

On Ecology of *Caulerpa scalpelliformis* var. *denticulata* in the Oki Islands

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Systematic exploration of the Oki Islands (Fig. 2) for a study on the ecology of *Caulerpa scalpelliformis* (R. Br.) Ag. var. *denticulata* (Decsn.) Weber van Bosse^{1),5)} (Fig. 1) has never been attempted by anyone since Okamura (1921) reported the occurrence of this alga in the Islands. He collected it on September 29, 1910, in shallow water around the remains of the Kurogi Palace on the northern shore of Beppu Bay in Nishinoshima Island. This interesting alga is well known among the people there to grow in Beppu Bay and Hishiura Bay in the District of Dozen. The alga is protected by the law as a natural monument since March 8, 1922.

The Oki Islands are divided into two districts, namely Dozen and Dogo,



Fig. 1. *Caulerpa scalpelliformis* var. *denticulata*. Habit of a fresh steril specimen collected in Mita Bay, 22 November 1967.

and comprise about 180 islands lying between latitudes $30^{\circ}22'N.$ and $35^{\circ}98'N.$ and between longitudes $132^{\circ}93'E.$ and $133^{\circ}26'E.$. The Islands are washed by Tsushima Warm Current all along the coasts, and their open coasts are often exposed to violent waves during typhoon and monsoon seasons in early autumn and in winter respectively.

The present report deals with the result of explorations carried out to study the ecology of this alga in twenty one bays in the Islands during the period from early May 1967 to middle May 1968. These bays are among the forty bays selected for my exploration project on the basis of the result of a preliminary exploration in Nishinoshima Island.

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Materials and Methods

The fronds or erect assimilatory branches in my materials are often found to attain 25 cm or more in height though they were described by Okamura to attain 10-15 cm in height⁵. The assimilatory branches often bear secondary and sometimes also tertiary branches proliferated from both surfaces. The branches are bright green in color when fresh from the sea, but they look dark green tinged with black while submerged in the field. Younger branches are all standing upright but older ones are prostrate and attached to the substratum by rhizoids issued from their surfaces.

A preliminary exploration on ecology of the alga was carried out at about thirty stations along the coast of Nishinoshima Island during the period from the beginning of September 1966 to the end of April 1967, and the results obtained are as follows. The plant was found growing only in Mita Bay, Beppu Bay and Ooyama Bay where the sea is calm almost throughout the year, but not growing along the open sea coasts. Rich vegetations of the alga were observed on sandy, muddy, or sandy-muddy bottom at a depth of 6-18 feet. The water in those bays was clear enough at that depth to make observations of the plant community from a boat possible. The plant was also growing on

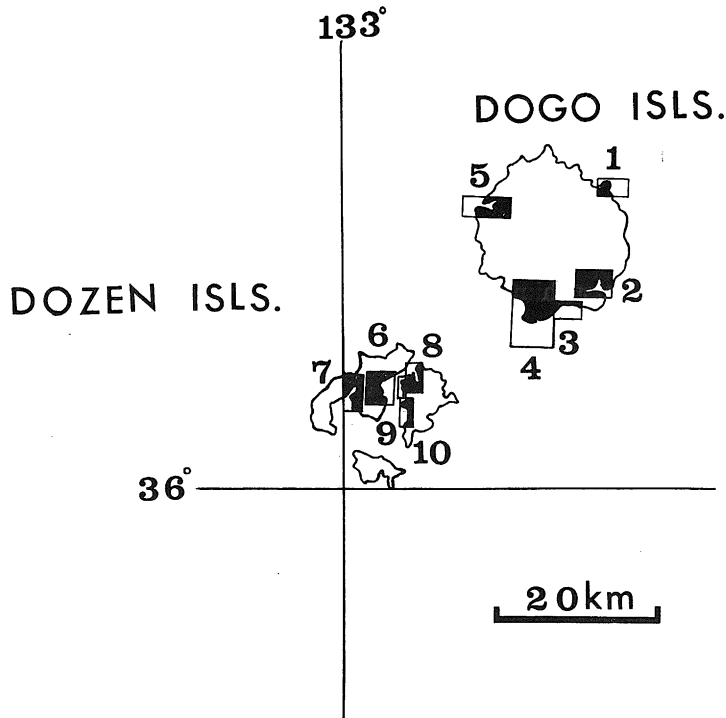


Fig. 2. Map of the Oki Islands, showing the site of the bays explored by blackening within the rectangles (1-10).

gravelly or rocky bottoms, on sunken tree-trunks, or even on ropes. Fragments of the plant were often collected with a steel dredge (Fig. 9), anchor or collector of sea-cucumber, from the bottom at a depth beyond 30 feet. However, present exploration was restricted to the bottom at a depth of 3-18 feet on account of the transparency of water at that depth. Thus the forty calm bays of the Islands were selected for my study but the exploration was carried out in twenty one of those bays, during the period ranging from early May 1967 to middle May 1968, namely in Fuse Bay, Saigo Bay, Imazu Bay, Tsutsuka Bay, Kamo Bay, Tsudo Bay, Tsuma Bay, Omosu Bay, Beppu Bay, Ooyama Bay, Sotohama Bay, Mita Bay, Hishiura Bay, Suwa Bay, Higashihishiura Bay, Nishihishiura Bay, Kitaatodo Bay, Minamiatodo Bay, Kitahinozu Bay, Hinozu Bay and Suga Bay (Fig. 2-4). The sea bottom was observed while swimming or skin-diving, while the extent of the plant-covered areas was measured with a sunken steel frame (Fig. 10, 11) or by taking photographs from the boat, and the specimens of the plant which had been tagged in advance (Fig. 8, 11) were collected with a hook from the boat.

Results

As far as the present exploration is concerned, *Caulerpa scalpelliformis* var. *denticulata* was found growing only in Mita Bay, Beppu Bay, Ooyama Bay, Hishiura Bay, Higashihishiura Bay, Nishihishiura Bay, Kitaatodo Bay and Minamiatodo Bay. Brief descriptions of these bays and other thirteen bays explored are given below.

