Preliminary Report on the Phytal Animals in the *Sargassum confusum* Region in Oshoro Bay, Hokkaido[1)]

By

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(*With 6 Text-figures and 1 Table*)

Marine seaweed regions harbour rich fauna of many different kinds of animals, and such animals life long or temporarily living in, on or among seaweeds are generally called "phytal animals". Numerous important studies on seaweed communities including these phytal animals have been so far carried out mainly in European seas from various biological view-points by many authors (Colman, 1940; Dahl, 1948; Wieser, 1952; Chapman, 1955; Ohm, 1964; Hagerman, 1966; Nagle, 1968; and other authors).

On the other hand, in Japan, seaweed communities were studied mainly in the *Zostera* and the *Sargassum* regions by Kitamori and Kobayashi (1958), Kitamori et al. (1959), Kikuchi (1961, 1962 and 1966), Fuse (1962a and b), Harada (1962) and others mainly from the view-point of fishery resources, especially for the relation between fishes and phytal animals as their food organisms. In these studies, however, most meio- or microorganisms, such as harpacticoids, nematodes, etc., were omitted or disregarded despite of their predominant existence in these communities. Therefore, Mukai (1971) recently made a quantitative investigation of phytal animals including meiofauna in the *Sargassum* region in the Inland Sea of Japan and described their seasonal fluctuations of abundance. His study was carried out mostly at higher taxonomic level, but it seems clearly desirable that such quantitative studies in the seaweed community are carried out rather at each species level and further in more various localities of different kinds of environment, particularly to clarify the precise structure and function of the seaweed community.

In the present study, with this ecological significance in mind, I treat the

1) Biology of phytal animals in the *Sargassum confusum* region in Oshoro, I.

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phytal animals in the *Sargassum* region in Oshoro Bay, Hokkaido, northern Japan. Since no study on this field has been carried out in this locality, clarification of general ecological aspect of the animals was the primary and main problem for this study. In this paper, seasonal change of faunal compositon and populations of non-sessile phytal animals is described as the first report from the present investigation, leaving detailed results elsewhere.

Methods

1. *Areas surveyed*: The investigation was carried out in the *Sargassum* region in Oshoro Bay (Fig. 1), about 15 km west of Otaru, on the west coast of Hokkaido, northern Japan. Oshoro Bay is under the influence of the warm Tsushima Current during summer to autumn, while under that of the cold Liman Current in the other seasons. The bay is mainly formed out of rocky shore except for the inner part.

In Oshoro Bay various algae form their luxuriant regions in the intertidal and subtidal zones. Among these regions, the *Sargassum* region is the most abundant and remarkable. The *Sargassum* region consists of some species of *Sargassum* and is formed on the hard sea-bottom distributed in various places within the subtidal zone (Fig. 1). The area indicated by an arrow was selected for the present work because this area was seemed moderate and was composed of rather pure growth of *Sargassum confusum* Agardh. In this area water temperature and specific gravity as environmental factors were measured at every sampling time. The natural environment and faunal and floral accounts of Oshoro Bay have been reported by Motoda (1971).

2. Sargassum *surveyed*: *Sargassum confusum* provides various habitats for phytal animals and, therefore, its changes of the shape with their growth and the seasonal variation of standing crop in the *Sargassum* region immediately influence their lives. For this reason the mean wet weight per plant and the standing crop were calculated every sampling month.

First, the number of *S. confusum*/m^2 bottom was estimated by the mean density of 5 quadrates (50$\times$50 cm^2). And, to estimate growth and standing crop of plant, all the individuals of *S. confusum* in one quadrate or two were collected and the length, volume, wet and dry weight, and so on were measured for all plants. In this paper the mean wet weight per plant and the standing crop are also used to quantify the individual numbers/m^2 bottom.

3. *Sampling procedure and treatment of animals*: The periodical sampling was made at daytime in the *Sargassum* region, once a month, from August in 1973 to July in 1974. Samples were quantitatively taken by using a bag as like to that adopted by Mukai (1971), which is 25 cm square at the base, 100 cm long, and made of XX 13 gauze (0.0095 mm meshes). Wearing a face mask and a snorkel, the collector enveloped a plant of *Sargassum* with this bag, taking care to keep phytal animals, and cut off the discoid holdfast from rock surface. As soon as this procedure was over, he closed the mouth of the bag, and brought it to the sea surface. Phytal animals except microfauna could be taken together with a plant by this method. Samples at each time were of two to five plants collected at random and were preserved in 5% neutralized formalin solution. In the solution each plant was shaken enough to release the animals from it, and macrofauna such as molluscs, some amphipods, decapods, etc. among the animals remained in it

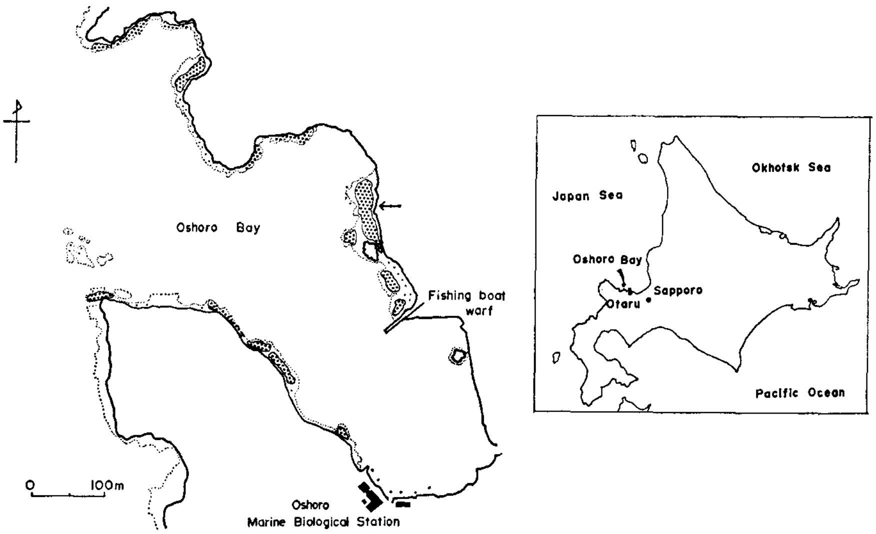

Fig. 1. Location of Oshoro Bay and distribution of the *Sargassum* region (dotted area). The area surveyed is indicated by arrow.

