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Title	Rhaetic Plants from Province Nagato (Yamaguchi Prefecture), Japan
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Citation	Journal of the Faculty of Science, Hokkaido Imperial University. Ser. 4, Geology and mineralogy, 2(1), 51-68
Issue Date	1932-11
Doc URL	https://hdl.handle.net/2115/35748
Type	departmental bulletin paper
File Information	2(1)_51-68.pdf



RHAETIC PLANTS FROM PROVINCE NAGATO (YAMAGUCHI PREFECTURE), JAPAN

By
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With 2 Plates and 1 Text-figure.

The fossil plants dealt with in this paper were collected by the present writer in the summer of 1931, and augmented by some additional material obtained at the occasion of his second visit in the spring of 1932 leading a geological excursion of the students of the Department of Geology and Mineralogy, Hokkaidô Imperial University.

The Rhaetic plant-bearing rocks in Province Nagato are developed in two separate areas, the one the south-western part of Asa⁽¹⁾ along the Sanyô Line, occupying an area of about 25 square kilometers, and the other the central part of this province (Ômine⁽²⁾ coal-field and its surrounding area) occupying about 64 square kilometers. The complex consists mainly of shales, sandstones and conglomerates in alternation, containing some anthracite seams in certain horizons, and, according to Y. OZAWA, overlies unconformably inverted Palaeozoic limestones.

The fossil localities are Yamanoi⁽³⁾ (Loc. No. 1, 3, 13 and 15); Kusaigawa⁽⁴⁾; Momonoki⁽⁵⁾; Ojigase⁽⁶⁾; and Michiichi⁽⁷⁾. Of these, Ojigase yielded only a single specimen of *Cycadocarpidium swabii* NATHORST described by Y. OZAWA⁽⁸⁾. The fossil plants from Michiichi are entirely of Mr. T. KOBAYASHI's collection; they are, however, mostly fragmentary and unsatisfactorily preserved. The greater number of species described in this paper are derived from Kusaigawa and Yamanoi, but the preservation is not very satisfactory.

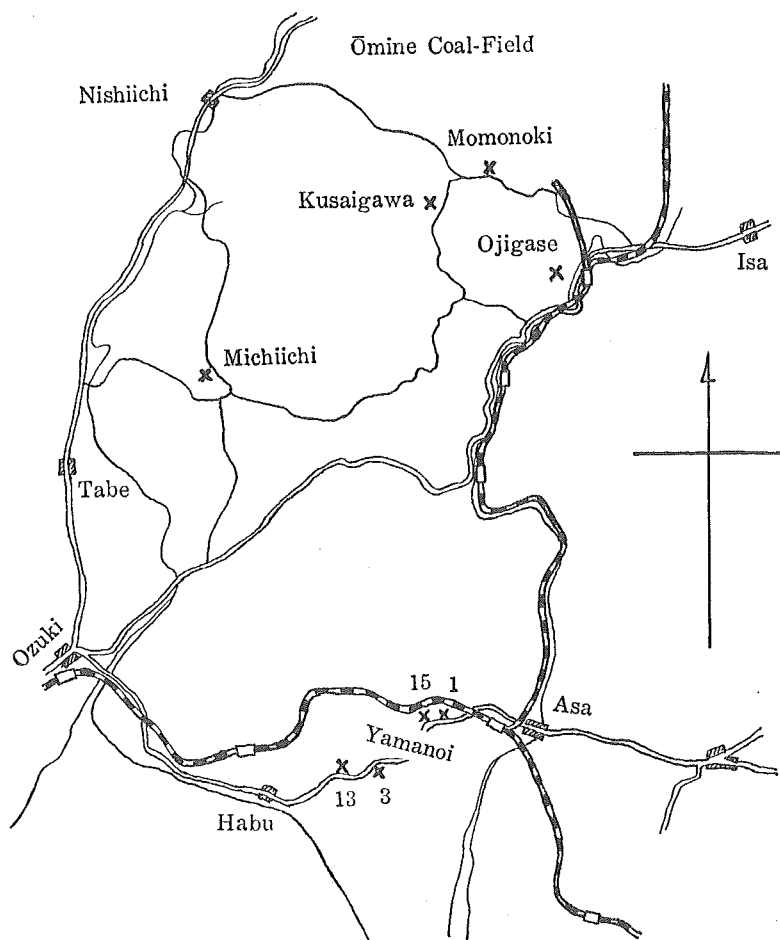
Dr. M. YOKOYAMA⁽⁹⁾ was the only one who has described fossil

(1) 厚狹. (2) 大嶺. (3) 山野井. (4) 草井川. (5) 桃ノ木.

(6) 祖父ヶ瀬. (7) 道市.

(8) Y. OZAWA: Palaeontological and Stratigraphical Studies on the Permo-Carboniferous Limestone of Nagato. Pt. II. Palaeontology. Journ. Coll. Sci., Imp. Univ. Tôkyô, Vol. XLV, Art. 6, 1925, p. 6, Pl. I, fig. 10.

(9) M. YOKOYAMA: On Some Fossil Plants from the Coal-bearing Series of Nagato. Ibid., Vol. IV, Art. 2, 1891. Mesozoic Plants from Nagato and Bitchû. Ibid., Vol. XX, Art. 5, 1905.



Text-Fig. 1. Map of a part of Prov. Nagato (Yamaguchi Prefecture) showing the approximate position of the localities of the Rhaetic plants described in this paper. 1/50,000.

plants from this province, though several geologists⁽¹⁾ have undertaken the geological and stratigraphical survey of this district. He dealt with some plant remains derived from Yamanoi collected by Dr. K. INOUE, Dr. T. KOCHIBE and by himself, and discriminated them as follows:

(1) K. INOUE: On the Mesozoic Formation in the Southern Part of Nagato. Journ. Geol. Soc. Tôkyô (Geol. Magazine), Vol. III, No. 35, 1896. T. SUZUKI: Explanatory Text to the Geological Map in 1/200,000; sheet Yamaguchi, 1907. T. OGURA: Explanatory Text to the Geological Map in 1/75,000; sheet Yamaguchi, 1923 (sec. edit. 1927). T. KOBAYASHI: Note on the Mesozoic Formations in Prov. Nagato, Chûgoku, Japan. Journ. Geol. Soc. Tôkyô, Vol. XXXIII, No. 398, 1926.