(1) Fuse Bay (Map 1, A). The northern part of the bay or the region extending from Matsushima to the estuary of the Kasuga River via Hirajima

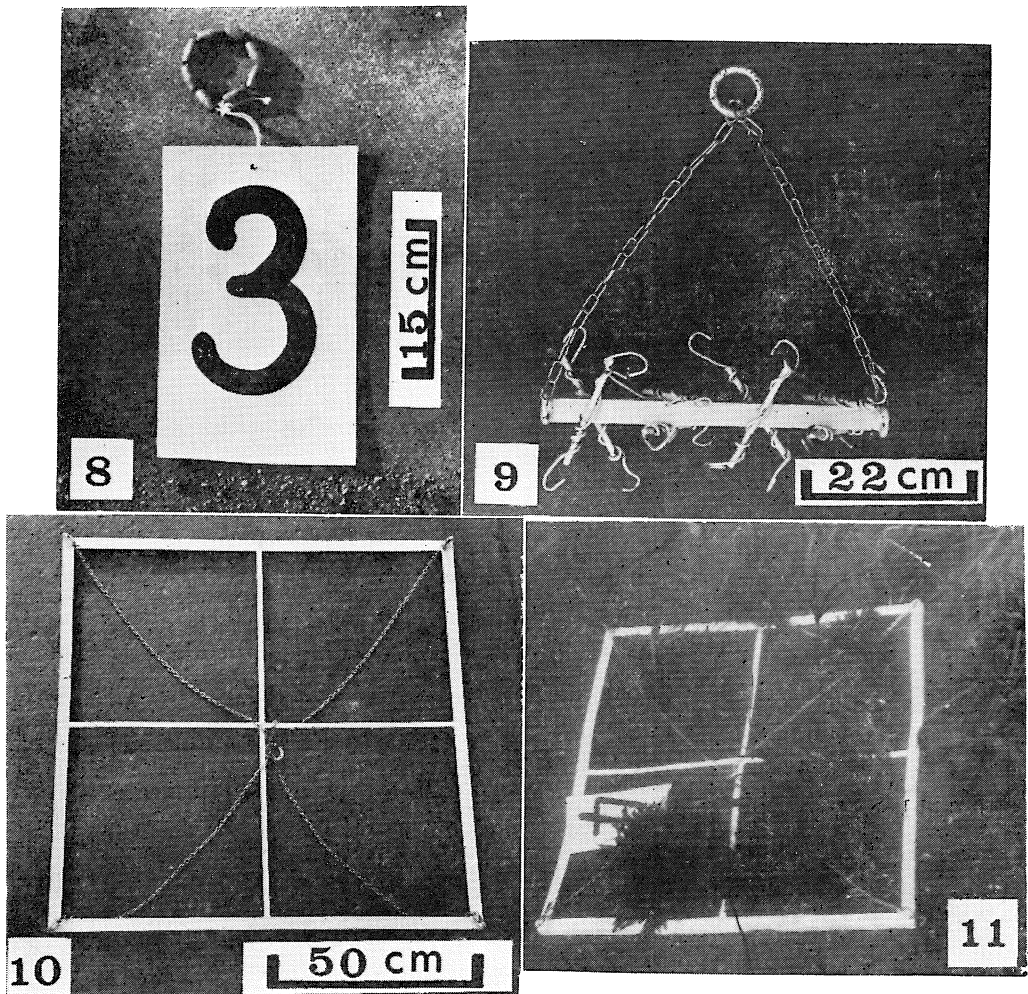


Fig. 8-11. Instruments used in the field research: 8, a plastic tag with a ring of lead sinkers used for numbering a group of *Caulerpa scalpelliformis* var. *denticulata*; 9, a steel dredge used for collecting the plant from a deeper bottom; 10, a steel frame used for measuring size of plant groups; 11, photograph of a steel frame placed on a group of the plant growing at a depth of 5 feet, taken from the boat.

Island was explored since the southern part is exposed to rough waves during typhoon and monsoon seasons. No growth of *Caulerpa* was found. There was a rich vegetation of *Zostera caespitosa* Miki^(2),8) which attained 6 feet in height, covering in groups nearly the whole bottom. There were growing poor vegetations of *Sargassum piluliferum* C. Agardh, *S. patens* C. Agardh, *S. horneri* (Turner) C. Agardh, *S. fulvellum* J. Agardh and *Chorda filum* (Linné) Lamouroux^(6),7) without forming marine forests on gravelly bottoms anywhere in July. No pollution of water was detected with the naked eye. Nature of the bottom was various, being gravelly at a place but sandy, muddy, or sandy-muddy in others.

(2) Saigo Bay (Map 2, B). Nishida Bay and the northern part of Saigo Bay or the region extending from Oda to Ooshimazaki via Togo and Iida were explored since the region extending from Ookamejima Island to Funejima Island via Kyogajima Island and that extending from Takai to Natagasaki are exposed to rough waves during typhoon and monsoon seasons. No growth of *Caulerpa* was found. There was a rich vegetation of *Zostera caespitosa*, which attained to 6 feet in height, covering nearly the whole bottom. There were also growing thin vegetations of *Sargassum kjellmanianum* Yendo^(6),7) besides the main members of the marine forests in Fuse Bay to form typical marine forests anywhere on gravelly bottom in July. A slight pollution of water was detected with the naked eye in the southern corner of Nishida Bay. The bottom was mostly muddy, but sandy-muddy or gravelly bottoms were also found here and there. A little amount of organic sediments consisting mostly of dead fronds of *Zostera* was found scattered.

(3) Imazu Bay (Map 3, C). The region outside the breakwater extending to a distance of 1 km and the whole area inside the breakwater except around the fishing port pier were explored. No growth of *Caulerpa* was found. Poor vegetation of *Zostera caespitosa* was seen covering the bottom in groups here and there. There were poor vegetations of almost the same main algal members as found in Saigo Bay without forming any typical marine forests on gravelly and rocky bottoms outside the breakwater in August. The bottom inside the breakwater was sandy or gravelly while it was mostly rocky outside. A slight pollution of water and some amount of organic sediments were detected in the innermost area of the bay.

(4) Tsutsuka Bay (Map 3, D). The coastal area extending from Akasaki Point to the opposite side of the bay was explored. No growth of *Caulerpa* was found. Rich vegetations of *Zostera caespitosa*, *Z. nana* Roth^(2),8) and *Halophila ovalis* (R. Br.) Hook.^(2),8) were found everywhere in the bay, covering the bottom in groups. There were growing poor vegetations of almost the same algal members as found in Saigo Bay, etc. without forming marine forests

on gravelly and rocky bottoms in August. Pollution of water and sediments of diatom cells were observed in the eastern part of the area, but organic sediments were rare. The bottom was mostly gravelly or sandy, but partly also rocky.

