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NOTES ON SOME MARINE ALGAE FROM THE TSUGARU STRAITS

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While researches were being carried out by the staff of our laboratory along the coast of the Tsugaru Straits, I collected algae several times at Mimmaya Village, Aomori Prefecture, which faces the western entrance of Mutsu Bay, and at Fukushima Town, Oshima Province, Hokkaido. These two localities stand just opposite each other across the Straits.

Among the specimens collected to date, several are found to be interesting and noteworthy from the viewpoint of their geographical distribution. Five species are reported and described in the present paper. They were collected by me except *Undaria peterseniana* (Kjellm.) Okam.

We owe our knowledge of marine flora of the Tsugaru Straits and the adjacent waters to the contributions made by Okamura (1927), Yamada (1928), Takamatsu (1938), and Yamamoto (1964 & 1965). It comprises at present as many as 206 species in total. The coasts along the Tsugaru Straits are washed by both warm and cold currents which meet and mix with each other and are rich with a variety of algal species including those which are peculiar to either the cold or the warm current. Some species such as those mentioned below are also found. They are considered to be limited in their distribution or near the Tsugaru Straits.

Before going further I wish to express my hearty thanks to Emer. Prof. J. Tokida of Hokkaido University for his critical reading of the manuscript and valuable advice. Thanks are also due to Dr. T. Masaki and Mr. T. Takahashi for their kindness in affording me the specimens of *Undaria peterseniana*.

Caulerpa okamurai WEBER VAN BOSSE

Fig. 2 & Pl. I, A

In Okamura, 1897, p. 5, pl. 1, figs. 13-14; Weber van Bosse, 1898, 385, pl. 34, fig. 9; Okamura, 1916b, p. 11, pl. 154, figs. 1-8; 1927, p. 3; 1930, p. 105; 1936, p. 104, fig. 53, 1-3; Takamatsu, 1938, p. 9; 1939, p. 28, pl. 5, fig. 1; Yamada, 1940, p. 12; Oshima, 1950, p. 15, fig. 12; Hasegawa, 1951, 56-57, fig. 4, A-B.

Japanese name: *Fusa-iwazuta* (Okamura).

Habitat: Growing gregariously on rocks, 1-3 meters below low tide mark at Kami-utetsu, Mimmaya Village (Ohmi, 13 August 1955).

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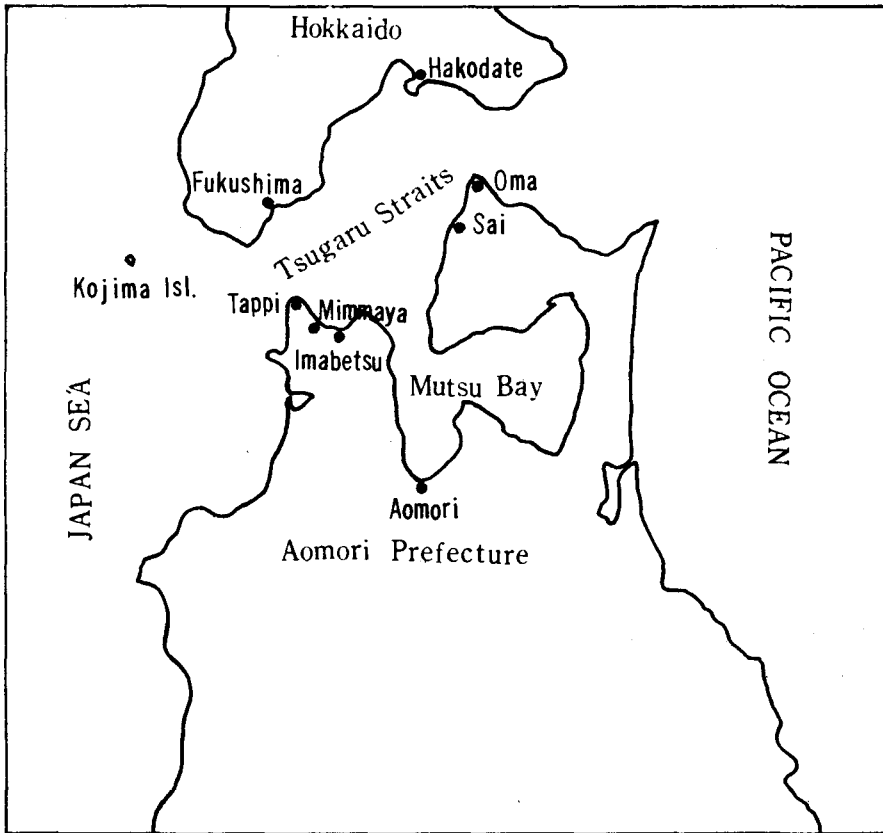