Cladophlebis nebbensis (BRONGN.)
C. yamanoiensis YOKOYAMA
Dictyophyllum japonicum YOKOYAMA
D. nathorsti ZEILLER
D. kochibei YOKOYAMA
Nilssonina inouyei YOKOYAMA
Baiera paucipartita NATHORST
Podozamites lanceolatus (L. and H.)

Of these *C. yamanoiensis* is, as Prof. H. YABE⁽¹⁾ mentioned, hardly distinguishable from *C. haiburnensis* (L. and H.).

Mr. T. KOBAYASHI⁽²⁾ who undertook the stratigraphical study of this district named the Upper Triassic coal-bearing formation developed at the Ômine coal-field "The Miné Formation" and subdivided it into two parts, namely, the upper and the lower. To this upper part corresponds the plant-bed of Michiichi mentioned above and to the lower the plant-beds of Kusaigawa, Momonoki and Ojigase. The plant-bed of Yamanoi is correlated by Mr. KOBAYASHI to this upper part.

The fossil plants from the upper and the lower parts which Mr. KOBAYASHI enumerated are as follows:—

From the upper (Michiichi):

Cladophlebis denticulata (BRONGN.)
Dictyophyllum japonicum YOKOYAMA
Nilssonina inouyei YOKOYAMA
Podozamites distans (PRESL)

From the lower (Kusaigawa):

Neocalamites carrerei (ZEILLER)
Cladophlebis raciborskii ZEILLER
C. nebbensis (BRONGN.)
Nilssonina inouyei YOKOYAMA
Taeniopteris stenophylla KRYSHTOFOVICH
T. Mc'Clelandi (OLDH. and MORR.)
Podozamites distans (PRESL)

Of these, *C. denticulata* is too imperfect to be determined specifically; *C. raciborskii* is a *C. nebbensis*; and *Nilssonina inouyei* (from the lower), *T. stenophylla* and *T. Mc'Clelandi* represent a new form

(1) H. YABE: Notes on Some Mesozoic Plants from Japan, Korea and China. Sci. Rep. Tôhoku Imp. Univ., 2nd Ser., Vol. VII, No. 1, 1922, p. 17.

(2) T. KOBAYASHI: Op. cit.

which the present writer calls *Taeniopteris minensis* sp. nov. in this paper; *Podozamites distans* is very difficult to distinguish specifically from *P. lanceolatus*, and in this paper the *Podozamites*-shoots with leaves of *P. lanceolatus*-type and detached leaves with similar form are all included in *P. lanceolatus*.

The following list shows the species described in this paper, and at the same time is a complete list of species of fossil plants hitherto known from the Rhaetic rocks in Province Nagato.

Species	Localities				Yamanoi (Loc. No. 1)	" (Loc. No. 3)	" (Loc. No. 13)	" (Loc. No. 15)
	Kusaigawa	Momonoki	Ojigase	Michiichi				
1. <i>Equisetites</i> sp.							×	
2. <i>Phyllothea</i> sp.							×	
3. <i>Neocalamites carrerei</i> (ZEILLER)	×	×					×	×
4. <i>Cladophlebis haiburnensis</i> (L. and H.)	×					×		
5. <i>C. nebbensis</i> (BRONGN.)	×	×			×	×	×	
6. <i>Dictyophyllum nathorsti</i> ZEILLER ?						×		
7. <i>D. japonicum</i> YOKOYAMA				×		×	×	
8. <i>D. kochibei</i> YOKOYAMA						×		
9. <i>D.</i> sp. indet.		×					×	
10. <i>Taeniopteris minensis</i> sp. nov.	×	×						
11. Cfr. <i>T. nabaensis</i> ÔISHI								×
12. <i>T.</i> sp.	×							
13. <i>Pterophyllum</i> ? sp. indet.								×
14. <i>Nilssonina inouyei</i> YOKOYAMA				×		×		
15. <i>N.</i> sp.		×						
16. <i>Ginkgoites digitata</i> (BRONGN.) var. <i>huttoni</i> SEWARD	×							
17. <i>Baiera paucipartita</i> NATHORST					×	×		×
18. <i>Czekanowskia</i> ? sp.					×			
19. <i>Stenorachis elegans</i> ÔISHI	×							
20. <i>Pityophyllum longifolium</i> (NATHORST)	×	×			×			
21. <i>Podozamites lanceolatus</i> (L. and H.)	×	×		×	×	×	×	
22. <i>P. schenki</i> HEER	×							
23. <i>Cycadocarpidium swabii</i> NATHORST	×		×					

Dr. YOKOYAMA is certainly correct in referring the plant-bed of Yamanoi to the Rhaetic on the occurrence of some important Rhaetic elements such as *Cladophlebis nebbensis*, *Dictyophyllum nathorsti* and *Baiera paucipartita*. Additional material from the same locality supports well this view. The plant-beds of Kusaigawa and Momonoki are believed to fall nearly in the same horizon; they are characterised by the occurrence of the following important species which indicate the Rhaetic age of the beds, namely, *Neocalamites carrerei*, Cfr. *Taeniopteris nabaensis* (closely allied to *T. nabaensis* from the Rhaetic of Nariwa), *Stenorachis elegans* and *Podozamites schenki*. Ojigase has never yielded more than a single specimen of *Cycadocarpidium swabii*, but the occurrence is very important as it is the characteristic species hitherto known only from the Rhaetic. The plant-bed of Michiichi may correspond to that of Yamanoi, both having important species in common, namely, *Dictyophyllum japonicum* and *Nilssonia inouyei*.

From the fact mentioned above, there is little doubt about that the flora of the "Miné formation" corresponds as a whole to that of the Rhaetic of the world.

Lastly the species common with the Rhaetic Nariwa flora⁽¹⁾ may be listed below:

Neocalamites carrerei (ZEILLER.)
Cladophlebis haiburnensis (L. and H.)
C. nebbensis (BRONGN.)
Taeniopteris nabaensis ÔISHI
Baiera paucipartita NATHORST
Stenorachis elegans ÔISHI
Pityophyllum longifolium (NATHORST)
Podozamites lanceolatus (L. and H.)
P. schenki HEER

DESCRIPTION OF THE SPECIES

1. *Equisetites* sp.

