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Marine Algae from Hirota Bay on the Pacific Coast of Northeastern Honshu, Japan

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Summary

Monthly collection of marine algae from the intertidal to subtidal zones in Hirota Bay (38°56′ N, 141°42′ E) on the Pacific coast of northeastern Honshu, Japan, was carried out from August 2005 to July 2006. A total of 95 species were listed, 12 of which belong to Chlorophyta, 24 to Phaeophyta, 58 to Rhodophyta, and one to sea grass. In these algae, the 10 species, *Urospora penicilliformis*, *Pachydictyon coriaceum*, *Chordaria flagelliformis*, *Myagropsis myagroides*, *Bangia gloiopeltidicola*, *Lithophyllum okamurae*, *Titanoderma tumidulum*, *Chondracanthus tenellus*, *Polysiphonia abscissa* and *P. sphaerocarpa*, were newly recorded to the marine algae from the coasts adjacent to Hirota Bay. The floral index of I/H value in Hirota Bay was 1.1, suggesting that the marine algal flora in Hirota Bay belongs to the typical subarctic zone.

Key words: marine algae, flora, maturation, life form

The marine algae from the Pacific coast of northeastern Honshu, Japan, have been extensively investigated in Shimokita Peninsula (Fuji and Yamamoto, 1972), the coast of Iwate Prefecture (Kawashima, 1954, 1955), Miyako (Taniguchi *et al.*, 1979), Okirai (Takamatsu, 1974), Iwai (Sato *et al.*, 2005), Kitakami (Nakata et al., 2001), Ogatsu (Taniguchi et al., 1985), Oshika Peninsula (Ogawa and Machida, 1976, 1977), Tomarihama (Agatsuma *et al.*, 2000), Sasunohama (Endo *et al.*, 2005), Matsushima Bay (Takamatsu, 1936; Narita *et al.*, 2006), and Iwaki (Suda, 1987; Sato *et al.*, 2001). For decades, marine flora is having been changed with the variation of hydrographic conditions, which is in turn affected by global warming (Taniguchi et al., 2006). Narita *et al.* (2006) reported that the flora index of I/H value in Matsushima Bay increased from 1.5 in 1936 to 1.7 in 2006, and the value in Iwaki also increased from 1.4 in 1987 to 1.9 in 2001. Detail records of current status of marine algae off a lot of coasts lead to a better

understanding of changing process of marine flora. In the present study, we investigated the marine algae from Hirota Bay (38°56′ N, 141°42′ E), an outstanding fishing ground under mixture of the Oyashio and Kuroshio Currents. The growth and maturation periods of these algae were also observed.

Materials and Methods

Marine algae and sea grasses were collected monthly by skin diving from the intertidal to subtidal zones in Hirota Bay, on the Pacific coast of northeastern Honshu, Japan (Fig. 1), from August 2005 to July 2006. The plants collected were preserved in 5% formaldehyde seawater and kept in dark conditions.

Each alga and sea grass was identified, and the presence of reproductive cells was recorded based on taxonomic literatures (Okamura, 1907-1933; Okamura, 1936; Segawa, 1956; Chihara, 1983; Yoshida, 1998). The algae identified were classified into five life-form groups: crustaceous algae, small annual algae, small perennial algae, large annual algae and large perennial algae, according to Taniguchi (1996). Finally, the marine algae and sea grass were preserved as dry herbarium specimens. The floral index of I/H value, that is the ratio of the number of species with isomorphic alternation of generations and lacking gametophytic generation, generally found in warm current areas (I) to heteromorphic alternation of generations, generally found in cold current areas (H) in both Chlorophyta and Phaeophyta (Nakahara and Masuda 1971), was also evaluated