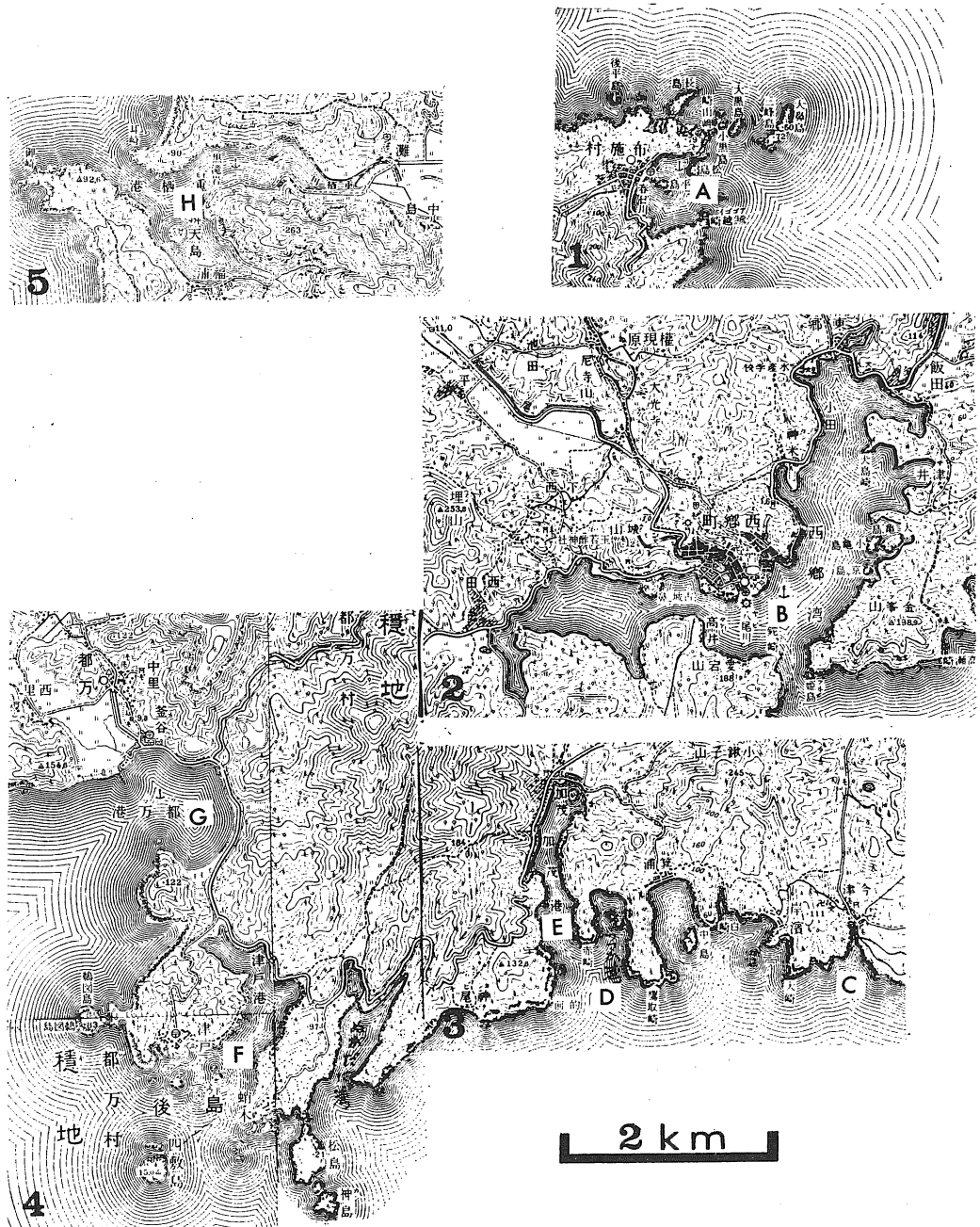


Fig. 3. Details of the rectangular pieces (1-5) of the Map in Fig. 2, showing the bays (A-H) explored.

(5) Kamo Bay (Map 3, E). The area extending from the pier to the middle portion of the eastern coast via Bentenjima Islet was explored since the eastern coast is exposed to rough waves during typhoon and monsoon seasons. No growth of *Caulerpa* was found. There was a rich vegetation of *Zostera caespitosa*, which attained to 6 feet in height, covering the bottom around the islet densely in groups. There were growing poor vegetations of almost the same members of *Sargassum* and *Chorda* as found in Saigo Bay, etc., to form no marine forests on gravelly or rocky bottoms in August. Pollution of water and sediment of diatom cells were observed in northeastern area, while a slight organic sediments were observed only around the islet.

The bottom was mostly muddy, but it was also sandy, gravelly, or rocky in part.

(6) Tsudo Bay (Map 4, F). The whole area of the bay was explored as it is well known among the people to be the most calm bay in Oki Province. No growth of *Caulerpa* was observed. Rich vegetations of *Zostera caespitosa* and *Z. nana*, which attained to 6 feet and 6 inches or more in height respectively, were found in the innermost area covering almost the whole bottom explored densely. There were growing vegetations of the same algal members as found in Fuse Bay but not enough to form marine forests on gravelly bottoms in August. Pollution of water was slightly observed with the naked eye. Organic sediments consisting mainly of dead fronds of *Zostera caespitosa* were rich in the innermost area called Okutsudo. The bottom was sandy or muddy, but partly also gravelly.

(7) Tsuma Bay (Map 4, G). The area extending from the middle of the eastern coast to the cape was explored since the northern coast of the bay is exposed to rough waves during typhoon and monsoon seasons. No growth of *Caulerpa* was found. Rich vegetations of *Zostera caespitosa*, *Z. nana*, and *Halophila ovalis* covered the bottom in groups almost all over the area explored. There were growing the same species of *Sargassum* and *Chorda* as found in Fuse Bay, etc. growing on gravelly bottom, but their vegetations were too poor to form marine forests in July. Pollution of water and organic sediments were hardly observed. The bottom was mostly sandy or muddy, but it was also gravelly in part.

