from the Rhaetic of northern Europe(10); *T. lenticuliformis* (ETHERIDGE JR.) from the Ipswich Series of Queensland(11); and lastly *T. MacClellandi* OLDHAM and

(1) R. ZEILLER: Flore fossile des gîtes de charbon du Tonkin, p. 66, Pl. X, figs. 1–6; Pl. XI, figs. 1–4; Pl. XII, figs. 1–4, 6–8; Pl. XIII, figs. 1–5.

(2) A. B. WALKOM: Mesozoic Floras of Queensland. Pt. I.-cont. The Flora of the Ipswich and Walloon Series. L.c., p. 32, Text-fig. 9.

(3) S. KAWASAKI: Some Older Mesozoic Plants in Korea. L.c., p. 30, Pl. XIX, figs. 59, 60.

(4) T. OLDHAM: and J. MORRIS: Fossil Flora of the Rajmahal Series in the Rajmahal Hills. Palaeont. Indica, Ser. II, Vol. I, Pt. 1, 1863, p. 34, Pl. VI, figs. 1–6 (non fig. 7). O. FEISTMANTEL: Jurassic (Liassic) Flora of the Rajmahal Group in the Rajmahal Hills. Ibid., Pt. 2, 1877, p. 97. FEISTMANTEL: Jurassic (Liassic) Flora of the Rajmahal Group from Golapili, near Ellore, South Godavari. Ibid., Pt. 3, 1877, p. 172, Pl. I, figs. 6b, 7b. FEISTMANTEL: Upper Gondwana Flora of the Outliers on the Madras Coast. Ibid., Pt. 4, 1879, p. 206, Pl. I, figs. 8–13, 17, 18; Pl. II, fig. 3; Pl. XV, fig. 11.

(5) A. B. WALKOM: The Flora of the Ipswich and Walloon Series. L.c., p. 30, Pl. V, fig. 2b.

(6) A. L. DU TOIT: The Fossil Flora of the Upper Karroo Beds. L.c., p. 351, Text-figs. 10A-C.

(7) R. ZEILLER: Flore fossile des gîtes de charbon du Tonkin, p. 74, Pl. XIII, figs. 6–12.

(8) Cfr. A. C. SEWARD: Jurassic Flora, Pt. 1, 1900, p. 157.

(9) W. FONTAINE: In WARD's Status of the Mesozoic Floras of the United States. Sec. Paper. U.S. Geol. Surv., Mon. Vol. XLVIII, 1905, p. 80, Pl. XIII, figs. 4–8.

(10) D. BRAUNS: Der Sandstein bei Seinstedt unweit des Fallsteins und die in ihm vorkommenden Pflanzenreste. Palaeontogr., Bd. IX, 1862, p. 50, Pl. XIII, figs. 1–3. A. G. NATHORST: Floran vid Bjuf, 1878, p. 47, Pl. VII, fig. 6; Pl. VIII, figs. 8, 11, 12, 14–16; Pl. X, figs. 2–5. NATHORST: Ibid., 1879, p. 59, Pl. XI, fig. 9. Cfr. also N. JOHANSSON: Die rhaetische Flora der Kohlengruben bei Stabbarp und Skromberga. L.c., p. 39, Pl. I, fig. 23; Pl. VI, figs. 14–16.

(11) A. B. WALKOM: The Flora of the Ipswich and Walloon Series. L.c., p. 35, Text-fig. 11.

MORRIS from the Jurassic of Korea[1] and India[2] and the Rhaetic of Tonkin[3]. The chief differences between each of these above named species and *T. lanceolata* are briefly mentioned in the following paragraphs.

Certain specimens of *T. jourdyi* illustrated by ZEILLER[4] seem to agree closely with the present form, but in ZEILLER's species the lamina contracts abruptly at the proximal end and the lateral nerves are denser, the number being said to be 35–50 per cm., instead of 25–30 as in ours.

A leaf with acuminate apex figured by WALKOM as *T. tenison-woodsi* is very similar to ours, but the lateral nerves are coarser and according to this author, 1 mm. apart at the margin.

T. spatulata has often an acuminate apex, though generally rounded or obtusely rounded and it is this former type that the present form resembles more or less. In *T. spatulata,* however, the leaf is more linear and gives a different aspect on the general habit of the frond. Among the figured specimens of *T. spatulata,* an incomplete leaf from the Upper Karroo Beds[5] is the nearest ally of ours.

T. MacClellandi also resembles ours more or less, especially in bearing acuminate apex, but there is a difference in the former's having the rounded proximal end of the lamina. In the form of leaf the present specimens are quite identical with the Rhaetic species *T. tenuinervis,* but the lateral nerves in this species are mostly simple and not frequently forked as in ours.

The most closely comparable species is *T. vittata* (BRONGN.) and the writer once, though provisionally, referred his specimens to BRONGNIART's species. Having compared more carefully the Japanese specimens with the figures of *T. vittata* illustrated by so many authors, the writer found that the lamina of *T. vittata* ends abruptly rounded at the proximal end and the apex of the leaf is less acumi-

(1) S. KAWASAKI: Some Older Mesozoic Plants in Korea. L.c., p. 34, Pl. XX, figs. 62, 63.

(2) T. OLDHAM and J. MORRIS: Fossil Flora of the Rajmahal Series in the Rajmahal Hills: L.c., p. 33, Pl. XXIII. O. FEISTMANTEL: Jurassic (Liassic) Flora of the Rajmahal Group in the Rajmahal Hills. L.c., p. 96, Pl. XLVI, figs. 5, 6. FEISTMANTEL: Upper Gondwana Flora of the outliers on the Madras Coast. L.c., p. 207, Pl. I, figs. 14–16; Pl. II, fig. 4.

(3) R. ZEILLER: Flore fossile des gîtes de charbon du Tonkin, p. 61, Pl. IX, figs. 3–5.

(4) R. ZEILLER: Ibid., p. 66, Pl. XIII, figs. 1–5.

(5) A. L. DU TOIT: The Fossil Flora of the Upper Karroo Beds. L.c., p. 351, Text-fig. 10A-C.

nate, so the writer now prefer to separate the present form specifically from *T. vittata*.

Our species also greatly resembles *T. lenticuliforme* which is closely allied to *T. vittata*, but in *T. lenticuliforme* the lamina increases its breadth upwards more rapidly than in ours and the apex is obtuse and "never acute." The density of the lateral nerves in *T. lenticuliforme* agrees well with the present form.

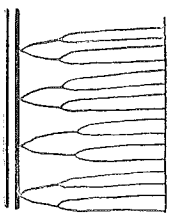
Lastly, some imperfect leaves from the Jurassic of Kamenka referred by THOMAS[1] to the Indian species *Taeniopteris densinervis* FEISTMANTEL seem to be almost identical with *T. lanceolata*.

Locality: Common at Kamihina (Loc. Nos. 40 and 50).

Taeniopteris nabaensis sp. nov.

Pl. XLIII (XXV), Figs. 11–13; Text-Fig. 3.

Some imperfect Taeniopteroid leaves shown in Pl. XLIII (XXV), figs. 11–13 differ in their nervation from any known species of Mesozoic *Taeniopteris*, and are called here under a new specific name *nabaensis*.



Text-fig. 3. *Taeniopteris nabaensis*. Showing the nervation.

The leaf in fig. 12, imperfect at both ends, is at least 4 cm. in length. 2 cm. in breadth in its upper broken end and thence tapers gradually to the proximal broken end which is 1.8 cm. in breadth. The rachis is thin and delicate and gives off the lateral nerves at a right angle. The lateral nerves are very crowded, being twice dichotomously branched, first close to their origin, and secondly in their midcourse. So their number at the margin is approximately 28 per centimeter. The margin is entire.

Taeniopteris major L. and H. figured by FONTAINE[2] from the Jurassic of Oregon somewhat resembles ours in the nervation, but in that species the forking of the lateral nerves occurs only once midway, and the nerves in the unit distance are far less in number.

The present specimens seem to agree essentially with some unnamed leaves from the Rhaetic of Persia figured by SCHENK[3]:

(1) H. H. THOMAS: The Jurassic Flora of Kamenka. Mém. Com. Géol., St.-Pétersbourg, N.S., Liv. 71, 1911, p. 71, Pl. IV, figs. 4, 5.

(2) W. FONTAINE: In WARD's Status of the Mesozoic Floras of the United States. L.c., p. 79, Pl. XIII, figs. 1–3.

(3) A. SCHENK: Fossile Pflanzen aus der Albourskette. L.c., p. 4, Pl. IV, fig. 17; Pl. V, fig. 20; ? Pl. VII, fig. 41.

in his work on the "Fossile Pflanzen aus der Albourskette," two imperfect leaves in his Pl. IV, fig. 19, only mentioned by this author as "Fragmente von *Oleandridium,*" agree well with the present specimens in all respects, especially in the thick rachis and the mode of dichotomy of the lateral nerves. These specimens from the Albours range differ from the specimens referred by that author to *Oleandridium* (*Taeniopteris*) *tenuinerve* in the same paper, his *O. tenuinerve* being provided with only once forking lateral nerves. However, BRAUNS' original specimens of *Taeniopteris tenuinervis* from Seinstedt are provided with simple lateral nerves, and the similar fronds are richly figured by NATHORST from the Rhaetic beds of Sweden. The writer's opinion is that *Oleandridium tenuinerve* from the Albours range figured by SCHENK differs specifically from *T. tenuinervis* BRAUNS in the sense of BRAUNS[1] and NATHORST[2] and belongs to quite a different species.

Locality: Nabae (Loc. No. 21).

Taeniopteris cfr. *stenophylla* KRYSHTOFOVICH

Pl. XLIII (XXV), Fig. 10.

Compare:

1910. *Taeniopteris stenophylla* KRYSHTOFOVICH: Jurassic Plants from Ussuriland. Mém. Com. Géol., St.-Pétersbourg, N.S., Liv. 56, p. 11, Pl. II, fig. 2.

1925. *Taeniopteris* cfr. *stenophylla* KAWASAKI: Some Older Mesozoic Plants in Korea. L.c., p. 31, Pl. XXI, fig. 65.

A single incomplete leaf, doubtlessly of a *Taeniopteris,* is provisionally referred to this Jurassic species first described by KRYSHTOFOVICH from the Middle Jurassic beds of Ussuriland. The specimen at hand is at least 5.5 cm. in length, being incomplete on both ends, linear, 1 cm. in breadth and nearly parallel-sided. It is traversed by a slender rachis, which gives off lateral nerves at an angle of approximately 55°. The lateral nerves are straight, not decurrent at the base, forking near their origin, and are about 18 in number per cm. along the margin. The margin is entire.

Without more complete specimens available, it is very difficult to discuss the existence of this Jurassic species in our Rhaetic beds. So far as the single specimen at hand is concerned, how-

(1) D. BRAUNS: Sandstein bei Seinstedt unweit des Fallsteins und die in ihm vorkommenden Pflanzenreste. L.c., p. 50, Pl. XIII, figs. 1–3.

(2) A. G. NATHORST: Floran vid Bjuf, 1878, p. 47 and following.

ever, it is very closely allied to *T. stenophylla*. The Korean specimen described by KAWASAKI[1] as *T.* cfr. *stenophylla* is probably identical with the present form.

Locality: Koyagaichi (Loc. No. 58).

Taeniopteris cfr. *carruthersi* TENISON-WOODS

Pl. XLIV (XXVI), Figs. 1–2.

Compare:

1872. *Taeniopteris daintreei* CARRUTHERS: Notes on Fossil Plants from Queensland, Australia. Q. J. Geol. Soc., London, Vol. XXVIII, p. 355, Pl. XXVII, fig. 6.
1903. *Taeniopteris carruthersi* SEWARD: Fossil Flora of Cape Colony. Ann. South African Museum, Vol. IV, Pt. I, p. 59, Pl. VIII, figs. 5, 6.
1908. *Taeniopteris carruthersi* SEWARD: On a Collection of Fossil Plants from South Africa. Q. J. Geol. Soc., London, Vol. LXIV, p. 98, fig. 6.
1917. *Taeniopteris carruthersi* WALKOM: The Flora of the Ipswich and Walloon Series. L.c., p. 34, Text-fig. 10.
1927. *Taeniopteris carruthersi* DU TOIT: The Fossil Flora of the Upper Karroo Beds. L.c., p. 347, Text-fig. 9.

To the Rhaetic species of the southern hemisphere, *T. carruthersi,* are assigned with some hesitation two incomplete leaves shown in Pl. XLIV (XXVI), figs. 1 and 2. The one in fig. 1 is linear leaf, without base and apex, measuring at least 9 cm. in length and 2.6 cm. in breadth in its upper broken end thence narrowing gradually towards the lower end which is 1.8 cm. in breadth. The rachis is not very strong, being 1 mm. or slightly more in breadth on the impression, and with minute transverse wrinkles. The lateral nerves which are perpendicular to the rachis are simple or once forking close to their origin, and there are about 23 of them per centimeter. The margin is entire.

Another specimen in fig. 2 is also an incomplete leaf, 3 cm. in breadth, nearly parallel-sided or narrowing very gradually towards the lower broken end. The rachis is thin and delicate, and gives off lateral nerves at right angles, or first acutely and immediately bending outwards assuming a straight course perpendicular to the rachis. The lateral nerves are distinct, simple or fork-

(1) S. KAWASAKI: Some Older Mesozoic Plants in Korea. L.c., p. 31, Pl. XXI, fig. 65.

ed close to their origin or midway, and are about 20 in number per centimeter. The margin is entire.

As was elsewhere mentioned by several authors, this species was first referred by CARRUTHERS to *T. daintreei* McCOY on a Australian specimen, but later TENISON-WOOD finding out the differences in the form of leaf existing between CARRUTHERS' specimen and McCOY's type instituted a new specific name *carruthersi.*

Though the actual existence of this Rhaetic species of the southern hemisphere can not yet be proved in our Rhaetic rocks, the Japanese specimen being represented by only a single imperfect leaf it is somewhat noticeable that our single specimen agrees, as far as the comparison is available, in all respects with *T. carruthersi* in the parallel lateral margins of the leaf and the lateral nerves which are perpendicular to the rachis, better than with any other species of Mesozoic *Taenipteris.*

SEWARD(1) referred three specimens of *Taeniopteris* from Cape Colony to *T. carruthersi,* of which one in his Pl. III, fig. 5, a narrower form, was described by WALKOM(2) as a synonym of *T. tenison-woodsi* ETHER. JR.; while DU TOIT(3) recognised SEWARD's identification. Our specimen is not unlike a Jurassic species *Taeniopteris vittata* BRONGN., in which, however, the lamina contracts abruptly at the lower end and the lateral nerves are much coarser than in ours.

Localities: Eda (Loc. No. 1); and Nabae (Loc. No. 21).

Taeniopteris cfr. *leclerei* ZEILLER

Pl. XLIV (XXVI), Fig. 3.

Compare:

1903. *Taeniopteris leclerei* ZEILLER: Flore fossile des gîtes de charbon du Tonkin, p. 294, Pl. LV, figs. 1–4.

1927. *Taeniopteris leclerei* HALLE: Fossil Plants from South-Western China. Palaeont. Sinica, Ser. I, Vol. I, Fasc. 2, p. 17, Pl. V, figs. 2–4.

Pl. XLIV (XXVI), fig. 3 shows an imperfect leaf of a *Taeniopteris* which is at least 3.4 cm. in length, and 2.6 cm. in

(1) A. C. SEWARD: Fossil Plants of Cape Colony. L.c., p. 59.

(2) A. B. WALKOM: The Flora of the Ipswich and Walloon Series, 1917, l.c., p. 33.

(3) A. L. DU TOIT: The Fossil Flora of the Upper Karroo Beds. L.c., p. 349.

breadth in its upper broken end, thence narrowing gradually towards the base. It is traversed by a very thick rachis which measures 3 mm. in breadth on the compressed surface at the lower extreme end and stands out prominently as a broad ridge. The lateral nerves which issue from the rachis nearly at a right angle fork close to their origin and reach the margin of leaf assuming a straight course. At the margin, the number of lateral nerves is counted to be approximately 28 per centimeter. The lamina is characterised by the transverse folding, and the nerves often become very indistinct on account of this folding. The black narrow transverse lines seen in the figure show the furrows which alternate with the broader ridges. Each ridge seems to correspond usually to two lateral nerves, which can be seen only through the magnifier. The margin is entire.

The present specimen differs somewhat from *T. leclerei* from China in the slightly denser lateral nerves, those of the latter being described by ZEILLER[1] as 20–25 per centimeter, though otherwise similar. An imperfect leaf figured by KAWASAKI[2] from Korea as *Taeniopteris* cfr. *superba* SAPORTA is closely allied to our specimen.

Locality: Yamamoto (Loc. No. 64).

Taeniopteris sp.

Pl. XLIV (XXVI), Fig. 4.

The specimen in Pl. XLIV (XXVI), fig. 4 is specifically indeterminable, but has been figured because it does not appear to belong to any of the other species described in this memoir. It is a portion of a leaf doubtlessly of a *Taeniopteris* without base and apex, measuring at least 3 cm. in length and 2 cm. in breadth, with lateral margins fairly parallel. The rachis is slender, and less than 1 mm. in breadth on the impression. The lateral nerves are coarse, simple or once forking close to their origin, nearly perpendicular to the rachis, reaching the margin of the leaf after assuming a straight course, and are 12 in number per cm.

This example differs from *Taeniopteris* cfr. *carruthersi* above described, in respect to the less crowded lateral nerves.

Locality: Hinabata (Loc. No. 44).

(1) R. ZEILLER: Flore fossile des gîtes de charbon du Tonkin. L.c.

(2) S. KAWASAKI: Some Older Mesozoic Plants in Korea. L.c., p. 35, Pl. XX, fig. 64.

Taeniopteris? sp.

Pl. XLIV (XXVI), Figs. 5, 5a.

A fragmentary specimen of a pinna of fern or a Taeniopteroid-leaf is shown in Pl. XLIV (XXVI), fig. 5. It is 4 cm. in length at least and 2.6 cm. in breadth, gradually increasing the breadth from the proximal broken end towards the upper. It is provided with a rachis which is 1 mm. in breadth at the lower end. The lateral nerves are always simple, distant, being approximately 1 mm. apart, perpendicular to the rachis and curving gently upwards near the margin. The margin is finely toothed, each tooth directed upwards and receiving a single lateral nerve. The most characteristic feature is the elevation, as a narrow ridge, of the interveining lamina. So prominent is this feature, that it often leads one mistaking the ridges for the true lateral nerves: the transverse lines, which stand out distinctly in the figure 5 are the folding of the lamina between the nerves and the true nerves are not seen in the photograph.

The present specimen somewhat reminds one of *T. nilssonioides* ZEILLER from the Rhaetic of Tonkin figured by ZEILLER[1], but there are many differences between them, first, the lateral nerves of ZEILLER's species fork frequently and are much more in number in the unit distance, secondly the transverse folding of the lamina do not always occur regularly as in ours.

Our specimen may be a new form, but the specific name is reserved for a while owing to the fragmentary state of the specimen.

Locality: Kamihina (Loc. No. 49).

Taeniopteris? sp. nov.

Pl. XLIV (XXVI), Fig. 6A–B.

A single incomplete specimen in Pl. XLIV (XXVI), fig. 6A does not agree with any species described in this memoir or other known species of Mesozoic *Taeniopteris* or related genera. It is 4.5 cm. in length at least and 4 cm. in breadth in its upper broken end, thence narrowing gradually towards the lower broken end. The rachis is very thick and measures 4 mm. in breadth on the impression. The lateral nerves, which are at about an angle of

(1) R. ZEILLER: Flore fossile des gîtes de charbon du Tonkin, p. 78, Pl. XV, figs. 1–4.

80°, are straight, or bending upwards close to the margin, and appear to be mostly simple. The lamina narrows very gradually towards the base (fig. 6B).

The most characteristic features of this specimen are the folding of the lamina and the presence of a marginal vasculum (?): the lateral nerves are coarse and 1 mm. apart, and the nerves themselves are elevated as a ridge, which alternates with a narrow groove between the nerves. Such features make the nerves of this example appear very strong and prominent; in reality the nerves themselves are very thin and delicate. The lateral margins are distinctly "gesaumt" close to the periphery, as noted by GEINITZ[1] in *Taeniopteris* (*Yabeiella*) *mareyesiaca* GEIN. from the Rhaetic of Argentina. Though it is not clear at present whether it is a vasculum or simply a marginal thickening of the lamina, such feature is worthy of special attention as one of the characteristics of this plant.

The specimen thus characterised may possibly belong to a new species but as the material is too fragmentary, the specific name is reserved for a while. The generic position is also indistinct; though it is in general habit a *Taeniopteris*, the simple lateral nerves remind one of a *Nilssonia*; but there is no other reliable evidence of its belonging to that genus.

Locality: Hata (Loc. No. 65).

NILSSONIALES

GENUS *Nilssonia* BRONGNIART

Nilssonia simplex sp. nov.

Pl. XLIV (XXVI), Figs. 7–9; Pl. XLV (XXVII), Figs. 1–4.

Frond simple, petiolate, long and narrow, linear-lanceolate, more than 17 cm. in length, broadest near the middle, where it measures 1.5–2 cm. in breadth, thence tapering very gradually towards both ends. Apex obtusely rounded. Rachis narrow but rigid, about 1–1.5 mm. across measured at the base, narrowing gradually upwards, with narrow longitudinal furrows on the median line of the upper surface. Nerves simple or once forking close to the

(1) H. B. GEINITZ: Ueber rhaetische Pflanzen- und Tierreste in den argentinischen Provinzen La Rioja, San Juan und Mendoza. Palaeontogr. Supp. III, Abth, 1, 1876, p. 9, Pl. II, figs. 1–3. Cfr. also S. ÔISHI: On *Fraxinopsis* WIELAND and *Yabeiella* ÔISHI, gen. nov. L.c., p. 261.

rachis or rarely near the margin, parallel to each other, straight or slightly curved, with the concave side upwards, nearly at right angles to the rachis, at the proximal end running obliquely downwards in the furrow of the rachis to its median line, and numbering approximately 23 per cm. at the margin. Margin entire.

The specimens are very common in the dump heat at the old pit-mouth of anthracite seams at Eda, but no complete frond is obtainable. The fronds are simple and concrescent, and these features are clearly seen in the specimen shown in Pl. XLIV (XXVI), figs. 7 and 8. A frond in Pl. XLV (XXVII), fig. 1 is the longest one in the collection. It is 17 cm. in length. The breadth of the frond in the broadest middle portion rarely exceeds 2 cm., but in some fronds in fig. 4 (which are possibly compressed accidentally in the longitudinal direction and increased in breadth more or less than natural) it is 2.3 cm. Whole length of the petiole is seen in neither of the specimens in the collection, but from the specimen in Pl. XLIV (XXVI), fig. 8, it is measured to be 1.5 cm. at least. The rachis is not very stout but rather slender and rigid, and has a narrow median furrow on its upper surface as is usually the case in the Nilssonian frond. On the other hand, the rachis is much elevated on the back surface as a prominent ridge above the general surface of the lamina. The frond narrows very gradually towards an obtusely rounded apex, and such is clearly recognisable in the specimens in figs. 2 and 3. The nerves are distinctly impressed; they are generally simple, but bifurcation occurs also frequently, mostly close to their origin and very rarely near the margin. They are nearly perpendicular to the rachis in most part, but at their base run obliquely downwards in the furrow of the rachis to its median line. The last feature is one of the characteristics of this species. The number of nerves generally approximates 23 per cm., but there is a slight variation in number according to the size or to the disfiguration of the frond to which it was subjected during the fossilization. The margin of the frond is naturally entire, but it is sometimes broadly undulating or shallowly crenulated, possibly due to the preservation or to damage done in its life time.

The general features of the fronds, especially the entire lateral margins and the distinct nerves, recall *Taeniopteris* to one rather than *Nilssonia*, but the lamina which covers the upper surface, and the nerves which reach the median line, of the rachis are features characteristic to *Nilssonia*.

So far as the writer knows there is no species of *Nilssonia* which agrees perfectly with *N. simplex*. More or less allied forms are *Nilssonia elegans* ARBER described by ARBER[1] from the Middle Jurassic strata of New Zealand and the well-known Wealden species *N. schaumburgensis* (DUNKER) which is very common in the Lower Cretaceous Ryôseki Series of the Japanese Islands. From the former, however, *N. simplex* is distinguished by its more narrowly elongated apical region; from the latter, it is also distinguished in its coarser and more distinct nerves which fork more occasionally. The apex in *N. schaumburgensis* is more obtusely rounded than in ours.

N. inouyei YOK.[2] from the Rhaetic of Yamanoi, Japan, is also not unlike our specimens. But in the original specimens which the writer had an opportunity of examining in the Geological Institute, Tôkyô Imperial University, the nerves are mostly simple and do not bend downwards at their proximal ends as in our specimens. The most allied species is *Nilssonia nigracollensis* WIELAND figured by WIELAND[3] from the Lower Cretaceous Dakota Formation of North America, and the two seem to be almost specifically identical. It appears to have a similar nervation to our specimens, but its fronds are more long and narrow, and with nerves mostly simple. However taking into consideration the fact that *Nilssonia nigracollensis* is of Lower Cretaceous age, it seems advisable to adopt the new specific name of *simplex* for the present specimens.

Locality: Eda (Loc. No. 1).

Nilssonia orientalis (HEER)

Pl. XLV (XXVII), Figs. 5–6; Pl. XLVI (XXVIII), Figs. 1–2.

1878. *Nilssonia orientalis* HEER: Beiträge zur Juraflora Ostsibiriens und des Amurlandes. L.c., p. 18, Pl. IV, figs. 5–9.
1889. *Nilssonia orientalis* YOKOYAMA: Jurassic Plants from Kaga, Hida, and Echizen. L.c., p. 40, Pl. XIV, figs. 4–9.
1911. *Nilssonia orientalis* SEWARD: The Jurassic Flora of Sutherland. L.c., p. 695, Pl. IV, figs. 60, 63–65; Pl. IX, figs. 34, 42; Pl. X, fig. 46.

(1) E. A. N. ARBER: The Earlier Mesozoic Floras of New Zealand. L.c., p. 52, Pl. VIII, fig. 8; Pl. IX, figs. 1, 2.
(2) M. YOKOYAMA: Mesozoic Plants from Nagato and Bitchû. L.c., p. 9, Pl. I, fig. 4; Pl. II, fig. 4.
(3) G. R. WIELAND: In WARD's Status of the Mesozoic Floras of the United States. L.c., p. 319, Pl. LXXIII, fig. 15.

1911. *Nilssonia orientalis* THOMAS: The Jurassic Flora of Kamenka. L.c., p. 86, Pl. VII, fig. 1.

1912. *Nilssonia orientalis* SEWARD: Mesozoic Plants from Afghanistan and Afghan-Turkistan. L.c., p. 30, Pl. III, fig. 46.

Frond linear-lanceolate, nearly parallel-sided, widening very gradually from the base upwards and contracting abruptly to the rounded apex, more than 13 cm. in length, and 4–8 cm. in breadth near the apex, the lamina fairly covering the upper surface of the rachis; rachis not very strong, being 2.5–3 mm. in breadth on the back surface. Nerves simple, densely crowded, counting 27–35 per centimeter, at wide angle to the rachis, and gently bending upwards.

This species displays a considerable variation in the size of frond and the number of nerves in unit distance. The lamina is as a whole, however, long and narrow, linear, and increases the breadth very gradually from the base upwards and contracts abruptly to the rounded apex. In a specimen in Pl. XLVI (XXVIII), fig. 1 the breadth is 4 cm., while in another specimen in fig. 2 on the same plate it is 8 cm. Though none of the examples shows the nature of the base or apex of the frond, one specimen in Pl. XLV (XXVII), fig. 5 is from the apical portion of a frond, and it is quite obvious that the frond exhibits a tendency to contract suddenly to the apex.

This species is characterised by the densely crowded nervation, though there are some exceptional cases. In the present examples, the density of nerves is nearly constant, being mostly 27–30 per centimeter; towards the apex, however, the nerves become somewhat denser, and in the specimen of an apical portion shown in fig. 5 there are 33 nerves per cm.

Among the specimens hitherto described under the name *Nilssonia orientalis*, those from the Upper Jurassic of Sutherland[1] and the Middle Jurassic of Kamenka[2] and Afghanistan[3] agree essentially with our examples, especially in the form of frond and the densely crowded nerves. Some specimens from the Tetori Series of Central Japan figured by YOKOYAMA[4] under this name seem to hav coarser nerves so far as exhibited in his figures, but in the description he mentions that there are four nerves in 1 milli-

(1) A. C. SEWARD: Jurassic Flora of Sutherland. L.c., p. 695.

(2) H. H. THOMAS: The Jurassic Flora of Kamenka. L.c., p. 86.

(3) A. C. SEWARD: Mesozoic Plants from Afghanistan and Afghan-Turkistan. L.c., p. 30.

(4) M. YOKOYAMA: Jurassic Plants from Kaga, Hida, and Echizen. L.c., p. 40.

meter. As the specimens of fossil plants from Kaga, Hida and Echizen described by YOKOYAMA were all destroyed by the fire following the Great Kwantô Earthquake of Sept. 1, 1923, it is now impossible to examine the original specimens.

Nilssonia orientalis is originally of the Middle Jurassic of Siberia, and has been known from several Mesozoic rocks in the northern hemisphere. GOTHAN[1] described this species from the Lower Liassic rocks near Nürnberg, and ENDÔ[2] figured a similar form, but with coarser nerves, from the Senonian rocks of Hokkaidô. *N. orientalis* from North America[3] differs somewhat from ours in having coarser nerves.

Locality: Hinabata (Loc. No. 44).

Nilssonia acuminata (PRESL)

Pl. XLVI (XXVIII), Figs. 3–4.

1838. *Zamites acuminatus* PRESL: In STERNBERG's Versuch, II, Fasc. VII-VIII, p. 199, Pl. XLIII, fig. 2.
1839. *Zamites heterophyllum* PRESL: Ibid., p. 199, Pl. XLIII, figs. 4, 5.
1914. *Nilssonia acuminata* GOTHAN: Die unter-liassische (rhaetische) Flora der Umgegend von Nürnberg. L.c., p. 35, Pl. XXVI, fig. 1; Pl. XXVIII, figs. 2, 3; Pl. XXXI-XXXII, figs. 2, 3; Pl. XXXIII, fig. 4; Pl. XXXIV, figs. 2, 4.

We have a number of specimens of imperfect fronds which are believed to be identical with certain specimens from the Lower Liassic beds of Germany which GOTHAN referred to the Upper Triassic and Lower Jurassic species *Nilssonia acuminata* (PRESL). Pl. XLVI (XXVIII), fig. 3 shows an apical portion of a frond which is imperfect at base and apex and the lateral margins, and 12 cm. long at least. The rachis is 2 mm. across measured on the compressed surface at the lower broken end. The lamina which fairly covers the upper surface of the rachis is divided up to the rachis into long and narrow segments more or less regular in breadth, straight or slightly falcate, and making a wide angle with the rachis.

(1) W. GOTHAN: Die unter-liassische (rhaetische) Flora der Umgegend von Nürnberg. L.c., p. 41, Pl. XXIV, fig. 2.

(2) S. ENDÔ: *Nilssonia*-Bed of Hokkaidō and its Flora. Sci. Rep., Tōhoku Imp. Univ., 2nd Ser., Vol. VII, No. 3, 1925, p. 65 (9), Pl. VI, figs. 12, 16, 18, 19.

(3) W. M. FONTAINE: In WARD's Status of the Mesozoic Floras of the United States. L.c., p. 90, Pl. XVI, figs. 3–9.

