

On Some Fossil Algae from the Miocene Nishikubiki Flora, Niigata Prefecture, Japan

By

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Several localities of the Nishikubiki flora have been reported from the upper reaches of the Haya-kawa, Nou-gawa and Nadachi-gawa in the westernmost area of Niigata Prefecture. Each of the localities yields fossils of brown algae belonging to Fucales; fossils are most abundant at the locality in the upper reaches of the Jinbagawa, a tributary of the Nadachigawa, in Nadachi-machi of Nishikubiki-gun (refer to Map). The fossils occur in the so-called "Nanbayama Formation" which is a thick somewhat siliceous black shale constituting the lower part of the Hiuchiyama Formation (NISHIDA *et al.*, 1966) of the Niigata oil field region. According to NISHIDA and others, the Hiuchiyama Formation underlies the Green Tuff Group and corresponds to the Bessho Formation of the northern and eastern areas of Nagano Prefecture. The formation is partly correlatable with the Uchimura Formation also. Accordingly, the Nishikubiki flora can be defined as a Daijima type flora. Coexisting marine algal fossils are relatively well preserved but most of them are portions of frond and their complete form remains unknown. Nevertheless, the characteristics of branches, leaves and vesicles are indicative of Fucales and Sargassaceae of Phaeophyta. Algae of these groups are classified by the rhizoid, the pattern of branching, the shape of leaves and the manner of their attachment, the features of vesicle and receptacle, etc., but owing to the great numbers of species and to the still deficient reserches, these are the most troublesome groups in classification, as pointed out by OKAMURA (1936) and YAMADA and FUNABASHI (1963). Since the species hitherto identified by the writer are only a few, the present paper is nothing but a preliminary report, although the writer intends to collect more specimens for further examination. Fossils of brown algae have been studied very little in any part of the world, and in Japan this paper is the second report after the first one by HORIGUCHI (1965). As for animal fossils in this black shale, HATAI and NODA (1972) reported a kind of ray from the upper reaches of the Nou-gawa. Small-size *Nautilus* and a few bivalves were also recorded, but the occurrence of Foraminifera that would be helpful for age determination has not been reported as yet. So, determination of geologic age by means of animal fossils is difficult, but judging from the rhythm of climatic conditions inferred from the components of the flora, the black shale may be reasonably placed in the middle period of the Middle Miocene age.

AKAHANE reported (1975) the detailed stratigraphy and geological structure of the

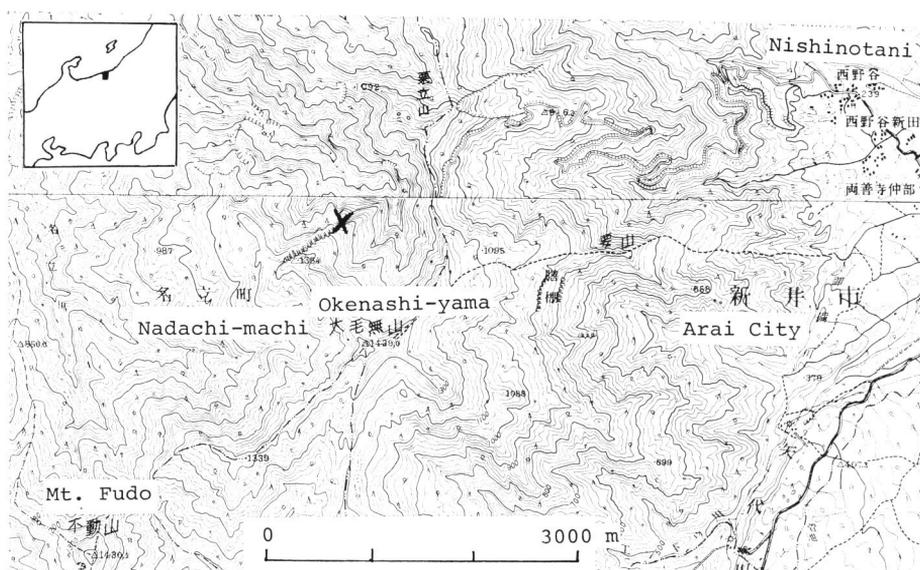


Fig. 1. Map showing the fossil locality (×).