A fragmentary specimen from a nodal region, more than 1.5 cm. broad, with internodes more than 2 cm. long. Specifically not determinable.

Locality: Yamanoi (Loc. No. 13).

(1) S. ÔISHI: The Rhaetic Plants from the Nariwa District, Prov. Bitchû (Okayama Prefecture), Japan. This Journal, Vol. I, Nos. 3-4, 1932.

2. *Phyllothea* sp.

Pl. IX (I), Fig. 1.

A fragmentary specimen of a leaf-sheath. The leaves which are fused basally into an open cup-like sheath are dissected into more than five spreading and incurved linear segments more than 2.5 cm. long and 1 mm. broad. Their very apices are not known. The whole number of the free parts of the leaves may be approximately 10.

Locality: Yamanoi (Loc. No. 13).

3. *Neocalamites carrerei* (ZEILLER)

1932. *Neocalamites carrerei* ÔISHI: The Rhaetic Plants from the Nariwa District, Prov. Bitchû (Okayama Prefecture), Japan. L. c., p. 269, Pl. XXI (III), figs. 1-4; XXII (IV), figs. 1-2.

Several specimens are examined. They agree closely with the specimens profusely illustrated by ZEILLER from Tonkin and by the present writer from the Nariwa bed, Okayama Prefecture.

Localities: Kusaigawa; Momonoki; and Yamanoi (Loc. No. 13 and 15).

4. *Cladophlebis haiburnensis* L. and H.

1891. *Asplenium roesserti* YOKOYAMA (non PRESL): On Some Fossil Plants from the Coal-bearing Series of Nagato. L. c., p. 241, Pl. XXXII, figs. 3, 3a, 4 (non Pl. XXXII, figs. 1, 2, 5; Pl. XXXIV. fig. 2).
1905. *Cladophlebis yamanoiensis* YOKOYAMA: Mesozoic Plants from Nagato and Bitchû. L. c., p. 4.
1922. *Cladophlebis haiburnensis* YABE: Notes on Some Mesozoic Plants from Japan, Korea and China. L. c., p. 16, Pl. II, figs. 9-10, ? 11; Text-figs. 12-16.
1932. *Cladophlebis haiburnensis* ÔISHI: The Rhætic Plants from the Nariwa District. L. c., p. 281, Pl. XXIV (VI), figs. 1-3; Pl. XXVI (VIII), figs. 1-2.

Numerous typical specimens are examined. *Asplenium roesserti* figured by YOKOYAMA from Yamanoi which was later renamed *Cladophlebis yamanoiensis* by the same author is, as Prof. YABE has already pointed out, more safely referable to *C. haiburnensis*.

Localities: Kusaigawa; and Yamanoi (Loc. No. 3).

5. *Cladophlebis nebbensis* (BRONGN.)

1891. *Asplenium roesserti* YOKOYAMA: On Some Fossil Plants from the Coal-bearing Series of Nagato. L. c., p. 241, Pl. XXXII, figs. 1, 2, 5; Pl. XXXIV, fig. 2 (non Pl. XXXII, figs. 3, 3a, 4).
 1905. *Cladophlebis nebbensis* YOKOYAMA: Mesozoic Plants from Nagato and Bitchû. L. c., p. 3, Pl. I, figs. 1-3.
 1922. *Cladophlebis nebbensis* YABE: Notes on Some Mesozoic Plants from Japan, Korea and China. L. c., p. 14.
 1932. *Cladophlebis nebbensis* ÔISHI: The Rhætic Plants from the Nariwa District. L. c., p. 285, Pl. XXIV (VI), figs. 4-5; Pl. XXVII (IX); Pl. XXIX (XI), fig. 1; Pl. XXX (XII), fig. 1; Pl. XXXIX (XXI), fig. 5C.

Several specimens are examined, but they are rather fragmentary.

Localities: Kusaigawa; Momonoki; and Yamanoi (Loc. No. 1, 3, and 13).

6. *Dictyophyllum nathorsti* ZEILLER?

1891. *Dictyophyllum* cfr. *acutilobum* YOKOYAMA: On Some Fossil Plants from the Coal-bearing Series of Nagato. L. c., p. 242, Pl. XXXII, fig. 6.
 1905. *Dictyophyllum nathorsti* YOKOYAMA: Mesozoic Plants from Nagato and Bitchû. L. c., p. 6.
 1905. *Dictyophyllum japonicum* YOKOYAMA: Ibid., p. 5, Pl. II, fig. 3 (non YOKOYAMA, 1891).

In Japan, this species is represented by only a single fragmentary specimen of pinna figured by YOKOYAMA, who first identified it with *D. cf. acutilobum* BRAUN and later referred it to *D. nathorsti* ZEILLER. It is characterised by a coarsely toothed lamina, with teeth: triangular, obtusely pointed at apex and slightly inclined forwards, and with reticulate nervation. As the example is too fragmentary, it is only provisionally that it has been here referred to ZEILLER's species. A basal portion of pinnae from Yamanoi which YOKOYAMA⁽¹⁾ identified to *D. japonicum* may more safely be referable to *D. nathorsti* than to *D. japonicum*, the laminae of pinnae in ZEILLER's species being confluent laterally at the base instead of being free as in YOKOYAMA's.

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

Dictyophyllum nathorsti is one of the characteristic ferns in the Rhaetic beds of Tonkin⁽¹⁾, and it has been reported also from the Rhaetic (or Liassic) of Kamenka⁽²⁾.

Locality: Yamanoi (Loc. No. 3).

7. *Dictyophyllum japonicum* YOKOYAMA

Pl. IX (I), Figs. 2-3.

1891. *Dictyophyllum japonicum* YOKOYAMA: On Some Fossil Plants from the Coal-bearing Series of Nagato. L. c., p. 243, Pl. XXXIII.

This species is very common at Yamanoi (Loc. No. 3 and 13), but none of the specimens represent a complete frond. YOKOYAMA gave the following diagnosis on this species: "Pinnae linear-lanceolate, broadest near the middle, slightly tapering towards both ends, lobed except near the base where they are simply wavy or entire; lobes more or less inclined forward, triangular in shape, with the anterior margin straight or concave, with the posterior margin usually convex, and the apex obtusely pointed. Rhachis very strong, straight or somewhat curved, running to the apex of the pinnae; secondary veins, coarse, slightly crooked or zigzag, directed forward and going up at the apex of each lobe, thus forming its median vein; tertiary veins distinct, somewhat inclined anteriorly and dichotomizing, the branches forming by their union with those of the neighbouring ones coarse pentagonal or hexagonal nets, which are usually drawn out in the direction of the median vein; quarternary veins very fine, forming secondary nets within the primary ones."