As the lower margin of a segment bends more or less abruptly upwards near the apex, the distal margin sometimes appears to be truncated. The nerves are simple, parallel to each other and to the upper margin of the segments, and there are generally 18 nerves per cm.

Another specimen in fig. 4 shows an impression of the upper surface of an apical portion of a frond, which is imperfect at the tip and one lateral side. The mode of segmentation of the lamina, which covers the upper surface of the rachis, is quite similar to the preceding specimen. In this, however, the nerves are more oblique to the rachis possibly on account of its being an apical portion of the frond. The nerves are simple and a little more crowded than the preceding, and there are about 23 nerves per cm.

The specimens here figured, though imperfect, agree very well with *N. acuminata* figured by GOTHAN[1] from Germany and there is little doubt about their identity (compare our specimens with GOTHAN's Pl. XXXI-XXXII, figs. 2, 3; Pl. XXIV, fig. 4). According to GOTHAN, this species displays a considerable variation in form and size of the fronds and segments, the segments being sometimes very long and narrow just as in the present specimens and sometimes short and broad with the distal margin truncated.

Some specimens figured under this specific name by BARTHOLIN[2] and MOELLER[3] from Bornholm are too imperfect to admit of their specific determination. Allied species are *Pterophyllum morrisianum* OLDHAM[4] and *P. princeps* OLDHAM and MORRIS[5], both species being now regarded as *Nilssonia* by SEWARD and SEHNI[6]; in the former, however, the segments are longer and straighter, while in the latter the nerves are occasionally branched or even anastomosed.

Localities: Nabae (Loc. No. 21); and Hinabata (Loc. No. 66).

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(1) W. GOTHAN: Die unter-liassische Flora der Umgegend von Nürnberg. L.c., p. 35.

(2) C. T. BARTHOLIN: Nogle i den bornholmske Juraformation forekommende Planterforsteninger. Bot. Tidsk., Bd. XIX, 1894, p. 90, Pl. I (IX), fig. 10.

(3) H. MOELLER: Bidrag till Bornholms Fossila Flora. Gymnospermer. Kgl. Svensk. Vet.-Akad. Handl., Bd. XXXVI, No. 6, 1903, p. 23, Pl. III, figs. 8–10.

(4) T. OLDHAM and J. MORRIS: Fossil Flora of the Rajmahal Series in the Rajmahal Hills. L.c., p. 20, Pl. XV, fig. 1; Pl. XVII, fig. 2.

(5) T. OLDHAM and J. MORRIS: Ibid., p. 23, Pl. X-XIII.

(6) A. C. SEWARD and B. SAHNI: Indian Gondwana Plants: A Revision. L.c., pp. 29 and 30.

Nilssonia muensteri (PRESL)

Pl. XLVI (XXVIII), Fig. 5; Pl. XLVII (XXIX), Figs. 1–2.

1838. *Zamites muensteri* PRESL: In STERNBERG's Versuch, II, Fasc. VII-VIII, p. 199, Pl. XLIII, figs. 1, 3.
1850. *Pterophyllum muensteri* UNGER: Genera et Species, p. 291.
1872. *Pterozamites muensteri* SCHIMPER: Traité de paléontologie végétale, Tom. II, p. 145.
1894. *Nilssonia* (*Pterozamites*) *muensteri* BARTHOLIN: Nogle i den bornholmske Juraformation forekommende Planteforsteninger. II. L.c., p. 91, Pl. I (IX), fig. 13; Pl. II (X), figs. 1, 2.
1903. *Nilssonia* cfr. *muensteri* MOELLER: Bidrag till Bornholms Fossila Flora. Gymnospermer. Kgl. Svensk. Vet.-Akad. Handl., Bd. XXXVI, No. 6, p. 22, Pl. II, figs. 20–23.
? 1909. *Nilssonia muensteri* NATHORST: Ueber die Gattung *Nilssonia* BRONGN. Kgl. Svensk. Vet.-Akad. Handl., Bd. XLIII, No. 12, p. 26, Pl. VI, figs. 26–28.
? 1925. *Nilssonia pterophylloides* KAWASAKI: Some Older Mesozoic Plants in Korea. L.c., p. 43, Pl. XXII, fig. 67.
? 1926. *Nilssonia muensteri* KAWASAKI: Addition to the Older Mesozoic Plants in Korea. Bull. Geol. Surv. Korea, Vol. IV, Pt. 2, p. 20.

A number of specimens which resemble somewhat *Nilssonia acuminata* described above, but differing distinctly from it in certain points, is referred here to a Rhaetic and Lower Jurassic species *N. muensteri* (PRESL). Pl. XLVI (XXVIII), fig. 5 shows a portion of a frond, 6 cm. in length, which has a slender rachis 2 mm. in breadth and lamina covering the upper surface of the rachis. The lamina appears to be separated into two parts by a very narrow median groove on the rachis. The segments into which the lamina is dissected are linear, at a wide angle to the rachis, slightly falcate, about 3 cm. in length, lightly expanded at the base, thence narrowing gradually towards the blunt apex. The segmentation of the lamina is rather regular, one segment being about 5 mm. wide at the base, though there is a slight variation in this. The nerves are distinct, simple, 10–11 per 5 mm., and end at the edge of the lamina on each side of the median groove. There is no downward bending of the nerves at the proximal end.

Pl. XLVII (XXIX), fig. 1 also shows an imperfect frond which occurred in association with the preceding specimen. It is at least 10 cm. in length, and a little narrower than that. The rachis is thin and there is also a narrow median groove on the rachis. The

lamina which covers the upper surface of the rachis is dissected into narrow segments which are likewise slightly falcate and set at the base, from there narrowing towards the blunt apex. The nerves are simple, numbering also about 10 per 5 mm.

A specimen of imperfect frond in Pl. XLVII (XXIX), fig. 2 differs somewhat from either of the former two described here, chiefly in shorter and narrower segments and more densely crowded nerves, though otherwise similar. Each segment is about 4 mm. in breadth, slightly expanded at the base and 1.2 cm. in length, with approximately 12–14 simple nerves.

Our specimens more closely resemble *Nilssonia muensteri* than any other species hitherto described. To the Bornholm specimens figured by BARTHOLIN(1) they may possibly be identical. NATHORST(2) pointed out on a Swedish specimen of *N. muensteri* the downward bending at the proximal end of the nerves, and a large specimen with similar feature of the nerves was figured by KAWASAKI from Korea first as *Nilssonia pterophylloides*(3), and later it was transferred to *N. muensteri*(4). In the present specimens, however, the nerves are straight at the proximity and do not bend downwards as NATHORST mentioned. In this point, the Japanese and Bornholm specimens seem to differ slightly from those with nerves which bend downwards at the proximity.

YABE and ÔISHI(5) once described a *Nilssonia* sp. from Roseiri in Korea, and compared it with KAWASAKI's *N. pterophylloides* from Korea and NATHORST's *N. muensteri* from the Rhaetic of Stabbarp, yet finding out some differences chiefly in the nerves which are at right angle to the rachis in *Nilssonia* sp., instead of being oblique to the rachis as in KAWASAKI and NATHORST's specimens. The specimen from Roseiri may very probably be specifically identical with the present specimen.

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(1) C. T. BARTHOLIN: Nogle i den bornholmske Juraformation forekommende Planteforsteninger. II. L.c., p. 91, Pl. I (IX), fig. 13; Pl. II (X), figs. 1, 2.

(2) A. G. NATHORST: Ueber die Gattung *Nilssonia*. L.c., p. 26.

(3) S. KAWASAKI: Some Older Mesozoic Plants in Korea. L.c., p. 43.

(4) S. KAWASAKI: Addition to the Older Mesozoic Plants in Korea. L.c., p. 20.

(5) H. YABE and S. ÔISHI: Notes on Some Fossil Plants from Korea and China Belonging to the Genera *Nilssonia* and *Pterophyllum*. Jap. Journ. Geol. Geogr., Vol. VI, Nos. 3–4, 1929, p. 89, Pl. XX, fig. 2.

ZEILLER[1] is certainly not correct in referring some specimens from the Rhaetic of Tonkin, with the lamina covering the upper surface of the rachis as is characteristic to the genus *Nilssonia*, to *"Pterophyllum" muensteri* (PRESL). The Tonkin specimens are certainly *Nilssonia* and not *Pterophyllum*. ZEILLER delimited the genus *Nilssonia* only to fronds, the lamina of which are irregularly divided into segments with the nerves always simple, and assigned to *Pterophyllum* the fronds with regularly divided segments and forking nerves. It is because of the latter features that ZEILLER assigned the Tonkin specimens to *Pterophyllum*. ZEILLER's *Pterophyllum muensteri* differs from most of the specimens described under PRESL's name in bearing forking nerves, and may probably belong to a species of *Nilssonia* other than *N. muensteri* (PRESL).

Localities: Eda (Loc. No. 33); and Kamihina Loc. No. 49).

Nilssonia sp.

Pl. XLVI (XXVIII), Fig. 6; Pl. XLVII (XXIX), Fig. 3.

We have here two imperfect fronds doubtlessly of a *Nilssonia* which do not agree with any *Nilssonia* species described in this memoir. In Pl. XLVII (XXIX), fig. 3 the lamina fairly covers the upper surface of the thick rachis which is about 4 mm. in breadth, and appears to be divided irregularly into segments perpendicular to the rachis. It is characterised by coarse nerves about 1 mm. apart. Another specimen in Pl. XLVI (XXVIII), fig. 6 shows only a segment into which the lamina is possibly divided. The segment is triangular in form, 2.5 cm. in breadth at the base, upper margin nearly straight and the lower broadly curved upwards and meeting with the upper margin at an acute angle. The nerves are also 1 mm. apart, and parallel to each other and the upper margin of the segment.

Locality: Nabae (Loc. No. 21).

Nilssonia? gen. et sp. indet.

Pl. XLV (XXVII), Fig. 7; Pl. XLVII (XXIX), Fig. 4.

Pl. XLVII (XXIX), fig. 4 shows a very imperfect frond which can not be attributed to any existing genera or species of the fossil

(1) R. ZEILLER: Flore fossile des gîtes de charbon du Tonkin, p. 183, Pl. XLV, figs. 1–5.

plant. It is more than 5 cm. in length, with slender rachis, and the lamina is deeply dissected to the rachis into segments. Each segment is 2.3 cm. in breadth at the base and appears to narrow towards the imperfect apex. The nerves are simple, parallel to each other and to the lateral margin of the segment and there are about 12 of them per cm.

The specimen is provisionally assigned to the genus *Nilssonia*, because the lamina seems to cover partly the upper surface of the rachis and the nerves are always simple so far as can be seen.

Another imperfect specimen in Pl. XLV (XXVII), fig. 7 differs somewhat from the preceding in having more crowded nervation, the nerves being 17 in number per cm. They appear to be simple.

Localities: Eda (Loc. No. 1); and Kamihina (Loc. No. 47).

GENUS *Ctenis* LINDLEY and HUTTON

Ctenis japonica sp. nov.

Pl. XLVII (XXIX), Figs. 5–7; Pl. XLVIII (XXX); Pl. XLIX (XXXI), Fig. 1.

1905. *Anthrophyopsis* ? sp. YOKOYAMA: Mesozoic Plants from Nagato and Bitchû. L.c., p. 12, Pl. III, fig. 6.
1931. *Ctenis fallax* ÔISHI: On the Upper Triassic Formation in Nariwa District. L.c., p. 6.
1931. *Ctenis fallax* ÔISHI: *Yabeiella* sp. from the Japanese Triassic. L.c., p. 359.

The following diagnosis is based on the specimen shown in Pl. XLVIII (XXX);

Frond of unknown size, being incomplete at both base and apex. Frond pinnate, more than 35 cm. in length and 24 cm. in breadth. Rachis 5 mm. across at the lowest and 3 mm. at the uppermost broken end, with no particular surface ornamentation. Pinnae long and narrow, parallel-sided, approximately 2.5–2.8 cm. in breadth, attached laterally at a wide angle or nearly right angle to the rachis, expanded but not confluent laterally at the base, with entire margin. Nature of apex not known. Nerves anastomosed, with meshes about 2 mm. wide elongated in the longitudinal direction. Fructification not known.

Unfortunately no complete specimens of fronds have been collected, though the fragments of pinnae are very common in the plant-bed of Nabae. The frond has probably attained more than

twice the size shown in the figure, but we have no complete specimen only some fragments of thicker rachis which suggests the possibility of the frond attaining a far larger dimension. Also no complete pinnae are obtained, but the longest pinna is at least 12 cm. in length. The nerves form elongated meshes of variable length in the longitudinal direction but with a nearly constant width of generally 2 mm. The length of each mesh is sometimes 2 cm. and sometimes 4 cm., but the prevailing case is the latter. The nerves sometimes stand out distinctly from the general surface of the lamina as a ridge, but in most cases they are flat.

In Pl. XLIX (XXXI), fig. 1 is shown an apical portion of a frond. It is badly preserved, but the features available for examination agree well with other specimens. Another specimen in Pl. XLVII (XXIX), fig. 6 differs somewhat from other specimens here illustrated in having a thicker rachis which is 1.3 cm. across on the compressed surface; the surface of the rachis is sometimes longitudinally striated indicator probably the course of the vasculum; the pinnae are narrower, being about 1 cm. in breadth, though otherwise similar. This example probably represents the lower portion of the frond, possibly near the base.

The pinnae of *Ctenis japonica* resemble in themselves a ribbon-like single leaf *Anthrophyopsis nilssoni* NATH., first figured by NATHORST(1) from the Scanian Rhaetic bed, and it is very difficult to distinguish the two forms merely on the basis of the fragments of the pinnae. Later NATHORST(2) transferred his *Anthrophyopsis* to *Ctenis* and renamed the Scanian species, together with another species *A. crassinervis* NATH., as *Ctenis fallax*. While on the contrary, HARRIS(3), who examined the cuticles of leaves of unknown form from Greenland which he identified with *Anthrophyopsis crassinervis*, mentioned that NASHORST's *Anthrophyopsis* differs in its cuticle from any *Ctenis* of which the cuticle is prepared, and reinstated the genus *Anthrophyopsis* for the Scanian and Greenland specimens.

In the present examples, however, there is no cuticle prepared. Accordingly the present writer can not give here an opinion on

(1) A. G. NATHORST: Floran vid Bjuf, 1878, p. 43, Pl. VII, fig. 5; Pl. VIII, fig. 6; Ibid., p. 58, Pl. XI, figs. 5, 5a, 7. NATHORST: Floran vid Höganäs och Helsingborg, p. 16, Pl. I, figs. 10; Pl. II, fig. 1.

(2) A. G. NATHORST: Floran vid Bjuf, 1886, p. 89.

(3) T. M. HARRIS: The Rhaetic Flora of Scoresby Sound, East Greenland. L.c., p. 74.

the relation of these two genera on the basis of the cuticle, and there is also no proof morphologically that *Anthrophyopsis* had a pinnate frond of the *Ctenis*-type. This is the reason why the present writer treated the Japanese specimens as a new form.

Anthrophyopsis ? sp. figured by YOKOYAMA[1] from the Nariwa district, its exact locality being unknown, is in all probability a fragment of a pinna of *Ctenis japonica*. Also *Ctenis*[2] sp. from the Scanian Rhaetic is probably identical with the present species.

Allied species are *Ctenis sulcicaulis* (PHILLIPS)[3] and *C. orovillensis* FONTAINE[4], both from the Jurassic of Oregon, but in the former the pinnae are narrower and in the latter the nervation is much more crowded, than in ours.

Localities: Nabae (Loc. No. 21); and Hayama (Loc. No. 30).

Ctenis yabei sp. nov.

Pl. XLIX (XXXI), Figs. 2–3.

Frond of unknown size. Frond pinnate, with large terminal segment. Rachis persisting to the tip of the frond, slender, 2–3 mm. across in the lowest broken end, with two longitudinal ridges on its surface, which become indistinct towards the apex. Pinnae ovate in form, closely set or overlapping each other laterally, contracted at the base and at right angle to the rachis. Nerves prominent, elevated as a ridge from the general surface of the lamina of pinna, divergent, simply forking near the proximal end and anastomosing near the distal margin of the pinna forming elongated polygonal meshes. Terminal segment broadly elliptical, traversed by the elongation of the rachis; nerves given off at approximately an angle of 50° with the rachis, nearly parallel to each other, forking and anastomosing just as in the ordinary pinnae.

The characteristic features of this species are the shape of the pinnae and the nervation. The pinnae are generally ovate in form, and a pinna in the apical portion of frond measured 5.5 cm. along

(1) M. YOKOYAMA: Mesozoic Plants from Nagato and Bitchû. L.c., p. 12, Pl. III, fig. 6.

(2) E. ANTEVS: Die liassische Flora des Hörsandsteins. L.c., p. 36, Pl. V, figs. 1–4.

(3) W. FONTAINE: In WARD's Status of the Mesozoic Floras of the United States. L.c., p. 113, Pl. XXV, fig. 9; Pl. XXVI.

(4) W. FONTAINE: Ibid., p. 115, Pl. XXVII, figs. 1–5; Pl. XXVIII, fig. 1.

its longer axis and 3.3 cm. in the shorter. Sometimes the pinnae may become wedge-shaped as shown in Pl. XLIX (XXXI), fig. 3, but the relation existing between the form of the pinnae and their position on the frond is yet uncertain. The wedge-shaped pinnae may probably belong to the proximal portion of the frond.

The nerves stand out very distinctly as a ridge from the general surface of the lamina of the pinnae and are frequently connected by cross bars to form elongated meshes only near the distal or outer margin of the pinnae.

We have no known species of the genus *Ctenis* which is identical with the present form.

Locality: Kamihina (Loc. No. 50).

Ctenis? sp.

Pl. XLVII (XXIX), Figs. 8–9.

In Pl. XLVII (XXIX), fig. 8 is figured a fragment of a leaf showing anastomosing nervation. Although it is very small, it appears to be a portion of a pinna of a *Ctenis*. Each mesh is narrowly elongated and is 1–3 cm. or more in length and 0.5–0.8 mm. in breadth. In another small specimen in fig. 9, one can see a rachis to which a pinna is attached. The pinna is, as far as can be seen, 1 cm. in breadth and seems to be nearly parallel-sided. The nerves are about 0.5 mm. apart from each other, but we can find no anastomosing in them.

There is a possibility that the specimen in fig. 8 belongs to the genus *Ctenis,* but in another specimen in fig. 9 it is somewhat doubtful, because there is no anastomosing seen.

Comparable forms are: *Ctenis yamanarii* KAWASAKI from the Daidô Formation of Korea(1); *Ctenis* ? sp. from the Rhaetic of Sweden(2); and *Ctenis kaneharai* YOKOYAMA from the Jurassic of China(3).

Locality: Kamihina (Loc. No. 50).

(1) S. KAWASAKI: Addition to the Older Mesozoic Plants in Korea. L.c., p. 20, Pl. V, fig. 18; Pl. VI, fig. 19.

(2) N. JOHANSSON: Die rhaetische Flora der Kohlengruben bei Stabbarp und Skromberga in Schonen. L.c., p. 38, Pl. V, fig. 24.

(3) M. YOKOYAMA: Mesozoic Plants from China. L.c., p. 29, Pl. IX, figs. 1, 1a.

III. GINKGOPHYTA

GINKGOALES

GENUS *Ginkgoites* SEWARD

Ginkgoites sibirica (HEER)

Pl. XLIX (XXXI), Figs. 4–5.

1876. *Ginkgo sibirica* HEER: Beitraege zur Juraflora Ostsibiriens und des Amurlandes. Flora Fossilis Arctica, Vol. IV (II), p. 61, Pl. IX, fig. 5b; Pl. XI; Pl. VII.

1922. *Ginkgo sibirica* YABE: Notes on Some Mesozoic Plants from Japan, Korea and China. L.c., p. 23, Pl. IV, figs. 10, 11; Text-figs. 22–24.

1925. *Ginkgoites sibirica* KAWASAKI: Some Older Mesozoic Plants in Korea. L.c., p. 44, Pl. XXIII, figs. 68–71.

1925. *Baiera gracilis* KAWASAKI (non BUNBURY): Ibid., p. 46, Pl. XXIV, fig. 72 (non Pl. XXIV, figs. 73, 74; Pl. XXV, figs. 75–77).

1926. *Baiera gracilis* KAWASAKI (non BUNBURY): Addition to the Older Mesozoic Plants in Korea. Ibid., Vol. IV, Pt. 2, p. 31, Pl. IX, fig. 25.

For further references see YABE, 1922, l.c.

Pl. XLIX (XXXI), fig. 4 shows an imperfect petiolate leaf with fan-shaped lamina which is deeply cleft into five linear ultimate segments. The ultimate segments are 2.5 cm. in length at least, 5 mm. in breadth, narrowing towards the base and each segment is supplied by about 7 parallel nerves which fork near the proximal end. As the outer margin of the lamina is imperfect, the apical nature of ultimate segments is unknown.

KAWASAKI incorrectly assigned to *Baiera gracilis* BUNBURY some Korean Ginkgoacean leaves, lamina of which divided into linear ultimate segments with obtuse to rounded apex. The segments of *B. gracilis* are narrowly linear and provided with acuminate apex. Certain specimens of KAWASAKI's *B. gracilis* are believed to be a type of *Ginkgoites sibirica*.

Localities: Hinabata (Loc. No. 44); Kamihina (Loc. No. 49); and Nabae (Loc. No. 21).

GENUS *Baiera* F. W. BRAUN

Baiera muensteriana (PRESL)

Pl. L (XXXII), Fig. 1.

1838. *Sphaerococcites muensterianus* PRESL: In STERNBERG's Versuch, II, Fasc. VII-VIII, p. 105, Pl. XXVIII, fig. 3.
1850. *Jeanpaulia dichotoma* UNGER: Genera et Species, p. 224.
1869. *Jeanpaulia muensteriana* SCHIMPER: Traité de paléontologie végétale, Tom. I, p. 683, Pl. XLIV, figs. 9, 10, 12 (?11).
1884. *Baiera muensteriana* SAPORTA: Plantes jurassiques, Tom. III, p. 272, Pl. CLV, figs. 10–12; Pl. CLVI, fig. 1 (?2–6); Pl. CLVII, figs. 1, 2, (?3).
1914. *Baiera muensteriana* GOTHAN: Die unter-liassische (rhaetische) Flora der Umgegned von Nürnberg. L.c., p. 63, Pl. XXIX, fig. 3; Pl. XXXIII, fig. 1; Pl. XXXVI, figs. 3, 4.
1919. *Baiera muensteriana* ANTEVS: Die liassische Flora des Hörsandsteins. L.c., p. 43, Pl. V, fig. 19.
1926. *Baiera muensteriana* HARRIS: The Rhaetic Flora of Scoresby Sound. L.c., p. 101. Text-figs. 24A-E.

We have very imperfect specimens of this species. One in Pl. L (XXXII), fig. 1 shows an imperfect fan-shaped lamina deeply dissected into more than 10 linear ultimate segments. These segments are nearly parallel-sided, 3–4 mm. broad, and with 2 or 3 parallel nerves. Though the specimen is thus fragmentary, it resembles most closely *Baiera muensteriana*.

Baiera muensteriana is not uncommon in the Rhaetic and Liassic rocks of the northern hemisphere. BARTHOLIN[1] figured a very small and indistinct specimen of a *Baiera* from Bornholm as *Baiera* cfr. *muensteriana*.

Localities: Eda (Loc. No. 1); Kamihina (Loc. No. 50); and Shirochi (Loc. No. 16).

Baiera furcata HEER

Pl. L (XXXII), Figs. 2A–3.

1865. *Sclerophyllina furcata* HEER: Urwelt der Schweiz, p. 55, Pl. II, fig. 9.
1877. *Baiera furcata* HEER: Flora Fossilis Helvetiae, p. 84, Pl. XXIX, figs. 30, 31; Pl. XXX, fig. 4c; Pl. XXXVI, figs. 4, 5.

(1) C. T. BARTHOLIN: Planteforsteninger fra Holsterhus paa Bornholm. Danmarks geologiske Undersøgelse, Vol. II, No. 25, 1910, p. 20, Pl. IV, fig. 1.

1903. *Baiera furcata* LEUTHARDT: Die Keuperflora von Neuewelt bei Basel. Abhandl. d. schweiz. Palaeont. Gesell., Vol. XXX, p. 7, Pl. II, figs. 1–4; Pl. III, figs. 1–5; Pl. IV, fig. 1.
1931. *Baiera furcata*? ÔISHI: On the Upper Triassic Formation in Nariwa District. L.c., p. 6.

Pl. L (XXXII), fig. 2A shows a lamina of a *Baiera*-leaf, which, though fragmentary, agrees well with *Baiera furcata*. Long and narrow ultimate segments which are more than 3 cm. in length and 1.5–3 mm. in breadth are parallel-sided, and seem to converge distally to a stalk. There are 1–3 parallel nerves in each ultimate segment. Fig. 3 shows another specimen in which the lamina becomes narrow gradually towards the base.

Baiera furcata is rather common in the Keuper beds of Switzerland, but has never been recorded outside of that country. As LEUTHARDT[1] pointed out, *B. furcata* resembles another Rhaetic *Baiera* species, *B. muensteriana* (PRESL), but is distinguished from it in tolerably longer ultimate segments. Another similar form is a Siberian Jurassic species known as *Baiera angustifolia*[2] HEER, and the present writer was once inclined even to refer the specimens to the Siberian species; but having examined more carefully the present specimens and compared with HEER and LEUTHARDT'S illustrations he found that there is a difference in the number of nerves in an ultimate segment: *B. angustifolia* has 3–4 nerves, while in *B. furcata* the number of nerves is 1–2 and very rarely 3. For this reason the writer has preferred to assign the Japanese specimens to the Keuper species.

Locality: Kamihina (Loc. No. 47).

Baiera filiformis sp. nov.

Pl. XL (XXXII), Fig. 4.

A single imperfect specimen of *Baiera* which the writer dared to call under a new specific name *filiformis* is characterised by the deep dissection of the lamina in dichotomous manner into long and narrow, filiform ultimate segments. The leaf may be petiolate, but the petiole is not seen in the specimen. As the outer margin of

(1) F. LEUTHARDT: Die Keuperflora von Neuewelt bei Basel. L.c., p. 9.
(2) O. HEER: Nachtraege zur Jura-Flora Sibiriens. Mém. l'Akad. Imp. d. Sci. d. St.-Pétersbourg, Ser. VII, Vol. XXVII, No. 10, 1880, p. 14, Pl. III, figs. 1–3.

the lamina is imperfect the total number of ultimate segments is not known, though one can see at least 6 of them. The segments are generally 1–1.2 mm. in breadth, and each bears 7–8, or probably more, fine parallel nerves.

Baiera filiformis apparently resembles very closely *Baiera lindleyana* (SCHIMPER)[1], a Middle and Upper Jurassic form, in the narrow, filiform segments, but is distinguished in having a larger number of nerves. In *B. filiformis* the nerves may be at least 7 in each segment, while in *B. lindleyana* they are 1–3. It resembles greatly also *Czekanowskia rigida* HEER, but in this the shoot frequently occurs in cluster and the nerves are generally 1–3 in number in each segment.

A *Baiera*-leaf with narrow, filiform segments described by KAWASAKI[2] from the Daidô Formation of Korea as *B. lindleyana* resembles ours more or less, but in the Korean specimen the nerves are said to be obscure.

Locality: Eda (Loc. No. 33); and Koyagaichi (Loc. No. 58).

Baiera taeniata F. W. BRAUN

Pl. L (XXXII), Fig. 5.

1914. *Baiera taeniata* GOTHAN: Die unter-liassische (rhaetische) Flora der Umgegend von Nürnberg. L.c., p. 62, Pl. XXIX, fig. 2; Pl. XXXI-XXXII, fig. 1; ? Pl. XXIX, fig. 4 and Pl. XXXIII, fig. 3.

1919. *Baiera taeniate* ANTEVS: Die liassische Flora des Hörsandsteins. L.c., p. 44, Pl. V, figs. 20–24; Pl. VI, fig. 43.

1922. *Baiera taeniata* JOHANSSON: Die rhätische Flora der Kohlengruben bei Stabbarp und Skromberga in Schonen. L.c., p. 46, Pl. IV, figs. 7, 8; Pl. VIII, fig. 12.

An impression shown in Pl. L (XXXII), fig. 5 appears to be identical with *Baiera taeniata* well-known in the Rhaeto-Liassic strata in northern Europe. The leaf is petiolate, the petiole being 3 cm. in length at least, and the wedge-shaped lamina which is about 7.5 cm. high is first deeply cleft to the petiole into two subequal halves, each being once or twice again dichotomously divided into six (possibly more in number) ultimate segments. These seg-

(1) Cfr. A. C. SEWARD: Fossil Plants, Vol. IV, 1919, p. 49.

(2) S. KAWASAKI: Some Older Mesozoic Plants in Korea. L.c., p. 49, Pl. XLIII, fig. 117b.

ments increase their width gradually from the base upwards, and then narrow gradually to an obtusely rounded apex. The exact number of nerves can not be made out, but it seems there are about 5 of them per 4 mm.

As elsewhere mentioned by several authors, *Baiera taeniata* resembles *B. phillipsi* NATH. of the Middle Jurassic, but seems to differ from it merely in the size of the leaf, NATHORST's species being much smaller. ANTEVS[1] and JOHANSSON[2] mentioned that the first deep cleft of the lamina was the characteristic feature of this species, but such was often met with in many other species of *Ginkgoites* and *Baiera*.

The present writer has provisionally assigned the specimen to BRAUN's species, as it resembles most *Baiera taeniata* as figured by ANTEVS and JOHANSSON than any other species of *Baiera* and the related genus *Ginkgoites*. A certain Chinese specimen figured by YABE[3] as *Baiera gracilis* BUNBURY is a form similar to the present specimen.

Locality: Hinabata (Loc. No. 66).

Baiera paucipartita NATHORST

Pl. L (XXXII), Fig. 6.

1886. *Baiera paucipartita* NATHORST: Floran vid Bjuf, p. 94, Pl. XX, figs. 7–13; Pl. XXI; Pl. XXII, figs. 1–2.
1891. *Baiera* ? sp. YOKOYAMA: On Some Fossil Plants from the Coal-bearing Series of Nagato. Journ. Coll. Sci., Imp. Univ. Tôkyô, Vol. IV, Art. 2, p. 246, Pl. XXXIV, fig. 6.
1894. *Baiera paucipartita* BARTHOLIN: Nogle i den bornholmske Juraformation forekommende Planteforsteninger. Bot. Tidskr., Bd. XIX, p. 95, Pl. III (XI), fig. 4.
1905. *Baiera paucipartita* YOKOYAMA: Mesozoic Plants from Nagato and Bitchû. Journ. Coll. Sci., Imp. Univ., Tôkyô, Vol. XX, Art. 5, p. 9, Pl. II, fig. 5.
1930. *Baiera* sp. cfr. B. *paucipartita* ÔISHI: Notes on Some Fossil Plants from the Upper Triassic Beds of Nariwa. L.c., p. 56, Pl. VII, fig. 6b.

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(1) E. ANTEVS: Die liassische Flora des Hörsandsteins. L.c., p. 44.
(2) N. JOHANSSON: Die rhaetische Flora der Kohlengruben bei Stabbarp und Skromberga in Schonen. L.c., p. 47.
(3) H. YABE: Notes on Some Mesozoic Plants from Japan, Korea and China. L.c., p. 24, Pl. IV, fig. 6.

We have but one imperfect specimen which is probably specifically identical with the Rhaetic species, *Baiera paucipartita* NATH. The lamina is long and narrow, cuneiform, 4, 5 cm. high, and 2 cm. broad in the middle portion, thence narrowing gradually towards the base and deeply divided into two equal lobes. The apex of each segment is obtusely rounded. The nerves are forking, and one can count about five of them in the middle portion of one segment. No definite petiole-like object can be seen.