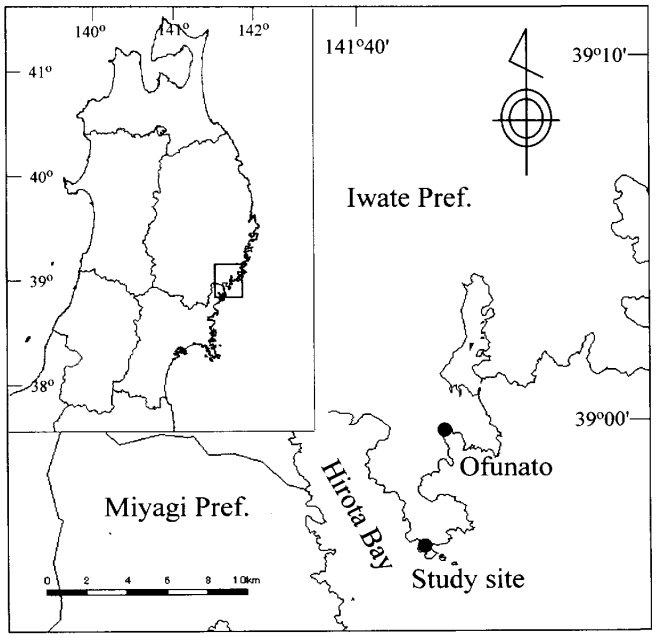

FIG. 1. The locations of study site in Hirota Bay and Ofunato in Iwate Prefecture, northeastern Honshu, Japan.

for determining the biogeographic region.

The surface water temperature in Hirota Bay during the study period was monitored with a normal thermometer every month. The data of monthly average water temperature at Ofunato (38°59′N, 141°43′E) (Fig. 1), a port near the study site, from 1980 to 2006 measured by Iwate Farming Fisheries Association were referred.

Results and Discussion

During this study, the surface water temperature in Hirota Bay ranged from a maximum of 23°C in August to a minimum of 5°C in March (Fig. 2). The water temperature was 0.3–1.3°C lower from February to May and 0.6–2.1°C higher from August to November than those of the monthly average water temperature for 27 years at Ofunato.

In this study, one sea grass and 94 species of marine algae were identified, 12 of which belong to Chlorophyta, 24 to Phaeophyta and 58 to Rhodophyta. These algae are shown with their growth and maturation periods and life forms in Fig. 3. In these algae, the 10 species, *Urospora penicilliformis*, *Pachydictyon coriaceum*, *Chordaria flagelliformis*, *Myagropsis myagroides*, *Bangia gloiopeltidicola*, *Lithophyllum okamurae*, *Titanoderma tumidulum*, *Chondracanthus tenellus*, *Polysiphonia abscissa* and *P. sphaerocarpa*, were newly recorded to the marine algae from the coasts adjacent to Hirota Bay (Kawashima, 1954, 1955; Takamatsu, 1974; Taniguchi *et al.*, 1979). In addition, six species of fucoids, *Cystoseira hakodatensis*, *Myagropsis myagroides*, *Sargassum hemiphyllum*, *S. horneri*, *S. macrocarpum* and *S. yezoense*, were recognized as drifting rockweeds.

The algae were classified into the five life forms as follows: 48 small annuals, 31 small perennials, six large annuals, six large perennials and three crustaceous

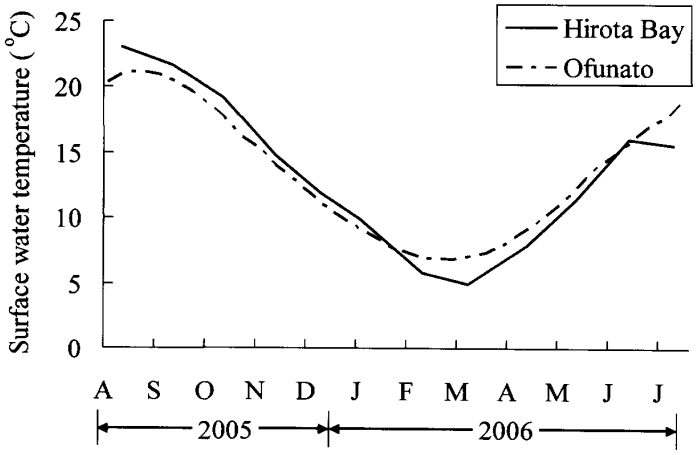

FIG. 2. Surface water temperature in Hirota Bay from August 2005 to July 2006 and monthly average water temperature for 27 years (1980–2006) at Ofunato.