It is quite beyond doubt that the specimens at hand are one and the same fern with those figured by YOKOYAMA from Yamanoi under the name *D. japonicum*. The most characteristic feature of this species is the gradual reduction of lamina of pinna proximally, and the pinna-rachis generally bears no lamina in its proximal portion. In view of this fact, a specimen of frond from Yamanoi which YOKOYAMA⁽³⁾ considered to be that of *D. japonicum* should be referred

(1) R. ZEILLER: Flore fossile des gîtes du charbon de Tonkin, p. 109, Pl. XXIII, fig. 1; Pl. XXIV, fig. 1; Pl. XXV, figs. 1-6; Pl. XXVII, fig. 1; Pl. XXVIII, fig. 3.

(2) H. H. THOMAS: The Jurassic Flora of Kamenka. Mém. Com. Géol. St.-Petersbourg, N. S., Liv. 71, p. 55, Pl. I, figs. 1-2.

(3) M. YOKOYAMA: Mesozoic Plants from Nagato and Bitchû. L. c., p. 5, Pl. II, fig. 3.

to some other species of this genus; the present writer believes that this specimen is a young frond of *D. nathorsti* ZEILLER.

So far as the isolated pinnae are concerned, *D. japonicum* closely resembles *Camptopteris spiralis* NATHORST as figured by NATHORST from Sweden in respect to the gradual reduction of lamina of pinnae towards the proximal end, and both seem to be specifically almost identical. But in the Japanese species the pinnae are broader than in NATHORST's species and moreover there is no reliable evidence whatever for referring the Japanese species to the genus *Camptopteris* which differs in habit of frond from the related genera, *Dictyophyllum* and *Clathropteris*. For these reasons, therefore, the present writer still wants tentatively to hold the Japanese species as a distinct species yet referring it to the genus *Dictyophyllum* rather than to the more or less narrowly delimited genus *Camptopteris*, the sporangia of which agree in essentials with those of *Dictyophyllum*. Therefore, the present writer much desires a further supply of material which indicates the characteristic habit of frond of *Camptopteris*-type before the substitution of the generic name is made.

Locality: Yamanoi (Loc. No. 3, 13); Michiichi.

8. *Dictyophyllum kochibei* YOKOYAMA

Pl. IX (I), Figs. 4-6.

1891. *Dictyophyllum kochibei* YOKOYAMA: On Some Fossil Plants from the Coal-bearing Series of Nagato. L. c., p. 244, Pl. XXXIV, figs. 1, 1a.
1896. *Dictyophyllum kochibei* INOUE: On the Mesozoic Formation in the Southern Part of Nagato. L. c., p. 363, Pl. XII, figs. 5, 7.
1905. *Dictyophyllum kochibei* YOKOYAMA: Mesozoic Plants from Nagato and Bitchû. L. c., p. 6, Pl. I, figs. 5, 7; Pl. II, figs. 1-2.

This species has been profusely and finely illustrated by YOKOYAMA in his two works on fossil plants from Yamanoi. The specimens at hand are all fragmentary, but some of which are figured in Pl. IX (I), figs. 4-6. YOKOYAMA gave the following diagnosis on this species: "Pinnae elongated, deeply pinnatifid; pinnules ovate or ovately lanceolate, crenate at margin, obtusely pointed at apex, passing off either at right angles from the rhachis, or slightly inclined forward. Rhachis moderately strong; secondary veins quite distinct, somewhat zigzag, one in each lobe; tertiary veins also distinct, forming by their union two to three rows of irregularly polygonal nets; quaternary veins very fine, forming secondary nets within the primary ones."

As YOKOYAMA suggested, *D. kochibei* certainly resembles *Thaumatopteris schenki* NATHORST in general habit, but in the Japanese form, there is no evidence of the mode of disposition of pinnae characteristic to the genus *Thaumatopteris*; moreover there is a great difference in the form and size of the pinnae, those of ours being longer and broader, more distantly placed, and there is a characteristic lobed lamina between two adjacent pinnae. Therefore, YOKOYAMA is certainly correct in not referring the specimens to NATHORST's species and in considering them as a new species.

Locality: Yamonoi (Loc. No. 3).

9. *Dictyophyllum* sp. indet.

Pl. IX (I), Figs. 7-8.

In Pl. IX (I), fig. 7 is shown a fragment of leaf with lobed margin and showing reticulate nervation. It is beyond doubt that the fragment belongs to the genus *Dictyophyllum*. As the midnerve is not preserved, the breadth of the pinna is not known. Fragments of three lobes are seen; these are triangular, about 2 cm. long and 1.3 cm. broad at the base and with subacute apex; the lower margin of the lobes is nearly straight or slightly convex, but the upper is not distinct. The margins seem to be almost entire all round. The midnerve of the lobe is very distinct, and the secondary nerves at a right angle to the midnerve are subdivided into tertiary nerves which unite with each other to form a reticulate nervation.

As far as the characters of the pinna can be made out, the fragmentary specimen does not agree with any species of *Dictyophyllum* described above, but is fairly closely comparable with *D. nilssoni* var. *brevilobatum* NATHORST from Sweden figured by NATHORST⁽¹⁾. But the scantiness of the material does not permit of a specific determination. A similar fragment was also obtained from Momonoki.

Locality: Momonoki; and Yamonoi (Loc. No. 13).

10. *Taeniopteris minensis* sp. nov.

Pl. X (II), Figs. 1-5.

Numerous specimens are examined.

Leaf simple, petiolate, long and narrow, reaching a length of more than 15 cm. and a breadth of 1-2 cm. The lamina increases

(1) A. G. NATHORST: Ueber *Dictyophyllum* und *Camptopteris spiralis*. Kgl. Svensk. Vet.-Akad. Handl., Bd. XLI, No. 5, 1906, p. 5, Pl. II; Pl. III, figs. 2-3.

gradually in breadth from the base and tapers towards a subacute apex. Margin entire or broadly wavy. Midnerve distinct, moderately strong, merging gradually into slender petiole not very much stronger than the midnerve. Lateral nerves distinct, at an angle of approximately 60° to the midnerve, simple or once forking at variable distances from their origin, and 20-25 in number per cm. at the margin.