(8) Omosu Bay (Map 5, H). The southern area extending from Bentenjima Islet to Fukuura was explored since the northern part of the bay was partly polluted heavily and exposed as a whole to rough waves during typhoon and monsoon seasons. No growth of *Caulerpa* was found. Rich vegetations of *Zostera caespitosa*, *Z. nana*, and *Halophila ovalis* were found covering the bottom densely in groups. There were growing poor vegetations of the same species of *Sargassum* as found in Saigo Bay, etc., to form no marine forests on gravelly bottoms around Bentenjima Islet in August. Pollution of water

and organic sediments were scarcely observed. The bottom was sandy or muddy, or gravelly in part.

(9) Beppu Bay (Map 6, I). The whole coast of the bay from Butsui on the north to the cape on the south, including the waters around the remains of the Kurogi Palace, Okimaru pier, Mitsukejima Islet and Mitajiri, was explored. Rich vegetation of *Zostera caespitosa* was found to cover the bottom widely. There were growing rich vegetations of such members of Phaeophyta as *Sargassum piluliferum*, *S. patens*, *S. horneri*, *S. fulvellum*, *S. kjellmanianum* and *Chorda filum* on gravelly bottoms to form moderate marine forests in the portion from Mitsukejima Islet southward during the time ranging from late fall to late spring. The vegetations were poor during the summer season. *Caulerpa*, 7 inches long and 0.6 inches wide on an average, was found

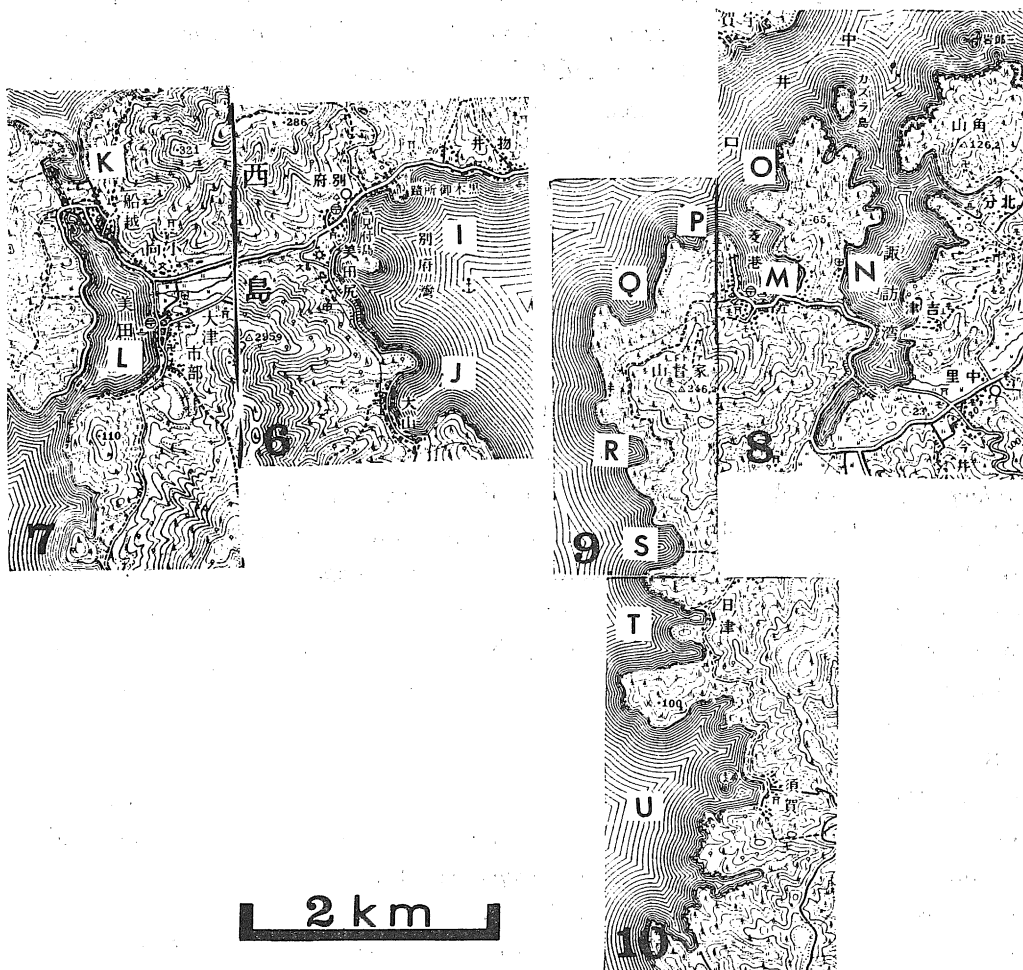


Fig. 4. Details of the rectangular pieces (6-10) of the Map in Fig. 2, showing the bays (I-U) explored.

growing in groups among the fronds of *Zostera caespitosa*, *Z. nana* and *Halophila ovalis* in April, in the area extending from Okimaru pier to the cape via Mitajiri and Mitsukejima Islet (Table 1; Fig. 5, I). The vegetation of the alga on the bottom explored was estimated to cover a wide area up to 20.8 m² in total, though the alga was believed to grow in deeper waters too from the fact that fragments of the alga were frequently collected by dredging or they attached to the anchor hauled up from the bottom beyond the depth explored. Pollution of water was not observed while a remarkable underwater current and slight organic sediments were seen around the pier. The bottom was sandy or muddy, or gravelly in part, and washed by a remarkable underwater current.

(10) Ooyama Bay (Map 6, J). Nearly the whole coast of the bay was explored. The poor vegetations of *Caulerpa*, 1.5 inches long and 0.3 inches wide on an average, were found growing among the fronds of *Zostera caespitosa*, 5 feet or more in height, covering the bottom widely in groups in August (Table 1; Fig. 5, J). *Sargassum piluliferum*, *S. patens* and *Chorda filum* were found growing on gravelly bottom but their vegetations were not rich enough to form marine forests in August. Pollution of water and organic sediments were slightly observed in the innermost area. A remarkable underwater current was detected in the neighborhood of the *Caulerpa* vegetation. The bottom was mostly muddy, but it was also gravelly in part.

(11) Sotohama Bay (Map 7, K). The whole area except the mouth of the bay was explored. This bay is connected with Mita Bay through Funahiki Canal. No growth of *Caulerpa* was found. *Zostera caespitosa* was found covering the bottom widely. There were growing poor vegetations of the same main algal members as found in Beppu Bay to form no marine forests on rocky bottoms at the mouth of the bay in August. Pollution of water and organic sediments were scarcely observed. The bottom was mostly sandy or muddy, but it was also rocky in part.