Fig. 1. Map showing the localities where the algae were collected

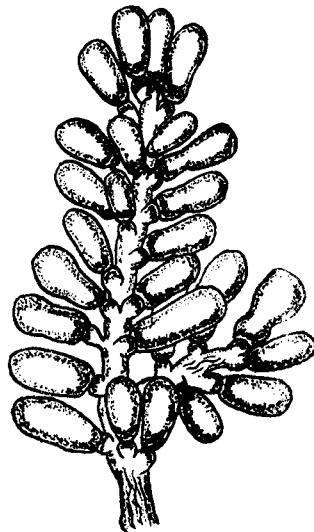


Fig. 2 *Caulerpa okamurai* Weber van Bosse \times ca. 3.5

Part of frond showing ramenta. The specimen was collected at Kami-utetsu in Mimmaya Village, Aomori Pref.

Distribution: Common in warmer parts of Japan along both the Pacific and the Japan Sea coasts, and distributed as far north as Kojima Island, Oshima Prov., Hokkaido. A dense association of this alga was found on the vertical face of a rock facing southeast at a depth of three meters below the low tide mark.

Codium adhaerens (CABR.) C. AG.

1822, p. 457; De Toni, 1889, p. 489; Okamura, 1915, p. 140, pl. 134, figs. 1-3; 1961, p. 261; Schmidt, 1923, p. 26; Börgesen, 1925, p. 89; Yamada, 1928, p. 498; 1934, p. 77, fig. 45; Okamura, 1934; 1936, p. 120, fig. 61, 1-2; Takamatsu, 1936a, p. 6; 1936b, p. 48; 1938, p. 8; Yamada, 1942, p. 99; Oshima, 1950, p. 16, fig. 14, 1-2; Fukuhara, 1958, pp. 39-43, fig. 3; Yamamoto, 1964, p. 85, fig. 2.

Japanese name: *Hai-miru* (Okamura).

Habitat: Growing on rocks near low tide mark. Bentenjima, Oma; Sai; Kamiutetsu (Ohmi, August 1955).

Distribution: Widely distributed in Japan along the Pacific coast from Ryukyu, Ogasawara-jima, and Hyuga northward to the Tsugaru Straits; on the Japan Sea coast at Shimamaki Village, Shiribeshi Prov. which lies a little north of the Straits, at Kojima Isl., Oshima Prov. in Hokkaido, and Etchu Prov. in northern Honshu.

Padina arborescens HOLMES

Fig. 3 & Pl. I, B

1895, p. 251, pl. 12; Okamura, 1916, p. 182; 1929, pp. 3-4, pl. 251, fig. 10 & pl. 252; 1930, p. 102; 1936, p. 182, fig. 94, 1-4; Oshima, 1950, p. 27, fig. 23.

Japanese name: *Umi-uchiwa* (Okamura).

Habitat: Growing on rocks between tide marks and below low tide mark to a depth of six meters at Kami-utetsu, Mimmaya Village (Ohmi, 12 August 1955).

Distribution: Widely distributed in Japan along both coasts from Kyushu to Hakodate. The present species was found growing on a rock in a tide pool at Kami-utetus, Mimmaya Village. This is believed to be the first record of this alga on the coast of Aomori Prefecture, while it has been known to grow at Hakodate on the opposite side of the Straits.

Frond solitary, fan-shaped with an arborescent base, 6-7 cm long, 5-6 cm wide, and 0.2-0.3 mm thick. Internally it consists of as much as 10 layers of cells. Surface wall 3-5 μ thick. Our specimens are all fertile.

Undaria peterseniana (KJELLM.) OKAM.

1915, p. 275, pl. 11, figs. 4-6; Yamada, 1942, p. 99; *Laminaria Peterseniana* Kjellm., in Kjellm. och Peters. 1885, p. 267, pls. 10-11; *Undariopsis Peterseniana* (Kjellm.) Miyabe et Okam. in Okamura, 1902, p. 128.