The specimen figured in Pl. X (II), fig. 4 shows a portion of a leaf incomplete at both ends and one side of the lamina. It has a length of 10 cm. and a breadth of 1 cm. at a short distance below the upper end and narrows very gradually towards the proximal end. It is clearly seen that the margin of the lamina is broadly wavy. In fig. 5 is illustrated a likewise incomplete leaf in order to show the wavy margin of the lamina. In this a crenulation reaches the midnerve. The margin is sometimes nearly entire, but in most cases it is lightly and broadly undulating. In all specimens examined the lateral nerves are always oblique to the midnerve. One of the characteristic features of this species is the gradual reduction in breadth of the lamina towards the proximal end; the specimens showing such features are figured in fig. 3. The apical nature is exhibited in figs. 1 and 2.

In respect to the size and form of the leaf, *Taeniopteris minensis* closely resembles *T. tenuinervis* BRAUNS as profusely illustrated by NATHORST⁽¹⁾ from Sweden. But in the present species, the lateral nerves are more oblique to the midnerve and mostly once forking at variable distances from their origin. Our species is also comparable to a New Zealand Rhaetic species described by ARBER⁽²⁾ as *T. thomsoniana* Arber, but in this species the leaf apex is broadly rounded and the lateral nerves are at right angles to the midnerve. Another comparable species is *T. stenophylla* KRYSHTOFOVICH⁽³⁾ originally from the Middle Jurassic of Siberia, and so great was the resemblance in the characteristic oblique lateral nerves that the present writer once thought even to adopt KRYSHTOFOVICH's specific name for the Japanese form. Having compared our specimens more

(1) A. G. NATHORST: *Flora vid Bjuf*, 1878, p. 47, Pl. VII, fig. 6; Pl. VIII, figs. 8, 11, 12, 14-16; Pl. X, figs. 2-5. *Ibid.*, 1879, p. 59, Pl. XI, fig. 9.

(2) E. A. N. ARBER: *The Earlier Mesozoic Floras of New Zealand*. New Zeal. Geol. Surv. Palaeont. Bull. No. 6, 1917, p. 47, Pl. VI, fig. 4; Pl. VIII, figs. 4, 7.

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

carefully with illustrations of this species given by KRYSHTOFOVICH and KAWASAKI⁽¹⁾, the present writer found that there are distinct differences between them which verify the need of their differentiation; in our species the leaf is always larger and the margin of the lamina is in most cases broadly undulating, while in *T. stenophylla* the leaf is smaller and the margin is believed to be entire. These are the chief reasons why the present writer distinguished the Japanese form from KRYSHTOFOVICH's species and treated it as a new species.

Localities: Kusaigawa; and Momonoki.

11. Cfr. *Taeniopteris nabaensis* ÔISHI

Pl. X (II), Figs. 7-7 a.

Compare:

1932. *Taeniopteris nabaensis* ÔISHI: The Rhaetic Plants from the Nariwa District, Prov. Bitchû (Okayama Prefecture), Japan. L. c., p. 328, Pl. XLIII (XXV), figs. 11-13; Text-fig. 4.

A fragmentary specimen of a *Taeniopteris*-leaf shown in Pl. X (II), fig. 7, is more than 6 cm. long and 1.6 cm. broad, being imperfect at the apical and proximal portion and narrowing gradually towards the proximal end. The midnerve is thin and slender, being less than 0.6 mm. broad. It sends off lateral nerves which are at right angle to the midnerve, slightly decurrent at the base, once or twice dichotomously forking, first close to the origin and then at the mid-course and number about 22 per cm. at the margin. The margin seems to be entire.

In respect to the characteristic nervation, the present specimen agrees closely with *T. nabaensis* from Nariwa, differing slightly in the former's having lateral nerve which are less crowded and slightly decurrent at the base. If the nature of the base in the present specimen is not due to the preservation, it can not be distinguishable from *T. nabaensis* but the lateral nerves are less dense.

Locality: Yamanoi (Loc. No. 15).

(1) S. KAWASAKI: Some Older Mesozoic Plants in Korea. Bull. Geol. Surv. Korea, Vol. IV, Pt. 1, 1925, p. 31, Pl. XXI, Fig. 65.

12. *Taeniopteris* sp.

Pl. X (II), Fig. 6.

An imperfect specimen of *Taeniopteris*-leaf shown in Pl. X (II), fig. 6, though it is specifically not determinable, has been figured as it seems to be not identical with any other species of *Taeniopteris* described in this paper. It shows proximal portions of two fronds incomplete at their distal ends. They are more than 8 cm. long, 2 cm. broad at the broken distal end and they narrow gradually towards the proximal end. The midnerve is moderately strong. It sends off lateral nerves at about 80°-90° to the midnerve, generally once forking close to their origin or at variable distances from the midnerve, slightly decurrent at the base and approximately 20-25 in number per cm. The margin is entire.

The present specimen differs from *T. minensis* described above in the more abrupt reduction of the lamina towards the proximal end and the less oblique lateral nerves. The more or less comparable species is *T. vittata* BRONGN., but the material is too poor to admit surely of their specific identity. *T. lanceolata* ÔISHI⁽¹⁾ is another allied species, though the apical nature of the leaf is not clear and the lateral nerves are less dense in the present specimen.

Locality: Kusaigawa.

13. *Pterophyllum*? sp. indent.

Pl. X (II), Fig. 8.

In Pl. X (II), fig. 8 is shown a very fragmentary frond which can hardly be attributed to any genera of Mesozoic fossil plants, though the general habit reminds one of the genus above referred to. It is characterised by a broad lamina more than 7 cm. broad, and traversed by a slender rachis. The nerves are prominent, very coarse, being 1-1.5 mm. apart, simple or once forking close to their origin, oblique to the axis and slightly decurrent at the base. The nature of the margin is not clear.

Locality: Yamanoi (Loc. No. 15).

(1) S. ÔISHI: The Rhaetic Plants from the Nariwa District. L. c. p. 325, Pl. XLIII (XXV), figs. 5-9.