Neogene formations, including the locality of the fossils described here, in the mountainous area west of Jōetsu City, Niigata Prefecture, as summarized below:

Group	Formation	Thickness (m)
Jōetsu G.	Tanihama F.	400– 500
	Nadachi F.	350– 500
	Kawazume F.	400–1400
Nishikubiki G.	Noudani F.	1100–1700
	Hiyama F.	600–1000
	Shiundani F.	1250–1500

Shiundani Formation	
Member	Lithic character
G	Laminated black shale. Muddy flysh.
F	Sandy flysh. Chert, slate, sandstone, porphyrite, rhyolite, etc. Intercalated with mudstone containing fine pebbles.
E	Laminated hard black shale.
D	Intermediate facies between C and E. Upper part is pebbly mudstone; lower part is stratified hard black mudstone.
C	Sandy flysh, with more sandstone than other members.
B	Poorly stratified black mudstone; slump structure is developed.
A	Sandy flysh; various sedimentary structures are developed.

The strata that have been known as the Nanbayama and Hiuchiyama Formations are included in the Nishikubiki Group as AKAHANE has newly proposed. The Nishikubiki Group is unconformable with the overlying Jōetsu Group. The stratigraphic position of the algae reported here is E Member of the Shiundani Formation, the lowermost formation in the Nishikubiki Group. The Shiundani Formation is composed mainly of sandy flysh, and is characterized by laminated black shale and mudstone having slump structure. Sandstone shows sedimentary structures of various types, for example, sole marks such as groove cast and flute cast, as well as ripple marks and load cast slump. E Member is very hard black shale marked with so distinct laminae that it exfoliates into thin slabs.

According to a private communication from AKAHANE, rock of similar lithofacies yielding marine algae occurs also on the Nagano Prefecture side.

The algal fossils are found in dense aggregate locally in the hard black shale. They comprise at least several species, but the description given in this article is just tentative, since the identification had to depend only on their external features. The reason the writer ventures to report them nevertheless is because the fossil occurrence of brown algae of this kind is very rare. From the standpoint of peleoecology, we ought to take into consideration the bottom configuration, tidal range, distribution of sediments and current of the Japan Sea of those days, but the data available at present are still meager. It is most likely that the brown algae moved about as drifting algae and settled on the bottom of a very shallow sea where *Zostera* and other algae were luxuriant.

The writer's sincere thanks are extended to the late Dr. Yukio YAMADA, Emeritus Professor of Hokkaido University, to Dr. Mitsuo CHIHARA, Professor of Tsukuba University for their valuable advice on the living species of Fucales, and to Mr. Sadayuki AKAHANE for valuable information on the geology around the locality of the fossil Fucales. The writer is indebted to Professor Hidekuni MATSUO of Kanazawa University who kindly assisted the writer by collecting and lending specimens for this work.

Description

Phaeophyta

Order Fucales

Family Sargassaceae

Genus *Cystophyllum* J. AGARDH

Cystophyllum cfr. *sisymbrioides* J. AGARDH

(*Myagropsis myagroides* FENSHOLT)

Pl. 1, fig. 1; Pl. 2, fig. 1; Pl. 3, fig. 1.

Numerous impressions identifiable to this species were found, though they are

merely parts of frond lacking stem, principal branch and rhizoid. Of them the specimens in a better state of preservation are described here. The one in Pl. 1, fig. 1 is a branch of an upper frond. The main branch is 10 cm long, 1.5 mm wide, and it gives off pinnate lateral branches in clusters, which again fork into smaller branches repeatedly. The vesicle is elliptical or fusiform, 5 mm long and 3 mm wide. It occurs on each ramulet independently, never linked with other vesicles. It has a short stipe about 2mm long at the base, and has leaflets, about 15 mm in maximum length, at the top. Some leaflets are simple and others bifurcate at the end. In some cases the end of the leaflet takes a narrow elliptical form with a width of about 1 cm, which is perhaps a receptacle. The specimen in Pl. 2, fig. 1 is also probably an upper branch of frond. It is about 6 cm long and 1.2 mm wide. The vesicle on each ramlet is clearly independent, and is situated at 1.5 to 2 mm from the branch. It is fusiform of 8 mm in length and 2.5 to 3 mm in width. Each vesicle has long leaflets. The topmost part of some branches becomes a long column looking like a receptacle. The specimen shown in Pl. 3, fig. 1 is a branch of an upper part of frond. It is 12 cm long, 1 mm wide, with slender linear alternate leaves. The topmost leaves are elliptical, about 5 mm long, in regular alternation. The vesicle is independent, 3 mm long and 1.5 mm wide, occurring on the stipe of about 2 mm long. At the head the vesicle has leaflets 5 times as long as the vesicle, and some leaflets are bifurcate.