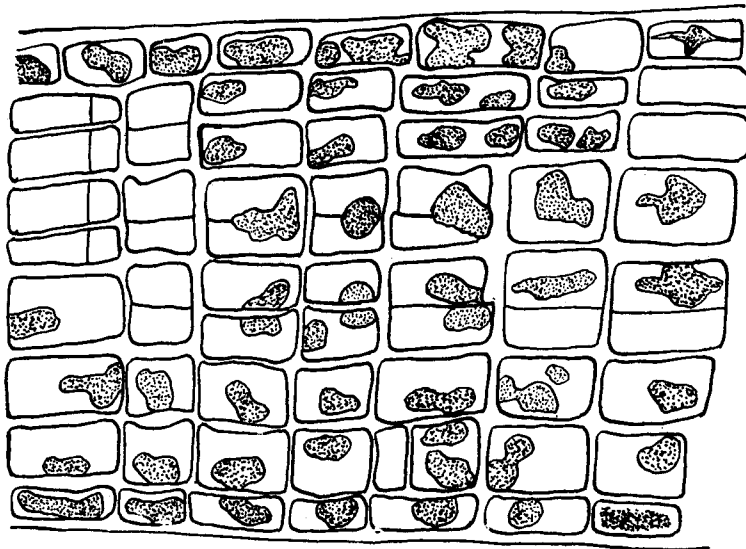


Fig. 3. *Padina arborescens* Holmes $\times 300$
Longitudinal section of vegetative portion of frond collected at Kami-utetsu.

Japanese name: *Ao-wakame*.

Habitat: Growing on rocks in littoral and sublittoral zones. Imabetsu (Miki, July 1961); Fukushima (Takahashi, May 1963).

Distribution: Common in warmer parts of Japan along both coasts from northwestern Kyushu to central Honshu, and in Hokkaido at Kojima Islet.

Mr. F. Miki of Mutsu Bay Aquicultural Research Laboratory, Aomori Prefecture, collected seven specimens of *Undaria peterseniana* while he was studying the propagation of *Laminaria japonica* by diving in July 1961. The specimens were brought to my laboratory through Dr. T. Masaki. A brief description of them is given as follows:

Lamina up to 50 cm long, 9.5 cm broad, broadly linear-lanceolate, ovate, oblong, or elliptical in shape, with more or less undulate margins, slightly thickened at median fascia, destitute of midrib; deep yellowish brown in color; stipe 12–20 cm long, 2–4 cm thick, compressed above; holdfast fibrous; well-developed mucilage gland cells and cryptostomata observed.

In May 1963 one specimen of this alga was collected by Mr. T. Takahashi at Hyuga, Fukushima Town, Oshima Prov., Hokkaido. It was found drifted on the sea bottom at about five meters deep and wrinkled on the surface. Lamina lanceolate, ca. 40 cm long, 4.5 cm broad, margins entire in the upper part, somewhat undulate near the base; yellowish green in color; cryptostomata numerous in surface view. From the structure of cryptostomata and mucilage gland cells, and from the absence of midrib, this specimen can be easily identified as the present

species. This alga has been known until now to be distributed along both coasts of Honshu, from Kyushu to the central Honshu and exceptionally at Kojima Islet, Hokkaido. So, it is interesting to find this alga growing on both sides of the Tsugaru Straits.

Hemineura schmitziana DE TONI et OKAMURA

Figs. 4, A-E & Pl. I, C

1894, p. 76, pl. 16, figs. 6-12; De Toni, 1895, p. 29; Okamura, 1899, Alg. Jap. Exsic., Fas. I, No. 18; De Toni, 1900, p. 720; Okamura, 1901, p. 23, pl. 8; 1936, p. 758, fig. 363, 1-6; Yamamoto, 1956, p. 218, pl. I, fig. 6, pl. II, figs. 6-8, pl. IV, fig. A.

Japanese name: *Habutae-nori* (Okamura).

Habitat: Growing on *Lithophyllum okamurai* in rather deep water. Hyoro, Mimmaya Village (Ohmi, 6 June 1955).

Distribution: Common in warmer parts of Japan along the Pacific coast from Kyushu as far north as the Tsugaru Straits.