(12) Mita Bay (Map 7, L). Nearly the whole coast of the bay except around the fishing port at the innermost part of the bay was explored. *Caulerpa*, 5 inches long and 0.4 inches wide on an average, was found growing in groups at Station h in November, and the plant 7 inches long and 0.6 inches wide at Stations d, e, f and g in April. The plant grows along the central part of the western coast opposite to Ootsu and also along the eastern coast from Komukai to the north via Ootsu and Ichibe, most richly on the western coast around Taikojima Point (Fig. 6, L). The area covered by the algal vegetation was estimated to be 31.6 m² in total (Table 1). The alga was commonly growing among the fronds of *Zostera caespitosa* and *Halophila ovalis*, mostly on muddy or sandy bottom but at times on gravelly or rocky bottom, or even

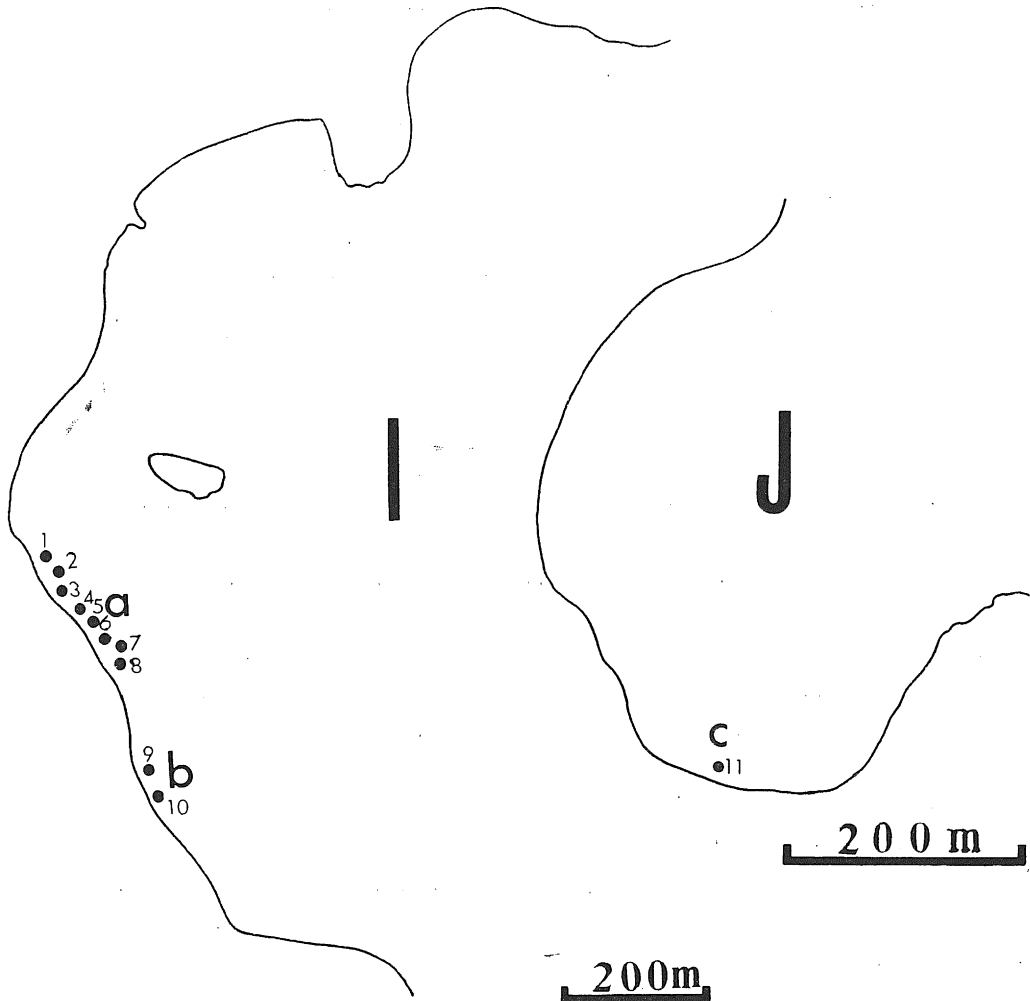


Fig. 5. Details of the bays (I and J) in the rectangular piece (6) of the Map in Fig. 2, showing stations (a-c) where *Caulerpa scalpelliformis* var. *denticulate* was detected as growing in groups (1-11).

on sunken tree-trunks, ropes, shells of molluscs or such organic deposits as cones of *Pinus thunbergii* Parl., *P. densiflora* Sieb. et Zucc., *Cryptomeria japonica* D. Don, *Cunninghamia lanceolata* Hook. or chaffs of *Oryza sativa* L., *O. sativa* L. var. *glutinosa* Matsum., *Triticum aestivum* L., *Hordeum vulgare* L. var. *hexastichon* Aschers., etc.. Rich vegetation of the alga was also supposed to be present in deeper waters from the fact that fragments of the alga were collected by dredging or they attached to the anchor hauled up from the bottom beyond the depth explored. Vegetations of almost the same algal members as found in Beppu Bay, etc., were rich on gravelly bottoms restrictively along the western bay-coast in April but they were poor during

the summer season. Pollution of water and organic sediments were scarcely observed in the area extending from Funakoshi to Ootsu via Komukai. The bottom was washed by an underwater current. Nature of the bottom was mostly muddy and sandy but gravelly or rocky in part.

(13) Hishiura Bay (Map 8, M). The whole coast of the bay except around Okimaru pier at the innermost part was explored. *Caulerpa*, 5 inches long and 0.4 inches wide on an average, was found growing in groups among the fronds of *Zostera caespitosa* and *Halophila ovalis*, on sandy-muddy bottom, covering an area of about 6 m² at a depth of 10 feet in November (Table 1 ; Fig. 6, M). There were growing poor vegetations of almost the same members of Phaeophyta as found in Beppu Bay, etc., to form no typical marine forests on gravelly bottom in November. In the neighborhood of the *Caulerpa* vegetation there was no pollution of water, but a little amount of organic sediments mainly consisting of dead fronds of *Zostera caespitosa* and a remarkable underwater current were observed. Nature of the bottom was mostly muddy but sandy-muddy or gravelly in part.

(14) Suwa Bay (Map 8, N). The whole coast of the bay, except its southernmost part and the fishing port at Kitabu in the north, was explored. No growth of *Caulerpa* was found. A rich vegetation of *Zostera caespitosa* which attained to 5 feet in average height was seen covering almost the whole area explored. There were growing rich vegetations of the same algal members as found in Beppu Bay, etc., to form luxuriant marine forests on rocky bottoms restrictedly around the mouth of the bay in November.