were counted under a binocular microscope, and meiofauna was estimated by counting the number of individuals appearing in each 1/100 subsample. Furthermore, larger animals caught from plant were sorted by hand and counted for the total. The number of animals per plant was totaled from the number of hand sorting and that calculated on the bases of 5 subsamples (Appendix 1). At the same time, length, volume, wet and dry weight of each plant were measured. In the present investigation, some epiphytes attached on *S. confusum* were regarded as parts of *Sargassum* and protozoans and fishes were not treated because their precise amount seemed to be unable to be estimated by this method.

4. *Estimation of the number of phytal animals*: First, mean population density/g algae was calculated from the individual number/plant described. And individual number /m^2 bottom was estimated from its mean density of animals/g algae and the standing crop of *Sargassum confusum* in each month. In this paper seasonal fluctuations of phytal animals are dealt with by these two indices, individuals/m^2 bottom and /g algae.

Results and Discussions

1. *Environmental conditions*: Water temperature and specific gravity were measured in the sampling area at every time. Seasonal variations of these environmental factors are shown in Fig. 2. Surface temperature ranged from 3.1 °C in February to 26.0°C in August in the sampling year. Specific gravity of surface water (σ_{15}) ranged from 1.0202 in May to 1.0259 in July. The decrease in April and May is caused by the inflow of snow melting water in early spring and

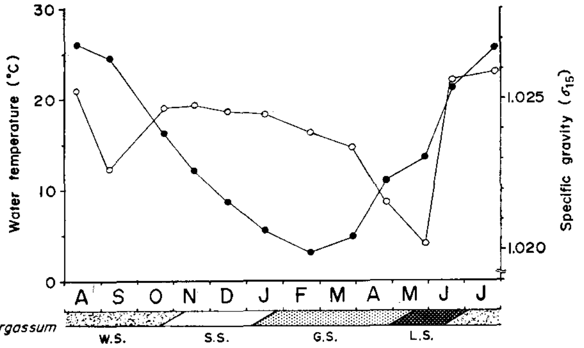

Fig. 2. Seasonal changes of water temperature (solid circles) and specific gravity (open circles) in the *Sargassum* region.

in the other months specific gravity is nearly constant.

The seasonal variations of mean length, mean wet weight, mean density and standing crop of *Sargassum confusum* are shown in Fig. 3 and Appendix 2. The minimum wet weight was found in September (24.3 g), and till January it nearly remained. Since February it tended to increase and reached the maximum in May (157.2 g), and then it decreased rapidly in June and July. The pattern of the seasonal variation of mean length nearly agreed with that of mean wet weight except that the minimum occurred in October (27.7 cm) and the maximum in June (117.9 cm). As shown in Fig. 3, the number of plants of *S. confusum*/m^2 bottom was 77.2 at maximum in September, though from November to June it seemed to be stable (mean 40.5 plants). At last, standing crop/m^2 bottom was calculated from mean wet weight and density of plants. Standing crop was poor during September and the following four months and was about 1.4 kg/m^2 bottom at minimum in January. Since February it increased and reached the maximum also in May (about 6.4 kg/m^2 bottom).

As a result, seasonal change in growth of *Sargassum confusum* is divisible roughly into the following four seasons.

Stable season (abr. S.S.), November to the middle of January: The dislodgement by wave action and withering is entirely finished and the density becomes stable (40.5 plants/m^2 bottom in the present survey). In this season a plant of *Sargassum* consists mainly of a primary stem and principal branches with large basal leaves, and these upper portions of the principal branches seem to elongate upward slightly. But the growth in length and wet weight is generally insignificant, therefore, the standing crop is the lowest during the year (about 1.41 to 1.80 kg/m^2 bottom).

Growth season (abr. G.S.), late January to early May: The upper portion of the principal branches elongates still more, the leaves gradually decreasing in

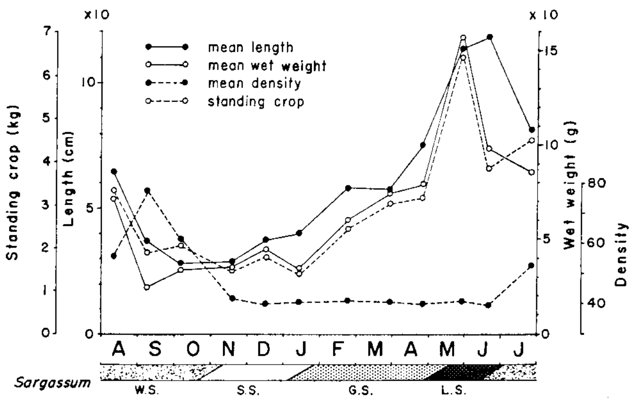

Fig. 3. Seasonal variation of mean length/plant, mean wet weight/plant, mean density/m² bottom and standing crop/m² bottom of *Sargassum confusum*.

size, and the principal branches send out more lateral branches rather than in the stable season. Thus, *Sargassum* grows rapidly in this season and the standing crop increases exceedingly.