Frond tufted or solitary, variable in breadth and outline, 4-7 cm long, 2 cm broad, tapering below to a short compressed stipe, nearly simple to excessively compound, provided with a disciform holdfast. Primary leaf varying from ovate

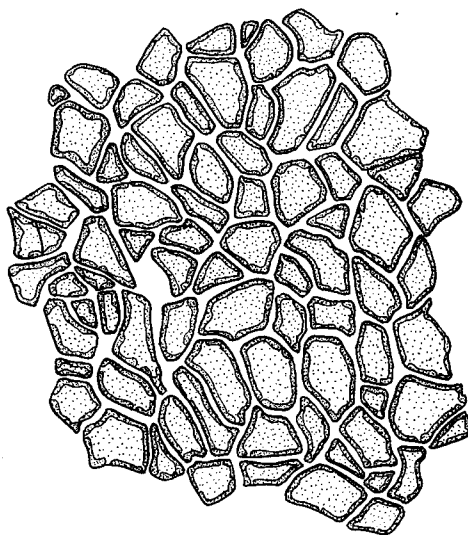


Fig. 4. A.

Fig. 4. *Hemineura schmitziana* De Toni et Okam. from Hyoro in Mimmaya Village

A. Surface view of frond $\times 200$; B. Margin of blade with a primordium of a lateral blade $\times 480$; C. Apical portion of blade $\times 480$; D. Cross section of frond $\times 200$; E. Longitudinal section of frond $\times 200$.

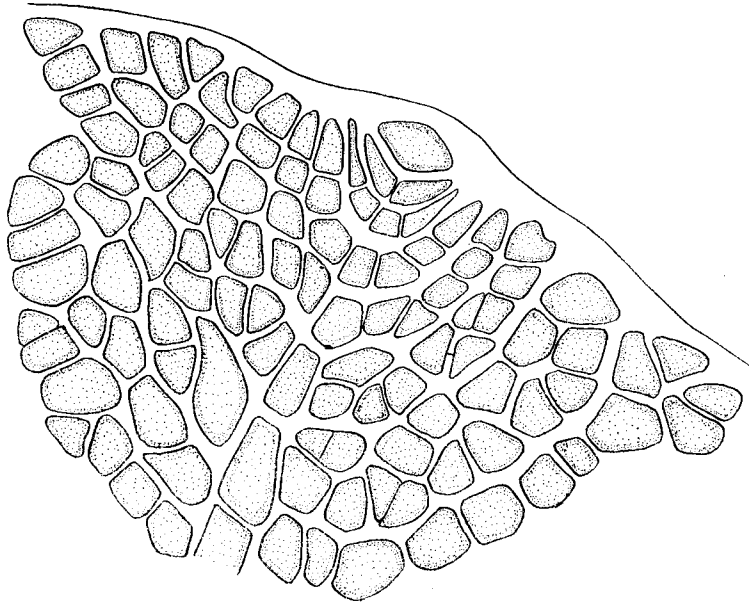


Fig. 4. B.

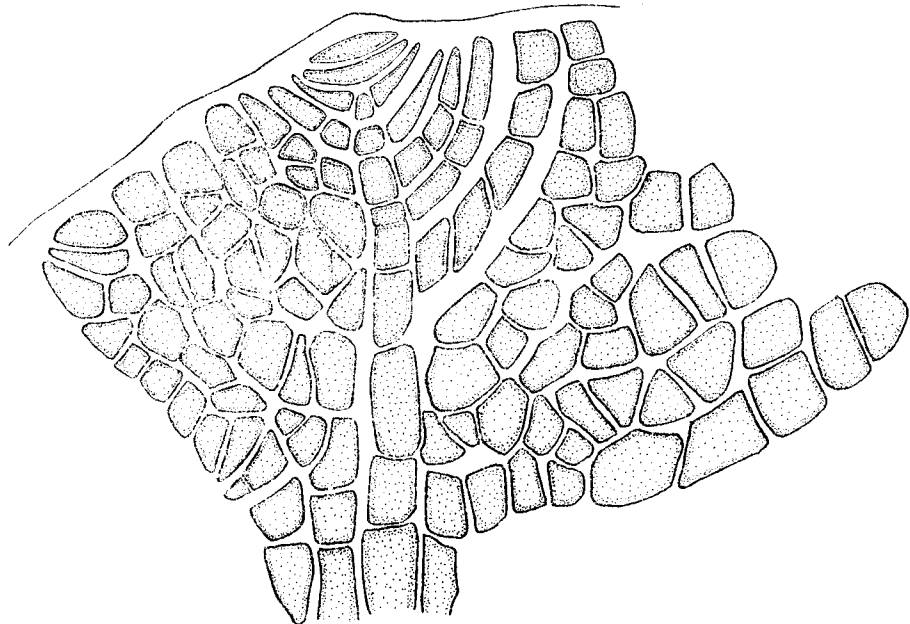


Fig. 4. C.