YOKOYAMA[1] was probably correct in referring a specimen from the Rhaetic of Prov. Nagato to *Baiera paucipartita*. Some imperfect specimens from Nariwa which the present writer once described as *Baiera* sp. cfr. *B. paucipartita* and *Baiera* sp.[2] may also be referable to NATHORST's species, though the latter has broader segments and has a *Baiera spectabilis*-aspect, as already mentioned.

A New Zealand Rhaetic specimen which AABER[3] once called *Baiera* cfr. *B. paucipartita* was later believed by the same author to be new type and named *B. robusta* ARBER.

Locality: Hinabata (Loc. No. 44).

Baiera elegans sp. nov.

Pl. XLIX (XXXI), Figs. 6–11; Text-Fig. 4.

Lamina semi-circular or wedge-shaped with rounded outer margin, 2–3-cm. high, deeply divided dichotomously four times into segments, which increase in breadth gradually from the proximal end upwards to 1.5–2.5 mm. breadth near the apex. Apex of each segment shallowly cleft into lobes. Nerves forking, 2–4 in number at the middle of the segments, ultimate lobe receiving a single nerve.

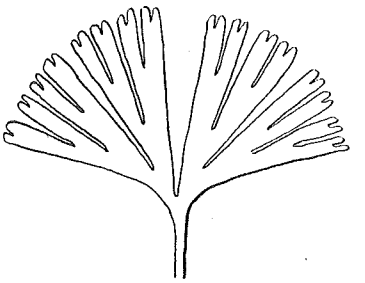
A series of specimens shown in Pl. XLIX (XXXI), figs. 6–11 indicates that the form and size and the mode of segmentation of the lamina are pretty constant. As none of the specimens is complete at the base, nothing can be said on the nature of the petiole; only a specimen in fig. 10 indicates a very small fragmental leaf showing the transition of the lamina to the petiole. The characteristic features of this species are the four times regular dichotomy

(1) M. YOKOYAMA: Mesozoic Plants from Nagato and Bitchû. L.c.

(2) S. ÔISHI: Notes on Some Fossil Plants from the Upper Triassic Beds of Nariwa. L.c., p. 56.

(3) E. A. N. ARBER: The Earlier Mesozoic Floras of New Zealand. L.c., p. 56, Pl. XI, figs. 3, 4.

of the lamina into segments and the shallow lobing at the top of each ultimate segment. As these features are constant in the specimens examined, one can believe them to be characteristics of this species. The number of the nerves is also fixed, being 2–3 in the middle of the segment, and each ultimate lobe receives a single nerve.



Text-fig. 4. Restored figure of *Baiera elegans*. Nat. siz.

Baiera elegans greatly resembles *Baiera minuta* NATH.[1] from the Rhaetic of Bjuf, and so great was the resemblance that the present writer first dared even to adopt NATHORST's specific name for the specimens. Having compared them more exactly with NATHORST's figures and the series of specimens of *B. minuta* illustrated by LUNDQVIST[2], the author finds that there exist certain differences which separate the Swedish and the Japanese specimens specifically: in *B. elegans*, first, the size and form and the mode of dissection of the lamina is constant, secondly, segments are broader, and lastly the nerves are more in number than in *B. minuta*. The characteristic lobing at the tip of each ultimate segment is another characteristic feature which does not occur in *B. minuta*.

Localities: Kamihina (Loc. Nos. 50, and ? 47).

Baiera guilhaumati ZEILLER?

Pl. LIII (XXXV), Fig. 5.

Compare:

1903. *Baiera guilhaumati* ZEILLER: Flore fossile des gîtes de charbon du Tonkin, p. 205, Pl. L, figs. 16–19.

This Rhaetic species from Tonkin seems to be represented also in our Rhaetic flora by some very imperfect specimens. This species resembles closely a Middle Jurassic type, *B. gracilis* BUNBURY, but ZEILLER distinguished it by the less acute apex of the segment. As

(1) A. G. NATHORST: Floran vid Bjuf, 1886, p. 93, Pl. I, fig. 3; Pl. XIII, figs. 1–2; Pl. XX, figs. 14–16. Cfr. also G. LUNDQVIST: Variationstypen von *Baiera minuta* NATH. Geol. Förening. Förhandl., Bd. 40, H. 5, 1918.

(2) G. LUNDQVIST: Ditto.

the nature of the apex is not known in our specimens, it is somewhat uncertain whether ZEILLER's species is indeed represented in our flora.

Certain specimens from Korea referred by KAWASAKI[1] to *Baiera gracilis* differ undoubtedly from the typical specimens of *B. gracilis*; the segments in the Korean specimens are provided with an obtusely rounded apex, and at least the specimens in KAWASAKI's Pl. XXV, figs. 75–77 and Pl. XXVI, figs. 78–79 appear to be rather referable to ZEILLER's species.

Locality: Eda (Loc. No. 33).

Baiera sp.

Pl. L (XXXII), Fig. 7.

Pl. L (XXXII), fig. 7 shows an imperfect *Baiera*-leaf characterised by its large size and the small number of segments. The petiole is 4 cm. in length and 1.2 mm. in breadth and merges gradually upwards into the lamina. The lamina is 9 cm. in height and deeply dissected into at least three elongate-lanceolate ultimate segments with acuminate apices. Owing to the longitudinal folds in the segments which are possibly due to the lateral compression or to the strain in the longitudinal direction of the matrix, the exact number of nerves can hardly be made out, though there seems to be 7–9 in the middle portion of each segment.

The figured specimen resembles most closely one from Korea assigned by KAWASAKI[2] to the Middle Jurassic species *Baiera phillipsi* NATH., though in the Korean specimen the nature of the apex is not known. In typical *B. phillipsi* from Yorkshire, the apex of the segments is obtusely rounded, instead of being acuminate as in the present specimen. Our specimen is not unlike *B. gracilis* BUNBURY from Korea and China figured by YABE[3], but in this species the segments are narrower and far more in number.

Locality: Suimyô (Loc. No. 69).

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(1) S. KAWASAKI: Some Older Mesozoic Plants in Korea. L.c.

(2) S. KAWASAKI: Some Older Mesozoic Plants in Korea. L.c., p. 45, Pl. XXVII, fig. 80c.

(3) H. YABE: Notes on Some Mesozoic Plants from Japan, Korea and China. L.c., p. 24, Pl. IV, fig. 6 (China); figs. 14, 15 (Korea).

GINKGOALES?

GENUS *Czekanowskia* HEER

Czekanowskia rigida HEER

Pl. L (XXXII), Figs. 8, 8a.

1876. *Czekanowskia rigida* HEER: Beitraege zur Juraflora Ostsibiriens und des Amurlandes. L.c., p. 70, Pl. V, figs. 8–11; Pl. VI, fig. 7; Pl. X, fig. 2a.

1931. *Czekanowskia rigida* ÔISHI: Mesozoic Plants from Kita-Otari, Prov. Shinano. L.c., p. 249, Pl. XVIII, figs. 5, 6.

For further references see ÔISHI, 1931, l.c.

No typical specimens of this species are found in the collection, but a number of clusters of some imperfect needle-like leaves have provisionally been assigned to this species. The leaves are more than 6 cm. in length, generally 1 mm. or less in breadth, and fork occasionally. Each leaf carries 3–4 parallel nerves.

A specimen in Pl. L (XXXII), fig. 8 is somewhat interesting, because a bundle of leaves is undoubtedly enclosed at their base by oval scale-leaves approximately 2 mm. in diameter. The leaves are at least seven in number in a bundle, 0.7 mm. in breadth, and each so far as can be seen carries a single median nerve.

Localities: Eda (Loc. No. 1); Kamihina (Loc. Nos. 47 and 48); and Suimyô (Loc. No. 69).

GENUS *Phoenicopsis* HEER

Phoenicopsis sp.

Pl. LI (XXXIII), Figs. 1–2.

We have some specimens of this genus in the collection. They are, moreover, somewhat fragmentary and very difficult to determine specifically. Pl. LI (XXXIII), fig. 1 shows a slab of rock covered with many fragmentary *Phoenicopsis*-leaves arranged nearly in parallel. The leaves are linear, more than 9 cm. in length, and generally 5–7 mm. in breadth, narrowing gradually to one end. The nerves are parallel, prominent, and numbering 10–11, with one faint interstitial nerve.

Though there is no evidence that this specimen is a *Phoenicopsis*, the long and narrow linear leaves arranged nearly in parallel

suggest the possibility of their belonging to the genus above referred. A more or less comparable species is *Phoenicopsis angustifolia* HEER and its forma *media* (Krasser) recorded from Korea, China, Siberia and several other Jurassic localities, but this species is said to have no interstitials.

Fig. 2 shows a very imperfect specimen provisionally assigned here to *Phoenicopsis*.

Localities: Kamihina (Loc. Nos. 49 and ? 50).

GENUS *Stenorachis* SAPORTA

The genus *Stenorachis* is represented in the collection by two distinct forms which the writer believes to be new. This generic name has been employed as a designation for specimens consisting of a central axis to which attached at either oblique or right angles a number of simple or forked appendages with oval expansion at the distal end. NATHORST[1] expressed an opinion that *Stenorachis*, at least the Scanian Rhaetic species, *S. scanicus* (NATH.) and *S. solmsi* NATH., was a sporophyll of a plant of Cycadean affinity, while on the other hand SEWARD[2] maintained the Ginkgoalean alliance of *S. scanicus* and some other species called under this genus. NATHORST is certainly careful in regarding the oval expansion of each appendage, which appears to be a seed, to be not a true seed and that there is a probability of its being the male organ or a scale-like object. In no species of *Stenorachis* have the actual seeds or pollen-sacs been recognised. From the comparison of some species of *Stenorachis* and the fertile shoot of *Ginkgo biloba* L., SEWARD states that the fossil type has resemblance to the abnormal seed-bearing shoots of *G. biloba*, though there is no evidence of actual seed.

In our specimens also there is no evidence whatever throwing light upon the closer affinity of this shoot in question or even whether it is a male or female organ; but the texture, delicate rather than woody, of the oval body seems to suggest its being a scale or bract or even cupular organ which originally enclosed a seed, or it may represent a pollen-sac. But there is no substantial ground for this view.

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(1) A. G. NATHORST: Beiträge zur Kenntnis einiger mesozoischen Cycadophyten. Kgl. Svensk. Vet.-Akad. Handl., Vol. XXXVI, No. 4, 1902, p. 17.

(2) A. C. SEWARD: Fossil Plants, Vol. IV, 1919, p. 55.

Stenorachis bitchuensis sp. nov.

Pl. L (XXXII), Fig. 9.

The specimen represented in Pl. L (XXXII), fig. 9 consists of a straight and moderately stout central axis bearing at nearly a right angle a number of appendages characterised by an oval expansion at the distal end. The oval body suggests the former presence of reproductive organs, but there is no trace of actual seeds or miscrosporangia.

Some Rhaetic and Liassic species known as *Stenorachis scanicus* (NATH.)[1], *S. solmsi* NATH.[2] and *S. dubius* ANTEVS[3] are not unlike the present species, but distinguished in their having bi-lobed appendages. Also KAWASAKI's *Stenorachis* sp. nov.[4] from Korea, which somewhat resembles *S. scanicus,* has appendages at the distal end bi-lobed.

Notwithstanding the imperfect state of the present specimen, the writer has dared to call the specimen characterised by the appendages which do not fork at the distal end under the new name *bitchuensis.*

Locality: Kamihina (Loc. No. 46).

Stenorachis elegans sp. nov.

Pl. L (XXXII), Fig. 10.

Another specimen which also belongs to the genus *Stenorachis* and is believed to represent a new form consists of a straight and moderately stout central axis, to which are attached at an oblique angle more or less crowded appendages. These are 0.5–0.6 cm. in length and characterised by an oval expansion at the distal end. On the surface of the oval body, there can be seen two faint striations in the longitudinal direction running from one end to another.

Stenorachis elegans differs from *S. bitchuensis* chiefly in the crowded appendages and their more oblique insertion to the axis.

Locality: Yamamoto (Loc. No. 63).

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(1) A. G. NATHORST: Beiträge zur Kenntnis einiger mesozoischen Cycadophyten. L.c., p. 16, Pl. I, figs. 16–17.

(2) A. G. NATHORST: Ibid., p. 17, Pl. I, figs. 18–21.

(3) E. ANTEVS: Die liassische Flora des Hörsandsteins. L.c., p. 38, Pl. V. figs. 8–15.

(4) S. KAWASAKI: Some Older Mesozoic Plants in Korea. L.c., p. 56, Pl. XLI, fig. 114.

IV. CONIFERALES

GENUS *Pityophyllum* (*Pityocladus* NATH.) NATHORST

Pityophyllum (*Pityocladus*) *longifolium* (NATHORST)

Pl. LI (XXXIII), Figs. 3–6.

A sterile coniferous shoot with leaves; leaves nine in number, long and narrow, more than 15 cm. in length and 5 mm. in breadth at the middle portion, from thence narrowing gradually towards both apex and narrow base, and attached to a short shoot covered with small scale-leaves. Midnerve prominent, with no other characteristic surface ornamentation.

The specimen in Pl. LI (XXXIII), fig. 3 (fig. 4 is the counterpart of fig. 3) on which the above diagnosis is based is derived from the plant-bed at Kamihina (Loc. No. 50). The shoot is finely impressed on the light-grayish soft shale. It is interesting that in this specimen the *Pityophyllum* leaves were found attached to a shoot, and such specimens, after NATHORST's proposal with a view to convenience, have been called under the generic name *Pityocladus*[1]. It is by no means certain that all the detached leaves hitherto described from several localities as *Pityophyllum longifolium* had a shoot like *Pityocladus longifolius*, but as the single leaf in this shoot agrees in all respects with *Pityophyllum longifolium* the present writer has followed NATHORST and SEWARD in applying their convenient designation for the present specimen.

Our specimen differs somewhat from *P. longifolium* from Scania[2] in the broader leaves, but it is still uncertain to what extent the variation in the breadth of leaves is constant in a single species. In the Scanian specimen SEWARD recognised numerous transverse striations or wrinkles on the surface of the lamina of the leaves, but such a feature is quite indistinct in our specimen.

Besides the shoot above described we have numerous detached leaves occurring at several localities, some of which are figured in figs. 5–6.

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(1) A. G. NATHORST: Zur mesozoischen Flora Spitzbergens. L.c., p. 62.
(2) A. C. SEWARD: Fossil Plants, Vol. IV, 1919, p. 378, figs. 775, 776.

KAWASAKI[1] described *Pityophyllum longifolium* from Korea and recently the present writer[2] recorded its occurrence in the Rhaetic rocks of Kita-Otari, Prov. Shinano.

Localities: Shoot:—Kamihina (Loc. No. 50); detached leaves:—Eda (Loc. No. 1); Hinabata (Loc. No. 44); Kamihina (Loc. Nos. 40, 46, 49); Nabae (Loc. No. 21); and Suimyô (Loc. No. 69).

GENUS *Elatocladus* HALLE

Elatocladus plana (FEISTMANTEL)

Pl. LI (XXXIII), Fig. 7.

1879. *Taxites planus* FEISTMANTEL: Upper Gondwana Flora of the Outliers on the Madras Coast. L.c., p. 31, P. XIII, figs. 1–8; P. XIV, figs. 1, 2, 4, 5; Pl. XV, fig. 2.

1882. *Taxites planus* FEISTMANTEL: The Fossil Flora of the South Rewah Gondwana Basin. Palaeont. Indica, Ser. XII, Vol. IV, p. 48, Pl. II, figs. 7–9, 11.

1917. *Taxites planus* WALKOM: The Flora of the Ipswich and Walloon Series. L.c., p. 25, Pl. IX, fig. 4.

1919. *Elatocladus planus* WALKOM: The Flora of the Burrum and Styx River Series. Queensland Geol. Surv. Publ. No. 263, p. 43, Pl. II, figs. 4, 5.

1919. *Elatocladus plana* SEWARD: Fossil Plants, Vol. IV, p. 431, fig. 802.

1928. *Elatocladus plana* SAHNI: Revision of Indian Fossil Plants. Pt. I, Coniferales. Palaeont. Indica, N.S., Vol. XI, p. 11, Pl. I, fig. 9.

SEWARD and SAHNI[3], in their work on the revision of Indian Gondwana plants, proposed to adopt the name *plana* in preference to *tennerima* on the ground that the majority of the specimens are included by FEISTMANTEL in the two species with only slight claim to the specific distinction; but later SAHNI recognised the existence of the species, *E. plana* and *E. tennerima*; he gave the following description of the species above referred to: "Sterile shoots with biseriately arranged narrowly linear leaves very gradually tapering to a point, attached spirally by the full width of the decurrent

(1) S. KAWASAKI: Some Older Mesozoic Plants in Korea. L.c., p. 52, Pl. XXX, figs. 85, 86.

(2) S. ÔISHI: Mesozoic Plants from Kita-Otari, Prov. Shinano, Japan. L.c., p. 252, Pl. XVII, fig. 7.

(3) A. C. SEWARD and B. SAHNI: Indian Gondwana Plants: A Revision. Palaeont. Indica, N.S., Vol. VII, Mem. No. 1, 1920, p. 36.

base. In the better preserved specimens a median vein is seen predominating over a faint longitudinal wrinkling. In most cases, however, the midrib alone is visible."

We have only one figured specimen of this species. It is a sterile shoot, 2.5 cm. long at least, provided with slender axis. The leaves are narrowly linear, 1.2 cm. long and 1.3 mm. broad, nearly parallel-sided or tapering very gradually to an acute apex, and attached to the axis at a wide angle possibly by their whole width of the decurrent base. A midverve is distinctly visible.

Elatocladus plana is originally of the Upper Gondwanas of India, and seems to be very common especially in the rocks of the Kota and the Jabalpur Stage. According to SAHNI(1), the specimens from Vemavaran referred by FEISTMANTEL(2) to *Taxites tennerimus* FEIST. are specifically identical with *Elatocladus plana.*

Locality: Eda (Loc. No. 1).

Elatocladus tennerima (FEISTMANTEL)

Pl. LI (XXXIII), Figs. 8–10.

1877. *Taxites* ? *tennerimus* FEISTMANTEL: Flora of the Jabalpur Group (Upper Gondwanas) in the Son-Narbada Region. Palaeont. Indica, Ser. XI, Vol. II, Pt. 2, p. 98, Pl. X, figs. 6–11 (non Pl. VIII, figs. 6–8; Pl. X, fig. 5).

1928. *Elatocladus tennerima* SAHNI: Revision of Indian Fossil Plants. L.c., p. 14, Pl. I, figs. 10–15.

SAHNI described this species in his "Revision of Indian Fossil Plants" as follows: "A slender much branched form with very narrow but rather stiff linear leaves which curve downwards without contraction into the strongly decurrent leaf-base. The ultimate branches lie in the same plane as the axis from which they arise, and all the leaves being pectinately arranged on their respective axes, the whole branch-system assume a very characteristic habit. The leaf has parallel margins and no clearly marked midrib; the tip is rounded or minutely pointed and turned upwards the lamina being, as in *E. plana,* expanded in the plane of the parent axis without a twist in the leaf-base."

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(1) B. SAHNI: Revision of Indian Fossil Plants. L.c., p. 11.

(2) O. FEISTMANTEL: Upper Gondwana Flora of the Outliers on the Madras Coast. L.c., p. 220, Pl. XV, figs. 3–5.

This species is comparatively common in the plant-bed of Eda, and some are illustrated in Pl. LI (XXXIII), figs. 8–10, of which fig. 8 shows a branched axis. The habit of this plant is very slender and elegant and the texture of the leaf seems to be pretty thin; the leaves are usually 1 cm. long and 1 mm. broad, parallel-sided, slightly curved directing their convex side upwards, with rounded or blunt apex, and decurrent at the base. The midnerve is faintly visible.

This species has hitherto been known only from the rocks of the Jabalpur Stage of India; a certain specimen referred by FEISTMANTEL[1] to *Palissya conferta* O. and M. is, according to SAHNI[2], specifically identical with the present species.

Localities: Eda (Loc. No. 1); and Kamihina (Loc. No. 46).

Elatocladus sp.

Pl. LI (XXXIII), Fig. 11.

The specimen in Pl. LI (XXXIII), fig. 11 is too incomplete to admit of specific determination, but it has been figured because it does not appear to belong to any of the two other species described in this memoir. It is a sterile coniferous shoot without base or apex, measuring 5 cm. in length. The leaves are biseriately arranged, about 2.5 cm. in length and 2.5 mm. in breadth, nearly parallel-sided, gently curved downwards, and attached spirally by the whole of the decurrent base; the nature of the apex is not clear. The midnerve is distinctly impressed.

The leaves of the present specimen are decidedly larger than those of *Elatocladus plana* and *E. tennerima*. A more or less comparable form is *Palissya indica* OLDHAM[3], but there is certainly a difference in the size of the leaves, those of *P. indica* being much smaller.

Locality: Eda (Loc. No. 1).

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(1) O. FEISTMANTEL: Upper Gondwana Flora of the Outliers on the Madras Coast. L.c., p. 216, Pl. XIV, fig. 3.

(2) B. SAHNI: Revision of Indian Fossil Plants. L.c., p. 14.

(3) B. SAHNI: Ibid., p. 16.

V. CONIFERALES?

GENUS *Podozamites* F. W. BRAUN

Podozamites schenki HEER

Pl. LII (XXXIV), Figs. 3–5.

1870. *Podozamites angustifolius* SCHIMPER: Traité de paléontologie végétale, Tom. II, p. 159.
? 1876. *Podozamites angustifolius*? NATHORST: Bidrag till Sveriges Fossila Flora. I. L.c., p. 54, Pl. XIII, fig. 4.
1878. *Podozamites schenki* NATHORST: Floran vid Höganäs och Helsingborg. L.c., p. 28, Pl. III, fig. 12.
1879. *Podozamites schenki* NATHORST: Floran vid Bjuf, p. 76, Pl. XVI, figs. 11–13.
? 1888. *Podozamites schenki* SZAJNOCHA: Ueber fossile Pflanzenreste aus Cacheuta in der Argetinischen Republik. Sitzungsb. k. Akad. Wiss. Wien. Math.-naturwiss. Kl., Bd. XCVII, Abth. 1, p. 17, Pl. II, fig. 3b.
1896. *Podozamites schenki* HARTZ: Planteforsteninger fra Cap Stewart i Ostgrønland. L.c., p. 240, Pl. XIII, figs. 2, 7.
1903. *Podozamites schenki* ZEILLER: Flore fossile des gîtes de charbon du Tonkin, p. 163, Pl. XLII, figs. 5, 6.
1914. *Podozamites schenki* COUNILLON: Flore fossile des gîtes de charbon de l'Annan. Bull. Serv. Géol. l'Indochine, Vol. I, f. 11, p. 13, Pl. I, fig. 2.
1925. *Podozamites schenki* KAWASAKI: Some Older Mesozoic Plants in Korea. L.c., p. 55, Pl. XLI, figs. 112–113; Pl. XLV, fig. 120.
1926. *Podozamites schenki* HARRIS: The Rhaetic Flora of Scoresby Sound, East Greenland. L.c., p. 115, Text-figs. 19A–D.
1931. *Podozamites schenki* ÔISHI: *Yabeiella* sp. from the Japanese Triassic. L.c., p. 359.

An imperfect shoot in Pl. LII (XXXIV), fig. 3 consists of a narrow and slender axis bearing long and narrow linear leaves characterised by an oblique insertion. The leaves are about 3.5 cm. in length and 2.5 mm. in breadth, broadest at a short distance from the base, and narrows gradually to the subacute apex. The nerves are distinct, forking at the proximal end and each leaf bears four of them at the broadest portion. Another specimen in fig. 4 also is quite similar to the preceding, though in this the leaves are a little broader, being 3 mm. in breadth, and there are 5–6 nerves in each leaf. Besides the shoots above described, we have a number of specimens of detached leaves, one of which is shown in fig. 5; there is no indication of the rachis, but the present writer

has referred them also to HEER's species as the leaves characterised by the long and narrow shape with six parallel nerves and subacute apex show the features characteristic to the species above cited.

Among the known species of *Podozamites, P. schenki* is characterised by the long and narrow leaves. It has been recorded from several Rhaetic and Liassic localities of the northern hemisphere. The only record of this species in the southern hemisphere is from the Rhaetic of Argentina described by SZAJNOCHA(1), but the specimen referred by this author to *P. schenki* is very fragmentary and can hardly be determined specifically.

In Europe this species has been recorded from the Rhaetic of Sweden(2), and also known from the Rhaetic of East Greenland(3). In Asia the occurrence of this species is confirmed by ZEILLER(4) and COUNILLON(5) in the Rhaetic of Tonkin and Annan respectively and by KAWASAKI(6) in the Liassic of Korea.

Localities: Eda (Loc. No. 1); and Shirochi (Loc. No. 10).

Podozamites lanceolatus (L. and H.)

Pl. XXXII (XIV), Fig. 2; Pl. LII (XXXIV), Figs. 6–9.

The name *Podozamites lanceolatus* is here used in a wide sense for a large number of *Podozamites*-shoots or detached leaves, except *P. schenki,* in the collection, characterised by the more or less broad lanceolate form of the leaves provided with blunt apex. Such specimens are shown in Pl. LII (XXXIV), figs. 6–9. In one in fig. 8 the axis is slender, the leaves are 5 cm. in length, and 1.8 cm. in breadth at the broadest portion a short distance below the middle. The nerves are about 25 in number, simple except at the base, and parallel to each other and to the lateral margins of the leaves. A shoot in fig. 6 differs somewhat from the ordinary one in having apparently thick and stout axis measuring 7 mm. across,

(1) L. SZAJNOCHA: Ueber fossile Pflanzenreste aus Cacheuta in der Argentinischen Republik. L.c.

(2) A. G. NATHORST: Floran vid Höganäs och Helsingborg. L.c.; Floran vid Bjuf. L.c.

(3) N. HARTZ: Planteforsteninger fra Cap Stewart i Østgrønland. L.c. T. M. HARRIS: The Rhaetic Flora of Scoresby Sound. L.c.

(4) R. ZEILLER: Flore fossile des gîtes de charbon du Tonkin. L.c.

(5) H. COUNILLON: Flore fossile des gîtes de charbon de l'Annan. L.c.

(6) S. KAWASAKI: Some Older Mesozoic Plants in Korea. L.c.

and some crowded leaves are attached at a wide angle; the shape of the leaves is similar to the former, but the nerves are a little crowded and there are 28 of them at the middle portion of each leaf. A detached leaf in fig. 7 is of a longer type, measuring 6.5 cm. in length and 1.1 cm. at the broadest middle portion and provided with a blunt apex. The nerves are much more crowded than in any specimens here illustrated, approximately 33 being counted at the middle portion. They converge gently to the apex.

The specific classification of the sterile shoots of *Podozamites*, especially when only detached leaves are disposed, is very difficult or sometimes almost impossible. HARRIS tried to divide *Podozamites* from the Rhaetic rocks of East Greenland based on the leaf-form, number of nerves and some other surface features and the epidermal cells of the leaves if available, but such also is artificial, though to some extent convenient.

Localities: Eda (Loc. Nos. 1 and 33); Hinabata (Loc. Nos. 44 and 45); Kamihina (Loc. Nos. 46, 49 and 50); Nabae (Loc. No. 21); Shirochi (Loc. No. 16); Hayama (Loc. No. 30); Suimyô (Loc. No. 69); Koyagaichi (Loc. No. 58); and Jitô (Loc. No. 55).

Podozamites sp.

Pl. L (XXXII), Fig. 11.

A specimen in Pl. L (XXXII), fig. 11 has been figured as it seems not to be identical with the usual type of *Podozamites*-leaves. It is a portion probably of an ovate leaf, with a breadth of 2.8 cm., but the nature of the base and apex is not known. The nerves are distinct and simple, numbering 32 at the middle portion.

It resembles *Podozamites striatus* VELENOVSKY[1] from the Bohemian Cretaceous, *P. reinii* GEYLER[2] from the Japanese Jurassic, and *P. stonesfieldensis* SEWARD[3] from the Jurassic of England. It resembles the last one most.

Locality: Hayama (Loc. No. 30).

(1) J. VELENOVSKY: Die Gymnospermen der böhmischen Kreideformation, 1885, p. 10, Pl. II, fig. 8.

(2) H. T. GEYLER: Ueber fossile Pflanzen aus der Juraformation Japans. Palaeontogr., Bd. XXIV, 1877, p. 229, Pl. XXXIII, fig. 4a; Pl. XXXIV, figs. 1–2, 5a; Pl. XXXVI, figs. 3b, 4.

(3) A. C. SEWARD: Jurassic Flora, Pt. II, 1904, p. 121, Pl. XI, figs. 1–2; ? Pl. III, fig. 4.

GENUS *Nageiopsis* FONTAINE

The genus *Nageiopsis* was established by FONTAINE[1] in 1889 for abundant vegetative shoots occurring in the Potomac flora resembling *Podozamites* but different from it in the branching habit of the rachis and some points in the nervation. It is certain that *Nageiopsis* shows striking similarly to the shoots of *Podocarpus* in the section of *Nageia*. Therefore FONTAINE was led to the establishment of this generic name. In the absence of branching twigs it is not easy to distinguish *Nageiopsis* from *Podozamites*; in such a case the only character to distinguish them is according to Fontaine as follows: "in the leaves of this plant, however, the nerves do not converge and unite in the tips as in *Podozamites*. This is the only feature which will distinguish detached leaves of the two genera." However, it is somewhat doubtful to the present writer to what extent this last feature is constant in the two genera.

The specimens which the present writer here referred to FONTAINE's genus are represented by some detached leaves and portions of twigs which do not show any branching, and if one can not, in the generic distinction between this and *Podozamites*, rely entirely upon the nervation of the leaves there is no reason whatever for referring our specimens to *Nageiopsis*. However, upon examining and comparing the figures of *Nageiopsis* by FONTAINE and those of *Podozamites*-leaves hitherto illustrated, the stems of *Nageiopsis* are seen to be thicker and woody just like in our present specimens instead of being thin and delicate as in *Podozamites*. This is the chief reason why the present writer has chosen here FONTAINE's generic designation for the specimens, though it is provisionally. Another reason for doing so lies in the fact that the *Nageiopsis*-leaves from North America and those in the present example are likewise of similar form, being broadly lanceolate, and the texture of the lamina is thick and coriaceous. While in *Podozamites*, the leaves are generally thinner and more linear lanceolate in outline, though there are exceptions in this.

Nageiopsis is represented abundantly in the Potomac flora, and has been recorded in the Jurassic of Yorkshire[2], Wealden of

(1) W. FONTAINE: Potomac or Younger Mesozoic Flora. U. S. Geol. Surv., Mon. Vol. XV, 1889, p. 196.

(2) A. C. SEWARD: Jurassic Flora, Pt. II, 1900, p. 289, fig. 51.

Sussex[1] and the Neocomian of New Zealand[2]. If our example be truly a *Nageiopsis,* then this is geologically the oldest occurrence of this genus.

Nageiopsis rhaetica sp. nov.

Pl. LII (XXXIV), Figs. 1–2.

Vegetative shoot consisting of thick stem bearing leaves. Stem 8 mm. across, with many striations on its surface running continuously in the longitudinal direction. Leaves very shortly stalked; lamina broadly lanceolate, with a length of 10-cm. and a maximum breadth of 2.5 cm., broadest near the base, narrowing gradually to an acute apex and rather abruptly to the base, and attached by a very short narrow stalk to the rachis. Mode of arrangement of leaves on the stem not clear. Nerves numerous, distinct, simple except at the base, parallel to each other and to the lateral margins of the leaf, converging towards the apex, and numbering approximately 25 at the broadest part.