Luxuriant season (abr. L.S.), early May to June: *Sargassum* shows the maximum growth in this season. The length and wet weight of plant remarkably increase. Moreover, the leaves on lateral branches markedly change in size and shape. So, *Sargassum* in this season looks as if they were different plants from those in the stable season. In this season the standing crop reaches the maximum (about 6.41 kg/m² bottom in May). On the other hand, it seems that this season is combined with the reproductive period, considering the present samples and the studies by Inoh (1930) in Asamushi, at the northern end of Honshu.

Withering season (abr. W.S.), late June to October: The tissue of *Sargassum* becomes fragile, after reproduction, defoliation beginning and the upper parts of the frond are carried away by animals grazing and wave action. Accordingly, length, wet weight and the standing crop of *Sargassum* decrease rapidly, while the density increases due to the appearance of new plants. Thereafter, some of the old plants wither completely and their considerable portion of the amount in a early period in this season is carried away together with some of new plants. Consequently, the density showing the maximum, 77.6 plants/m² bottom in September, begins to decrease and recovers the stability.

2. *Total individual number of whole phytal animals*: Total number of individuals of non-sessile phytal animals/m² bottom and /g algae varied through the year as shown in Fig. 4. The total number/m² bottom increased slightly once in September (about 1,304,000 individuals) and became minimum from

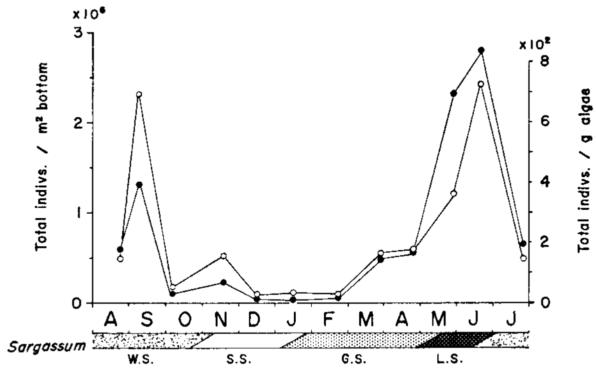

Fig. 4. Seasonal fluctuation of total individual number/m² bottom (solid circles) and total individual number/g algae (open circles) of phytal animals.

December to February (about 42,490 in January). After that it increased greatly and reached the maximum in June with about 2,788,000/m² bottom. On the other hand, the number of animals/g algae showed a seasonal change of similar pattern to that of number/m² bottom, and reached the minimum, 20.7/g algae in February, the maximum, 726.5/g algae in June. But the increase in September was remarkably high (691.6/g algae) and it seems that population density/g algae increases twice in a year.

When the standing crop of *Sargassum confusum* at each sampling period is considered, a clear correlation between these fluctuations of animal population and that of *Sargassum* is recognized through the year except for September as follows. According to the standing crop of *Sargassum* increasing in the growth season, the density represented by total animal species also increased at the same phase and reached the maximum slightly later rather than the maximum period of standing crop in the luxuriant season. After that, the number decreased rapidly in the withering season except for September, and came in the minimum period slightly late to the stable season. Thus, the total number of individuals seems to vary slightly late to the trend of seasonal fluctuation of the standing crop of *Sargassum confusum*. But the increase of animal density by individual number in September does not coincide with the change of the standing *Sargassum* crop. This phenomenon is probably explainable by certain specificity presented in phytal animals themselves rather than *Sargassum*.

As a result, the total individual number seems to vary with some correlations with the standing *Sargassum* crop nearly in all seasons.

3. *Relative abundance in phytal animals:* In order to clarify the seasonal change of the composition within the phytal animals, they were classified into the following 19 taxonomic groups; Turbellaria and Nemertinea, Nematoda,

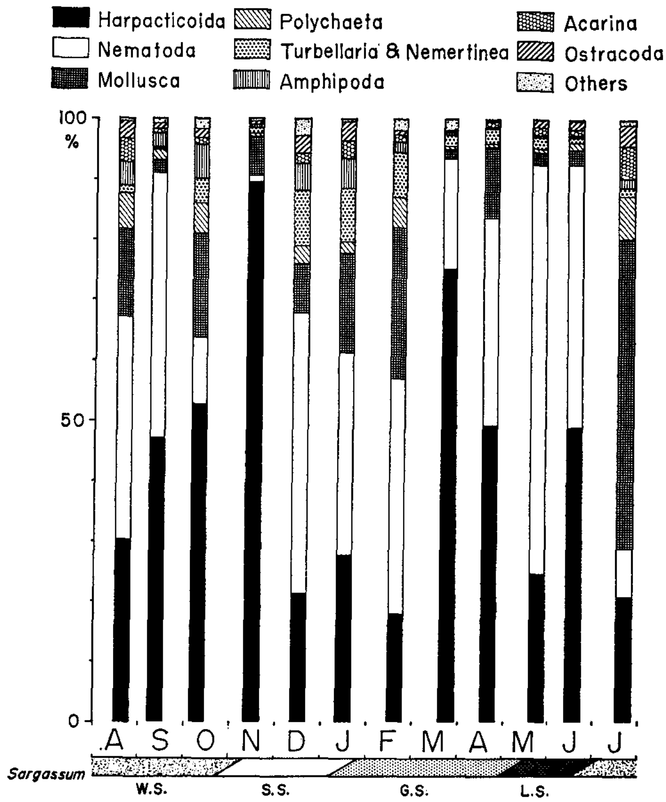

Fig. 5. Seasonal variation of relative abundance of phytal animals in the *Sargassum confusum* region.