Remarks: Six species of Genus *Cystophyllum* are known in Japan. Among them, *C. caespitosum* and *C. turneri* are closer to the species described here, but are different in branching, thickness of branch, shape and length of leaves. The most characteristic difference lies in vesicle. Comparison of the vesicle in the three species is given below.

	<i>C. sisymbrioides</i> J. AGARDH	<i>C. caespitosum</i> YENDO	<i>C. turneri</i> YENDO
Shape	Lower one is elliptical, upper one is fusiform	Same as <i>sisymbrioides</i> .	Sometimes globular.
Size	Diameter 4–5 mm, length 5–10 mm.	Diameter 2 mm, length 5–10 mm.	Diameter 1–2 mm.
Manner	Simple. With stipe of same length as, or shorter than, vesicle.	Simple. With stipe of same length as, or shorter than, vesicle.	With short stipe. Two or three vesicles linked together.
Leaflet	Two or three times as long as vesicle.	Several times as long as vesicle.	Several times as long as vesicle

Horizon: E Member of Shiundani Formation

Depository: Illustrated specimens NSM-PP 15622 (Pl. 1, fig. 1); 15623 (Pl. 2, fig. 1); 15624 (Pl. 3, fig. 1); 15631 (Pl. 5, fig. 2)

Cystophyllum cfr. *hakodatense* YENDO

Pl. 4, fig. 1, 2

The specimen shown in Pl. 4, fig. 1 is perhaps a part of the middle portion of frond. The stem is thick and angular, the length is at least 7.5 cm and the width 2 mm. It

gives off branches on one plane, with smaller branches extending in all directions. Differentiation of stem and leaf is fairly distinct. Leaves are slender with entire margin, like bamboo leaves. The vesicle is fusiform, 2–3 mm long, 1.5–2 mm wide, and three or four vesicles are linked in the manner of a string of beads, without stipe in between. The tip of the vesicle branches into a tuft of thin strings which are apparently receptacles.

Remarks: In the linking manner of vesicles the species is closely similar to *Cystophyllum crassipes* J. AGARDH, but the vesicles are completely joined together, whereas those in the latter species are linked to each other by a short thin stipe.

Horizon: E Member of Shiundani Formation

Depository: Illustrated specimen NSM–PP 15626 (Pl. 4, figs. 1, 2)

Cystophyllum cfr. *caespitosum* YENDO

Pl. 3, fig. 2; Pl. 5, fig. 1.

This specimen is a part of an imperfect frond. The main branch has a length of at least 10 cm or more, and is 2–2.5 mm wide. It gives off lateral branches which are



Fig. 2. Detailed sketch of the same specimen shown in fig. 1, Plate 5.

5–6 cm long and alternately spread. The branch terminates in a tuft of linear leaves, some of which suggest receptacles though details are unclear. It is evident that the leaves have been partly altered to vesicles. The vesicles are always independent, elliptical or fusiform, 5–6 mm long and approximately 3.5 mm wide. Each vesicle has, at its base, a short stipe of roughly the same length as the vesicle, and at the tip one or two thin linear leaflets are recognized. The length of the leaflets is 2.5 cm in maximum, five times as long as the vesicle.

Remarks: Specific identification is difficult because the specimen is imperfect and similar species are numerous, but the writer tentatively assigns it to *C. caespitosum* YENDO on the basis of the shape, size and the manner of vesicles. Allied species are *C. sisymbrioides* J. AGARDH and *C. turneri* YENDO. According to YAMADA and FUNAHASHI (1963), the diameter of vesicle of *C. caespitosum* is 1/2 of that of *C. sisymbrioides*, but the vesicle of the present species is larger than that. This might be a result of compression in the process of fossilization. The leaflets at the end of vesicles are much longer than those of *C. sisymbrioides*.