14. *Nilssonia inouyei* YOKOYAMA

1905. *Nilssonia inouyei* YOKOYAMA: Mesozoic Plants from Nagato and Bitchû. L. c., p. 9, Pl. I, fig. 4; Pl. II, fig. 4.

1911. *Nilssonia inouyei* THOMAS: The Jurassic Flora of Kamenka. L. c., p. 86, Pl. VI, figs. 4, 4a, 5.

There are a number of incomplete fronds of this species in the collection. YOKOYAMA's diagnosis is slightly modified as follows: Frond simple, elongated, narrow, more than 9 cm. long and 1.2 cm. broad, nearly parallel-sided or widening gradually from the base upwards and tapering to an obtuse apex. Rachis moderately strong. Nerves mostly simple, nearly at right angle to the rachis, and numbering 20-23 per cm.

A nearly complete frond of this species has already been figured by YOKOYAMA from Yamanoi. Outside Japan, this species is known from the Jurassic rocks of Kamenka⁽¹⁾.

Localities: Yamanoi (Loc. No. 3); and Michiichi.

15. *Nilssonia* sp.

Pl. IX (I), Fig. 9.

A very imperfect specimen shown in Pl. IX (I), fig. 9 belongs to the genus *Nilssonia*, though specifically not determinable. The lamina fairly covers the upper surface of the rachis. The nerves are simple, oblique to the rachis, and number about 24 per cm.

Locality: Momonoki.

16. *Ginkgoites digitata* (BRONGN.) var. *huttoni* SEWARD

Pl. X (II), Fig. 9.

Pl. X (II), fig. 9 shows a lamina 3 cm. high and 4.5 cm. broad, deeply cleft into four segments. Each segment is broadly oval in outline and provided with rounded apex. A segment in the extreme right is again shallowly cleft. The nerves are distinct, forking, about 1.5-2 mm. apart from one another and run parallel to the lateral margins of the segments. The petiole is not known.

(1) H. H. THOMAS: Op. cit.

The figured specimen agrees closely with laminae described by the present writer⁽¹⁾ from the Rhaetic beds of Kuruma under the same designation, though the nerves in the present specimen are slightly coarser than those in the specimens from Kuruma.

Locality: Kusaigawa.

17. *Baiera paucipartita* NATHORST

Pl. IX (I), Figs. 10-11.

1891. *Baiera?* sp. YOKOYAMA: On Some Fossil Plants from the Coal-bearing Series of Nagato. L. c., p. 246, Pl. XXXIV, fig. 6.
1896. *Baiera paucipartita* INOUE: On the Mesozoic Formation in the Southern Part of Nagato. L. c., p. 363, Pl. XII, fig. 6.
1905. *Baiera paucipartita* YOKOYAMA: Mesozoic Plants from Nagato and Bitchû. L. c., p. 9, Pl. II, fig. 5.
1932. *Baiera paucipartita* ÔISHI: The Rhætic plants from the Nariwa District, L. c., p. 351, Pl. L (XXXII), fig. 6.

Pl. IX (I), fig. 10 shows a lamina 4 cm. high, dichotomously divided into more than six narrow ultimate segments, each bearing about 4 parallel nerves forking at the proximal portion. The apex of the segments is obtusely rounded. The very base of the lamina is not clear. Fig. 11 shows another specimen incomplete at base and apex.

Localities: Yamanoi (Loc. No. 1, 3 and 15).

18. *CZEKANOWSKIA?* sp.

A specimen of long and narrow, needle-like leaves (?) crowded on a slab of rock has provisionally been referred to the genus above cited. They attain sometimes a length of more than 4 cm. and breadth of 0.6-0.8 mm. and are traversed by a single nerve. No branching of leaves is observable.

Locality: Yamanoi (Loc. No. 1).

19. *Stenorachis elegans* ÔISHI

Pl. IX (I), Figs. 12-12a.

1932. *Stenorachis elegans* ÔISHI: The Rhætic Plants from the Nariwa District, L. c., p. 357, Pl. L (XXXII), fig. 10.

Pl. IX (I), fig. 12 shows a *Stenorachis* which is hardly distinguishable from *Stenorachis elegans* recently described by the present

(1) S. ÔISHI: Mesozoic Plants from Kita-Otari, Prov. Shinano, Japan. This Journal, Vol. I, No. 2, 1931, p. 247, Pl. XVIII, figs. 1B, 4.

writer⁽¹⁾ from the Rhaetic beds of the Nariwa district. The specimens consist of a straight and moderately strong central axis more than 4.5 cm. long, to which are attached more or less crowded appendages at an angle of approximately 45°. These are 0.7–0.9 cm. long, slightly decurrent at the base, for the greater part expanded in oval outline, and bilobed at the distal end. Two faint striations in the longitudinal direction on the surface of the oval body are also observable.

The oval body suggests the former presence of reproductive organs, but there is no trace of these. This species is not uncommon at Kusaigawa.

Locality: Kusaigawa.

20. *Pityophyllum longifolium* (NATHORST)

Numerous detached long and narrow coniferous leaves.

Localities: Kusaigawa; Momonoki; and Yamanoi (Loc. No. 1).

21. *Podozamites lanceolatus* (L. and H.)

1925. *Podozamites distans* OZAWA: Palæontological and Stratigraphical Studies on the Permo-Carboniferous Limestone of Nagato. L. c., p. 6.

Some imperfect shoots and numerous detached leaves.

Localities: Kusaigawa; Momonoki; and Yamanoi (Loc. No. 1, 3, 13); and Michiichi.

22. *Podozamites schenki* HEER

A shoot indistinguishable from the typical *P. schenki* as figured by the present writer⁽²⁾ from the Rhaetic of Nariwa.

Locality: Kusaigawa.

23. *Cycadocarpidium swabii* NATHORST

Pl. X (II), Figs. 10–10a.

1911. *Cycadocarpidium swabii* NATHORST: Ueber die Gattung *Cycadocarpidium* NATHORST nebst einigen Bemerkungen ueber *Podozamites*. Palæobot. Mitteil. 10. Kgl. Svensk. Vet.-Akad. Handl., Bd. XLVI, No. 8, p. 5, Pl. I, figs. 11–15.

(1) S. ÔISHI: 1932, op. cit.