Polychaeta, Mollusca, Acarina, Ostracoda, Harpacticoida, Amphipoda, Coelenterata, Rotatoria, Kinorhyncha, Pycnogonida, Copepoda excluding Harpacticoida, Cirripedia, Tanaidacea, Isopoda, Decapoda, Echinodermata and Chironomidae. Among them, the latter 11 groups were collected together in one group in this section.

Seasonal change in the composition of these groups is shown in Fig. 5. At a glance of the figure it is clear that Harpacticoida and Nematoda are predominant. Harpacticoida was the most dominant, counting 89.5% of the total individuals of whole the animal group in November and 75.1% in March to 17.9% in February. The second dominant group Nematoda varied in dominance between only 1% in November and 68.1% in May. Among other groups Mollusca was comparatively abundant next to Harpacticoida and Nematoda, and took the first place in July with 51.5% exceeding above two groups. The other groups were not so abundant throughout the year and each group constituted only less than 10% of the total individuals. Turbellaria and Nemertinea were abundant from December to February (9.2% at maximum). Polychaeta ranged from 0.3 to 7.1% and increased in summer. Amphipoda occupied 0.2 to 5.5%, somewhat abundant in summer and winter rather than the other seasons. Acarina and Ostracoda varied similarly and increased also in summer and winter (5.5% and 3.4% at maximum, respectively).

Considering the seasonal change of relative abundance of animals from August to October (the withering season), Harpacticoida increased greatly and other groups except for Nematoda which fairly decreased were relatively abundant, but in November Harpacticoida also occupied 89.5% of the total individuals and from December to February (slightly late in the stable season) the faunal composition showed high diversity as much as Nematoda became dominant and further other groups except for Harpacticoida increased in abundance. Although Harpacticoida constituted most part of the number individuals in March, after that Harpacticoida and Nematoda were predominant to June. But soon after entering into the withering season, the animal composition changed remarkably and suddenly Mollusca dominated 51.5% in July.

As mentioned above, it was observed that in the lowest period of the total individuals coinciding with the stable season of *Sargassum* the animal composition was fairly diversified, and in the months before and after that period Harpacticoida was most dominant and in September and June, when the total number of individuals reached the peak, Harpacticoida and Nematoda taking nearly the same percentages within the total animals.

4. *Individual number of each phytal animal group*: Individual number of each animal group of the *Sargassum* community was calculated through the year and seasonal changes of abundant groups are shown in Fig. 6. From this figure, it is apparent that Turbellaria and Nemertinea, Ostracoda, Nematoda and Harpacticoida show their maximum occurrence in May or June, while Coelenterata, Polychaeta, Mollusca and Acarina show it in July, and Tanaidacea, Amphipoda, Isopoda and Decapoda, in September. Thus, the phytal animal groups in the surveyed area show the maximum occurrence generally from May to September and these periods correspond with the luxuriant and the withering seasons of *Sargassum*.

Coelenterata: The individual number of this group was generally poor from the late withering to the growth season and began to increase in the luxuriant season and then reached the maximum in July (Fig. 6). The maximum number of individuals was about 3,100/m^2 bottom in July and the maximum population density was 0.7/g algae in the same month. Following seven species were collected; Hydrozoa: *Climacocodon ikarii* Uchida, *Cladonema uchidai* Hirai, *Obelia* sp., *Gonionema oshoro* Uchida; Scyphozoa: *Sasakiella cruciformis* Okubo, *Haliclystus auricula* Clark; Anthozoa: *Anthopleura* sp. .