Horizon: E Member of Shiundani Formation

Depository: Illustrated specimens NSM–PP 15625 (Pl. 3, fig. 2), 15627 (Pl. 5, fig. 1)

Rhodophyta

Order Crystonemiales

Family Endocladiaceae

Genus *Gloiopeltis*

Gloiopeltis cfr. *furcata* POSTELS et RUPRECHT

Pl. 6, fig. 1.

This is an imperfect specimen of perhaps an upper half of frond. The stem, at least 7–10 cm in height, is more or less subtereta, the thicker part is 5 mm wide. The branch is constricted at the base. It bifurcates successively, and the tip changes abruptly to a dense tuft of thin small branches.

Horizon: E Member of the Shiundani Formation

Depository: Illustrated specimen NSM–PP 15628 (Pl. 6, fig. 1)

Marine phanerogams

Order Helobiales

Family Zosteraceae

Genus *Zostera*

Zostera? sp.

Pl. 7, figs. 1, 2.

The specimen seems to be a part of *Zostera*-like frond. The leaves are slender band-like or linear leaves, somewhat pointed at the tip. They are branching off with a

steep inclination. Their length is at least 10 cm or more, and the width is 3 mm in minimum, 5 mm in maximum. They lack creeping stem, and their venation is not clear, but they probably belong to a lower part of frond. On account of the general shape, the writer tentatively records it as *Zostera*. *Z. marina* may be closest to this species.

Horizon: E Member of Shiundani Formation

Depository: Illustrated specimen NSM-PP 15630 (Pl. 7, figs. 1, 2)

Literature Cited

- AKAHANE, S., 1975. Stratigraphy and geological structure of the Neogene System in the western part of Jōetsu City, Niigata Prefecture, Central Japan. *Jour. Geol. Soc. Japan*, **81** (12): 737-754. [in Japanese].
- FENSHOLT, D. E., 1955. An emendation of the genus *Cystophyllum* (Fucales). *Amer. Jour. Bot.*, **42**: 305-332.
- HATAI, K. & H. NODA, 1972. A problematica from the Mizuho-tyō of Niigata Prefecture. *Trans. Proc. Palaeont. Soc. Japan, N.S.*, (86): 319-324, pl. 39.
- HORIGUCHI, M., 1965. The first occurrence of *Cystophyllum* species in the Tertiary of Japan. *Sci. Rep. Saitama Univ., Ser. B.*, **5** (1): 45-47, pl. 6.
- NISHIDA, S., K. TSUDA & R. ICHIMURA, 1966. On the Neogene Deposits of the Northern Part of the Fossa Magna Region.—Studies of the so-called “Nanbayama Formation”. Part 1. *Rep. Geol. Miner. Niigata Univ.*, (1): 1-14. [in Japanese].
- OKAMURA, K., 1936. *Nihon Kaiso-shi*, Tokyo. [in Japanese].
- YAMADA, Y., 1933. Notes on Some Japanese Algae V. *Jour. Fac. Sci., Hokkaido Imp. Univ., Ser. V*, **2** (3): 280-281, pl. 11.
- YAMADA, Y. & S. FUNAHASHI, 1963. On *Cystophyllum caespitosum* YENDO. *Bull. Japan Soc. Phycology*, **2** (2): 1-5. [in Japanese].
- YENDO, K., 1907. The fucaceae of Japan. *Jour. Coll. Sci. Imp. Univ. Tokyo*, **21**: 1-174.

Explanation of Plates

(All figures in natural size)

Locality: Upper reaches of the Jinba-gawa, Nadachi-machi, Nishikubiki-gun, Niigata Prefecture

Horizon: E Member of the Shiundani Formation.

Plate 1

Fig. 1. *Cystophyllum* cfr. *sisymbrioides* J. AG. The upper portion of frond.

Plate 2

Fig. 1. *Cystophyllum* cfr. *sisymbrioides* J. AG.