(15) Higashihishiura Bay (Map 8, O). The coast of the bay was wholly explored. *Caulerpa*, 5 inches long and 0.4 inches wide on an average, was found growing respectively among the fronds of *Zostera caespitosa* which was in poor vegetations at a depth of 15 feet near the northern end of the bay in November (Table 1 ; Fig. 7, O). There were growing rich vegetations of the same members of Phaeophyta as found in Beppu Bay, etc., to form luxuriant marine forests on gravelly bottom in southern part of the bay in November. In the neighborhood of the *Caulerpa* vegetation there was no pollution of water but a little amount of organic sediments consisting mostly of dead fronds of *Zostera caespitosa* and a remarkable underwater current were detected with the naked eye. Nature of the bottom was mostly sandy muddy but gravelly in part.

(16) Nishihishiura Bay (Map 9, P). The entire coast of the bay including the islet on the western end of the bay was explored. *Caulerpa*, 1.5 inches long and 0.3 inches wide on an average, was found growing in groups among poor vegetations of *Zostera caespitosa* on sandy-muddy bottom at a depth of 10 feet around the middle of the bay-coast in August (Table 1 ; Fig. 7, P).

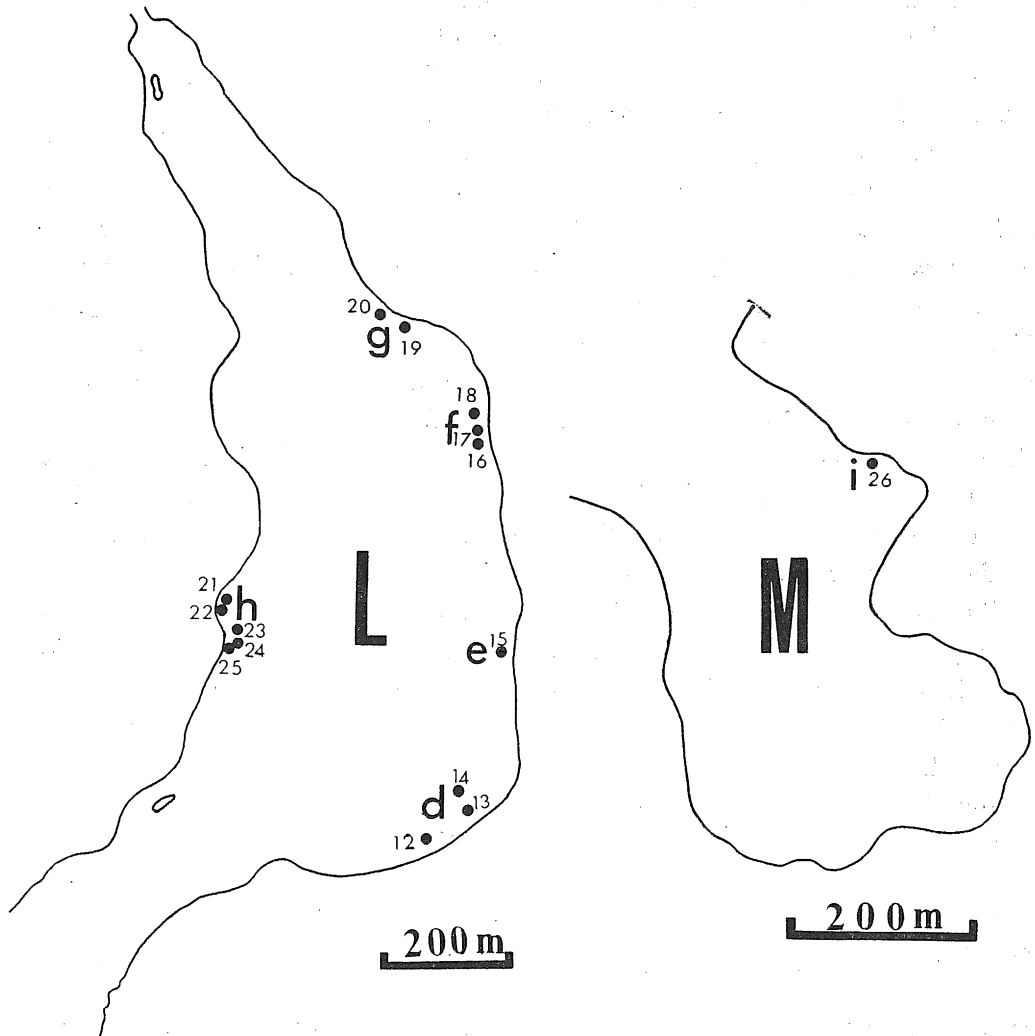


Fig. 6. Details of the bays (L and M) in the rectangular pieces (7 and 8) of the Map in Fig. 2, showing stations (d-i) where *Caulerpa scalpelliformis* var. *denticulata* was detected as growing in groups (12-26).

There were growing poor vegetations of *Sargassum patens*, *S. piluliferum*, *S. horneri*, *S. kjellmanianum* and *Chorda filum* to form sparse marine forests here and there on gravelly bottoms in August. A remarkable underwater current and a slight amount of organic sediments consisting mainly of dead fronds of *Zostera caespitosa* but no pollution of water were detected around the *Caulerpa* vegetations with the naked eye. Nature of the bottom was sandy-muddy or gravelly.

(17) Kitaatodo Bay (Map 9, Q). Only the western half of the bay-coast was explored since the eastern half of the coast had rich vegetations of Phaeophyta,

up to 20 feet high, which formed luxuriant marine forests on gravelly or rocky bottoms and it was impossible to make an exploration there in April. The species of Phaeophyta found were as follows: *Sargassum piluliferum*, *S. horneri*, *S. serratifolium*,^(6),7) *S. patens*, *S. fulvellum*, *S. confusum*,⁽⁷⁾ *S. ringgoldianum*,^(6),7) *S. tortile*,^(6),7) and *Chorda filum*. The marine forests were fringed with a belt consisting of rich vegetations of brown algae such as *Sargassum thunbergii*,^(6),7) *S. kjellmanianum*, *S. hemiphyllum*,^(6),7) and *S. micracanthum*,^(6),7). The floor of the marine forest was densely covered with drifted fronds of brown algae such as *Ecklonia stolonifera* Okamura, *Colpomenia sinuosa* (Roth) Derbes et Solier and *Hydroclathrus clathratus* (Bory) Howe^(3),4),7). *Caulerpa*, 7 inches long and 0.6 inches wide on an average, was found abundantly growing in groups among the fronds of *Zostera caespitosa*, *Z. nana* and *Halophila ovalis* at a depth of approximately 12 feet in April (Table 1; Fig. 7, Q). Rich vegetations of *Caulerpa* were also supposed to be present in deeper waters from the fact that fragments of the alga were frequently collected by dredging or they attached to the anchor hauled up from the bottom beyond the depth explored. A remarkable underwater current washing the bottom and a slight amount of organic sediments consisting mainly of dead fronds of *Zostera caespitosa* were detected with the naked eye around the *Caulerpa* vegetations. There was no pollution of water. The bottom was mostly sandy-muddy, but partially gravelly or rocky.