Pl. LII (XXXIV), fig. 1 shows a thick stem to one side of which attached two leaves, the distance between the bases being 3.5 cm.; the mode of arrangement of the leaves on the rachis is not certain. In this specimen the leaves are at a right angle to the stem, while they are quite oblique in another one in fig. 2, in which though there is no indication of the stem the leaves probably show their original life-time position. In these the former may probably indicate the lower portion of the plant, while the latter were higher up probably near the top.

The specimens here called *Nageiopsis rhaetica* resemble somewhat in the leaf form *N. zamioides* FONTAINE[3] and *Podozamites distantinervis* FONTAINE[4] from the Potomac of North America, but in these Potomac species the nerves are far less in number.

Locality: Eda (Loc. No. 1).

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(1) A. C. SEWARD: Wealden Flora, Pt. II, 1895, p. 211, Pl. XII, fig. 3.

(2) E. A. N. ARBER: The Earlier Mesozoic Floras of New Zealand. L.c., p. 59, Pl. VII, figs. 1–2.

(3) W. M. FONTAINE: Potomac or Younger Mesozoic Flora. L.c., p. 196, Pl. LXXIX, figs. 1, 3; Pl. LXXX, figs. 1–2, 4; Pl. LXXXI, figs. 1–6.

(4) W. M. FONTAINE: Ibid., p. 179, Pl. LXXIX, fig. 5; Pl. LXXXII, fig. 4; Pl. LXXXIII, figs. 1–2, 6–7; Pl. LXXXIV, figs. 1–2, 8, 10, 14–15; Pl. LXXXV, figs. 12, 16.

PROBLEMATICUM

Pl. LIII (XXXV), Fig. 6.

A specimen in Pl. LIII (XXXV), fig. 6 is too imperfect and curiously-shaped to admit of the specific or even generic determination. It is an imperfect lamina of 6.5 cm. in height, imperfect at both apex and base, somewhat wedge-shaped, with numerous divergent nerves which fork occasionally. The lamina appears to be deeply cleft unequally into three segments, but the cleft is possibly accidental.

The example in question reminds one of *Noeggerathiopsis* or *Baiera,* but there is no evidence whatever for referring it to either of them.

Locality: Yamamoto (Loc. No. 63).

VII. CORRELATION AND AGE OF THE FLORA

The number of species of fossil plants from the Nariwa district which the present writer has discriminated is 82 in total, of which 35 are referable to known species, 23 to new species or varieties, whereas 7 have been provisionally compared with other known species, and the remaining 17 are specifically indeterminable. The constitution of the flora is as follows: Equisetales 6, Filicales 25, Bennettitales? 20, Nilssoniales 9, Ginkgoales 9, Ginkgoales? 4, Coniferales 4, Coniferales? 4 and a Problematicum. Of these the Filicales occupy the largest number among the flora and then Cycadophytan fronds such as Bennettitales and Nilssoniales. Equisetales, Ginkgoales and Coniferales are comparatively few. Equisetales is represented by 4 genera, namely, *Equisetites, Phyllotheca, Neocalamites* and *Annulariopsis,* of which *Neocalamites* is most abundant. The occurrence of *Annulariopsis* and *Phyllotheca* is noteworthy. Filicales is represented by four families, viz., Marattiaceae, Osmundaceae, Dipteridaceae and Polypodiaceae?. It is by far the most interesting fact that Dipteridaceae is represented by four characteristic genera, namely, *Clathropteris, Thaumatopteris, Dictyophyllum* and *Hausmannia* or 12 species all together. In Osmundaceae the genus *Todites* is the characteristic; *Cladophlebis* belongs possibly to Osmundaceae, but there is no positive proof of it. In Gymnospermae, Cycadophytan fronds are represented by

8 genera, viz., *Pterophyllum, Campylophyllum, Otozamites, Ptilozamites, Yabeiella, Taeniopteris, Nilssonia* and *Ctenis*; of these the last two from their epidermal structure have been grouped by THOMAS and BANCROFT in his new group Nilssoniales. Ginkgoales is represented by two genera, namely, *Ginkgoites* and *Baiera,* but their generic distinction is very vague. *Czekanowskia* and *Phoenicopsis* have been placed by some authors near Ginkgoales, but their epidermal structure seems to differ in certain points from that of *Ginkgoites* and *Baiera.* Coniferales is represented by two genera, namely *Pityophyllum* (*Pityocladus*) and *Elatocladus.* The botanical position of *Podozamites* and *Nageiopsis* is yet uncertain, but they are sometimes placed near Coniferales.

In the accompanying table is shown the correlation of the present flora with those of Korea and foreign countries.

With the Rhaetic flora of Tonkin there are 10 species common, namely:

Neocalamites carrerei (ZEILLER)
Annulariopsis inopinata ZEILLER
Marattiopsis muensteri (GOEPP.)
Todites roesserti ZEILLER (non PRESL)
Cladophlebis nebbensis (BRONGN.)
C. raciborskii ZEILLER
Pterophyllum schneki (ZEILLER)
Otozamites indosinensis ZEILLER
Baiera guilhaumati ZEILLER
Podozamites schenki HEER

However, it is interesting that there is no common species in Dipteridaceae which is represented by a number of species in both floras.

With the Rhaetic flora (Molteno) of South Africa there are only five common and comparable species, namely:

Neocalamites carrerei (ZEILLER)
Marattiopsis muensteri (GOEPP.)
Cladophlebis nebbensis (BRONGN.)
C. roesserti ZEILLER (non PRESL)
Taeniopteris cfr. *carruthersi* TENISON-WOODS

It is striking that the present flora has 20 species common with the Rhaetic-Liassic flora of Sweden, though some are a little doubtful. The identical and comparable species are:

CORRELATION TABLE

LIST OF SPECIES FROM NARIWA	LOCALITIES IN THE NARIWA DISTRICT.																								FLORAS OUTSIDE JAPAN PROPER							
	Loc. No. 1 (Eda).	Loc. No. 10 (Shirochi)	Loc. No. 16 (Shirochi)	Loc. No. 21 (Nabae)	Loc. No. 30 (Hayama)	Loc. No. 33 (Eda)	Loc. No. 40 (Kamihina)	Loc. No. 44 (Hinabata)	Loc. No. 45 (Hinabata)	Loc. No. 46 (Kamihina)	Loc. No. 47 (Kamihina)	Loc. No. 48 (Kamihina)	Loc. No. 49 (Kamihina)	Loc. No. 50 (Kamihina)	Loc. No. 54 (Jitô)	Loc. No. 55 (Jitô)	Loc. No. 58 (Koyagaichi)	Loc. No. 62 (Nishihata)	Loc. No. 63 (Yamamoto)	Loc. No. 64 (Yamamoto)	Loc. No. 65 (Hata)	Loc. No. 66 (Hinabata)	Loc. No. 68 (Hinabata)	Loc. No. 69 (Suimyô)	Tonkin: Rhaetic	Sweden: Rhaetic-Liassic	Greenland: Rhaetic-Liassic	South Africa: Rhaetic	Korea: Liassic	Bornholm: Liassic	New Zealand: Rhaetic-Liassic	Germany: Liassic
1. *Equisetites multidentatus* sp. nov.	×												×																			
2. *E.* sp.			×		×	×		×		×			×																			
3. *Phyllotheca* sp.																								×								
4. *Neocalamites hoerensis* (SCHIMPER)									×			×														×	×			?		
5. *N. carrerei* (ZEILLER)		×											×		×		×								×			×	×			
6. *Annulariopsis inopinata* ZEILLER ?	×		×																						×							
7. *Marattiopsis muensteri* (GOEPPERT)								×					×												×	×		×	×	×		
8. *Todites roesserti* ZEILLER (non PRESL)						×						×													×	?		×				
9. *T. williamsoni* (BRONGN.)								×														×							×			
10. *T. princeps* (PRESL)													×														×			×		×
11. *Cladophlebis haiburnensis* (L. and H.)							×	×				×		×															×	×		
12. *C. gigantea* sp. nov.								×																								
13. *C. bitchuensis* sp. nov.								×																								
14. *C. nebbensis* (BRONGN.)	×					×		×								×								×	×	×		×	×	?		
15. *C. raciborskii* ZEILLER								×			×	×	×												×				×			
16. *C. denticulata* (BRONGN.)		×	×		×								×											×					×		×	×
17. *C. pseudodelicatula* sp. nov.								×																								
18. *Clathropteris meniscoides* (BRONGN.) var. *elegans* var. nov.	×																															
19. *C. obovata* sp. nov.								×										×						×								
20. *Thaumatopteris nipponica* sp. nov.	×																															
21. *T. elongata* sp. nov.												×	×																			
22. *T. schenki* NATHORST					×																					×	×			×		×
23. Cfr. *T. brauniana* POPP																							×			×	×					
24. *Dictyophyllum spectabile* NATHORST					×																					×						
25. *D. nilssoni* (BRONGN.)					×								×													×	×			?		
26. *D. muensteri* (GOEPPERT)													×						×							×	×			?		
27. *Hausmannia nariwaensis* ÔISHI	×																		×													
28. *H. crenata* NATHORST	×																									×						
29. *H. dentata* sp. nov.	×																															
30. *Spiropteris* sp.													×																			
31. *Sphenopteris gracilis* sp. nov.								×																								
32. *Pterophyllum schenki* (ZEILLER)	×															×									×		×					
33. *P. jaegeri* BRONGN.								×			×																					
34. *P. ctenoides* sp. nov.										×																						
35. Cfr. *P. distans* MORRIS																		×														
36. *P.* spp.														×																		
37. *Campylophyllum hörmanni* GOTHAN																		×														×
38. *Otozamites lancifolius* sp. nov.											×																					
39. *O. indosinensis* ZEILLER											×														×							
40. *O.* sp.											×																					
41. *Ptilozamites tenuis* sp. nov.														×																		
42. *P. nilssoni* NATHORST ?																		×								×						
43. *Yabeiella* sp.										×							?															
44. *Taeniopteris lanceolata* sp. nov.							×							×																		
45. *T. nabaensis* sp. nov.				×																												
46. *T.* cfr. *stenophylla* KRYSHT.																	×												×			
47. *T.* cfr. *carruthersi* TENISON-WOODS	×			×																								×				
48. *T.* cfr. *leclerei* ZEILLER																				×												
49. *T.* sp.								×																								
50. *T.* ? sp.													×																			
51. *T.* ? sp. nov.																					×											
52. *Nilssonia simplex* sp. nov.	×																															
53. *N. orientalis* (HEER)								×																								×
54. *N. acuminata* (PRESL)				×																		×								?		×
55. *N. muensteri* (PRESL)						×							×													×				×		
56. *N.* sp.				×																												
57. *N.* ? gen. et sp. indet.	×										×																					
58. *Ctenis japonica* sp. nov.				×	×																											
59. *C. yabei* sp. nov.														×																		
60. *C.* ? sp.														×																		
61. *Ginkgoites sibirica* (HEER)				×				×					×													×			×	×		
62. *Baiera muensteriana* (PRESL)	×		×											×												×	×					×
63. *B. furcata* HEER											×																					
64. *B. filiformis* sp. nov.						×											×															
65. *B. taeniata* F. W. BRAUN																						×				×						×
66. *B. paucipartita* NATHORST								×																		×				×		
67. *B. elegans* sp. nov.											?			×																		
68. *B. guilhaumati* ZEILLER ?						×																			×				?			
69. *B.* sp.																								×								
70. *Czekanowskia rigida* HEER	×										×	×												×		×				×		
71. *Phoenicopsis* sp.													×	?																		
72. *Stenorachis bitchuensis* sp. nov.										×																						
73. *S. elegans* sp. nov.																			×													
74. *Pityophyllum* (*Pityocladus*) *longifolium* (NATHORST)	×			×			×	×		×			×	×										×		×			×	×		
75. *Elatocladus plana* (FEISTMANTEL)	×																															
76. *E. tennerima* (FEISTMANTEL)	×									×																						
77. *E.* sp.	×																															
78. *Podozamites schenki* HEER	×	×																							×	×	×		×	×		
79. *P. lanceolatus* (L. and H.)	×		×	×	×	×		×	×	×			×	×		×	×							×		×	×		×			
80. *P.* sp.					×																											
81. *Nageiopsis rhaetica* sp. nov.	×																															
82. Problematicum																			×													

Neocalamies hoerensis (SCHIMP.)
Marattiopsis muensteri (GOEPP.)
Todites roesserti ZEILLER (non PRESL)
Cladophlebis nebbensis (BRONGN.)
Thaumatopteris schenki NATH.
T. brauniana POPP
Dictyophyllum nilssoni (BRONGN.)
D. muensteri (GOEPP.)
D. spectabile NATHORST
Hausmannia crenata NATH.
Ptilozamites nilssoni NATH.
Nilssonia muensteri (PRESL)
Ginkgoites sibirica (HEER)
Baiera muensteriana (PRESL)
B. taeniata F. W. BRAUN
B. paucipartita NATH.
Czekanowskia rigida HEER
Pityophyllum longifolium (NATH.)
Podozamites schenki HEER
P. lanceolatus (L. and H.)

With the Rhaetic (partly basal Liassic?) flora of East Greenland there are 9 identical and comparable species, they are:

Neocalamites hoerensis (SCHIMP.)
Todites princeps (PRESL)
Thaumatopteris schenki NATH.
T. brauniana POPP
Dictyophyllumn nilssoni (BRONGN.)
D. muensteri (GOEPP.)
Pterophyllum schenki (ZEILL.)
Baiera muensteriana (PRESL)
Podozamites schenki HEER

Our flora seems to have some common species also with the Liassic flora of Bornholm, but the latter is represented mostly by fragmental specimens, so exact correlation is somewhat difficult. However, the following species seem to be common in both floras:

Neocalamites hoerensis (SCHIMP.)
Marattiopsis muensteri (GOEPP.)
Todites princeps (PRESL)
Cladophlebis nebbensis (BRONGN.)

C. haiburnensis (L. and H.)
Thaumatopteris schenki NATH.
Dictyophyllum muensteri (GOEPP.)
D. nilssoni (BRONGN.)
Nilssonia acuminata (PRESL)
N. muensteri (PRESL)
Ginkgoites sibirica (HEER)
Baiera paucipartita NATH.
Czekanowskia rigida HEER
Pityophyllum longifolium NATH.
Podozamites schenki HEER

Besides the Rhaetic and Liassic floras above correlated, our flora has eight species common with the Lower Liassic flora of the Nürnberg district, they are:

Todites princeps (PRESL)
Cladophlebis denticulata (BRONGN.)
Thaumatopteris schenki NATH.
Campylophyllum hörmanni GOTHAN
Nilssonia orientalis (HEER)
N. acuminata (PRESL)
Baiera muensteriana (PRESL)
B. taeniata F. W. BRAUN

With the Rhaetic and Liassic Flora of New Zealand there is only one common species, *Cladophlebis denticulata,* and with the Lower Jurassic flora of India the affinity is also very poor.

Lastly, with the Liassic flora of Korea ours has the following common species:

Neocalamites carrerei (ZEILLER)
Marattiopsis muensteri (GOEPP.)
Cladophlebis denticulata (BRONGN.)
C. raciborskii ZEILLER
C. nebbensis (BRONGN.)
C. haiburnensis (L. and H.)
C. williamsoni (BRONGN.)
Taeniopteris stenophylla KRYSHT.
Ginkgoites sibirica (HEER)
Pityophyllum longifolium (NATH.)
Podozamites lanceolatus (L. and H.)
P. schenki HEER

As it is obvious from the above correlation, our flora should be compared most closely with the rich Rhaetic flora of Tonkin and the Rhaeto-Liassic flora of Sweden. As mentioned above it is striking that there is no identical species of Dipteridaceae between the Tonkin and our floras, although each is represented by a number of species belonging to this family; in this point, however, there is close similarity between the Swedish flora and ours.

It is indeed a matter of a considerable difficulty to distinguish the Rhaetic and the Lower Liassic flora based merely on the fossil plants available, and in doing so there is always need of investigation as carefully as possible in connection with the results of palaeozoology and precise stratigraphical observation in the field. Our flora indicates, as a whole, the Rhaetic, but there are also some elements of the so-called *Thaumatopteris*-zone of East Greenland to which HARRIS attributed the basal Liassic age (T. M. HARRIS: Rhaetic Floras. Biological Review, Vol. VI, No. 2, 1931). The consideration of AKAGI that the plant beds are in the same age with the marine beds with *Pseudomonotis ochotica* in the Nariwa district is now rejected because of the fact that the writer's own field observation has revealed that the plant and the *Pseudomonotis* beds are brought into the juxtaposition to one another always by severe dislocations.

Now, taking into consideration the fact that first there is no indication of animal fossils found in this district indicating or even suggesting the occurrence of rocks somewhat younger or older age than the upper Triassic, and secondly the palaeogeographical evidence that in the Japanese Islands there is a remarkable unconformity at the base of the Liassic formation, it seems advisable at present to consider the flora, as a whole, to be Rhaetic.

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PALAEONTOLOGICAL INDEX.

Synonyms and fossils to which only passing reference is here made are printed in *italics*. The principal page-references to names of genera and species described are shown in heavy type.

EXPLANATION OF PLATES XIX (I)–LIII (XXXV).

The photographs are by Mr. T. TAKEDA. As to the photomicrographs the author is particularly indebted to our colleague Mr. T. WATANABE. Some are retouched and the drawings in Pl. XXV (VII); Pl. XLII (XXIV), fig. 6a; Pl. XLIV (XXVI), fig. 5a; Pl. L (XXXII), fig. 8a and Pl. LIII (XXXV), fig. 4 are by the author. The figures are all natural size unless otherwise stated.

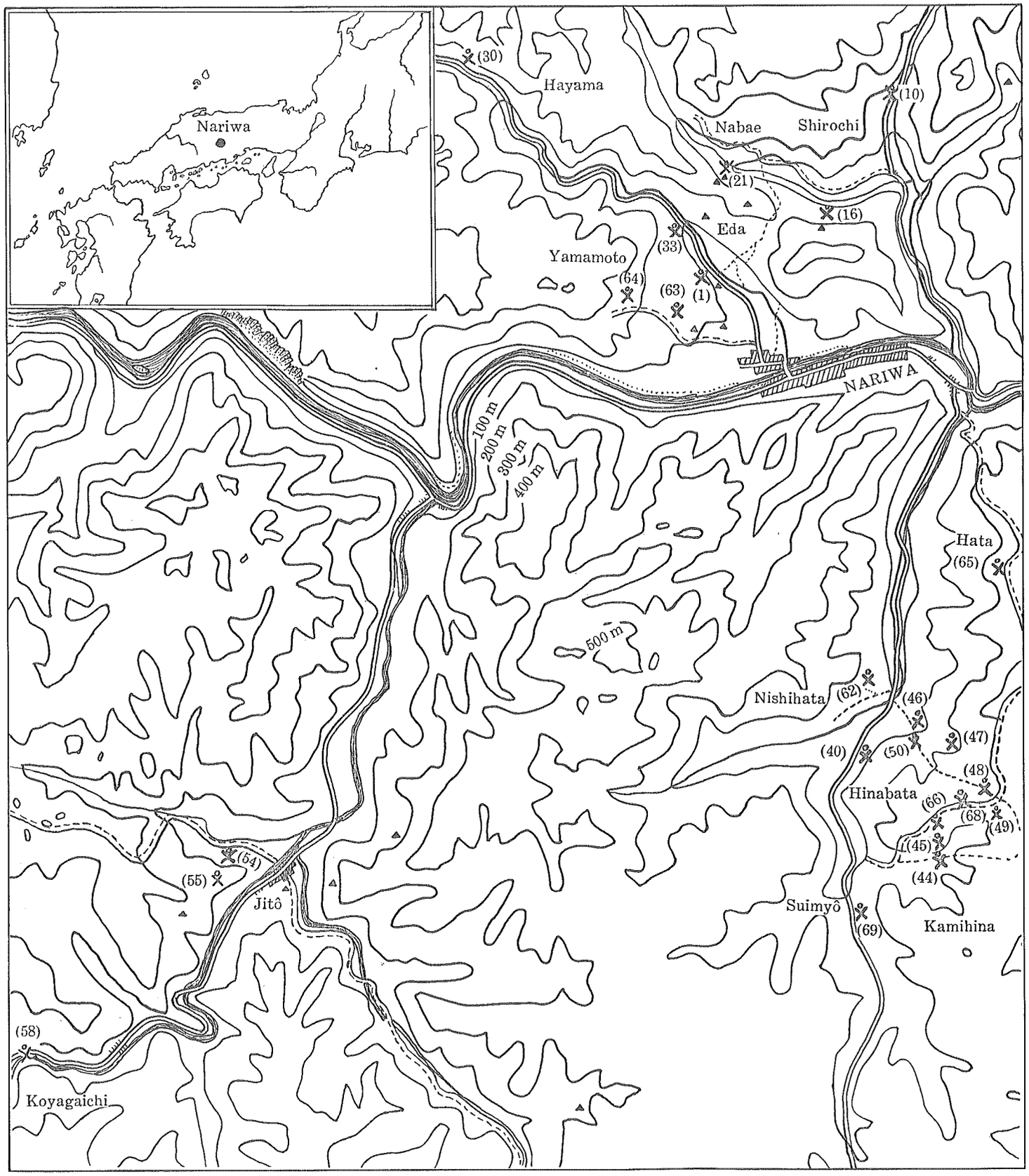
Plate XIX (I)

PLATE XIX (I).

A map showing the localities of plant and animal fossils in the Nariwa district (drawn by Mr. K. YAMASHITA). Scale 1/50,000.

⚹ Plant fossils.

▲ *Pseudomonotis ochotica* (KEYS.) var. *eurhachis* TELL.



S. Ōishi : Rhaetic Plants from Nariwa.

Plate XX (II)

PLATE XX (II).

Fig. 1. *Equisetites multidentatus* sp. nov. Kamihina (Loc. No. 49). (3980).

Fig. 2. *Equisetites multidentatus* sp. nov. Eda (Loc. No. 1). (3886).

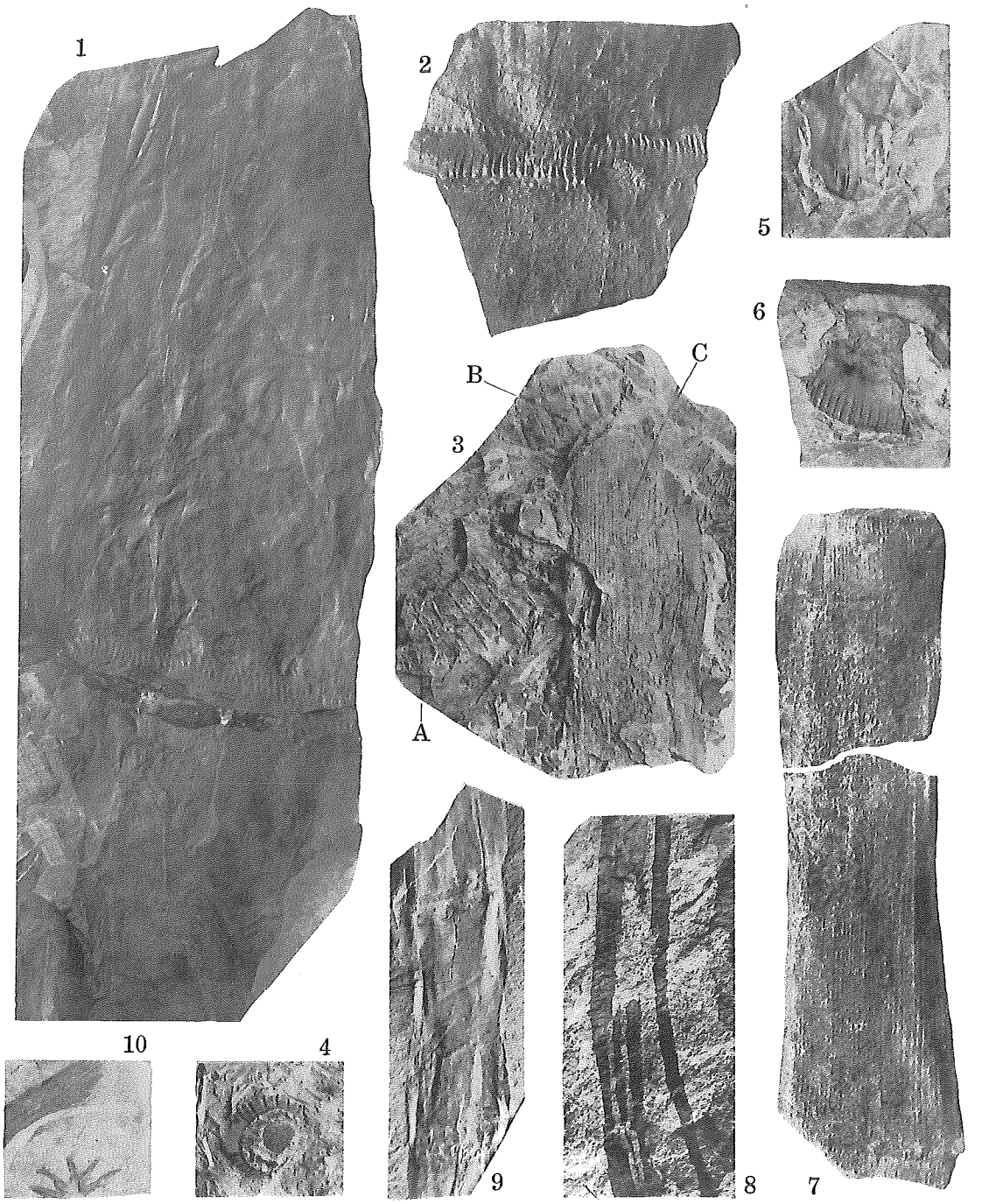
Figs. 3–4. *Equisetites* sp. Shirochi (Loc. No. 16). (4115).

Figs. 5–6. *Equisetites* sp. Hinabata (Loc. No. 49). (4022).

Figs. 7–8. *Neocalamites hoerensis* (SHIMPER). Hinabata (Loc. No. 45). (4043).

Fig. 9. *Neocalamites hoerensis* (SHIMPER). Kamihina (Loc. No. 48). (4090).

Fig. 10. *Phyllotheca* sp. Suimyô (Loc. No. 69). (4101).



S. Ōishi: Rhaetic Plants from Nariwa.

Plate XXI (III)

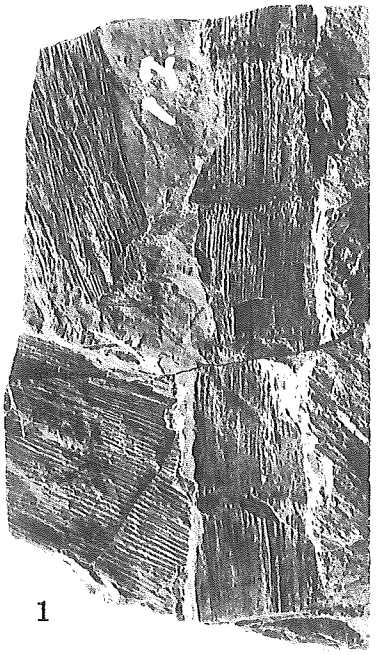
PLATE XXI (III).

Figs. 1–2. *Neocalamites carrerei* (ZEILLER). Shirochi (Loc. No. 10). (4072; 4027).

Fig. 3. *Neocalamites carrerei* (ZEILLER). Koyagaichi (Loc. No. 58). (4046).

Fig. 4. *Neocalamites carrerei* (ZEILLER). Kamihina (Loc. No. 49). (3980).

Fig. 5. *Annulariopsis inopinata* ZEILLER? Shirochi (Loc. No. 16). (4111).



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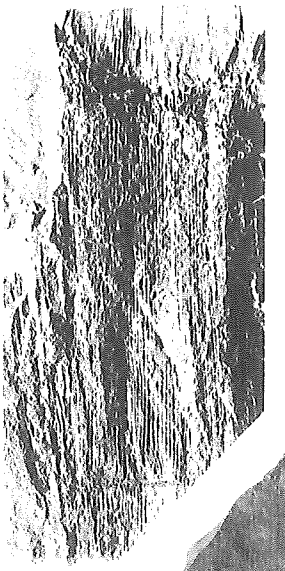

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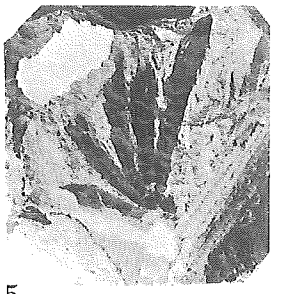

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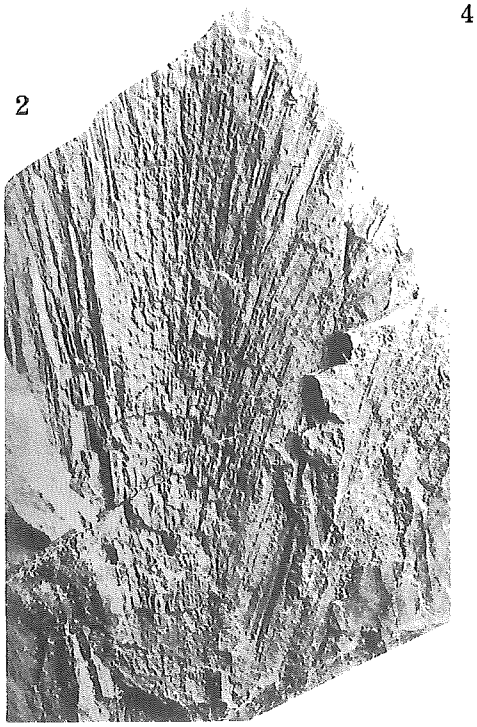

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S. Ōishi: Rhaetic Plants from Nariwa.

Plate XXII (IV)

PLATE XXII (IV).

Fig. 1. *Neocalamites carrerei* (ZEILLER). Jitô (Loc. No. 54). (4059).

Fig. 2. *Neocalamites carrerei* (ZEILLER). Kamihina (Loc. No. 49). (3987).