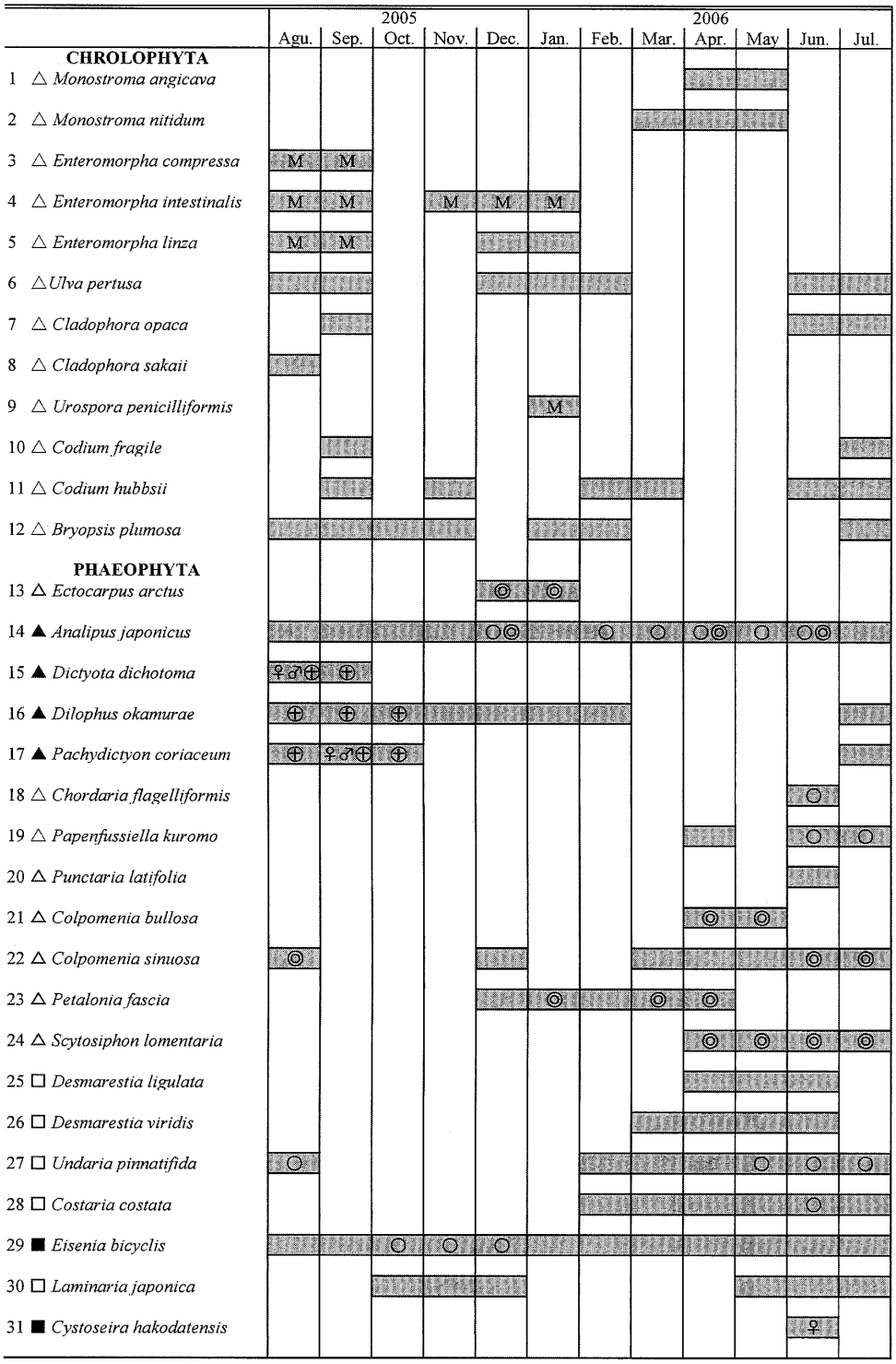
2005
2006
Agu.
Sep.
Oct.
Nov.
Dec.
Jan.
Feb.
Mar.
Apr.
May
Jun.
Jul.
CHROLOPHYTA
1 △ Monostroma angicava
2 △ Monostroma nitidum
3 △ Enteromorpha compressa
4 △ Enteromorpha intestinalis
5 △ Enteromorpha linza
6 △ Ulva pertusa
7 △ Cladophora opaca
8 △ Cladophora sakaii
9 △ Urospora penicilliformis
10 △ Codium fragile
11 △ Codium hubbsii
12 △ Bryopsis plumosa
PHAEOPHYTA
13 △ Ectocarpus arctus
14 ▲ Analipus japonicus
15 ▲ Dictyota dichotoma
16 ▲ Dilophus okamurae
17 ▲ Pachydictyon coriaceum
18 △ Chordaria flagelliformis
19 △ Papenfussiella kuromo
20 △ Punctaria latifolia
21 △ Colpomenia bullosa
22 △ Colpomenia sinuosa
23 △ Petalonia fascia
24 △ Scytosiphon lomentaria
25 □ Desmarestia ligulata
26 □ Desmarestia viridis
27 □ Undaria pinnatifida
28 □ Costaria costata
29 ■ Eisenia bicyclis
30 □ Laminaria japonica
31 ■ Cystoseira hakodatensis