(18) Minamiatodo Bay (Map 9, R). Only the northern half area of the bay was explored since the southern half of the bay had in April exuberant marine forests consisting mostly of the same main algal members as found in Kitaatodo Bay. The bay-floor was widely covered with a luxuriant marine meadow consisting of brown algae such as *Ecklonia stolonifera*, *Colpomenia sinuosa* and *Hydroclathrus clathratus*. *Caulerpa*, 7 inches long and 0.6 inches wide on an average, was observed growing in groups among thin vegetations of *Zostera caespitosa* at a depth of 17 feet near the northern end of the bay in April (Table 1; Fig. 7, R). Slight pollution of water and a remarkable underwater current were detected with the naked eye in the neighborhood of the *Caulerpa* vegetation. A little amount of organic sediments consisting mainly of dead fronds of *Zostera caespitosa* was observed occasionally on the bottom. Nature of the bottom was mostly sandy-muddy but gravelly or rocky in part.

(19) Kitahinozu Bay (Map 9, S). The bay was explored along the whole coast. No growth of *Caulerpa* was found. A marine meadow consisting mostly of the same main members of Phaeophyta as found in Minamiatodo Bay was seen covering widely the bottom in April, while poor vegetations of *Zostera caespitosa* were observed fringing the bay-coast. Slight pollution of water and underwater current were detected with the naked eye. A little amount of organic sediments consisting mainly of dead fronds of *Zostera caespitosa* was

observed in shallower areas along the coast. Bottom was mostly rocky or gravelly but partially sandy.

(20) Hinozu Bay (Map 10, T). Whole coast of the bay was explored. No growth of *Caulerpa* was found. A rich marine meadow consisting of *Zostera caespitosa* was observed in two innermost areas, covering densely the entire

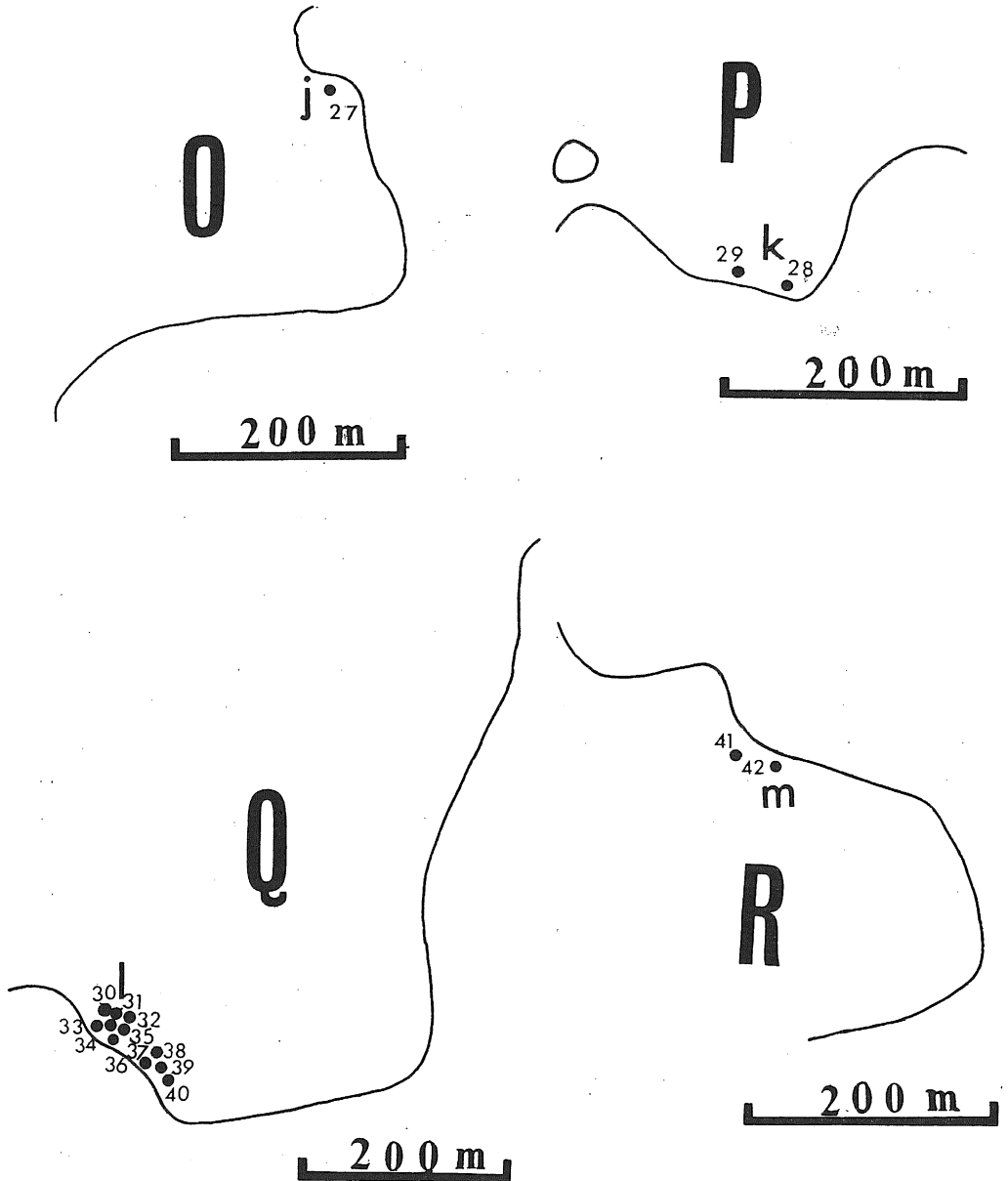


Fig. 7. Details of the bays (O-R) in the rectangular pieces (8 and 9) of the Map in Fig. 2, showing stations (j-m) where *Caulerpa scalpelliformis* var. *denticulata* was detected as growing in groups (27-42).

bottom. Other portions of the bay were mostly occupied by luxuriant *Sargassum* forests in April consisting mostly of the same species as found in Minamiatodo Bay, etc.. There was detected no pollution of water nor underwater current. A rich amount of organic sediments consisting mainly of dead fronds of *Zostera caespitosa* was observed in the innermost areas. Nature of the bottom was mostly rocky and gravelly except the innermost areas where it was simply muddy.