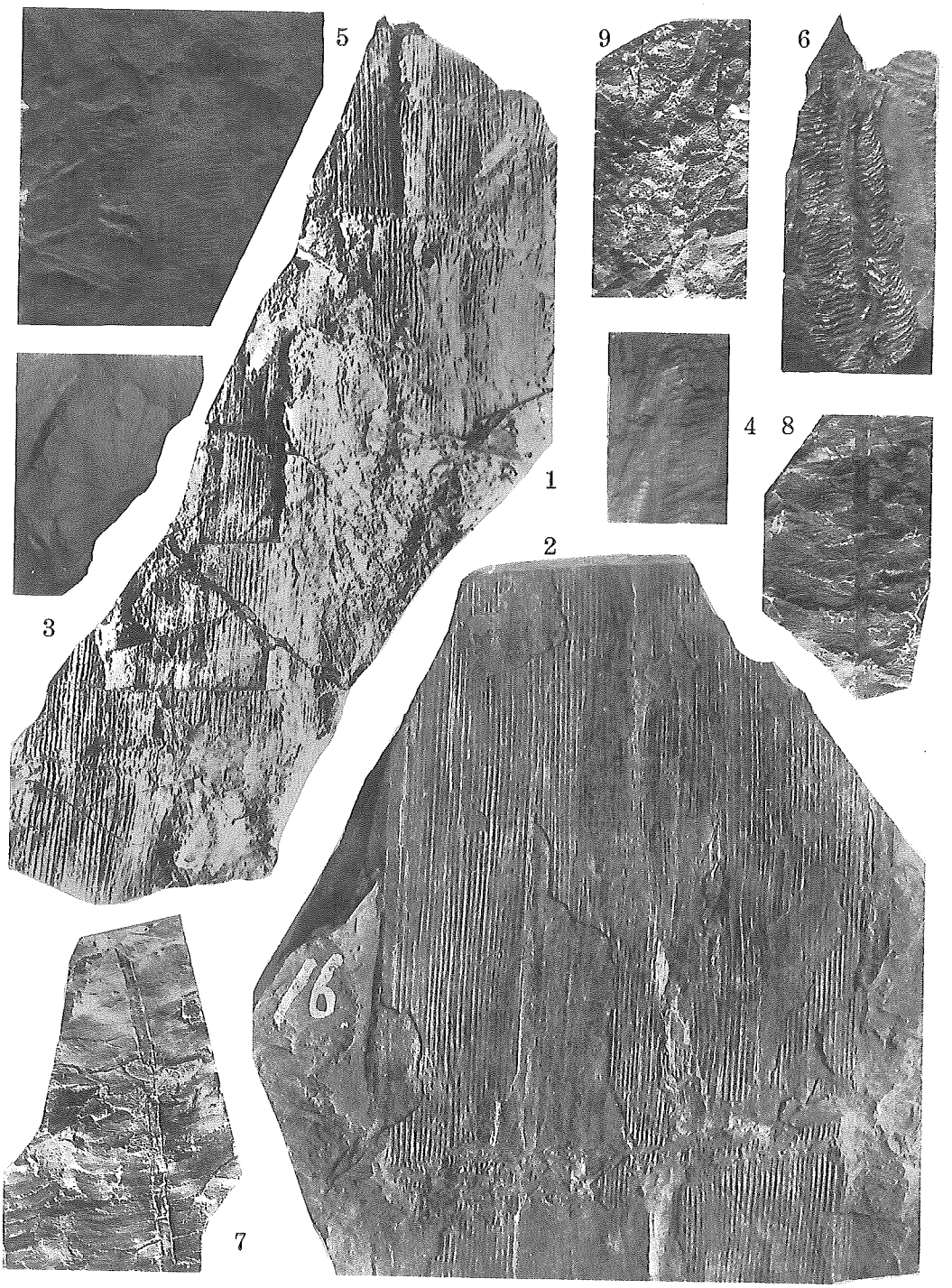
Fig. 3. *Annulariopsis inopinata* ZEILLER? Eda (Loc. No. 1). (3967).

Figs. 4, 6. *Marattiopsis muensteri* (GOEPPERT). Kamihina (Loc. No. 49). (3995).

Fig. 5. *Marattiopsis muensteri* (GOEPPERT). Hinabata (Loc. 44). (4140).

Figs. 7–8. *Todites roesserti* ZEILLER (non PRESL). Kamihina (Loc. No. 48). (4095).

Fig. 9. *Todites roesserti* ZEILLER (non PRESL). Eda (Loc. No. 33). (3899).



S. Ōishi : Rhaetic Plants from Nariwa.

Plate XXIII (V)

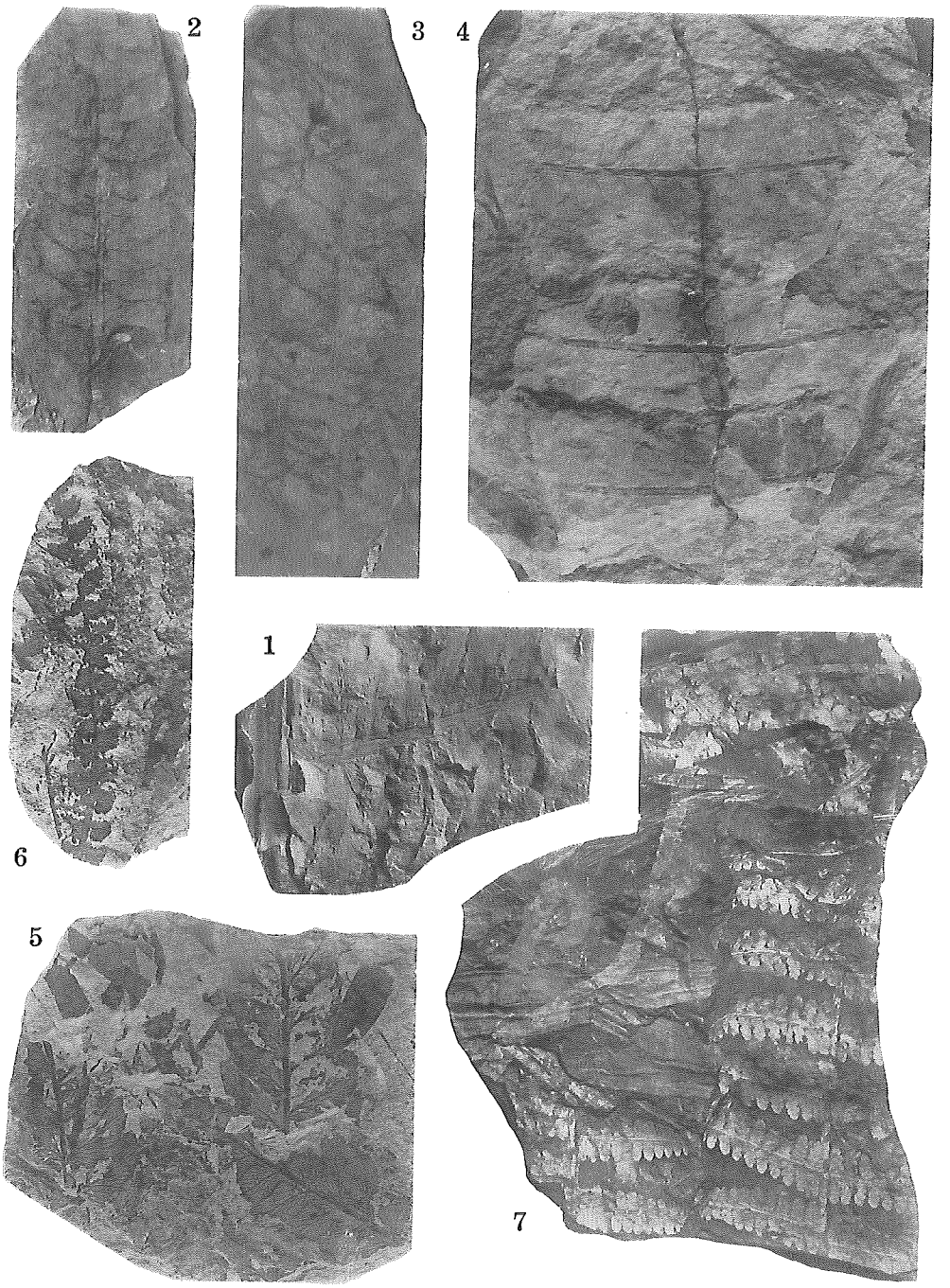
PLATE XXIII (V).

Figs. 1–2. *Todites roesserti* ZEILLER (non PRESL). Fig. 2, a fertile pinna. Kamihina (Loc. No. 48). (4095).

Fig. 3. *Todites roesserti* ZEILLER (non PRESL). A fertile pinna. Eda (Loc. No. 33). (3899).

Figs. 4–6. *Todites williamsoni* (BRONGNIART). Fig. 6, a fertile pinna. Hinabata (Loc. No. 66). (4073).

Fig. 7. *Todites princeps* (PRESL). Kamihina (Loc. No. 49). (3985).



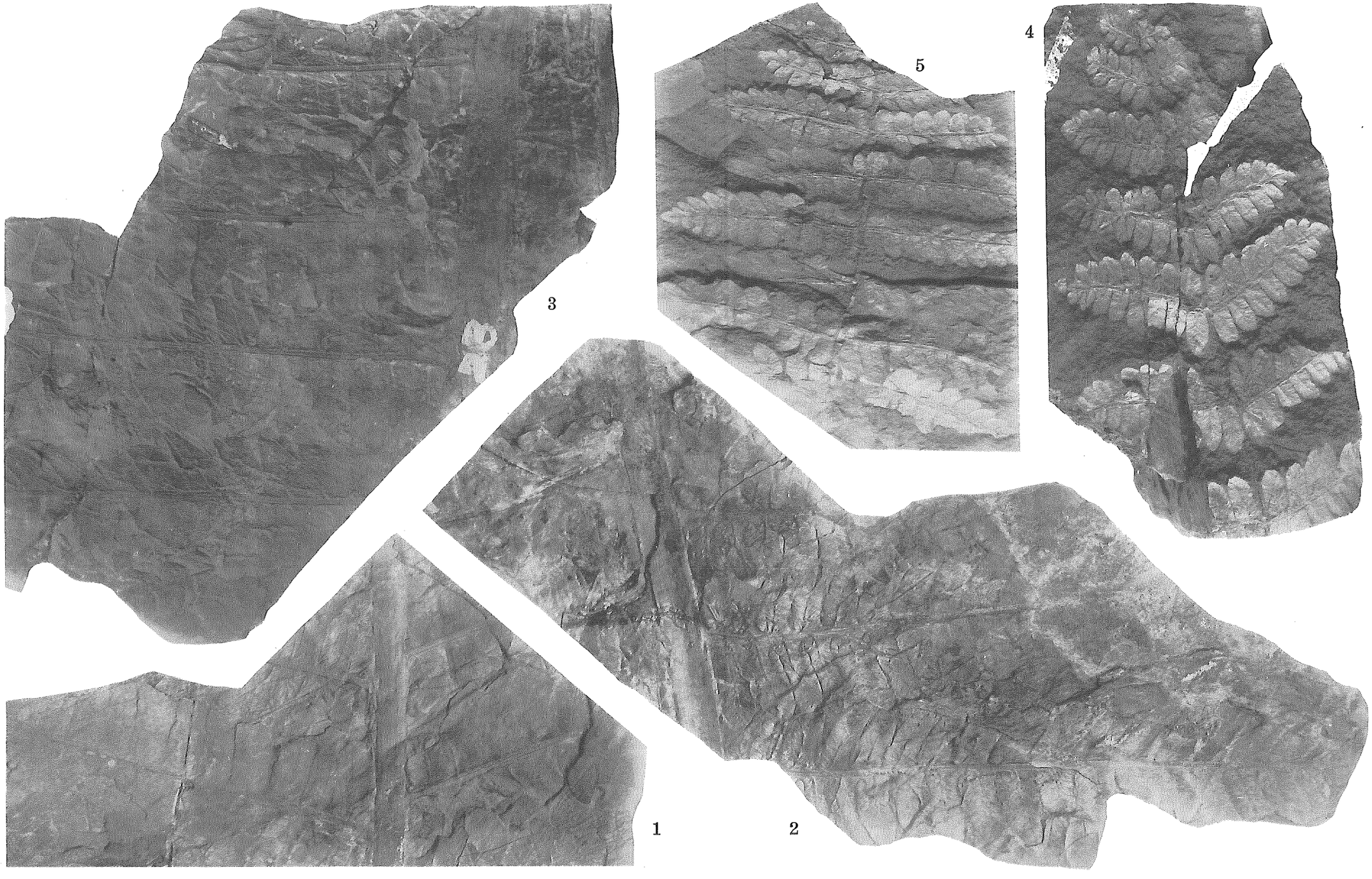
S. Ōishi: Rhaetic Plants from Nariwa.

Plate XXIV (VI)

PLATE XXIV (VI).

Figs. 1–3. *Cladophlebis haiburnensis* (L. and H.). Hinabata (Loc. No. 44). (4151).

Figs. 4–5. *Cladophlebis nebbensis* (BRONGNIART). Eda (Loc. No. 1). (3932).



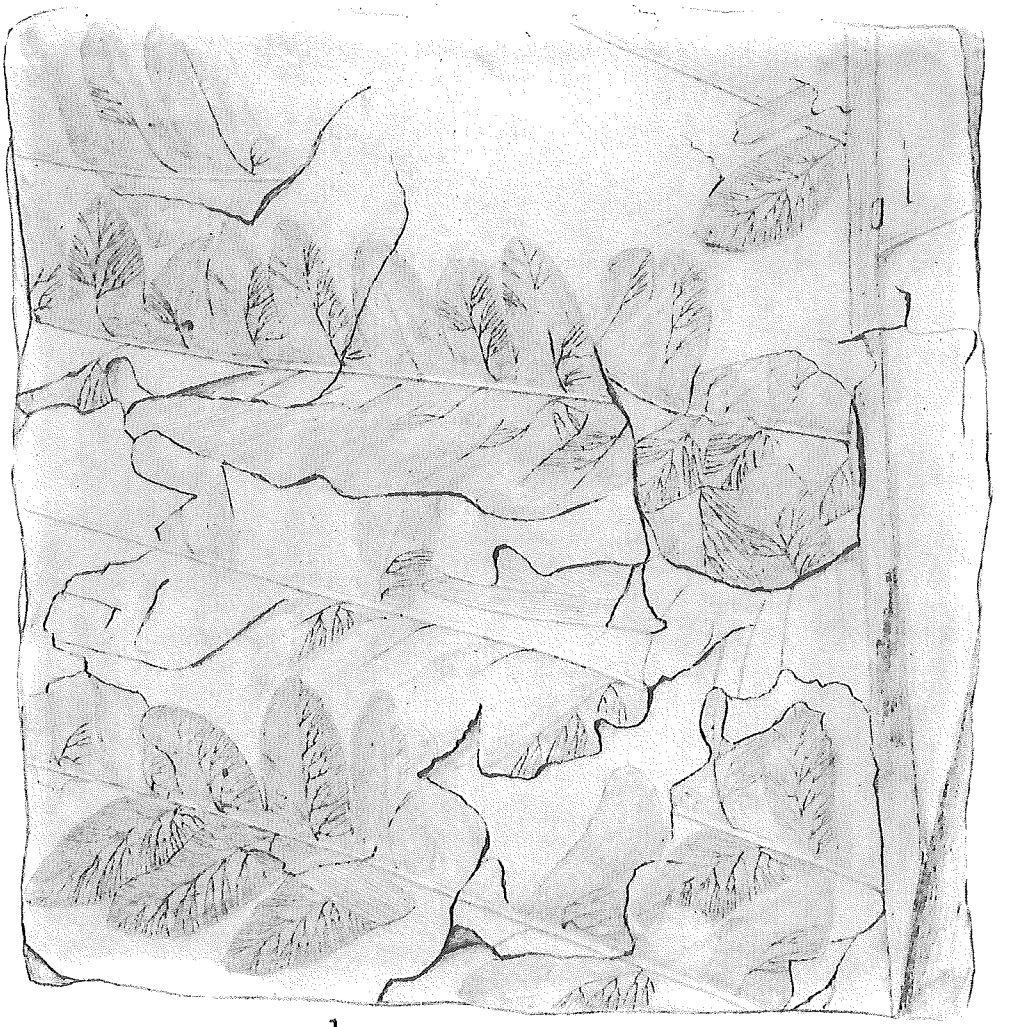
S. Ōishi : Rhaetic Plants from Nariwa.

Plate XXV (VII)

PLATE XXV (VII).

Fig. 1. *Cladophlebis bitchuensis* sp. nov. Hinabata (Loc. 44). (4118).

Fig. 2. *Cladophlebis gigantea* sp. nov. Hinabata (Loc. No. 44). (4130).



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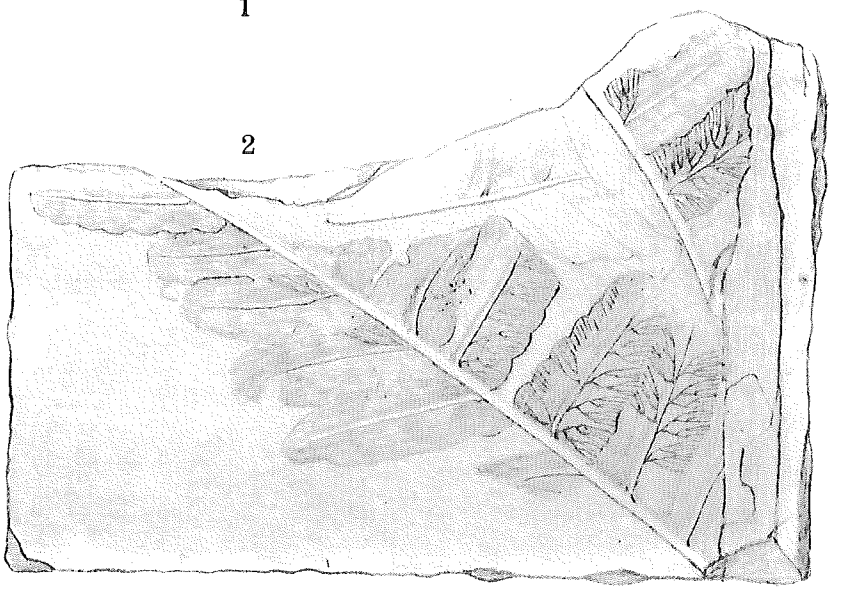

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S. Ōishi: Rhaetic Plants from Nariwa.

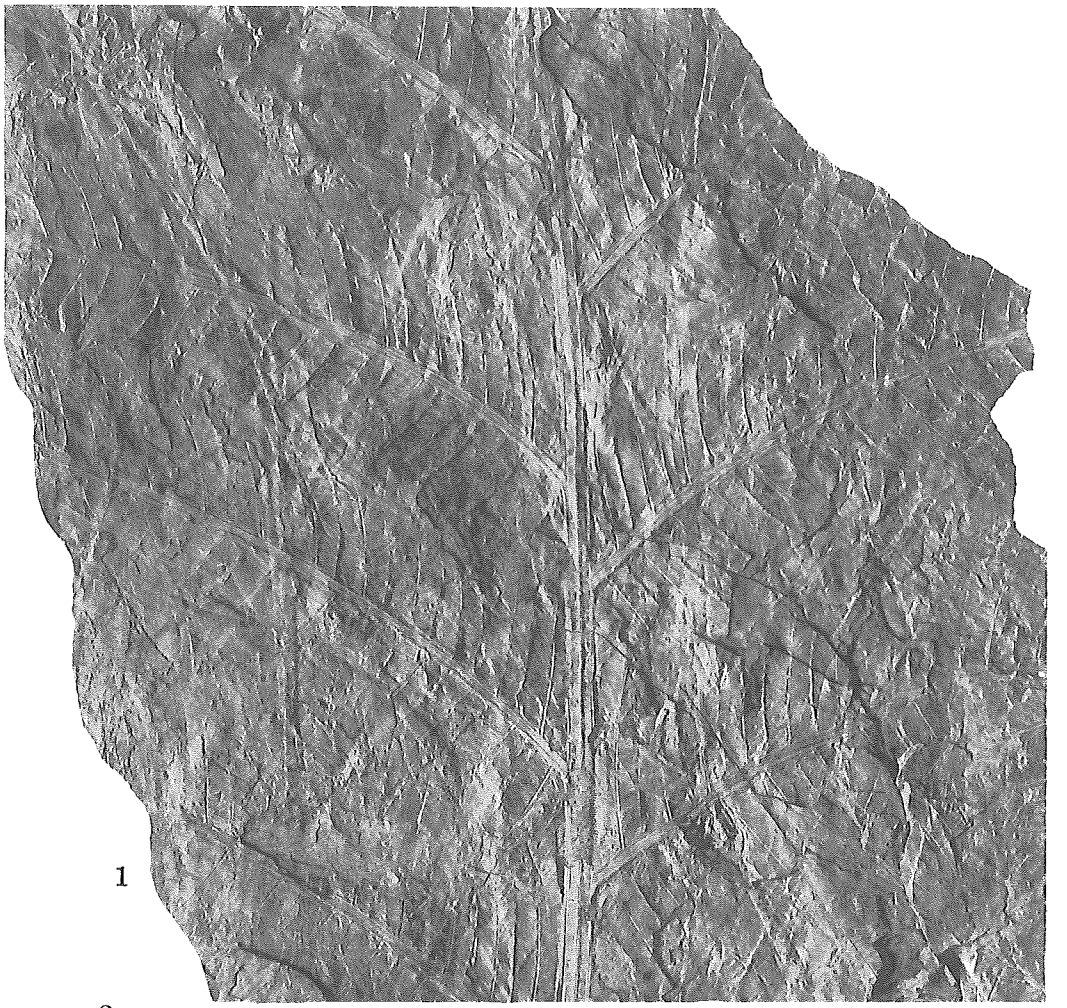
Plate XXVI (VIII)

PLATE XXVI (VIII).

Fig. 1. *Cladophlebis haiburnensis* (L. and H.). Hinabata (Loc. No. 44). (4128).

Fig. 2. *Cladophlebis haiburnensis* (L. and H.). Kamihina (Loc. No. 49). (4093).

Fig. 3. *Cladophlebis* cfr. *raciborskii* ZEILLER. Hinabata (Loc. No. 44). (4139).



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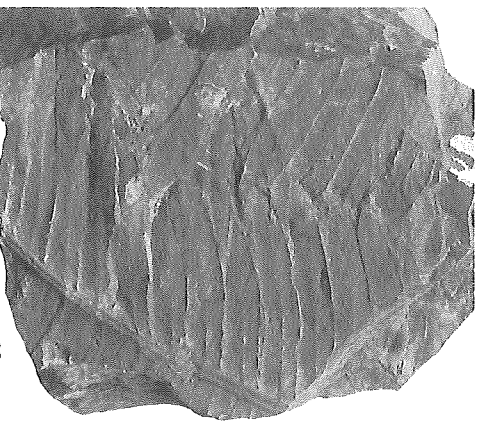

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S. Ōishi: Rhaetic Plants from Nariwa.

Plate XXVII (IX)

PLATE XXVII (IX).

Cladophlebis nebbensis (BRONGNIART). Eda (Loc. No. 1). (3977).

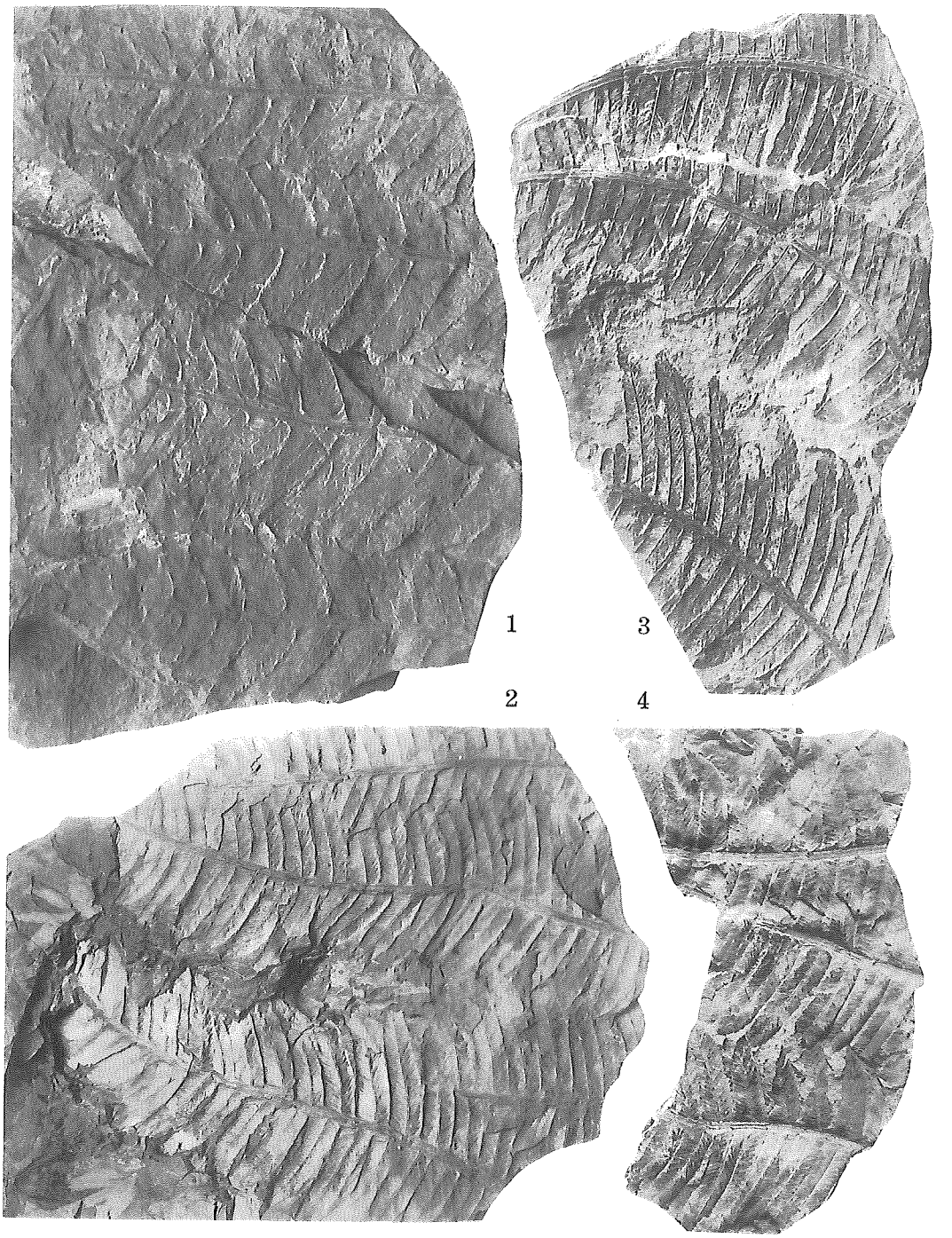
S. Ōishi: Rhaetic Plants from Nariwa.

Plate XXVIII (X)

PLATE XXVIII (X).

Figs. 1–2. *Cladophlebis raciborskii* ZEILLER. Hinabata (Loc. No. 44). (4141; 4154).

Figs. 3–4. *Cladophlebis* cfr. *raciborskii* ZEILLER. Hinabata (Loc. No. 44). (4153).



S. Ōishi: Rhaetic Plants from Nariwa.

Plate XXIX (XI)

PLATE XXIX (XI).

Fig. 1. *Cladophlebis nebbensis* (BRONGNIART). Eda (Loc. No. 1). (3960).

Fig. 2. *Cladophlebis pseudodelicatula* sp. nov. Hinabata (Loc. No. 44). (4133).

Fig. 3. *Cladophlebis denticulata* (BRONGNIART). Suimyô (Loc. No. 69). (4069).

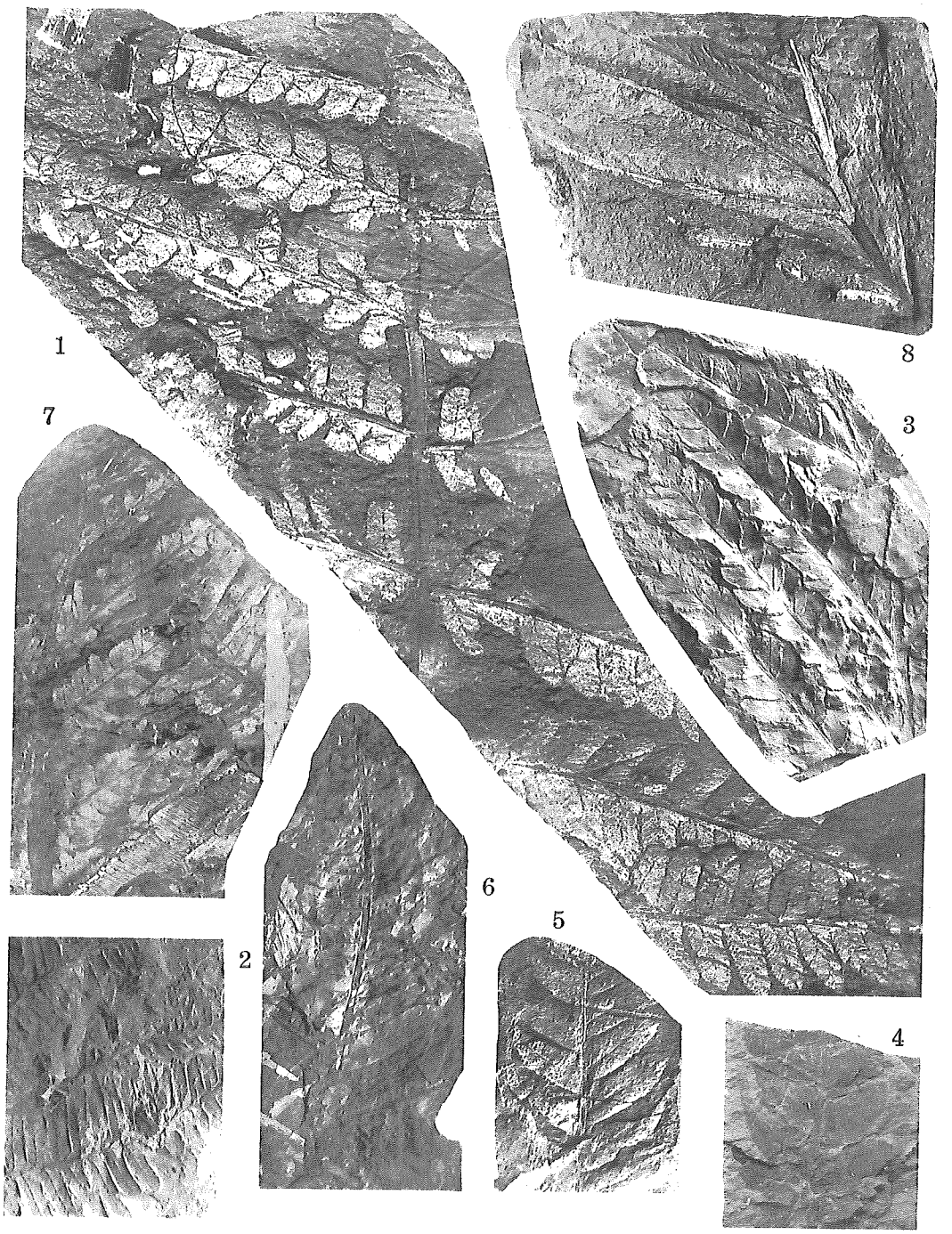
Fig. 4. *Cladophlebis denticulata* (BRONGNIART). Shirochi (Loc. No. 16). (4117).

Fig. 5. *Cladophlebis denticulata* (BRONGNIART). Shirochi (Loc. No. 10). (4097).

Fig. 6. *Cladophlebis denticulata* (BRONGNIART). Hayama (Loc. No. 30). (3993).

Fig. 7. *Cladophlebis denticulata* (BRONGNIART). Kamihina (Loc. No. 49). (4064).

Fig. 8. *Clathropteris meniscoides* (BRONGNIART) var. *elegans* var. nov. Eda (Loc. No. 1). (3948).



S. Ōishi: Rhaetic Plants from Nariwa.

Plate XXX (XII)

PLATE XXX (XII).

Fig. 1. *Cladophlebis nebbensis* (BRONGNIART). Eda (Loc. No. 1). (3932).

Fig. 2. *Clathropteris obovata* sp. nov. Nishihata (Loc. No. 62). (3914).

Figs. 3–4. *Clathropteris meniscoides* (BRONGNIART) var. *elegans* var. nov. Fig. 4, fertile pinnae. Eda (Loc. No. 1). (4109; 3963).

Figs. 5–6. *Thaumatopteris nipponica* sp. nov. Fig. 6, showing petiole and basal portion of pinnae. Eda (Loc. No. 1). (3969; 3956).