(2) S. ÔISHI: 1932, op. cit., p. 362, Pl. LII (XXXIV), figs. 3–5.

1925. *Cycadocarpidium swabii* OZAWA: Palæontological and Stratigraphical Studies on the Permo-Carboniferous Limestone of Nagato. Pt. II. Palaeontology. L. c., p. 6, Pl. I, fig. 10.
1925. *Cycadocarpidium swabii* OZAWA: The Post-Palæozoic and Late-Mesozoic Earth-Movements in the Inner Zone of Japan. Journ. Fac. Sci., Imp. Univ. Tôkyô, Sect. II, Vol. I, p. 94, fig. 1.

Pl. X (II), fig. 10 shows a sporophyll 3.6 cm. long, of which 3.2 cm. is a leaf-like sterile lamina thin in texture. The lamina is elongate oval in outline, 6 mm. broad at the middle portion and it narrows gradually towards both ends. The apex is obtusely rounded. The nerves fork at the base, parallel to each other and to the lateral margins of the lamina and converge to the apex. The nerves count 8. The seeds are elongate oval in outline, 6 mm. long and 2 mm. broad, and the longitudinal axis is parallel to that of the sporophyll. The stalk is more than 2 mm. long.

The present specimen differs slightly from *C. swabii* from Sweden⁽¹⁾ in that the longitudinal axis of seeds in ours is nearly parallel to that of the sporophyll, instead of being fairly oblique as in the Swedish specimens; otherwise the two are quite indistinguishable.

C. swabii described by OZAWA⁽²⁾ from Ojigase, about 4 km. SEE from Kusaigawa, is a more incomplete specimen. Having examined the original specimen of OZAWA in the Geological Institute, Tôkyô Imperial University, the present writer found that the ovules in the figured specimen are 3 mm. long and 2 mm. broad, and laterally compressed so as to make two seeds overlap each other.

The occurrence of this species in Japan is particularly interesting, because it has hitherto been known only from the Rhaetic of Sweden.

Localities: Kusaigawa; and Ojigase.

In conclusion, I wish to express my sincere thanks to Professor HISAKATSU YABE in Sendai and Professor TAKUMI NAGAO of our Department for their offering several valuable suggestions during the preparation of this paper.

Department of Geology and Mineralogy,
Hokkaidô Imperial University, Sapporo.
July, 1932.

(1) A. G. NATHORST: Op. cit.

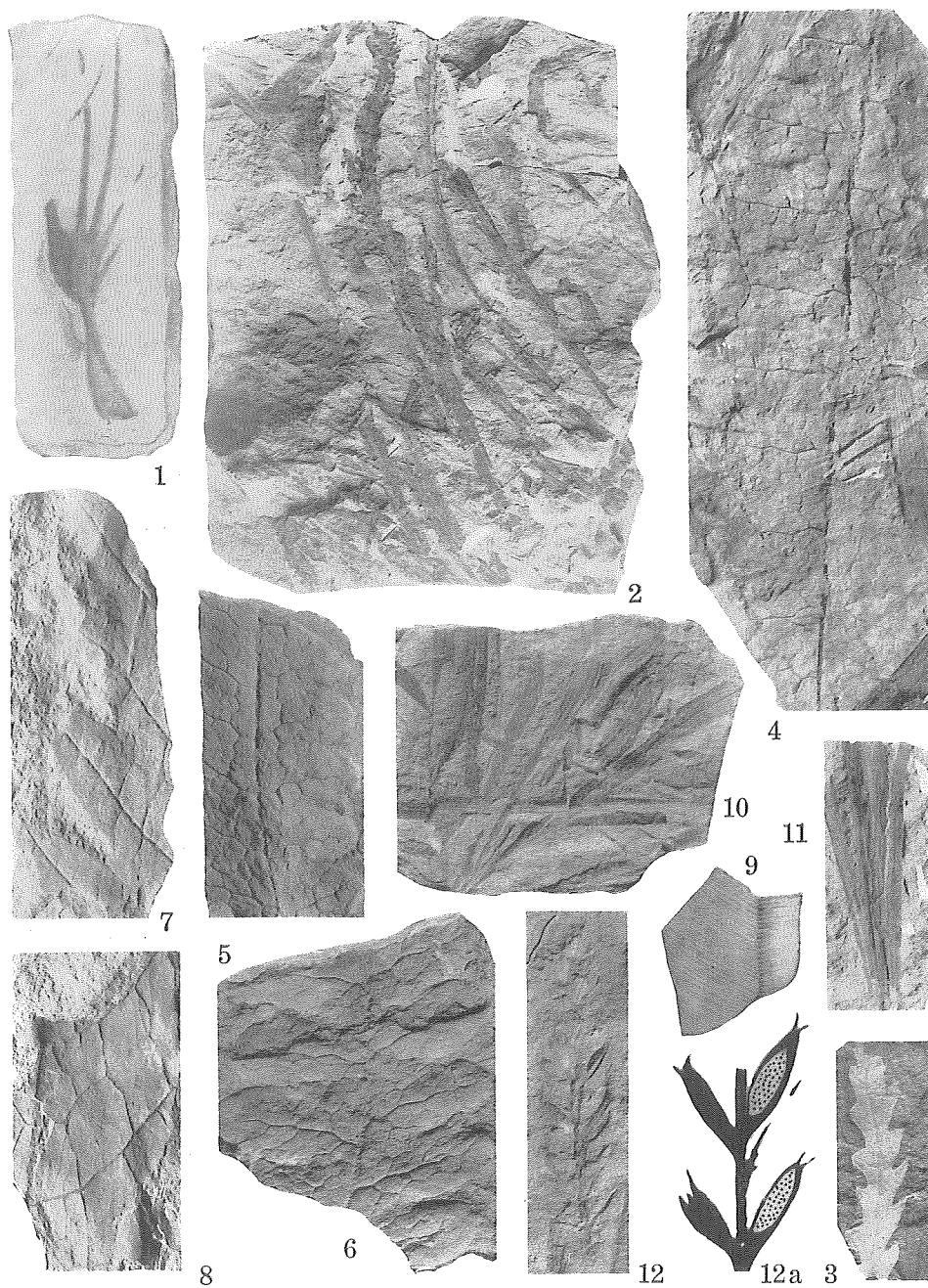
(2) Y. Ozawa: Op. cit.