FIG. 3.

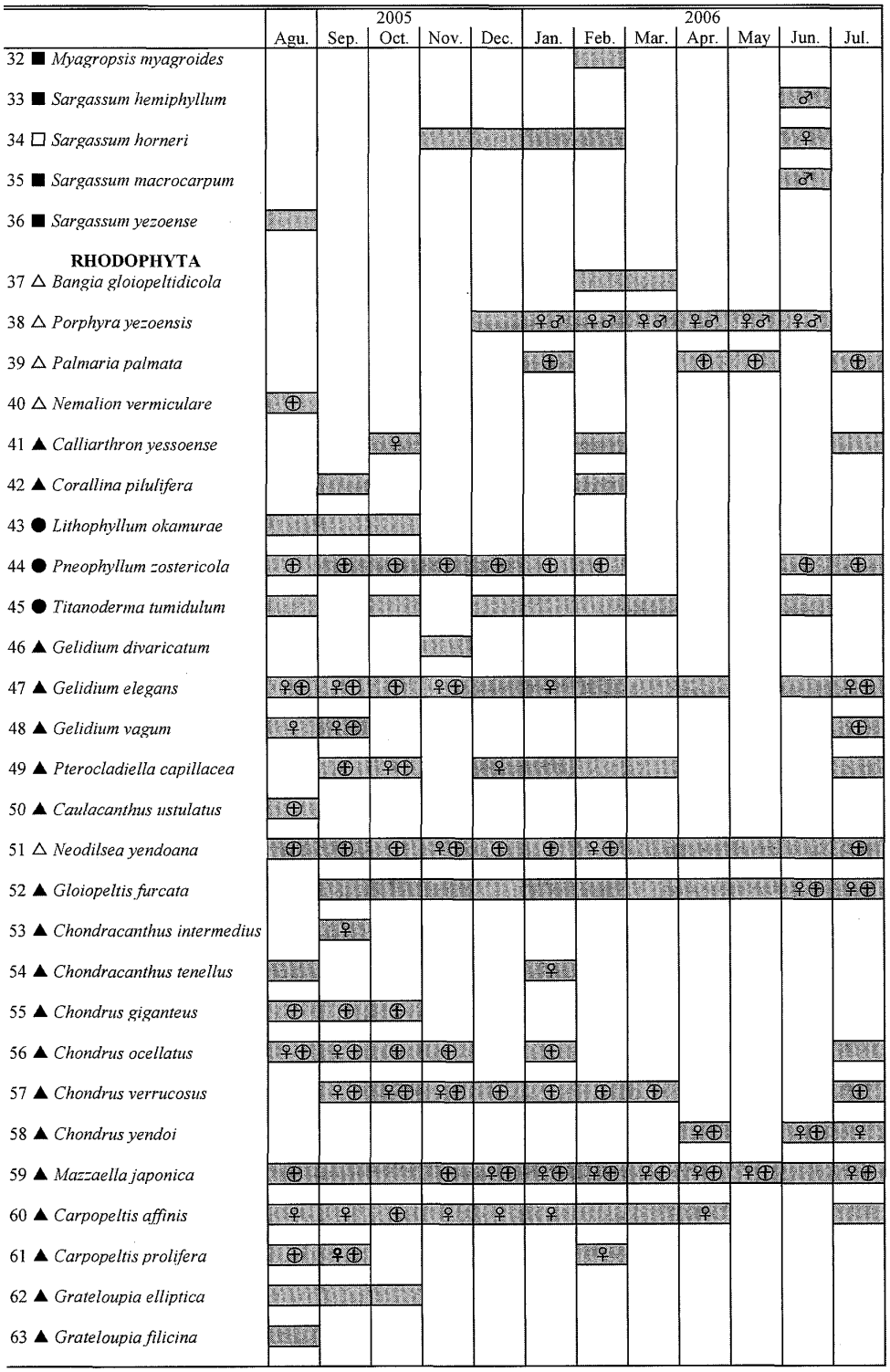

FIG. 3. (continued)