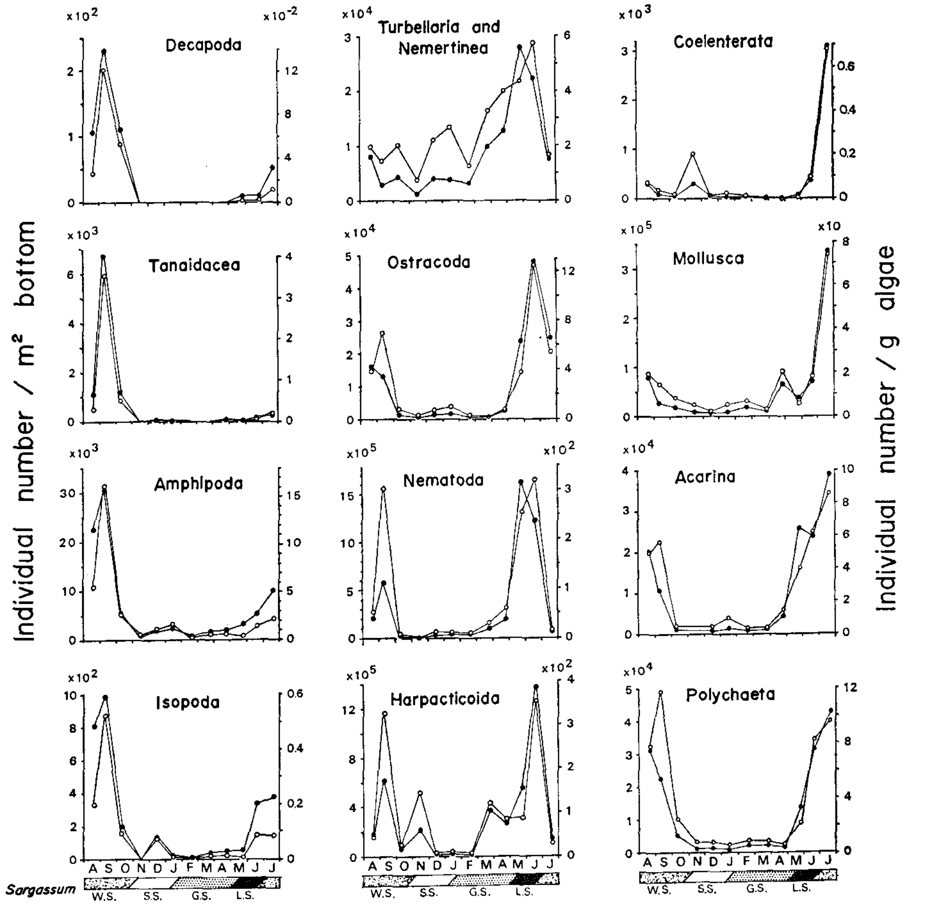

Fig. 6. Seasonal fluctuation of individual number/m² bottom (solid cricles) and individual number/g algae (open circles) of twelve phytal animal groups; Decapoda, Tanaidacea, Amphipoda, Isopoda, Turbellaria and Nemertinea, Ostracoda, Nematoda, Harpacticoida, Coelenterata, Mollusca, Acarina and Polychaeta.

Turbellaria and Nemertinea: Since it was rather difficult to classify turbellarians and nemertineans completely, they were treated as one group in the present study. The individual number of this group was scarce from September to February, beginning to increase in the growth season and reached the maximum in the luxuriant season (about 27,900/m² bottom in May) (Fig. 6). The individual number/g algae fluctuated and the maximum density occurred in June (5.8/g algae). Each the minimum value was about 1,100/m² bottom and 0.7/g algae both in November. Specimens collected in this region were not identified except for a nemertinean, *Tubulanus punctatus* Takakura.

Table 1. Seasonal occurrence of individual number/m² bottom of Rotatoria, Kinorhyncha, Pycnogonida and other Copepoda excluding Harpacticoida.

		Rotatoria	Kinorhyncha	Pycnogonida	other Copepoda
1973	Aug.	-	-	42	745
	Sep.	-	493	-	1, 340
	Oct.	-	-	7	272
	Nov.	-	-	-	1, 187
	Dec.	-	-	-	1, 023
1974	Jan.	-	-	-	-
	Feb.	393	-	-	14
	Mar.	9, 420	-	-	-
	Apr.	723	72	-	-
	May.	792	-	905	-
	Jun.	-	717	640	4, 833
	Jul.	-	350	110	1, 144

Rotatoria: Rotifers appeared only from February to May. The maximum number was recorded in March, 9,420/m² bottom and the number/g algae was 3.1 also in March (Table 1). Specimens were unable to be identified with each species.

Kinorhyncha: As shown in Table 1, this group was collected in September, April, June and July, though it was very poor and only about 720/m² bottom at the maximum in June. They seem to be all of one species, *Echinoderes* ? sp. .

Nematoda: Nematodes were the second abundant group next to Harpacticoida in phytal animals. The individual number/m² bottom ranged from about 1,000 in November to about 1,620,000 in May. Nematodes showed a slight increase in September, followed by a decrease during the late withering to early growth season (Fig. 6). According as the standing crop of *Sargassum* increases, they began to increase and suddenly reached the maximum number in May. This increase is closely similar to that of *Sargassum* in the luxuriant season. And as soon as it entered in the withering season, they became scarce rapidly. On the other hand, the number of nematodes/g algae took the minimum value, 0.7 in the same season as the number/m² bottom, though higher density/g algae was recorded twice, 303.1 in September and 317.5 in June. It should be noted that the smaller and immature nematodes might pass through the XX 13 gauze of collecting net used in the present study. Furthermore, all the specimens of nematodes were not identified entirely.

Polychaeta: Polychaetes were not so abundant through the year. The individual number of non-sessile polychaetes was very scarce during both the stable and growth seasons and showed the minimum, about 710/m² bottom in January (Fig. 6). In the luxuriant season of the *Sargassum*, the number increased considerably, but the maximum occurred in next the withering season, July (about 42,800 /m² bottom). The population density showed only less than 1/g algae in the same season as the number being poor, and the maximum, 11.9/g algae in September further late for that of the number/m^2 bottom. *Platynereis bicanaliculata* Baird, *Typosyllis nipponica* Imajima, *Nicolea gracilibranchis* Grube and small syllids were collected, but the individual number of each species was not so abundant.

Mollusca: Mollusca was the third abundant group next to Harpacticoida and Nematoda among phytal animals. As shown in Fig. 6, the individual number of molluscs decreased gradually towards the stable season and took the minimum value, about 3,510/m^2 bottom in December. From the growth season to the luxuriant one it tended to increase with a fluctuation and suddenly reached the maximum, 335,900/m^2 bottom in July. Also, the number/g algae appeared nearly the same fluctuation in number/m^2 bottom. The maximum was 74.3/g algae in July and the minimum was 1.9/g algae in December. The increase of the number and density in February and April was due to the occurrence of a number of juvenile gastropods, and in July several species of juveniles appeared and grew simultaneously. Throughout the year, gastropods were far more abundant than pelecypods. Polyplacophora: Only two young specimens were collected in June. Gastropoda: Prosobranchia; This was very abundant group throughout the year and more than ten species were collected as follows, *Cantharidus jessoensis* (Schrenck), *Omphalius rusticum* (Gmelin), *Lirularia iridescens* (Schrenck), *Homalopoma sangarense* (Schrenck), *Hiloa tristis* (Pilsbry), *Neritrema sitkana* (Philipi), *Epheria decorata* (A. Adams), *Barleeia angustata* (Pilsbry), *Ocenebra japonica* (Dunker), *Mitrella tenuis* (Gaskoin), *Reticunassa* (*Hinia*) *fratercula hypolia* (Pilsbry) and so on. Opisthobranchia; This group was very rare throughout the year. *Haloa japonica* (Pilsbry) ? and small unidentified eolids occurred occasionally. Pelecypoda: Only juvenile specimens were collected in most months but were not so abundant.