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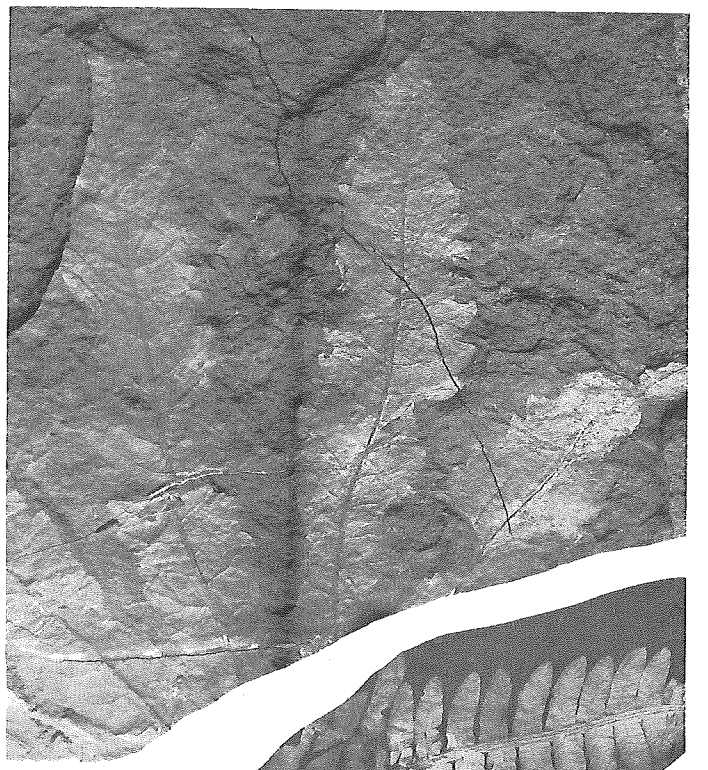

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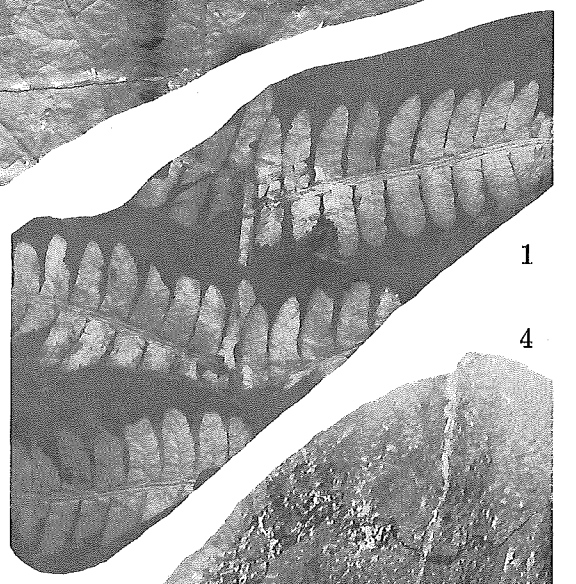

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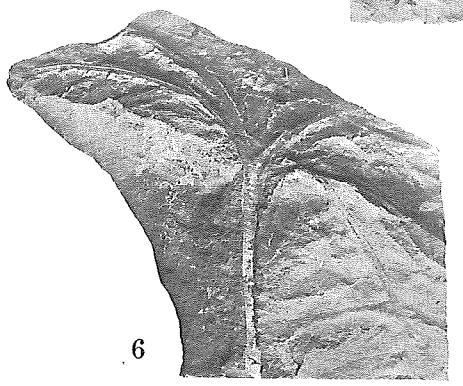

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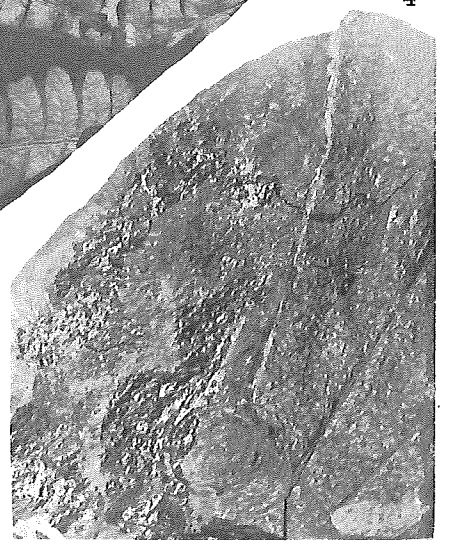

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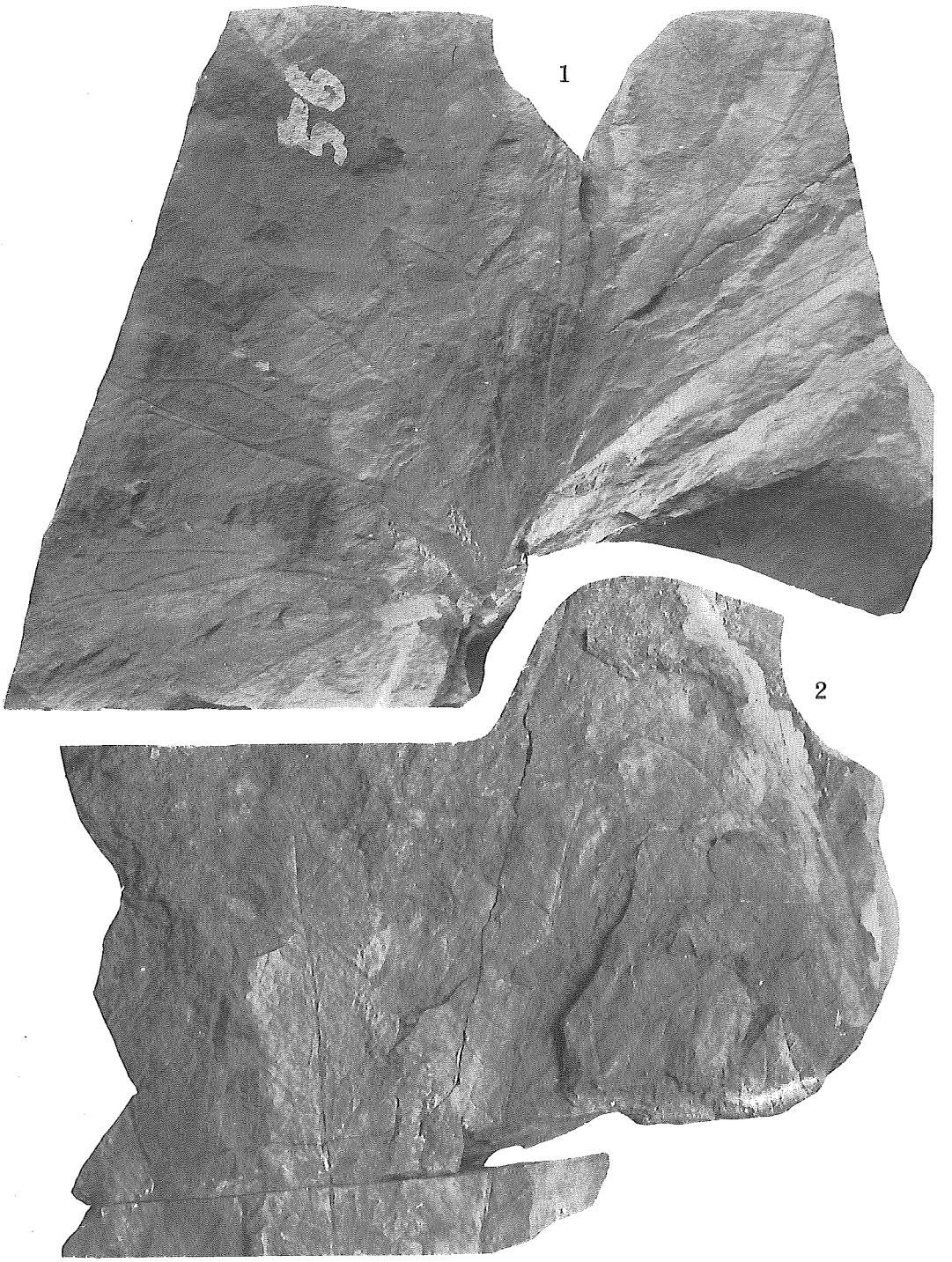
2

S. Ōishi : Rhaetic Plants from Nariwa.

Plate XXXI (XIII)

PLATE XXXI (XIII).

Figs. 1–2. *Clathropteris meniscoides* (BRONGNIART) var. *elegans* var. nov. Fig. 1, a basal portion, and Fig. 2, an apical portion, of pinnae. Eda (Loc. No. 1). (3965; 3974).



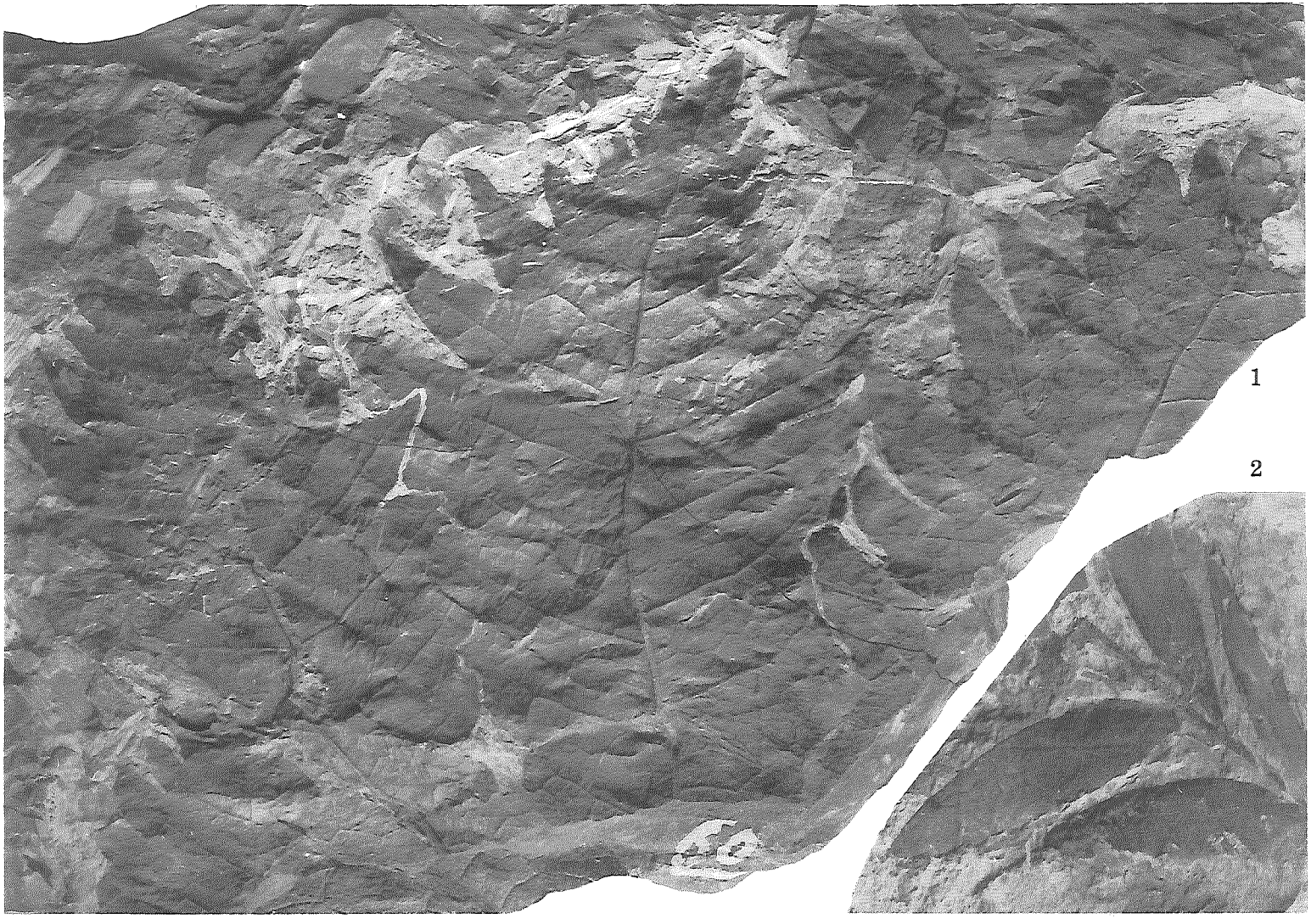
S. Ōishi : Rhaetic Plants from Nariwa.

Plate XXXII (XIV)

PLATE XXXII (XIV).

Fig. 1. *Clathropteris obovata* sp. nov. Hinabata (Loc. No. 44). (4142).

Fig. 2. *Podozamites lanceolatus* (L. and H.). Kamihina (Loc. No. 50). (4011).



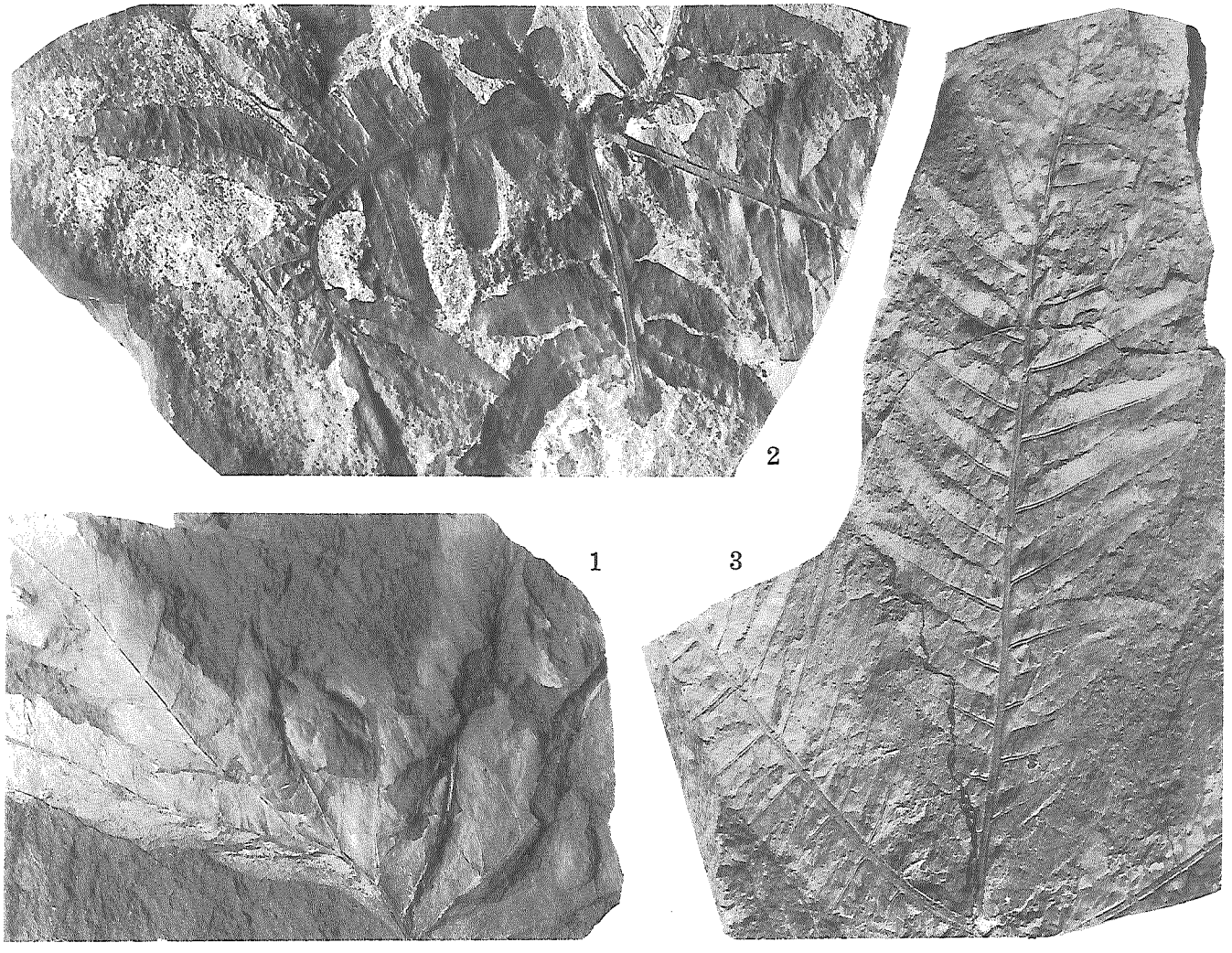
S. Ōishi: Rhaetic Plants from Nariwa.

Plate XXXIII (XV)

PLATE XXXIII (XV).

Fig. 1. *Clathropteris meniscoides* (BRONGNIART) var. *elegans* var. nov. Eda (Loc. No. 1). (3962).

Figs. 2–3. *Thaumatopteris nipponica* sp. nov. Eda (Loc. No. 1). (3950; 3951).



S. Ōishi: Rhaetic Plants from Nariwa.

Plate XXXIV (XVI)

PLATE XXXIV (XVI).

Fig. 1. *Thaumatopteris nipponica* sp. nov. Eda (Loc. No. 1). (3944).

Fig. 2. *Thaumatopteris elongata* sp. nov. Kamihina (Loc. No. 49). (3984).

S. Ōishi : Rhaetic Plants from Nariwa.

Plate XXXV (XVII)

PLATE XXXV (XVII).

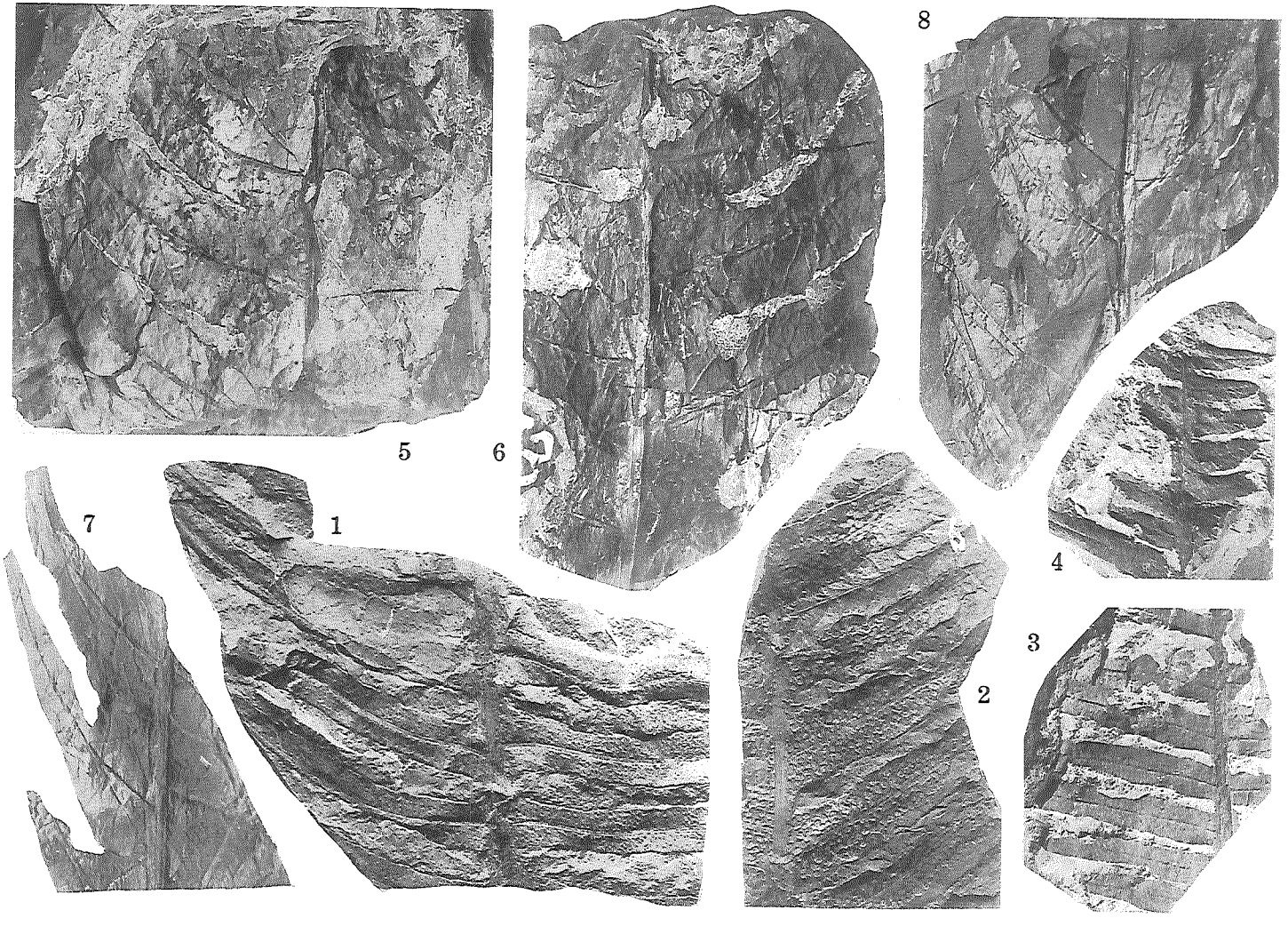
Fig. 1. *Thaumatopteris elongata* sp. nov. A fertile pinna. Kamihina (Loc. No. 48). (4091).

Fig. 2. *Thaumatopteris elongata* sp. nov. A fertile pinna. Kamihina (Loc. No. 49). (4021).

Figs. 3–4. *Thaumatopteris schenki* NATHORST. Hayama (Loc. No. 30). (4123).

Figs. 5–6. *Dictyophyllum spectabile* NATHORST. Hayama (Loc. No. 30). (4023).

Figs. 7–8. *Dictyophyllum nilssoni* (BRONGNIART). Hayama (Loc. No. 30). (3999).



S. Ōishi: Rhaetic Plants from Nariwa.

Plate XXXVI (XVIII)

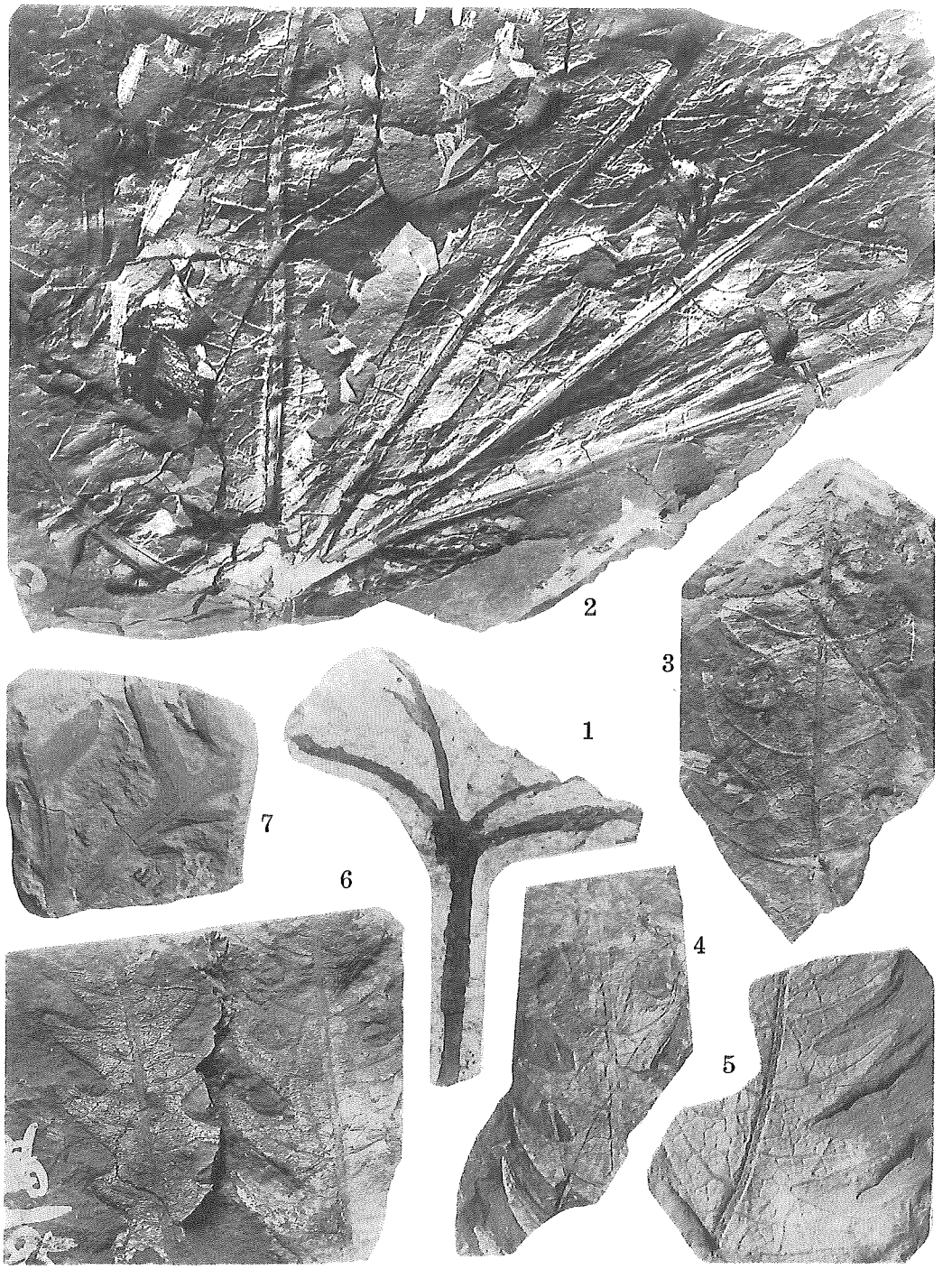
PLATE XXXVI (XVIII).

Fig. 1. *Thaumatopteris schenki* sp. nov. Hayama (Loc. No. 30). (4123).

Fig. 2. *Dictyophyllum nilssoni* (BRONGNIART). Kamihina (Loc. No. 49). (3982).

Figs. 3–6. *Dictyophyllum muensteri* (GOEPPERT). Kamihina (Loc. No. 49). (3981).

Fig. 7. *Dictyophyllum muensteri* (GOEPPERT). Yamamoto (Loc. No. 63). (3908).



S. Ōishi: Rhaetic Plants from Nariwa.

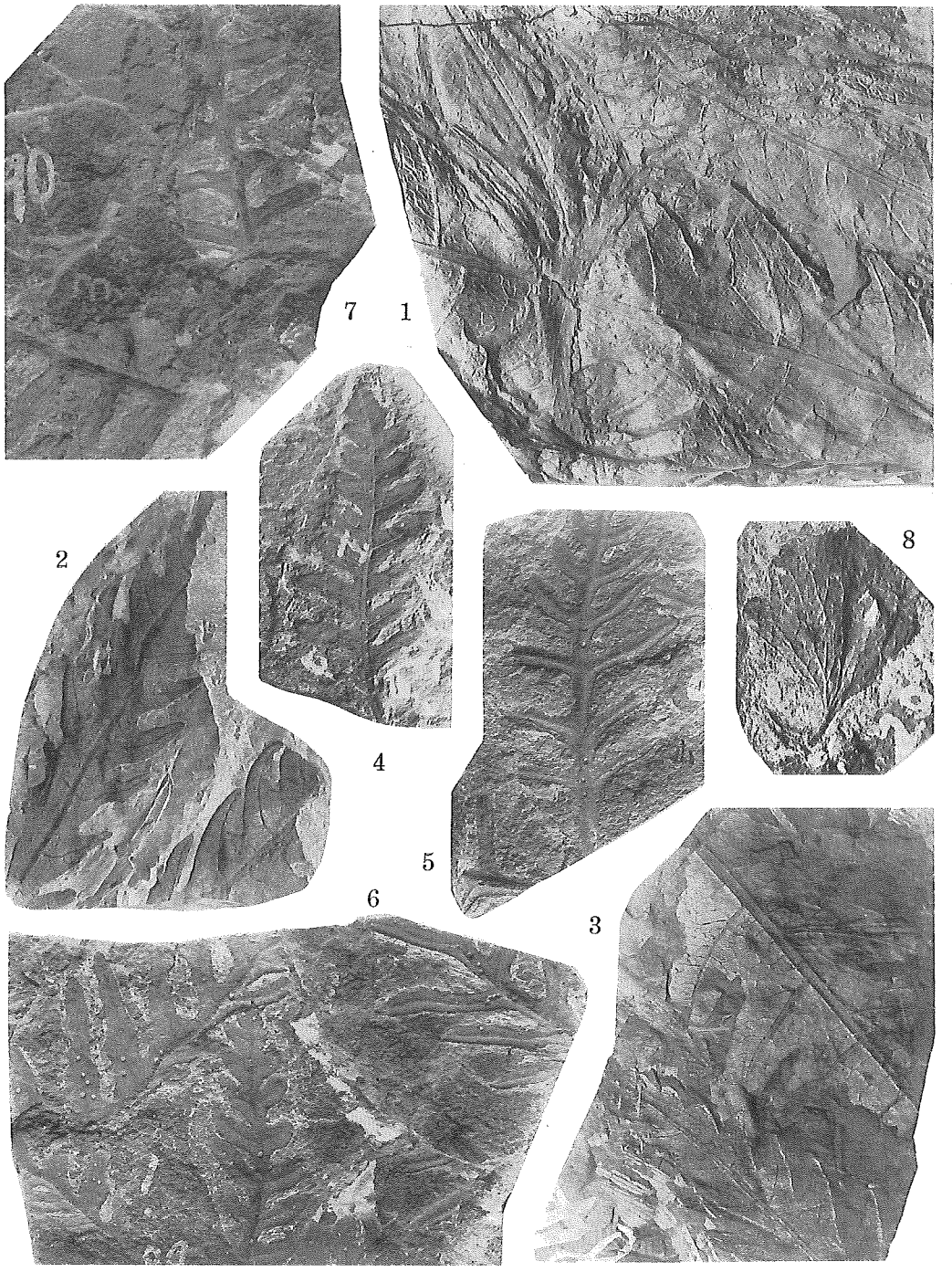
Plate XXXVII (XIX)

PLATE XXXVII (XIX).

Figs. 1–3. *Dictyophyllum muensteri* (GOEPPERT). Kamihina (Loc. No. 49). (3981).

Figs. 4–7. *Dictyophyllum muensteri* (GOEPPERT). Yamamoto (Loc. No. 63). (3908).

Fig. 8. *Hausmannia crenata* NATHORST. Eda (Loc. No. 1). (3966).



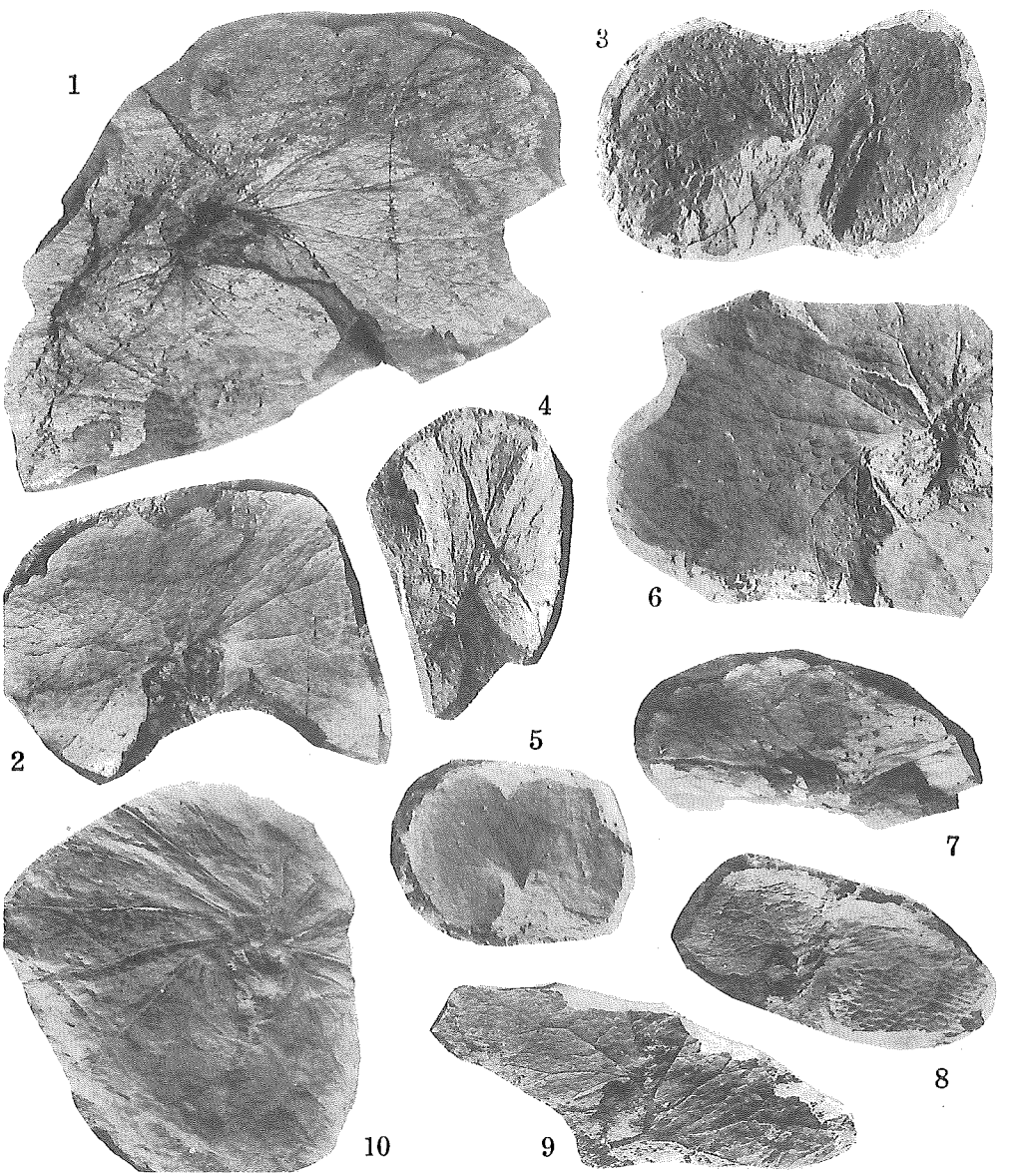
S. Ōishi: Rhaetic Plants from Nariwa.