Fig. 2. A part of the same.

Fig. 3. Detailed sketch of the same specimen shown in Fig. 1.

Plate 3

Fig. 1. *Cystophyllum* cfr. *sisymbrioides* J. AG. Upper portion of a fertile lateral branch.

Fig. 2. *Cystophyllum* cfr. *caespitosum* YENDO.

Plate 4

Fig. 1. *Cystophyllum* cfr. *hakodatensis* FENSHOLT. A fertile lateral branch

Fig. 2. Detailed sketch of the same specimen shown in Fig. 1.

Plate 5

Fig. 1. *Cystophyllum* cfr. *caespitosum* YENDO.

Fig. 2. *Cystophyllum* cfr. *sisymbrioides* J. AG.
A portion of withered principal branch.

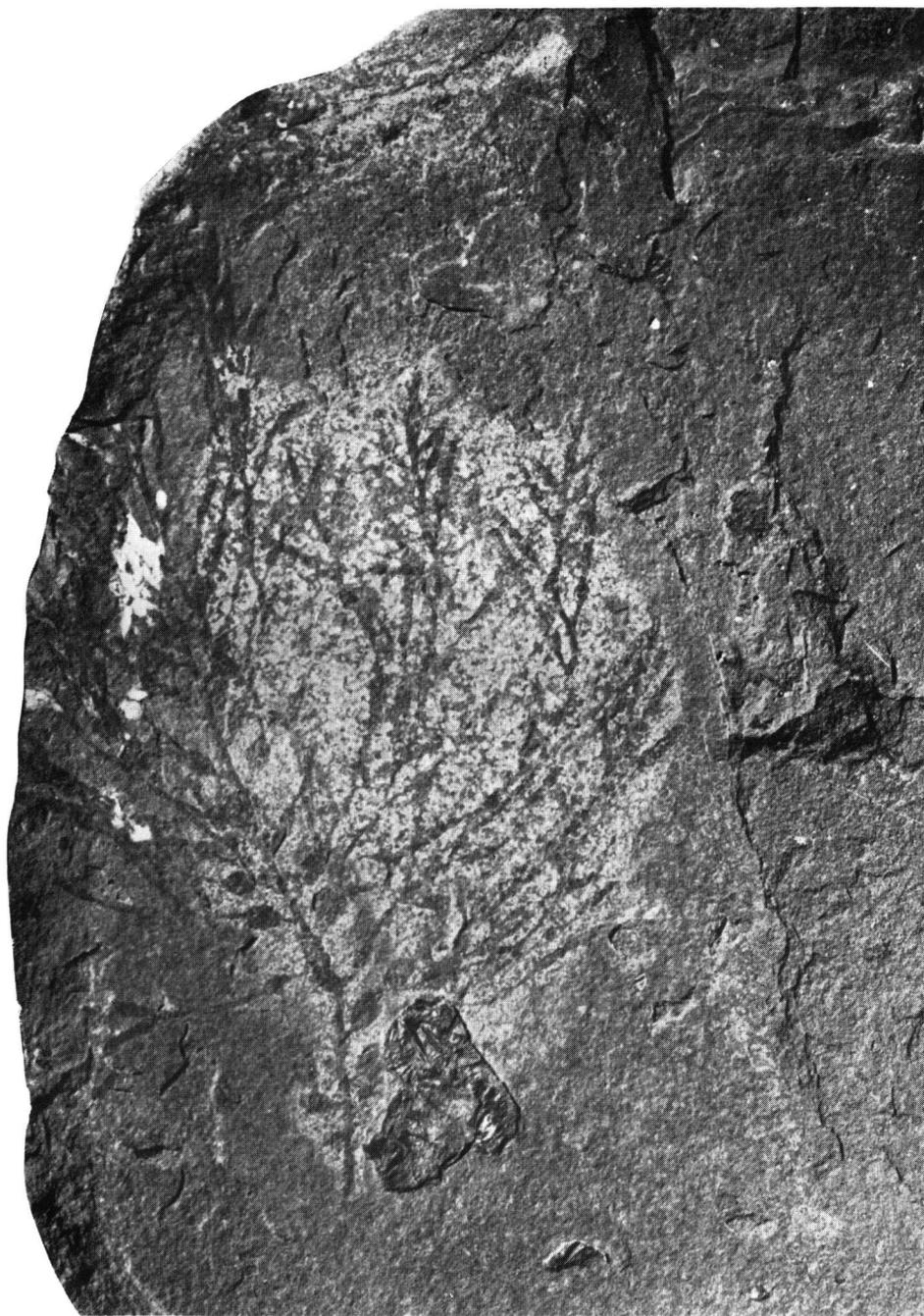
Plate 6

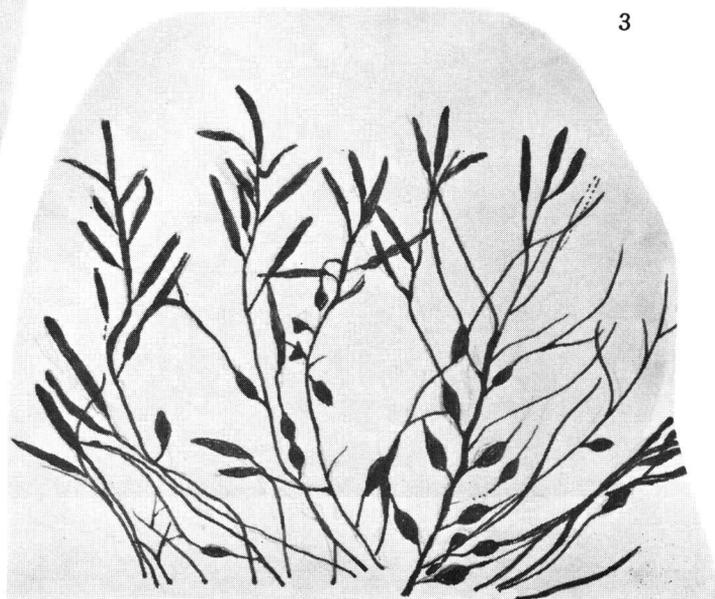
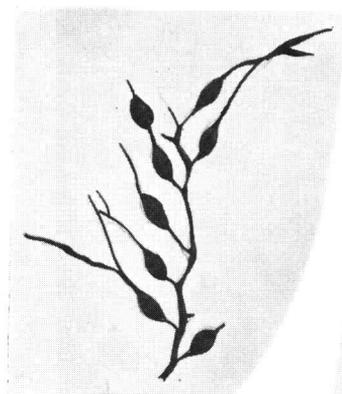
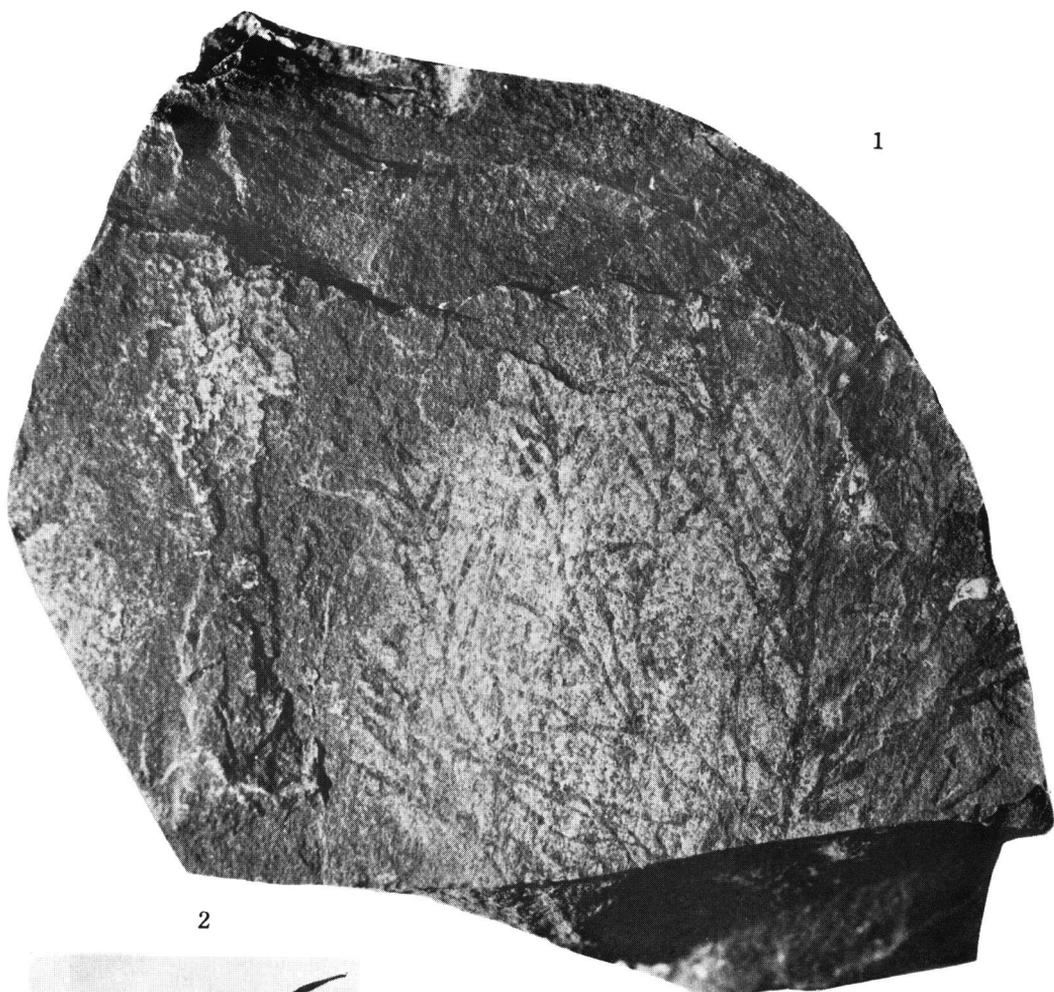
Fig. 1. *Gloiopeltis* cfr. *furcata* POSTELS and RUPRECHT.