Plate IX

PLATE IX (I)

(The figures are natural size unless otherwise stated)

- Fig. 1. *Phyllothea* sp. Loc. Yamanoi (No. 13). (Reg. No. 4200).
- Fig. 2. *Dictyophyllum japonicum* YOKOYAMA. Loc. Yamanoi (No. 3).
(Reg. No. 4174).
- Fig. 3. *Dictyophyllum japonicum* YOKOYAMA. Loc. Yamanoi (No. 13).
(Reg. No. 4199).
- Figs. 4-6. *Dictyophyllum kochibei* YOKOYAMA. Loc. Yamanoi (No. 3).
(Reg. No. 4191, 4196).
- Figs. 7-8. *Dictyophyllum* sp. indet. Loc. Yamanoi (No. 13). (Reg. No. 4197).
- Fig. 9. *Nilssonia* sp. Loc. Momonoki. (Reg. No. 4170).
- Figs. 10-11. *Baiera paucipartita* NATHORST. Loc. Yamanoi (No. 15).
(Reg. No. 4175, 4176).
- Figs. 12-12a. *Stenorachis elegans* ÔISHI. Loc. Kusaigawa.
Fig. 12a ca. 2x natural size. (Reg. No. 4189).



Takeda Photo.

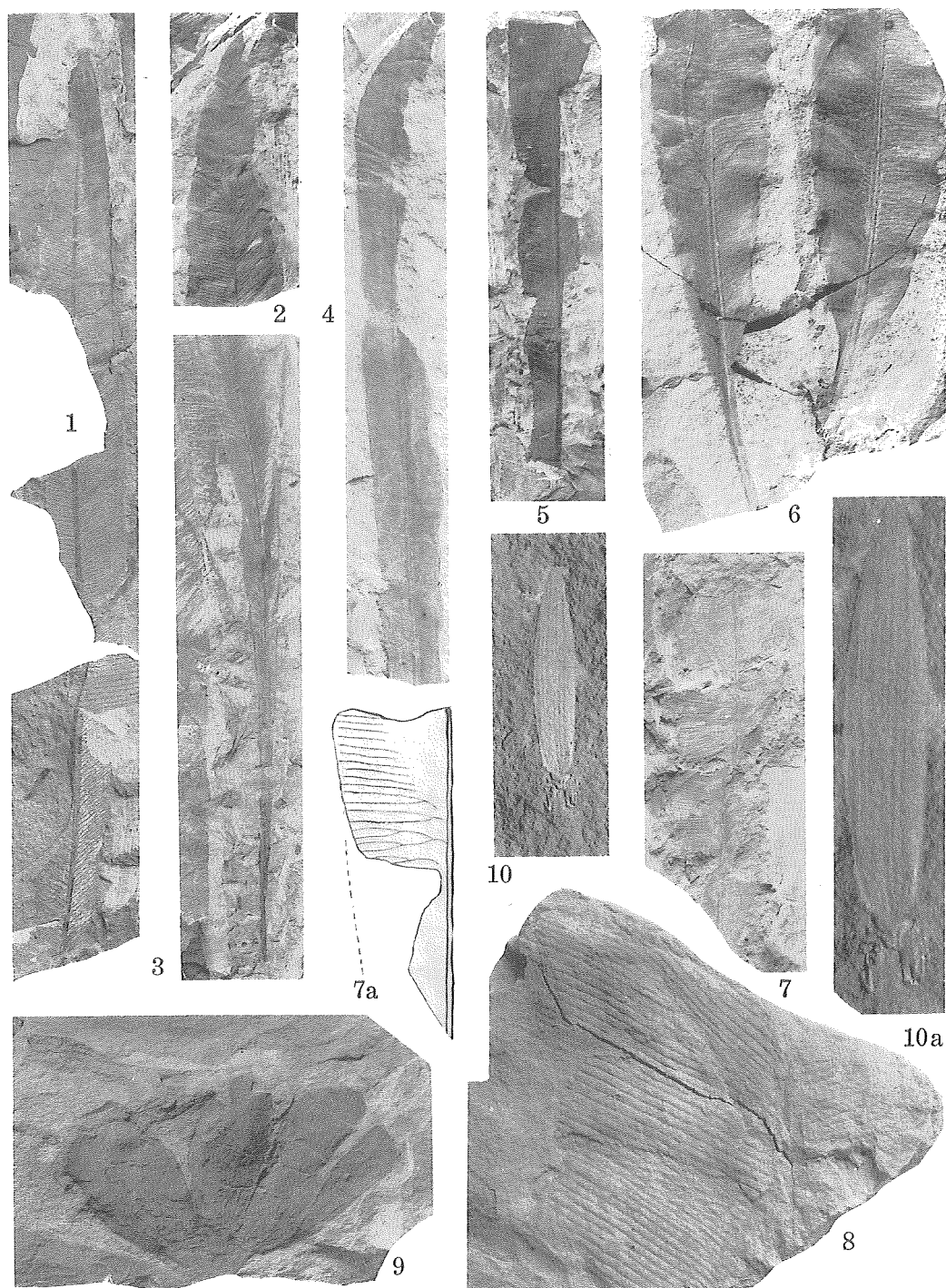
S. Ôishi: Rhaetic Plants from Nagato.

Plate X

PLATE X (II)

(The figures are natural size unless otherwise stated).

- Figs. 1-5. *Taeniopteris minensis* sp. nov. Loc. Kusaigawa.
(Reg. No. 4161, 4162, 4163, 4165, 4224).
- Fig. 6. *Taeniopteris* sp. Loc. Kusaigawa. (Reg. No. 4164).
- Figs. 7-7a. Cfr. *Taeniopteris nabaensis* ÔISHI. Loc. Yamanoi (No. 15).
(Reg. No. 4171).
- Fig. 8. *Pterophyllum?* sp. indet. Loc. Yamanoi (No. 15). (Reg. No. 4172).
- Fig. 9. *Ginkgoites digitata* (BRONGN.) var. *huttoni* SEWARD. Loc. Kusaigawa.
(Reg. No. 4173).
- Figs. 10-10a. *Cycadocarpidium swabii* NATHORST. Loc. Kusaigawa.
Fig. 10a 2× natural size. (Reg. No. 4225).



Takeda photo.

S. Ôishi: Rhaetic Plants from Nagato.