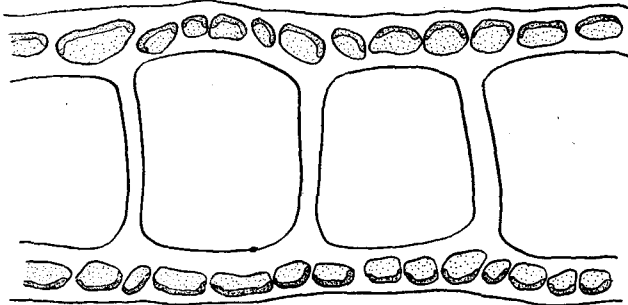


Fig. 4. D.

or oblong to lanceolate and narrow-linear in shape, with a midrib vanishing upwards; laciniae with or without midrib, becoming fainter at the base and the apex when present, and almost or quite vanishes just below the apex; laciniae ending in blunt apices. Margins irregularly crenate or sparingly proliferous, denticulate, and sometimes laxly and distantly laciniate. The lateral laciniae patent, with rounded axils, oblong in shape, up to 2 cm in length, either broad or narrow rounded or obtuse at the apex. Color rosy red, often faint. Substance softly membranous, delicate but not gelatinous, and the frond can be immersed long in fresh water without damage. The plant firmly adheres to paper on drying. Our specimens are all sterile. Internally the frond is up to $150\ \mu$ thick and

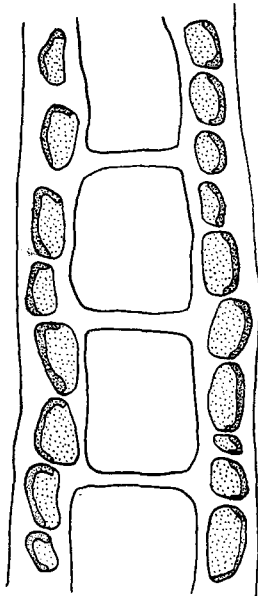


Fig. 4. E.

Table 1. The dimensions of the cortical cells of *Hemineura schmitziana* in surface view

No. of cell	Height	Breadth
1	$45\ \mu$	$15\ \mu$
2	45	15
3	39	21
4	36	33
5	36	21
6	35	18
7	30	15
8	30	15
9	21	15
10	16	9

composed of one layer of large medullary cells and one layer of small cortical cells on either side of the medulla. The medullary cells are $90\ \mu$ high, nearly quadrate in shape with rounded corners in transverse section, colorless, with cell walls $5\ \mu$ thick. The cortical cells are rather flat as seen in transverse section, $15\text{--}18\ \mu \times 24\text{--}36\ \mu$, with rose red content filled with minute granules, irregularly polygonal in shape in surface view, $16\ \mu \times 9\ \mu$ to $45\ \mu \times 15\ \mu$ (cf. Table 1); surface jelly $3\text{--}4\ \mu$ thick.

The specimens of this species were collected together with several sea urchins by dredging from the sea bottom at the depth of 20.1 meters and 500 meters off the shore of Hyoro, Mimmaya Village. They were attached to *Lithophyllum okamurai* which was growing on rocks. Our specimens agree quite well with the plant illustrated by Okamura (1901) in external and internal structures except in having several perforations on the surface of the frond. The number of the specimens at hand are not enough to ascertain whether these perforations are of normal occurrence or only exceptional.

This beautiful deep-water alga has hitherto been known to occur along the Pacific coast from Kyushu as far north as the Tsugaru Straits.

Summary

1. In the present paper is reported the occurrence in the Tsugaru Straits of five warm water species of marine algae, namely, *Caulerpa okamurai*, *Codium adhaerens*, *Padina arborescens*, *Undaria peterseniana*, and *Hemineura schmitziana*, collected in June and August, 1955, at Mimmaya Village, Aomori Prefecture, except for *Undaria peterseniana* which was collected in July 1961 at Imabetsu Town, Aomori Prefecture, and again in May 1963 at Fukushima Town, Oshima Province, Hokkaido. All of them except *Codium adhaerens* seem to have their northern limit of distribution in the Straits.