(21) Suga Bay (Map 10, U). The whole coast of the bay including the islets in front of Sugajinja Shrine was explored. No growth of *Caulerpa* was found. The bottom was widely covered with a rich marine meadow in April which consisted of nearly the same main algal members as found in Minamiatodo Bay, while a meadow of *Zostera caespitosa* was observed covering densely the bottom in the innermost areas. Pollution of water was slightly detected in the innermost areas where some amount of organic sediments consisting mainly of dead fronds of *Zostera caespitosa* was observed. There was no underwater current. Nature of the bottom was generally rocky or gravelly except the innermost areas where it was simply sandy-muddy.

Discussion

Caulerpa scalpelliformis var. *denticulata* was found growing restrictively in eight of the twenty one bays explored which are calm throughout the year because of their geographical conditions. Existence of luxuriant marine forests in certain bays was considered to have a moderating influence on wave action which seemed to be favorable for the growth of *Caulerpa* in colder seasons. *Caulerpa* was commonly found growing in groups among the fronds of *Zostera caespitosa*, mostly on muddy, sandy-muddy, or sandy bottoms which were generally covered by slight organic sediments consisting mainly of dead fronds of *Zostera caespitosa*, though it was also growing in some bays among the vegetations of *Zostera nana* or *Halophila ovalis* or exceptionally on gravelly or rocky bottoms, sunken tree-trunks, shells of molluscs, ropes, pine cones, or chaffs of cereals. It was commonly to observe a remarkable underwater current but no pollution of water in the neighborhood of *Caulerpa* vegetations, though a slight pollution of water was exceptionally detected with the naked eye around *Caulerpa* vegetations in some bays. Existence of underwater current and wave action, as well as absence of pollution of water, were considered to be favorable for the growth of this alga. The area occupied by the vegetations of *Caulerpa* in the Oki Islands was estimated to be 138.6 m² in total (Table 1). However, rich vegetations of this alga were supposed with certainty to be present in deeper places beyond the depth explored in certain bays from the

Table 1. Results of ecological observation on the groups of *Caulerpa scalpelliformis* var. partially thick ; PSP, partially sparse ; S, sandy ; M, muddy ; SM,

Bay	I									
Station	a								b	
Group #	1	2	3	4	5	6	7	8	9	10
Size of group (m ²)	2.0	3.5	6.1	0.7	4.0	1.0	1.5	2.0	1.5	1.0
Density of group	TH	TH	TH	SP	TH	TH	PSP	TH	TH	TH
Measuring method	DI	DI	DI	PH	DI	DI	DI	DI	DI	DI
Substratum	M	G&S	M						M	
Month of observation	Apr.								Apr.	
Total size of groups at each station (m ²)	20.8								2.5	

Bay	M	O	P		Q					
Station	i	j	k		l					
Group #	26	27	28	29	30	31	32	33	34	35
Size of group (m ²)	6.0	12.5	1.0	0.8	8.3	3.0	1.0	9.2	5.3	3.2
Density of group	TH	PSP	SP	SP	TH	TH	TH	TH	PSP	TH
Measuring method	DI	DI	DI	DI	PH	DI	DI	DI	DI	DI
Substratum	SM	SM	SM		SM					
Month of observation	Nov.	Nov.	Aug.		Apr.					
Total size of groups at each station (m ²)	6.0	12.5	1.8		46.9					

fact that fragments of this alga were frequently collected by dredging or found attached to an anchor. *Caulerpa* showed marked seasonal variations in frond size and vegetation density (Table 1). Annual change of the growth rate of *Caulerpa* has its maximum in colder seasons while its minimum just after the fruiting season¹⁾.

As a result of the present ecological study, it seems to be quite reasonable to claim that the *Caulerpa* vegetations found in the southern part of Beppu Bay, Mita Bay and Kitaatodo Bay are more worthy of receiving legal protection as a natural monument than those found in the waters around the remains of the Kurogi Palace on the northern shore of Beppu Bay and in Hishiura Bay which have enjoyed such protection since March 8, 1922.

denticulata ; DI, direct method ; PH, photographic method ; SP, sparse ; TH, thick ; PTH, sandy-muddy ; R, rocky ; DO, dead organisms ; G, gravelly

J	L													
c	d			e	f			g		h				
11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
7.0	2.5	1.3	2.8	1.0	1.0	1.5	1.0	2.3	4.2	3.5	1.5	2.0	6.0	1.0
SP	PSP	PSP	PSP	TH	TH	PSP	TH	TH	PSP	PSP	TH	TH	TH	TH
DI	DI	PH	DI	DI	PH	PH	DI	DI	DI	PH	PH	DI	DI	DI
M	M			M	M			S	M	S&G	S	S&G	DO &M	R
Aug.	Apr.			Apr.	Apr.			Apr.		Nov.				
7.0	6.6			1.0	3.5			6.5		14.0				

					R	
					m	
36	37	38	39	40	41	42
2.5	7.5	2.5	3.5	0.9	6.5	3.0
TH	TH	TH	TH	TH	PSP	TH
DI	DI	DI	DI	DI	DI	DI
					SM	
					Apr.	
					9.5	

Summary

In this paper are reported the results of my explorations carried out during one year period ranging from early May 1967 to middle May 1968 at 21 bays in the Oki Islands for studying the ecology of *Caulerpa scalpelliformis* var. *denticulata*.

The alga was found growing restrictively in eight calm bays. Ecological considerations of these bays led to a conclusion that underwater current, wave action and water pollution are limiting factors of the growth of this alga.

Possibility of presence of the algal vegetations in deeper places beyond the explored depth (3-18 feet) is suggested. Legal protection of the algal vegetations in certain places other than those already protected is proposed with reasons.

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