Pycnogonida: Pycnogonida was collected in five months and the number of individuals was very poor (Table 1). *Lecythorhynchus hilgendorfi* (Böhm) was identified.

Acarina: Acarines were collected through the year except for November. Seasonal fluctuation of individual number was shown in Fig. 6. The maximum number/m^2 bottom was 38,900 in July and the number decreased after that. Acarines were scanty in the stable and growth season, and that they increased in the luxuriant season. The population density reached the maximum, 8.6/g algae in July and fluctuated almost in parallel with the change of number/m^2 bottom. *Litarachna divergens* Walter ? and *L. kamui* Uchida were identified and Halacaridae was more abundant in samples.

Ostracoda: The individual number of ostracods showed a clear seasonal change as shown in Fig. 6. The number was very scarce in the stable and growth season and in succeeding months it increased rapidly. The maximum number was about 48,000/m^2 bottom in June and the minimum, 152/m^2 bottom in March. The density/g algae changed seasonally almost as in the trend of number/m^2 bottom. The maximum density was 12.5/g algae in June and the minimum, less than 0.1/g algae in March. Specimens were not identified, but more than 10 species might be present.

Harpacticoida: Harpacticoida was the most dominant group in phytal animals. The number of individuals increased slightly in September and decreased till February (Fig. 6). December, January and February combined was the lowest period in number (8,260/m^2 botton in February). After that it increased gradually during the growth season and reached the maximum in June (1,360,000 /m^2 bottom), but in summer it decreased rapidly again. On the other hand, the population density showed a striking increase not only in the luxuriant season (355. 3/g algae, June) but also in September (326.7/g algae). The minimum/g algae occurred in February (3.4/g algae) as that of individual number/m^2 bottom. The number of species collected was more than 10 even in poor months, November to January, and more than 20 species were recognized in rich months. As a result, more than 50 species including the following ones were collected throughout the year; *Ectinosoma melaniceps* Boeck, *E.* sp., *Microsetella norvegica* Boeck, *Harpacticus uniremis* Kröyer, *H.* sp., *Zaus unisetosus* Itô, *Z. robustus* Itô, *Scutellidium arthuri* Poppe, *S.* spp., *Alteutha* spp., *Peltidium* sp., *Syngastes* sp., Tegastidae spp., *Porcellidium ovatum* Haller, *P.* spp., *Parathalestris areolata* Itô, *P.* sp., *Diarthrodes* spp., *Dactylopodia glacialis* (Sars), *D.* sp. aff. *tisboides* (Claus), *D.* spp., *Paradactylopodia* spp., *Eudactylopus andrewi* Sewell, *E.* sp., *Idomene purpurocincta* (Norman et T. Scott), *Amenophia* sp., *Thalestris* spp., *Diosaccus ezoensis* Itô, Diosaccidae sp., *Amphiascoides* sp., *Parastenhelia spinosa* (Fisher), *Nitocra* sp., *Laophonte cornuta* Philippi, *Heterolaophonte* spp., *Echinolaophonte oshoroensis* Itô, *Orthopsyllus* sp., and so on.

Other Copepoda: Some species of Calanoida and Cyclopoida appeared in most months, but most of them seem to be transients as plankton. Also, the number of them was not so significant among phytal animals (Table 1).

Cirripedia: Only the larvae were found among phytal animals. Cypris larvae appeared in February and July, and were very scarce in number.

Tanaidacea: Tanaids seem to be present through the year. The individual number/m^2 bottom increased and reached the maximum, about 6,700/m^2 bottom in September, while it hardly appeared from October to May (Fig. 6). The number/g algae changed as in number/m^2 bottom and the maximum was 3.6/g algae in September. Thus, tanaids were not so abundant among phytal animals and the maximum occurrence was not in the luxuriant but in the withering season. They seem to be of a single species, *Anatanais normani* (Richardson).

Amphipoda: The number of individuals increased in the withering season and reached the maximum in September, 30,200/m^2 bottom (Fig. 6). After that, the number decreased rapidly and was very scarce in both the stable and growth seasons (about 700/m^2 bottom in November to February) and gradually increased again in the luxuriant season. Population density also drew almost the same figure as that of the individual number. The maximum was 16.0/g algae in September and the minimum was 0.3/g algae in February. Amphipods are divisible into two groups, gammarids and caprellids, and the former comprised more than 90% of total amphipods population in most months. Most species were not identified, but many gammarids such as *Jassa falcata* (Montagu), *Pleustes* sp., *Biancolina* sp., *Ampithoe* spp., *Corophium* spp., Phliantidae sp., etc. and a few species of *Caprella* were recognized.

Isopoda: This taxonomic group occurred in all seasons but the number of individuals was very poor. The number/m^2 bottom and /g algae showed the maximum in September (986/m^2 bottom and 0.5/g algae, respectively (Fig. 6). Some species of Anthuridae (*Paranthura* sp.), Parasellidae (*Janiropsis* sp.), Idoteidae (*Idotea* sp., etc.), Sphaeromidae (*Dynoides* sp. and one another species), Limnoriidae (one species) and Bopyridae (*Athelges takanoshimensis* Ishii) were collected.

Decapoda: Individual number of this group showed the maximum in September, though they were not so abundant, less than 300/m^2 bottom and about 0.12/g algae even at the maximum (Fig. 6). This group is quantitatively insignificant in spite of their great wet weight. Anomurans; *Pagurus middendorffii* Brandt, brachyurans; *Pugettia quadridens* (De Haan) and macrurans; Hippolytidae sp. were collected.