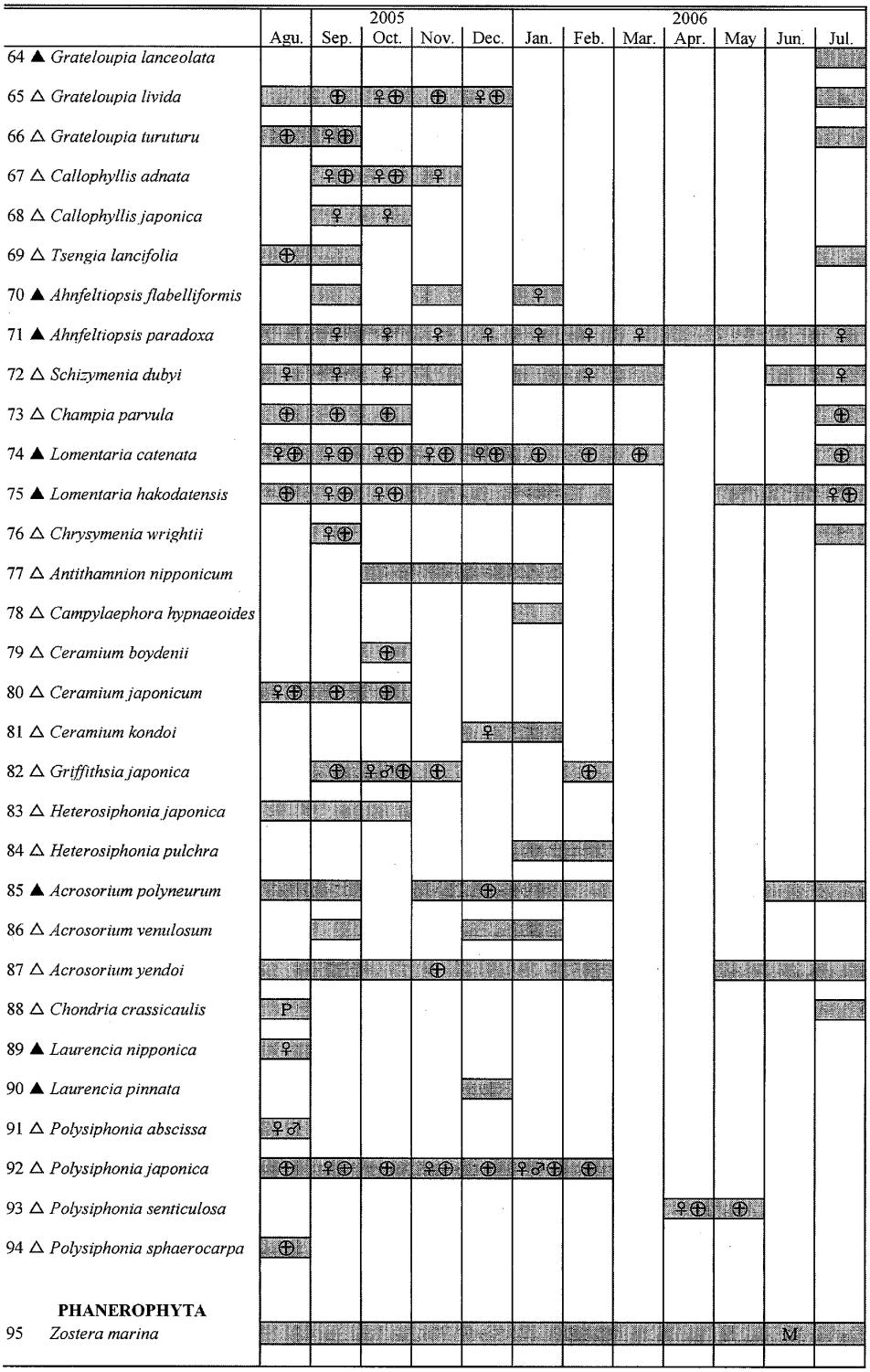

FIG. 3. Growth and maturation periods, and life forms of marine algae and sea grass collected in Hirota Bay. ▩; growing period, ○; unilocular sporangia, ◎; plurilocular sporangia, P; propagule, M; mature thallus, ♂/♀; male/female reproductive organ, ⊕; tetrasporangia, △; small annual algae, ▲; small perennial algae, □; large annual algae, ■; large perennial algae, ●; crustaceous algae.

ones. Most of small annuals such as *Enteromorpha compressa*, *E. intestinalis*, *E. linza*, *Colpomenia sinuosa*, *Neodilsea yendoana*, *Schzymenia dubyi*, *Champia parvula*, *Ceramium japonicum* and *Polysiphonia japonica* matured from spring to summer although the mature species appeared in every month. For small perennials, the maturation periods were mainly divided into three seasons, spring such as *Analipus japonicus*, autumn such as *Dictyota dichotoma*, *Dilophus okamurae* and *Pachydictyon coriaceum*, and year-round such as *Chondrus verrucosus*, *Mazzaella japonica* and *Ahnfeltiopsis paradoxa*. Among large annuals, only *Undaria pinnatifida* matured from spring to summer. Among large perennials, the three fucoids *Cystoseira hakodatensis*, *Sargassum hemiphyllum* and *S. macrocarpum* matured in summer, while the kelp *Eisenia bicyclis* did in autumn. Among crustaceous algae, the reproductive cells were present only in *Pneophyllum zostericola* from summer to winter.

Along the Pacific coast of northeastern Honshu from Oshika Peninsula, where are biogeographically located in subarctic floral zone (Okamura, 1931), I/H values were 1.4 in Shimokita Peninsula (Fuji and Yamamoto, 1972), 1.4 in Miyako (Taniguchi *et al.*, 1979), 1.4 in Iwai (Sato *et al.*, 2005), 1.4 in Kitakami (Nakata *et al.*, 2001), 1.9 in Ogatsu (Taniguchi *et al.*, 1985), 1.3 in Tomarihama (Agatsuma *et al.*, 2000) and 1.4 in Sasunohama (Endo *et al.*, 2005). The value in Hirota Bay was 1.1, suggesting that the marine algal flora in Hirota Bay belongs to the typical subarctic zone although it is slightly lower than those on other coasts.

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