Plate 7

Figs. 1-2. *Zostera?* sp.

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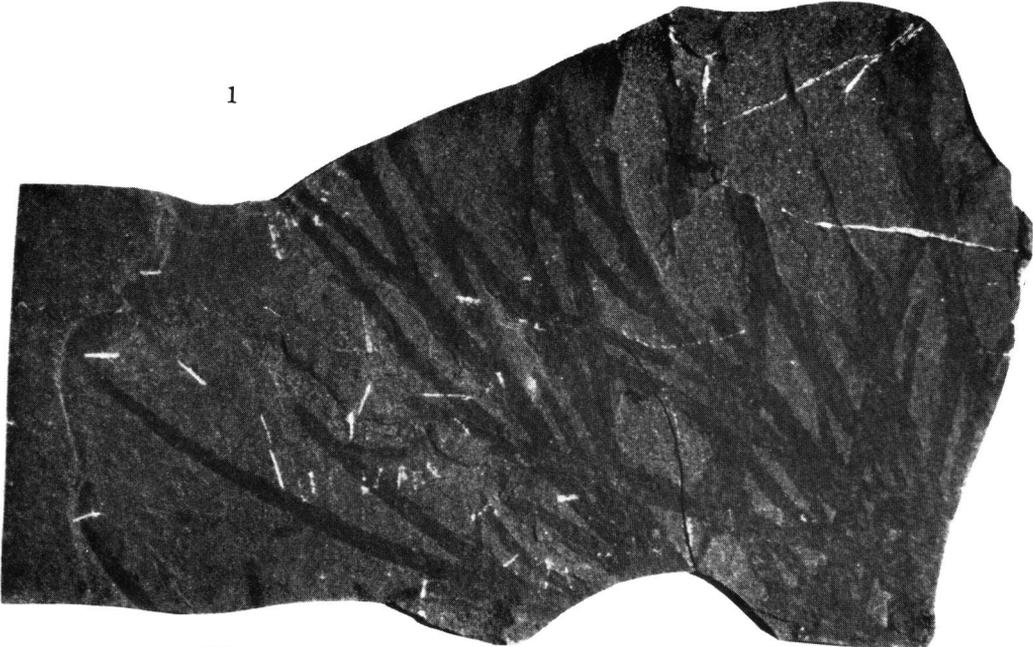
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2