Echinodermata: Echinodermata was a very rare group in this region and only one young asteroid, *Henricia* sp. and also one young echinoid, *Strongylocentrotus intermedius* (A. Agassiz) were collected during the sampling year.

Chironomidae: Larvae of these insects occurred in September, October and June, but they were absent in other months. Individual number was very scarce in each sample.

Sessile fauna: Although quantitative examination on the sessile fauna was not carried out in the present study, some following animals were collected; Hydrozoa: *Coryne pusilla* Gaertner, *Obelia* sp., etc., Polychaeta: small tube worm Spirorbinae, Bryozoa: *Celleporina* sp., *Microporella* sp., etc., Tunicata: *Distaplia* sp., *Botryllus* sp., *Botrylloides* sp., *Leptoclinum* sp. . Among them, *C. pusilla* was also found on a small snail *Homalopoma sangarense*. Generally hydrozoans and bryozoans were abundant on older stipes of the *Sargassum* and Spirorbinae on old lamina. Moreover egg-masses of gastropods were found abundantly in spring.

Conclusion

In the present study, the total individual number of non-sessile phytal animals in the *Sargassum confusum* region was about 2,788,000/m^2 bottom at maximum and the minimum was about 42,490/m^2 bottom. From these figures together with the Mukai's results (1971) obtained from the *Sargassum serratifolium* region, it is concluded that the *Sargassum* community is rather abundant in the density of phytal animals than the other seaweed communities (see Mukai, 1971).

Mukai observed that seasonal fluctuations of the individual number of phytal animals generally corresponded with those of the standing *Sargassum* crop. Contrary to this, Fuse (1962b) indicated that the number of phytal animals fluctuated without certain relation to the standing crop of *S. serratifolium*. In the present study, the total individual number varied slightly late to the fluctuation of the standing crop of *Sargassum*. This result seems to support the Mukai's observation to a certain degree.

However, as far as each taxonomic group is separately considered, all their seasonal fluctuations of individual number did not coincide with those of the standing crop of *Sargassum*. Turbellaria and Nemertinea, Ostracoda, Nematoda, Harpacticoida and other Copepoda showed the each maximum appearance in May or June when *Sargassum* was in the luxuriant season, while other groups showed it in other different seasons. The increase of animals depends generally upon their reproductions, and various environmental factors influence them complicately. Each group consists of more or less number of species of various types of life history. Therefore, the correlation between seasonal variations of phytal animals and *Sargassum* is unable to be generalized simply.

As regards the composition of phytal animals in the *Sargassum confusum* community Harpacticoida was the most dominant, constituting 42.1% of the total individuals in mean through the year. The next dominant group was Nematoda (32.1%), followed by Mollusca (13.3%), Turbellaria and Nemertinera (3.4%), Polychaeta (2.7%), Amphipoda (2.2%), Acarina (1.7%), Ostraocda (1.6%) and others. In the *S. serratifolium* community (Mukai, 1971), benthonic Copepoda (mainly Harpacticoida) and Nematoda were also very dominant, but other groups varied considerably in order. Ohm (1964) reported that Harpacticoida dominated and constituted more than 60% of the total fauna in *Fucus* vegetation in winter but in the other seasons Nematoda was dominant. Though Acarina and Ostracoda were not so abundant in the *Sargassum* region, in *Ascophyllum* (Colman, 1940) and *Fucus* communities (Hagerman, 1966) Ostracoda was dominant and Harpacticoida was next, and also Colman's result revealed the general abundance of Acarina. Besides, Polychaeta was abundant in the *Laminaria* holdfasts, Mollusca on *Lichina pygmaea* (Colman, 1940) and Rotatoria in the *Cladophora* belt (Jansson, 1967). As a result, Harpacticoida, Nematoda, Acarina and Ostracoda seem to be generally abundant in the seaweed region.

Thus, in phytal animals meiofauna was more important in number than macrofauna such as Decapoda and Echinodermata. Wigley and McIntyre (1964) reported that the ratio of macro- to meiofauna in the offshore of the East Coast of USA was numerically 1:70 and by weight 24:1. Thus, macrofauna was more important of weight in spite of their less occurrence rather than meiofauna. Furthermore, macrofauna occupies higher trophic level in the community. These suggest that the ecological importance of phytal animals is not simply determined by the individual number alone.

Summary

1) A quantitative investigation of the phytal animals in a *Sargassum confusum* region in Oshoro Bay, on the west coast of Hokkaido, was carried out

from August, 1973 to July, 1974. In this region, seasonal variations of relative abundance and population density of the non-sessile phytal animals and their seasonal fluctuation of individuals were described.

2) Population change of *Sargassum confusum* as a habitat for phytal animals was also traced and their standing crop fluctuated between 1.41 kg/m^2 bottom in January and 6.41 kg/m^2 bottom in May. And, seasonal change in growth was described for the following four seasons; stable season (November to mid January), growth season (late January to early May), luxuriant season (early May to June) and withering season (late June to October).

3) Total individual number of whole phytal animals reached the maximum in June with 2,788,000/m^2 bottom in the luxuriant season and the minimum in January with 42,490/m^2 bottom in the stable season. General trend of seasonal fluctuation of individual number seems to agree with that of the standing *Sargassum* crop, though there were some exceptional cases.

4) Among the phytal animals, Harpacticoida was the most dominant group, and Nematoda was the second through the year. Although other groups were generally not so abundant, Mollusca took the first place exceeding the former two groups in July.