Plate XXXVIII (XX)

PLATE XXXVIII (XX).

Figs. 1–4, 7–8, 10. *Hausmannia nariwaensis* ÔISHI. Eda (Loc. No. 1). (3956).

Figs. 5–6, 9. *Hausmannia nariwaensis* ÔISHI. Yamamoto (Loc. No. 63). (3909).



S. Ōishi: Rhaetic Plants from Nariwa.

Plate XXXIX (XXI)

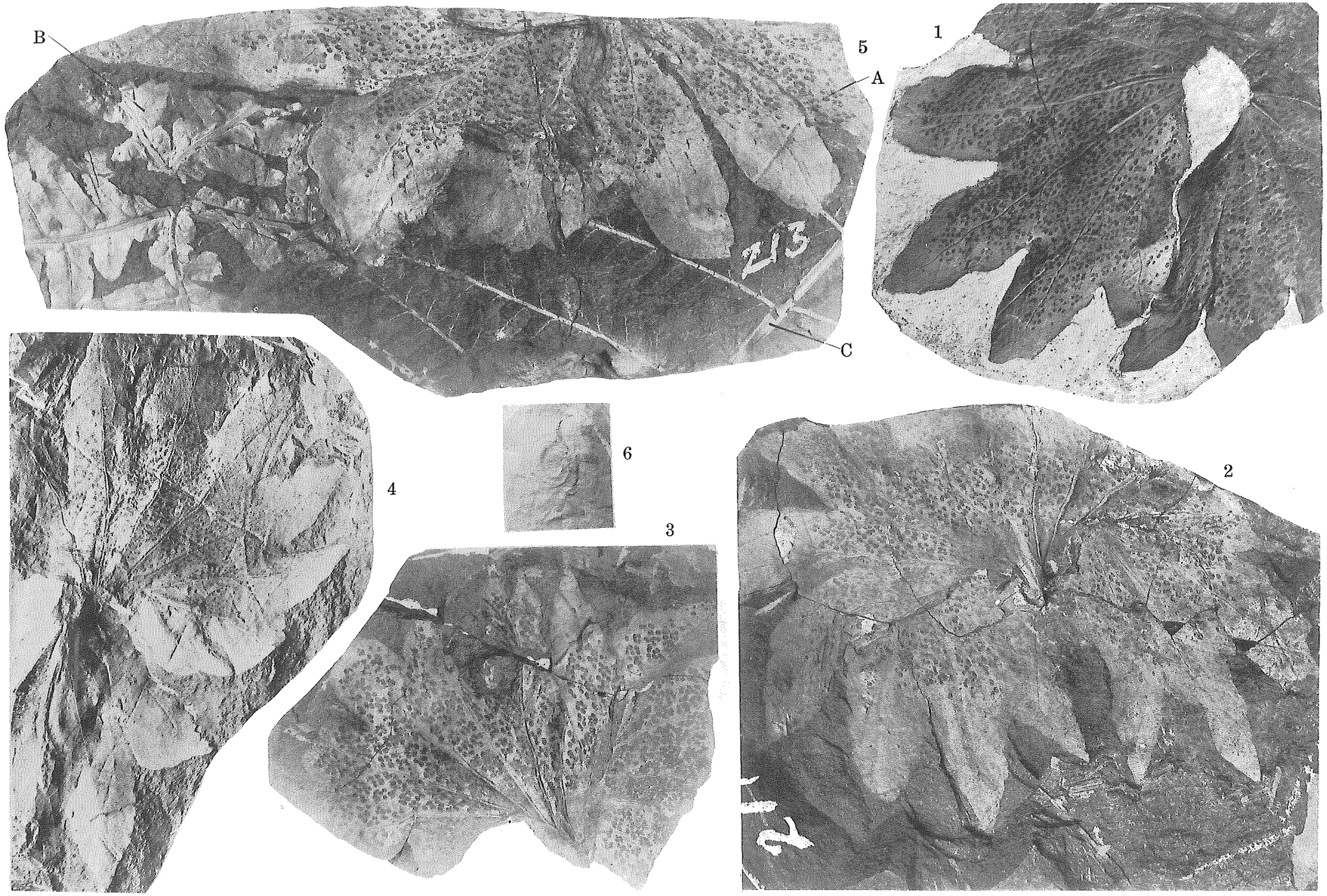
PLATE XXXIX (XXI).

Figs. 1–4, 5A. *Hausmannia dentata* sp. nov. Eda (Loc. No. 1). (3830; 3959; 3971; 3884; 3961).

Figs. 5B. *Thaumatopteris nipponica* sp. nov. Eda (Loc. No. 1). (3961).

Fig. 5C. *Cladophlebis nebbensis* (BRONGNIART). Eda (Loc. No. 1). (3961).

Fig. 6. *Spiropteris* sp. Kamihina (Loc. No. 49). (3996).



S. Ōishi : Rhaetic Plants from Nariwa.

Plate XL (XXII)

PLATE XL (XXII).

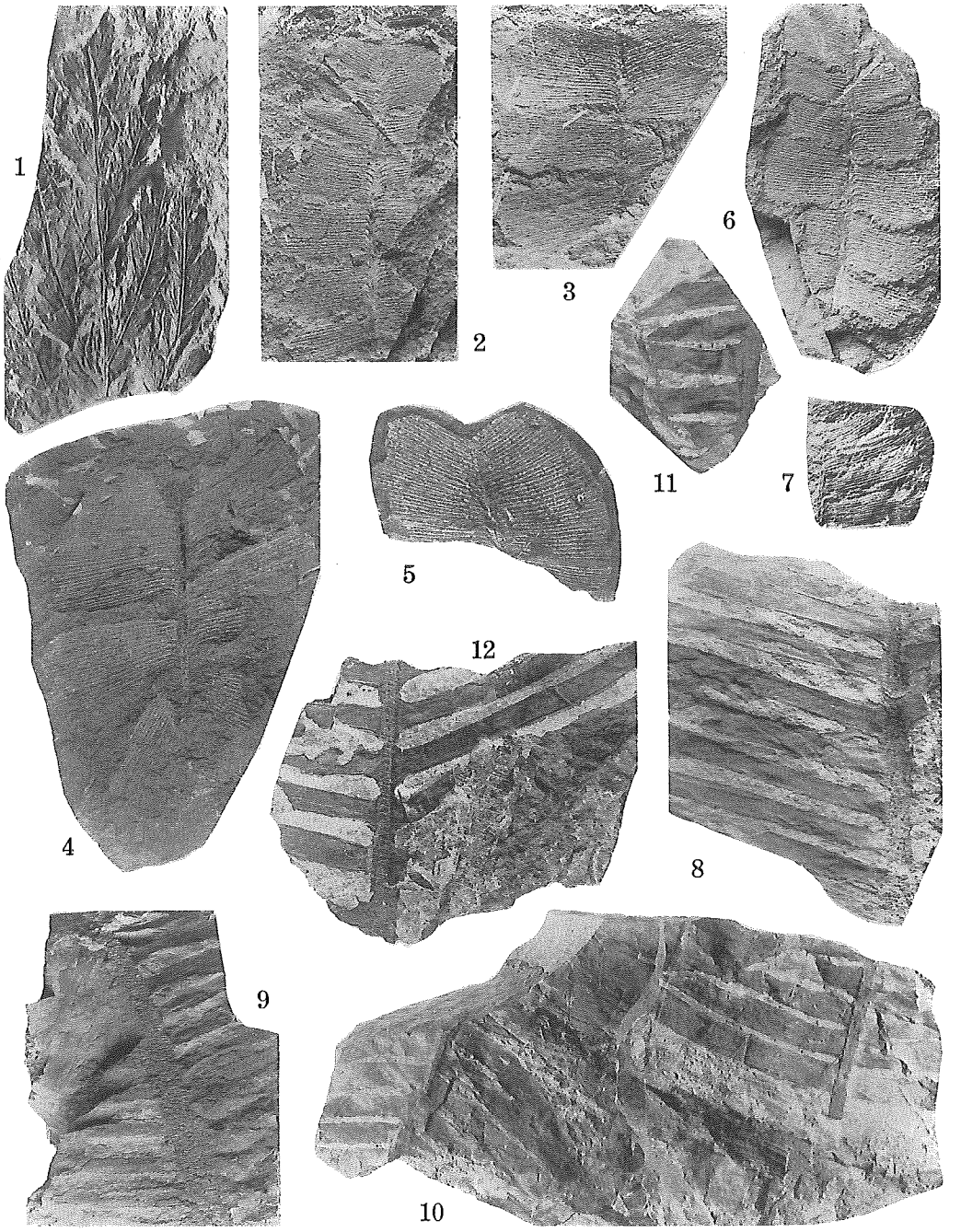
Fig. 1. *Sphenopteris gracilis* sp. nov. Hinabata (Loc. No. 44). (4130).

Figs. 2–6. *Pterophyllum schenki* (ZEILLER). Eda (Loc. No. 1). (3970; 3952).

Fig. 7. *Pterophyllum schenki* (ZEILLER). Jitô (Loc. No. 55). (4085).

Figs. 8–9, 12. *Pterophyllum jaegeri* BRONGNIART. Kamihina (Loc. No. 47). (4065).

Figs. 10–11. *Pterophyllum jaegeri* BRONGNIART. Hinabata (Loc. No. 44). (4129).



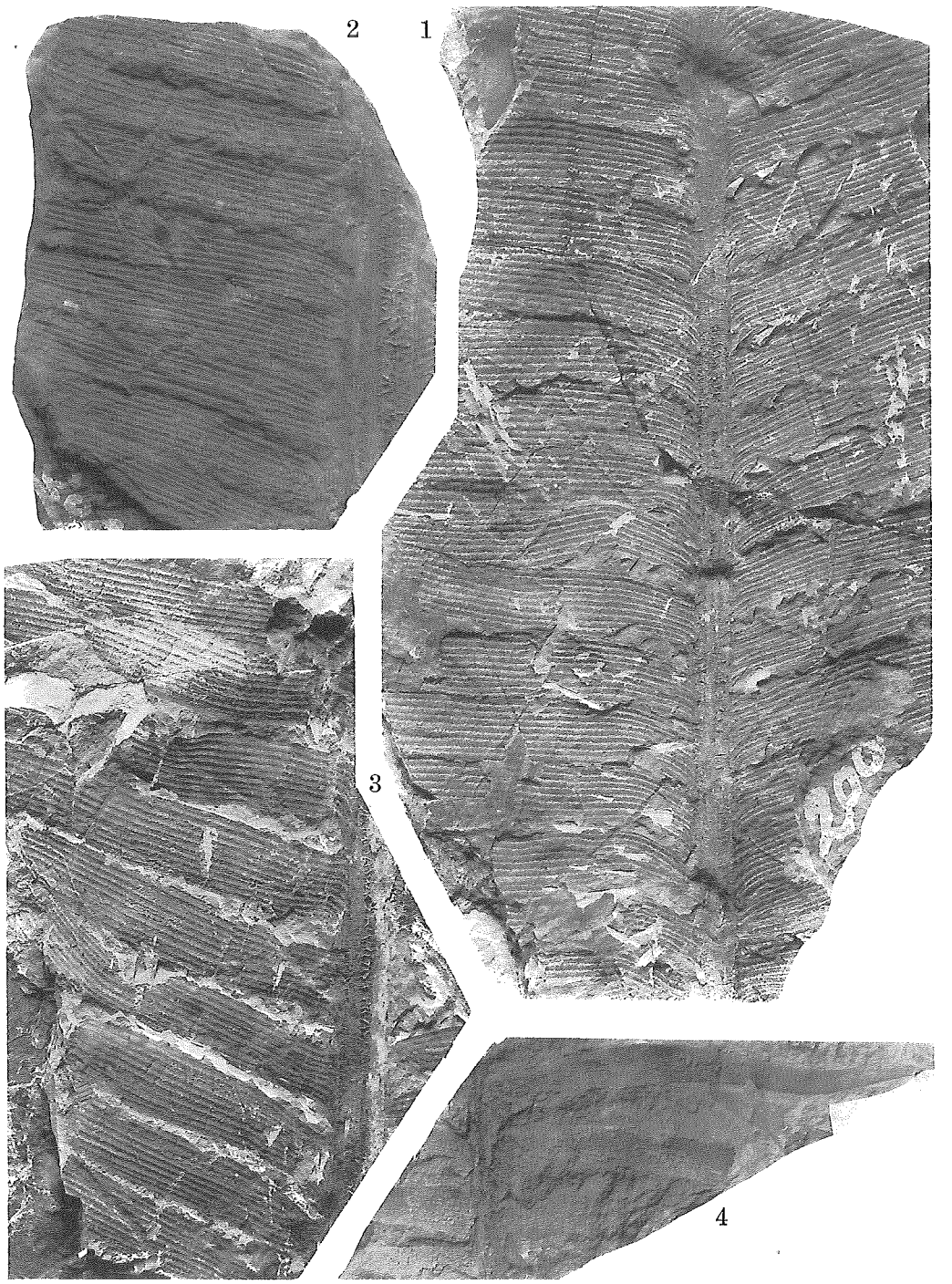
S. Ōishi: Rhaetic Plants from Nariwa.

Plate XLI (XXIII)

PLATE XLI (XXIII).

Figs. 1–3. *Pterophyllum ctenoides* sp. nov. Kamihina (Loc. No. 46). (4057).

Fig. 4. Cfr. *Pterophyllum distans* MORRIS. Nishihata (Loc. No. 62). (3916).



S. Ōishi: Rhaetic Plants from Nariwa.

Plate XLII (XXIV)

PLATE XLII (XXIV).

Fig. 1. *Pterophyllum ctenoides* sp. nov. Kamihina (Loc. No. 46). (4057).

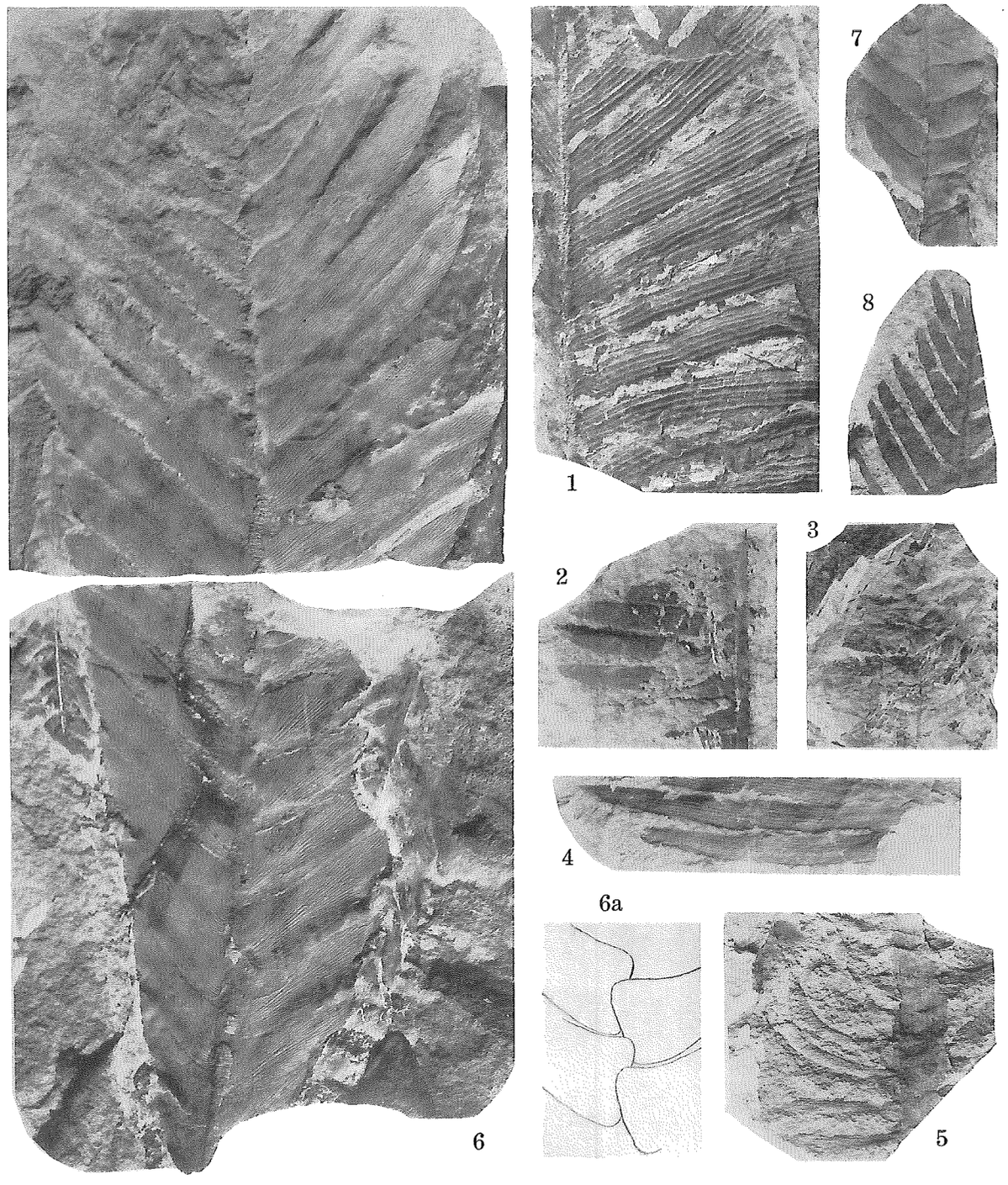
Figs. 2–4. *Pterophyllum* spp. Kamihina (Loc. No. 50). (4012; 4017).

Fig. 5. *Campylophyllum hörmanni* GOTHAN. Nishihata (Loc. No. 62). (3973).

Figs. 6, 6a. *Otozamites lancifolius* sp. nov. Kamihina (Loc. No. 47). (4063).

Fig. 7. *Otozamites indosinensis* ZEILLER. Kamihina (Loc. No. 47). (4060).

Fig. 8. *Otozamites* sp. Kamihina (Loc. No. 47). (4028).



S. Ōishi: Rhaetic Plants from Nariwa.

Plate XLIII (XXV)

PLATE XLIII (XXV).

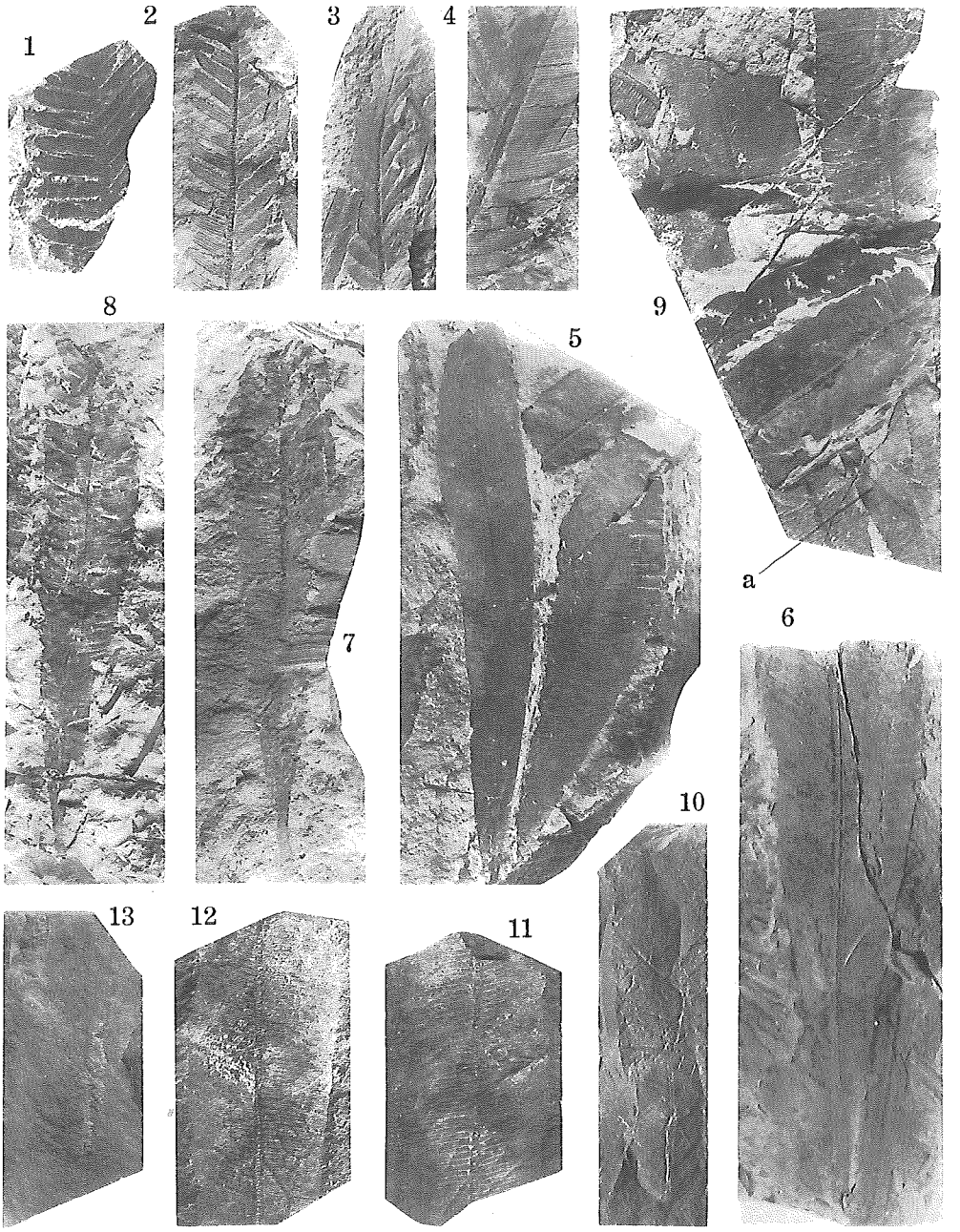
Figs. 1–3. *Ptilozamites tenuis* sp. nov. Kamihina (Loc. No. 50). (4018).

Fig. 4. *Ptilozamites nilssoni* NATHORST? Nishihata (Loc. No. 62). (3913).

Figs. 5–9. *Taeniopteris lanceolata* sp. nov. Kamihina (Loc. No. 50). (4008).

Fig. 10. *Taeniopteris* cfr. *stenophylla* KRYSHTOFOVICH. Koyagaichi (Loc. No. 58). (4053).

Figs. 11–13. *Taeniopteris nabaensis* sp. nov. Nabae (Loc. No. 21). (3894).



S. Ōishi: Rhaetic Plants from Nariwa.

Plate XLIV (XXVI)

PLATE XLIV (XXVI).

Fig. 1. *Taeniopteris* cfr. *carruthersi* TENISON-WOODS. Nabae (Loc. No. 21). (3891).

Fig. 2. *Taeniopteris* cfr. *carruthersi* TENISON-WOODS. Eda (Loc. No. 1). (3904).

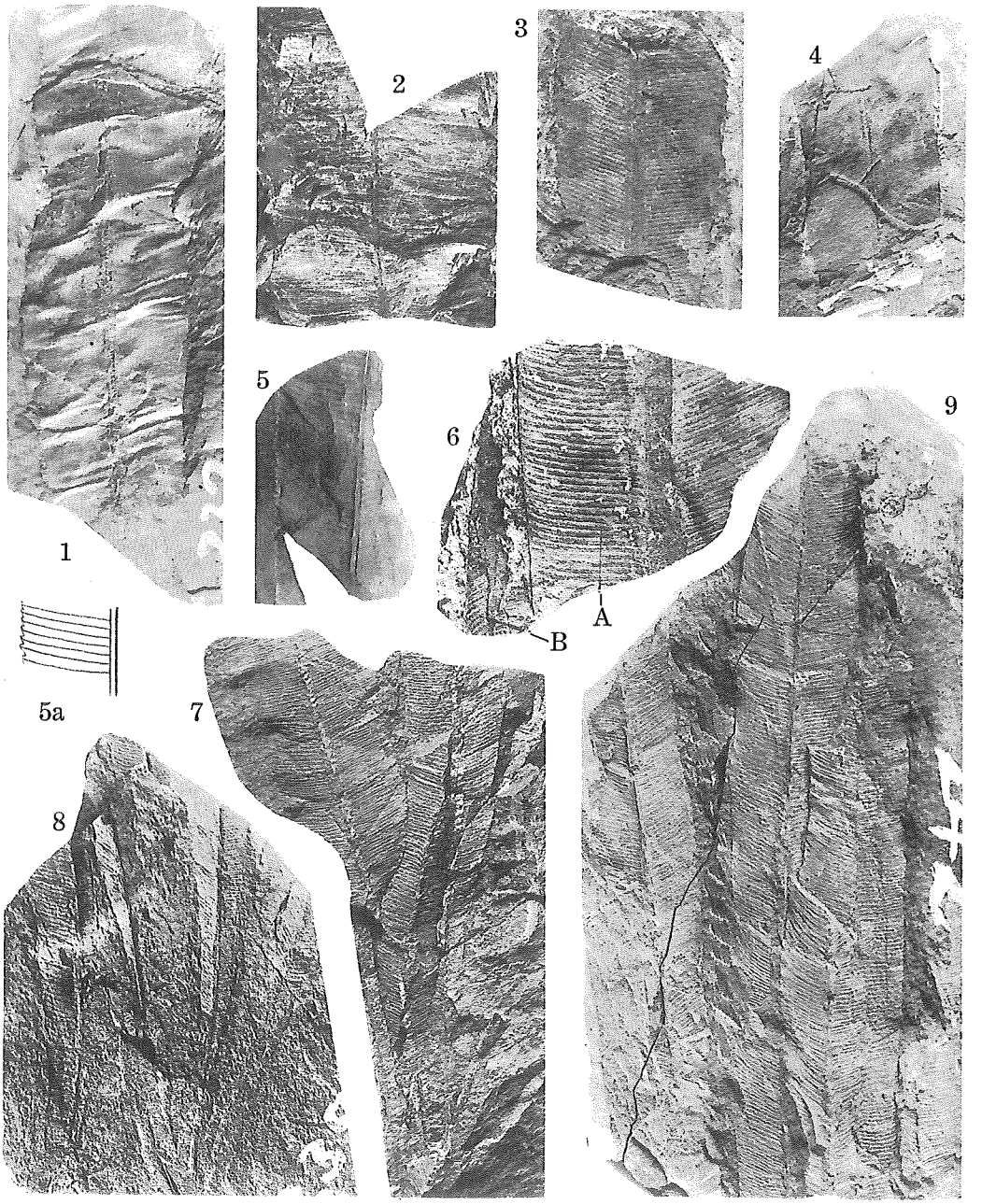
Figs. 3. *Taeniopteris* cfr. *leclerei* ZEILLER. Yamamoto (Loc. No. 64). (3912).

Fig. 4 *Taeniopteris* sp. Hinabata (Loc. No. 44). (4138).

Figs. 5, 5a. *Taeniopteris*? sp. Kamihina (Loc. No. 49). (3983).

Figs. 6A-B. *Taeniopteris*? sp. nov. Hata (Loc. No. 65). (4076).

Figs. 7–9. *Nilssonia simplex* sp. nov. Eda (Loc. No. 1). (3954; 3955).



S. Ōishi: Rhaetic Plants from Nariwa.

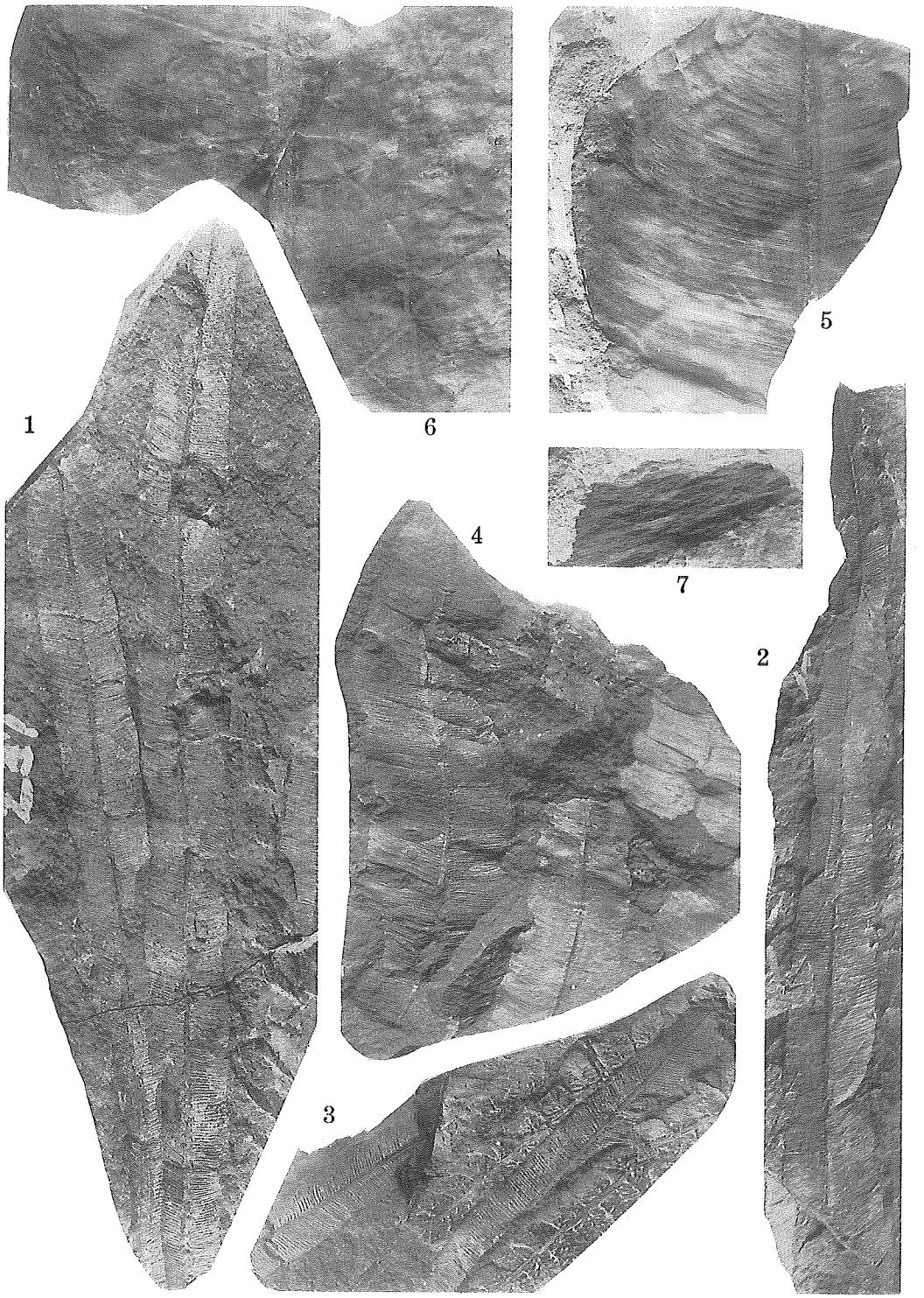
Plate XLV (XXVII)

PLATE XLV (XXVII).