2. *Padina arborescens* and *Hemineura schmitziana* are reported for the first time from the coast of Aomori Prefecture within the Tsugaru Straits; *Undaria peterseniana* is also reported for the first time from both sides of the Straits.

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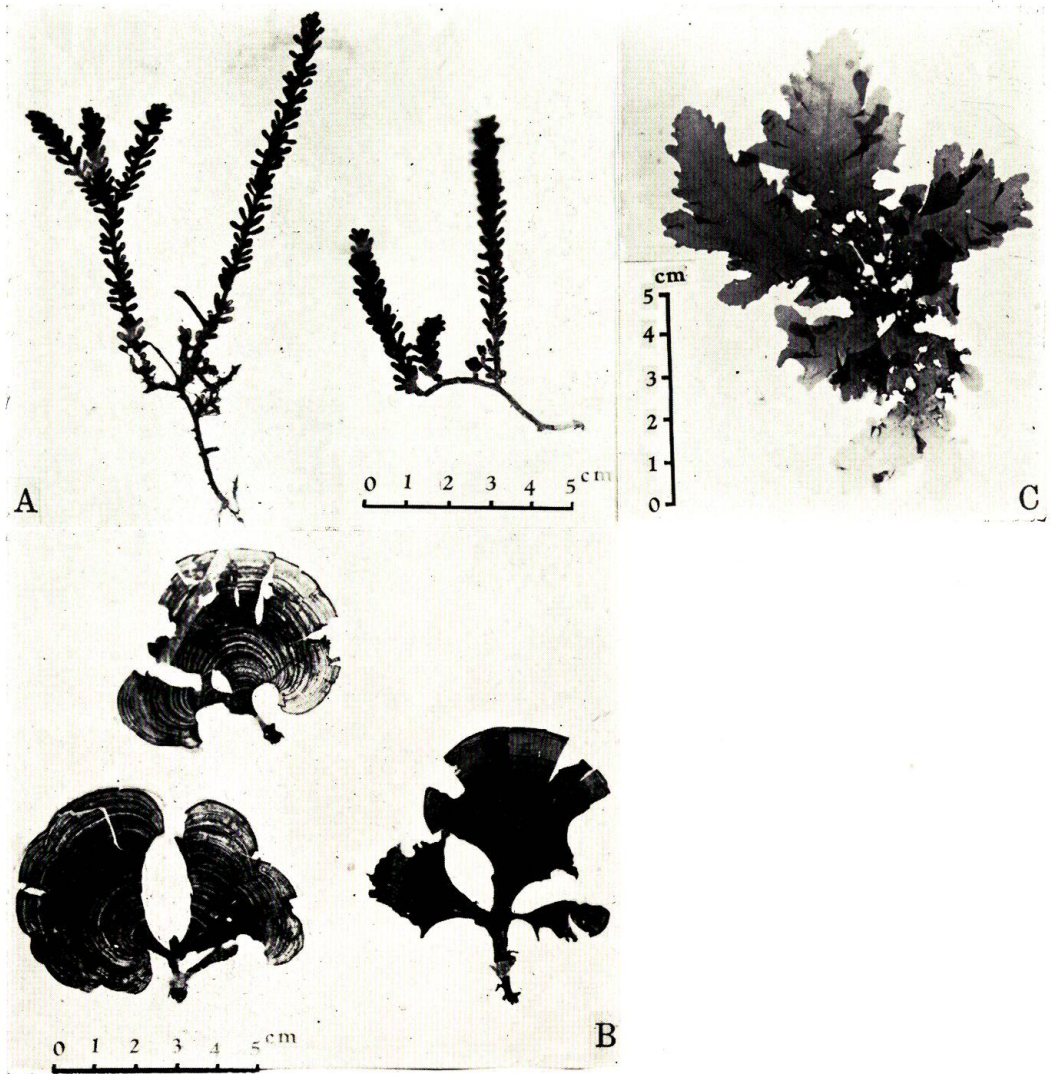
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Explanation of Plate

PLATE I

Habit of plants

- A. *Caulerpa okamurai* Weber van Bosse from Kami-utetsu, Mimmaya Village
- B. *Padina arborescens* Holmes from the same locality as A
- C. *Hemineura schmitziana* De Toni et Okam. from Hyoro in Mimmaya Village



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