5) Judging from the relation between seasonal fluctuation of phytal animals and that of the standing *Sargassum* crop, phytal animal groups were divided into two major groups. Turbellaria and Nemertinea, Ostracoda, Harpacticoida and Nematoda fluctuated in the individual number according with changes in the standing crop. Fluctuations of the other groups, such as Mollusca, Acarina, Polychaeta, Coelenterata, Amphipoda, Isopoda, Tanaidacea and Decapoda, however, did not correlate to that of *Sargassum.*

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Appendix 1. The numerical distribution of non-sessile phytal animals

Date	23. VIII. 73.		7. IX. 73.		4. X. 73.		17. XI. 73.		14. XII. 73.		16.
Length, cm	104.2	114.5	102.0	89.0	104.0	64.5	42.0	60.5	62.0	55.0	59.0
Wet weight, g	194.0	162.5	98.5	171.0	152.7	130.0	49.5	42.0	62.2	81.5	85.5
Animals/g algae	175.2	108.8	757.2	625.9	51.0	43.2	254.8	51.2	23.3	24.0	30.6
Coelenterata	15	9	4	6	5	-	20	-	-	2	4
Turbellaria and Nemertinea	426	289	184	179	395	182	43	25	206	84	227
				-							
Rotatoria	-	-	-		-	-	-	-	-	-	-
Kinorhyncha	-	-	40	20	-	-	-	-	-	-	-
Nematoda	12,175	6,760	31,540	48,900	1,440	220	20	40	780	780	740
Polychaeta	1,600	1,184	969	2,399	621	102	42	20	35	67	45
Mollusca	3,563	3,254	1,349	2,653	1,345	986	209	245	84	207	397
Pycnogonida	4	-	-	-	1	-	-	-	-	-	-
Acarina	950	820	500	1,060	80	60	-	-	20	40	120
Ostracoda	900	540	560	1,400	180	40	-	20	40	60	100
Harpacticoida	12,900	4,000	37,200	47,140	2,820	3,880	12,180	1,780	200	560	880
Other Copepoda	-	60	140	-	40	-	80	-	40	40	-
Cirripedia	-	-	-	-	-	-	-	-	-	-	-
Tanaidacea	47	50	228	820	165	-	-	-	1	-	1
Amphipoda	1,380	664	1,820	2,324	652	147	20	22	39	115	83
Isopoda	26	43	42	106	27	1	-	-	7	2	2
Decapoda	3	6	9	26	14	2	-	-	-	-	-
Echinodermata	-	-	-	-	-	-	-	-	-	-	-
Chironomidae	-	-	-	2	1	-	-	-	-	-	-
Others (indet.)	2	3	-	-	-	-	-	-	-	-	20
Total	33,991	17,682	74,585	107,035	7,786	5,620	12,614	2,152	1,452	1,958	2,619

Appendix 2. Seasonal variation of mean length/plant, mean wet weight/plant, mean density/m² bottom and standing crop/m² bottom of *Sargassum confusum*.

	1973					1974						
	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.
Mean length (cm)	64.4	36.9	27.7	28.8	37.3	39.8	57.9	57.5	75.1	113.1	117.9	80.8
Mean wet weight (g)	72.0	24.3	33.6	35.3	45.1	34.5	59.5	74.5	79.4	157.2	97.9	85.6
Mean density/m²	56.0	77.6	61.6	41.6	40.0	40.8	41.2	40.8	40.0	40.8	39.2	52.8
Standing crop/m² (kg)	4.03	1.89	2.07	1.47	1.80	1.41	2.45	3.04	3.18	6.41	3.84	4.52

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on each *Sargassum confusum* collected through the sampling year.

I. 74.	22. II. 74.		28. III. 74.		24. IV. 74.		28. V. 74.		19. VI. 74.		26. VII. 74.	
61.0	103.0	117.0	106.0	92.0	126.0	176.0	148.0	120.0	138.0	155.0	137.0	105.0
56.6	88.5	158.0	195.0	106.0	439.0	268.0	709.0	257.0	180.0	214.0	306.0	129.0
29.7	29.2	12.2	149.9	167.6	175.1	163.1	517.5	200.1	733.3	719.6	169.7	117.9
-	-	1	1	1	1	-	4	4	11	28	166	106
154	100	215	564	381	2,020	911	1,454	1,707	907	1,395	545	199
-	20	15	620	320	200	-	120	20	-	-	-	-
-	-	-	-	-	20	-	-	-	-	80	-	20
640	700	980	5,700	3,020	37,720	8,760	267,280	32,620	50,700	75,600	3,340	1,460
27	50	156	118	75	186	126	2,253	261	1,492	1,741	2,264	1,486
304	1,206	60	422	324	7,327	6,358	4,653	1,346	3,456	3,572	27,208	7,704
-	-	-	-	-	-	-	200	-	60	-	3	5
20	40	21	40	40	440	460	2,840	1,020	1,340	1,040	4,360	380
40	20	8	20	-	180	240	2,020	1,140	2,320	2,600	2,660	260
380	360	420	23,620	13,520	28,480	26,700	85,700	13,180	71,280	67,340	10,500	3,240
-	1	-	-	-	-	-	-	-	180	325	60	40
-	20	-	-	-	-	-	-	-	-	-	-	20
-	-	-	-	-	2	-	1	-	7	8	66	16
118	29	43	128	58	293	143	365	129	231	321	717	265
-	1	-	1	2	3	5	5	2	11	24	27	10
-	-	-	-	-	-	-	2	-	-	1	7	-
-	-	-	-	-	-	-	-	-	-	1	1	-
-	-	-	-	-	-	-	-	-	-	8	-	-
-	40	-	-	20	-	-	-	-	-	-	-	-
1,683	2,587	1,919	29,234	17,761	76,877	43,703	366,897	51,429	131,995	154,084	51,924	15,211

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