Figs. 1–4. *Nilssonia simplex* sp. nov. Eda (Loc. No. 1). (3949; 3954; 3955).

Figs. 5–6. *Nilssonia orientalis* (HEER). Hinabata (Loc. No. 44). (4135).

Fig. 7. *Nilssonia*? gen. et sp. indet. Kamihina (Loc. No. 49). (4029).



S. Ōishi: Rhaetic Plants from Nariwa.

Plate XLVI (XXVIII)

PLATE XLVI (XXVIII).

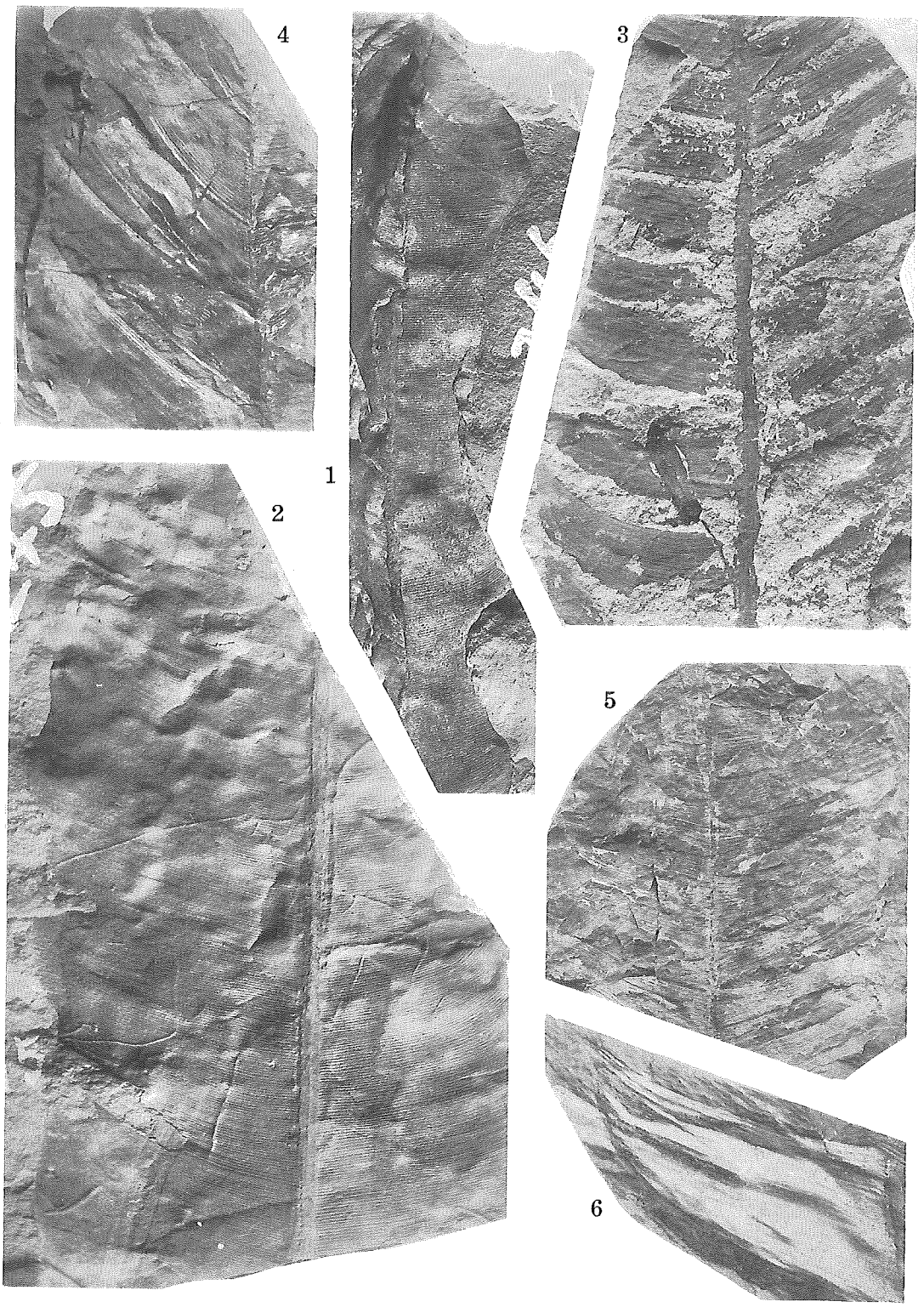
Figs. 1–2. *Nilssonia orientalis* (HEER). Hinabata (Loc. No. 44). (4135).

Fig. 3. *Nilssonia acuminata* (PRESL). Hinabata (Loc. No. 66). (4074).

Fig. 4. *Nilssonia acuminata* (PRESL). Nabae (Loc. No. 21). (3895).

Fig. 5. *Nilssonia muensteri* (PRESL). Kamihina (Loc. No. 49). (3998).

Fig. 6. *Nilssonia* sp. Nabae (Loc. No. 21). (3891).



S. Ōishi: Rhaetic Plants from Nariwa.

Plate XLVII (XXIX)

PLATE XLVII (XXIX).

Fig. 1. *Nilssonia muensteri* (PRESL). Kamihina (Loc. No. 49). (3998).

Fig. 2. *Nilssonia muensteri* (PRESL). Eda (Loc. No. 33). (3922).

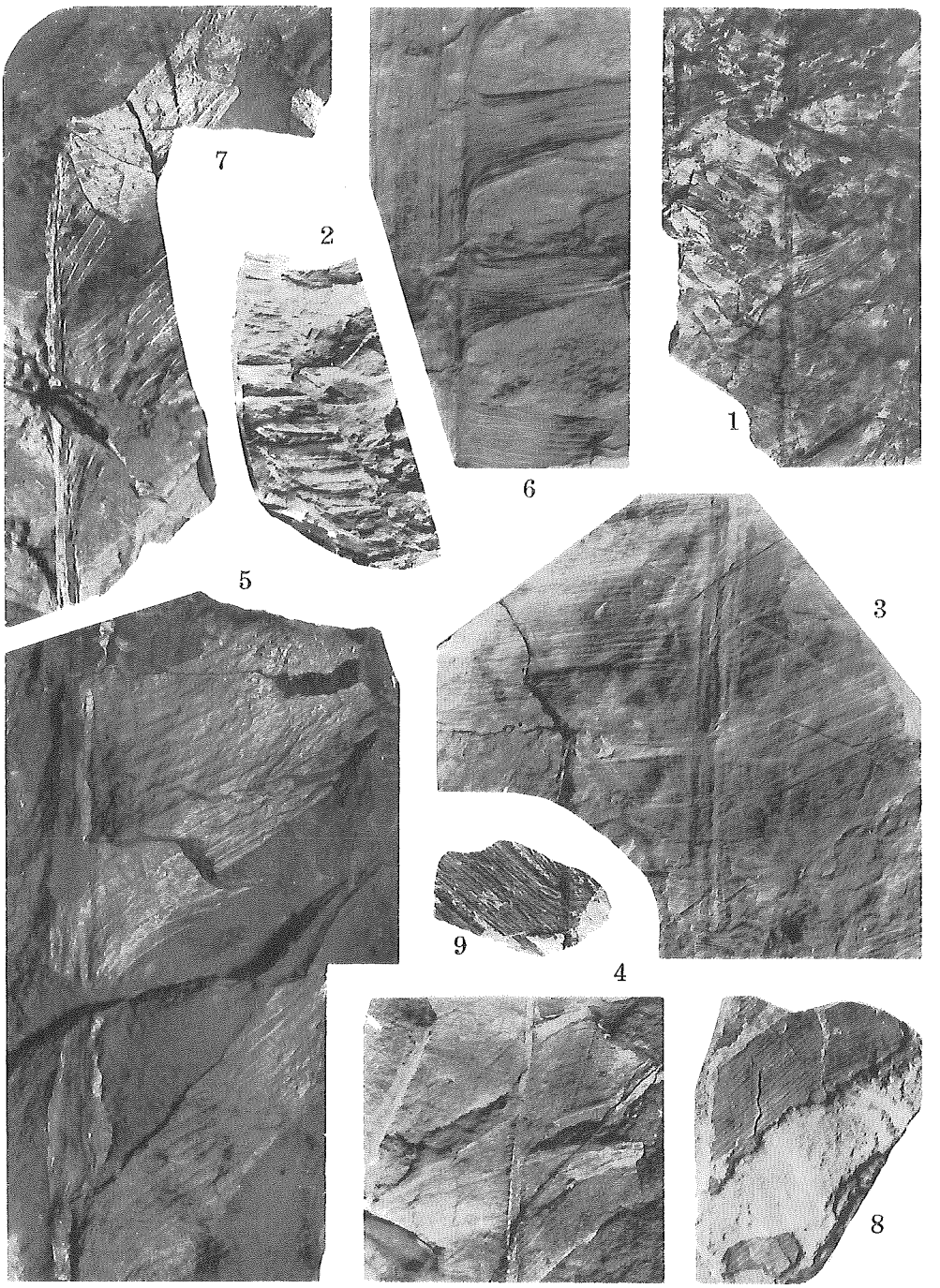
Fig. 3. *Nilssonia* sp. Nabae (Loc. No. 21). (3890).

Fig. 4. *Nilssonia*? gen. et sp. indet. Eda (Loc. No. 1). (3888).

Figs. 5, 7. *Ctenis japonica* sp. nov. Nabae (Loc. No. 21). (3896; 3906).

Fig. 6. *Ctenis japonica* sp. nov. Hayama (Loc. No. 30). (4001).

Figs. 8–9. *Ctenis*? sp. Kamihina (Loc. No. 50). (4016).



S. Ōishi: Rhaetic Plants from Nariwa.

Plate XLVIII (XXX)

PLATE XLVIII (XXX).

Ctenis japonica sp. nov. Nabae (Loc. No. 21). (3897).

S. Ōishi : Rhaetic Plants from Nariwa.

Plate XLIX (XXXI)

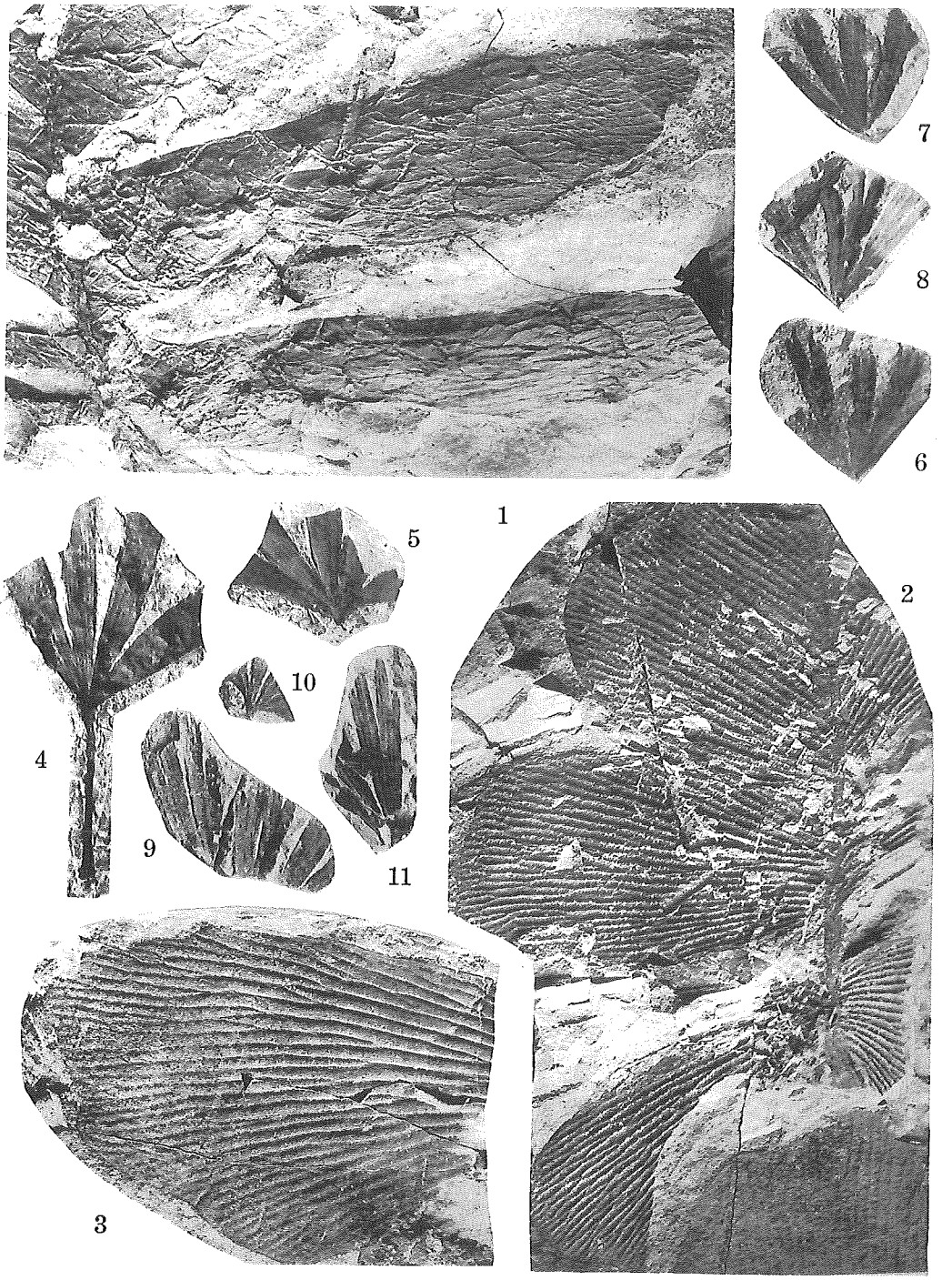
PLATE XLIX (XXXI).

Fig. 1. *Ctenis japonica* sp. nov. Hayama (Loc. No. 30). (4001).

Figs. 2–3. *Ctenis yabei* sp. nov. Kamihina (Loc. No. 50). (4019).

Figs. 4–5. *Ginkgoites sibirica* (HEER). Hinabata (Loc. No. 44). (4134).

Figs. 6–11. *Baiera elegans* sp. nov. Kamihina (Loc. No. 50). (4010).



S. Ōishi: Rhaetic Plants from Nariwa.

Plate L (XXXII)

PLATE L (XXXII).

Fig. 1. *Baiera muensteriana* (PRESL). Eda (Loc. No. 1). (3964).

Figs. 2A, 3. *Baiera furcata* HEER. Kamihina (Loc. No. 47). (4027; 4025).

Fig. 2B. *Otozamites* sp. Kamihina (Loc. No. 47). (4027).

Fig. 4. *Baiera filiformis* sp. nov. Eda (Loc. No. 33). (3901).

Fig. 5. *Baiera taeniata* F. W. BRAUN. Hinabata (Loc. No. 66). (4070).

Fig. 6. *Baiera paucipartita* NATHORST. Hinabata (Loc. No. 44). (4132).

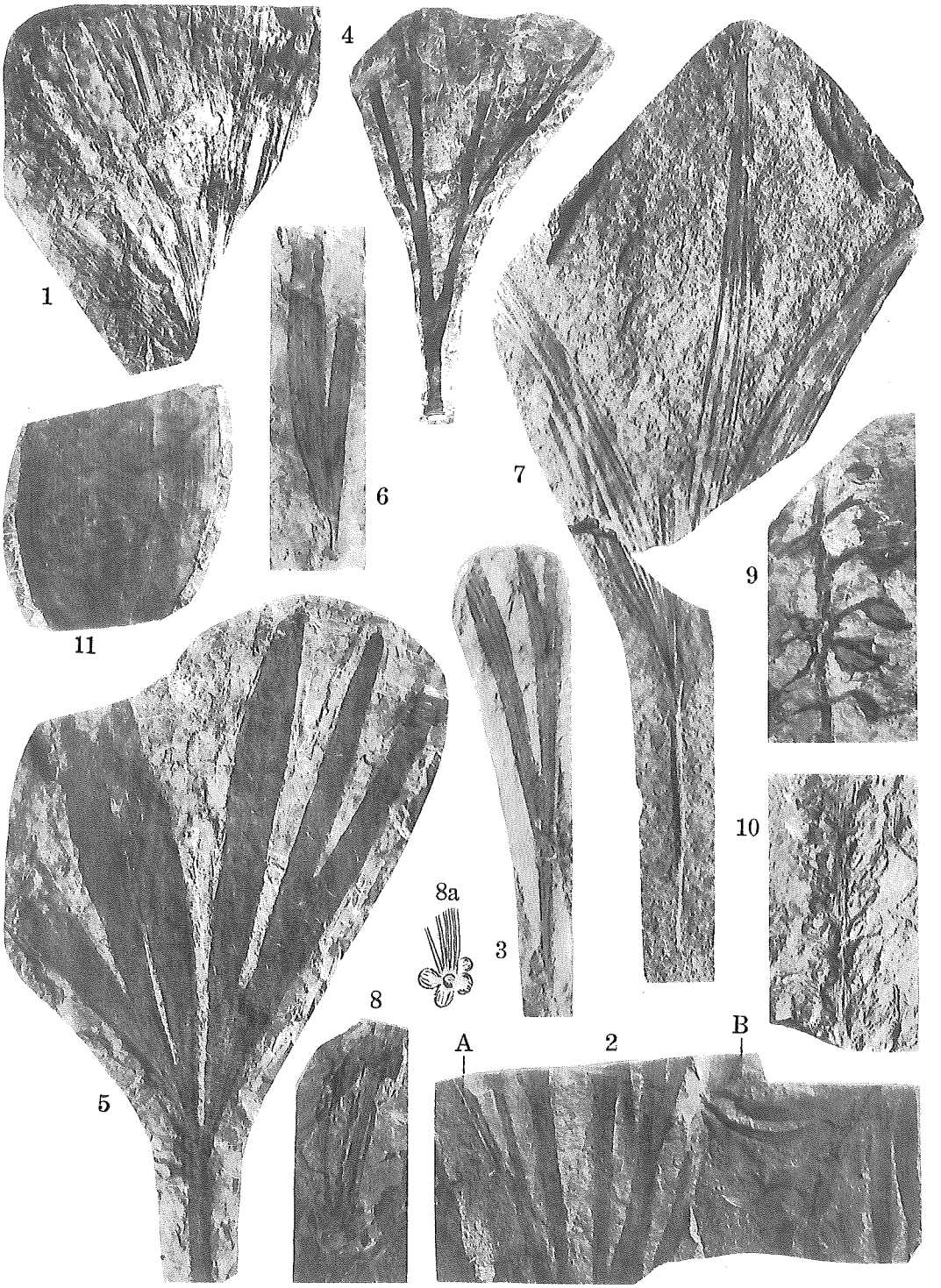
Fig. 7. *Baiera* sp. Suimyô (Loc. No. 69). (4068).

Figs. 8, 8a. *Czekanowskia rigida* HEER. Kamihina (Loc. No. 48). (4146).

Fig. 9. *Stenorachis bitchuensis* sp. nov. Kamihina (Loc. No. 46). (4147).

Fig. 10. *Stenorachis elegans* sp. nov. Yamamoto (Loc. No. 63). (3910).

Fig. 11. *Podozamites* sp. Hayama (Loc. No. 30). (4024).



S. Ōishi: Rhaetic Plants from Nariwa.

Plate LI (XXXIII)

PLATE LI (XXXIII).

Fig. 1. *Phoenicopsis* sp. Kamihina (Loc. No. 49).

Fig. 2. *Phoenicopsis* sp. Kamihina (Loc. No. 50). (4015).

Figs. 3–4. *Pityophyllum* (*Pityocladus*) *longifolium* (NATHORST). Kamihina (Loc. No. 50). (4013; 4014).

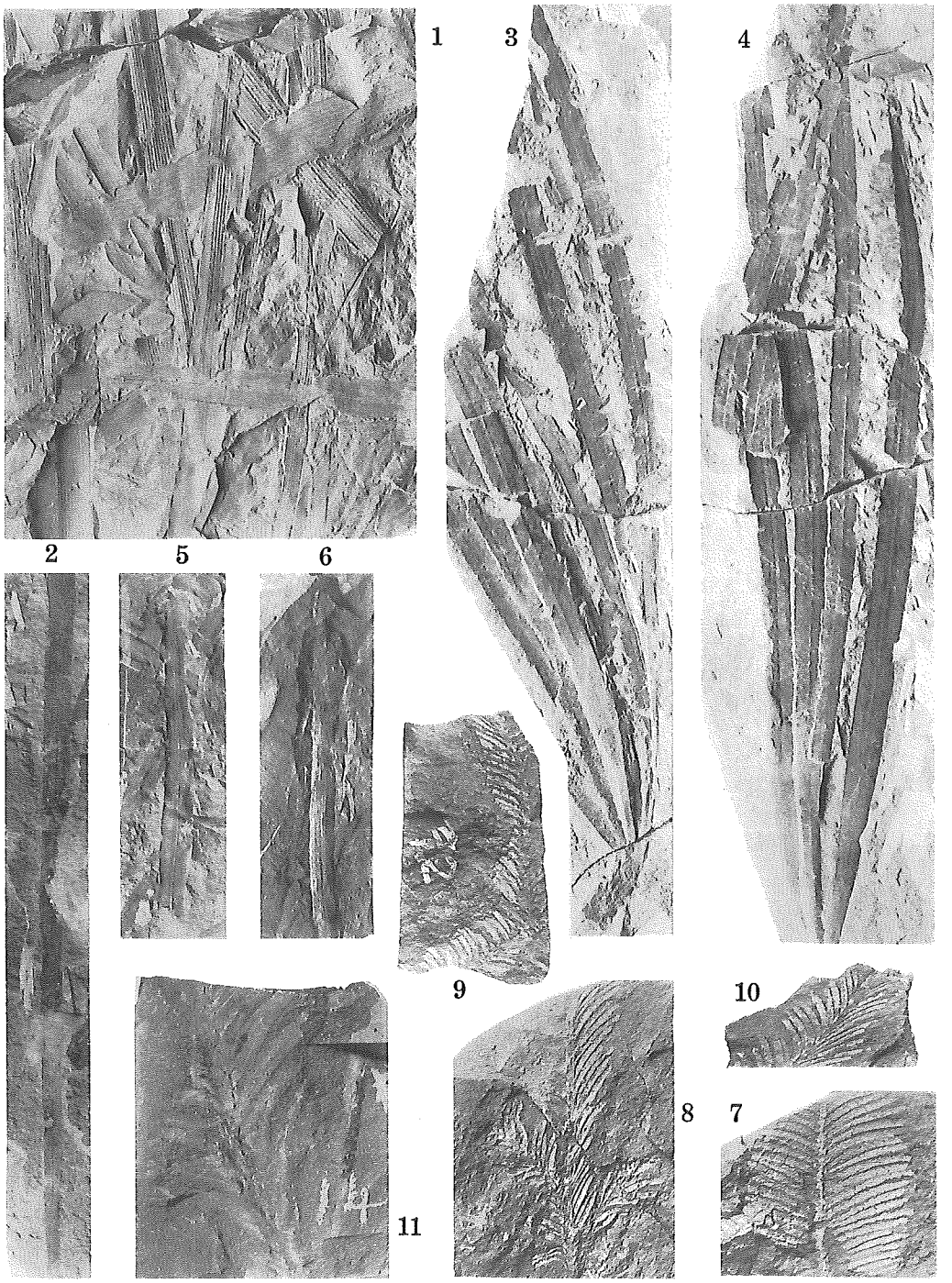
Fig. 5. *Pityophyllum longifolium* (NATHORST). Suimyô (Loc. No. 69). (4104).

Fig. 6. *Pityophyllum longifolium* (NATHORST). Eda (Loc. No. 1). (3883).

Fig. 7. *Elatocladus plana* (FEISTMANTEL). Eda (Loc. No. 1). (3903).

Figs. 8–10. *Elatocladus tennerima* (FEISTMANTEL). Eda (Loc. No. 1). (3881).

Fig. 11. *Elatocladus* sp. Eda (Loc. No. 1). (3968).



S. Ōishi : Rhaetic Plants from Nariwa.

Plate LII (XXXIV)

PLATE LII (XXXIV).

Figs. 1–2. *Nageiopsis rhaetica* sp. nov. Eda (Loc. No. 1). (3928; 3880).

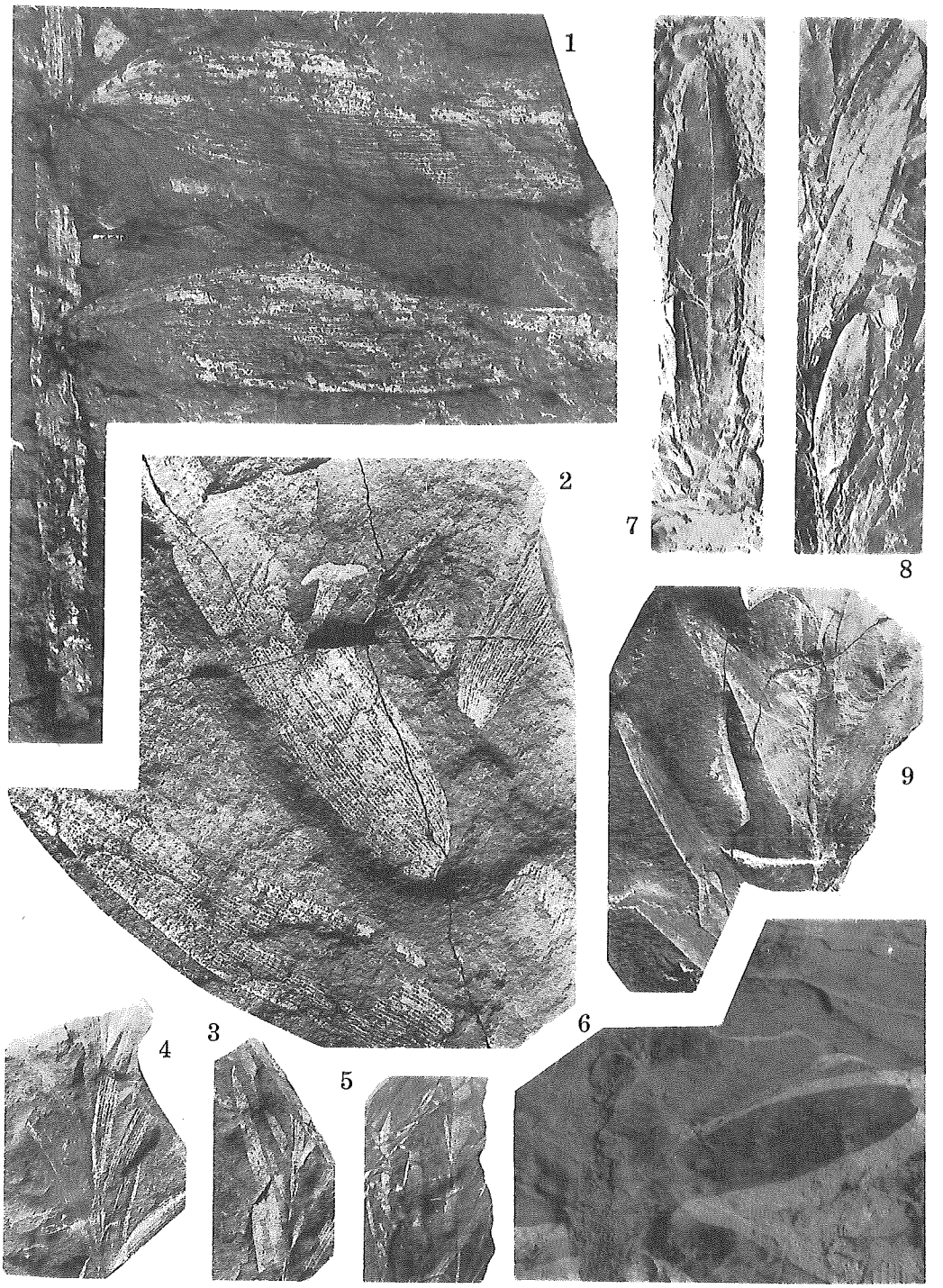
Figs. 3–4. *Podozamites schenki* HEER. Eda (Loc. No. 1). (3887).

Fig. 5. *Podozamites schenki* HEER. Shirochi (Loc. No. 10). (4071).

Figs. 6–7. *Podozamites lanceolatus* (L. and H.). Kamihina (Loc. No. 46). (4026; 4056).

Fig. 8. *Podozamites lanceolatus* (L. and H.). Eda (Loc. No. 1). (3892).

Fig. 9. *Podozamites lanceolatus* (L. and H.). Kamihina (Loc. No. 48). (4088).



S. Ōishi: Rhaetic Plants from Nariwa.

Plate LIII (XXXV)

PLATE LIII (XXXV).

Fig. 1. *Dipteris conjugata* from Formosa. From Journ. Jap. Botany, Vol. V, No. 7, 1928.

Fig. 2. *Hausmannia dentata* sp. nov. A sorus. ×34.

Fig. 3. *Hausmannia dentata* sp. nov. A sporangium. ×85.

Fig. 4. Cfr. *Thaumatopteris brauniana* POPP. Hinabata (Loc. No. 68). (4077).

Fig. 5. *Baiera guilhaumati* ZEILLER? Eda (Loc. No. 33). (3900).

Fig. 6. Problematicum. Yamamoto (Loc. No. 63). (3911).

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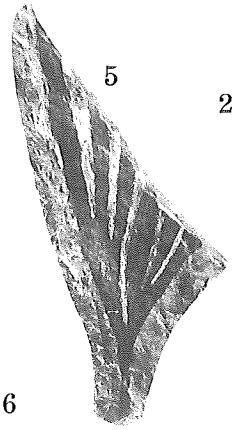

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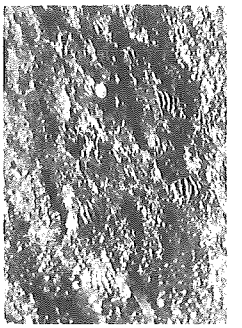

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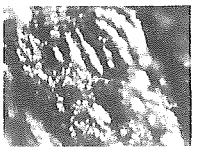

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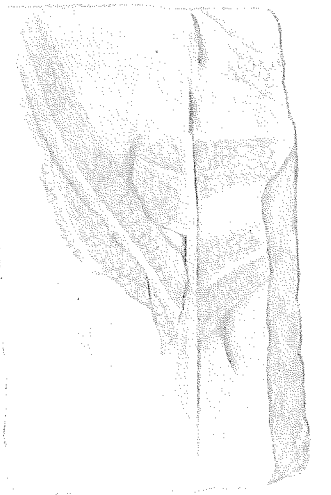

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S. Ōishi: Rhaetic Plants from Nariwa.