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Phytal Animals in the *Sargassum confusum* Region in Oshoro Bay, Hokkaido: Phenology of Harpacticoid Copepods[1)]

By

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(*With 2 Text-figures*)

In the previous report (Kito, 1975), the seasonal fluctuations of relative abundance and population trends of the phytal animals were preliminarily described, based upon a series of periodical samplings carried out in a *Sargassum* region in Oshoro Bay, while the detailed results and discussions on each animal group was remained entirely untouched. As the second report of the study, the present paper deals with the seasonal appearance and abundance of the harpacticoid copepods which represented the most dominant group in the *Sargassum* community studied and were estimated as occupying 42.1% of the total individual number of non-sessile phytal animals in the mean through the 12 months surveyed. Accurate discrimination of each species is of course most essential for such the investigation, nevertheless the marine harpacticoid fauna in Japan is unfortunately not yet completely clarified, though our knowledge is now being acutely accumulated (notably, Tanaka and Hue, 1968; Gamô, 1969a and b; Itô, 1968, 1969, 1971a and b, 1972, 1973, 1974, 1976). In the present paper, therefore, some those species which were well established are described in detail. On the other hand, we have some works of Anraku (1953), Itô (1968~) and Motoda (1971) on the harpacticoid fauna in Oshoro Bay. Of some pelagic species among them, their seasonal appearances have been already reported by Anraku (1953), Motoda (1971) and Hirakawa (1974), but those of most benthic species have not yet been treated. I hope this work would stimulate further studies to accumulate the ecological knowledge on the benthic harpacticoid copepods in Japan.

Before going further, I wish to express my sincere tanks to Dr. Tatsunori Itô for his pertinent guidance through the present study, and to Professor Mayumi Yamada for his reading through the manuscript.

Materials and Methods

The harpacticoid copepods collected were separated into three different stages,

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i.e., adult, copepodid and nauplius. The adults were classified into each species as far as possible, and nineteen species were recognized.

Treatment and estimation of number of harpacticoids were done by the same way as in the previous paper and the total number of individuals is represented by two indexes, individuals/m^2 bottom and /g algae, and abundance of each species is represented by individual number/m^2 bottom.

Results and Discussion

Seasonal appearance

Harpacticoids are roughly divisible into three groups according to the characteristic differences in their seasonal appearances (Fig. 1). These are as follows: (1) year-round species, which appear throughout the year; *Porcellidium ovatum* Haller, *P.* sp. A, *P.* sp. B, *Idomene purpurocincta* (Norman et T. Scott), *Ectinosoma melaniceps* Boeck, *E.* sp., *Orthopsyllus* sp. and *Zaus unisetosus* Itô; seasonal species, which appear in a defenite season; (2) summer to autumn species; *Eudactylopus andrewi* Sewell, *E.* sp., *Dactylopodia* sp. aff. *tisboides* (Claus), *Microsetella norvegica* Boeck and *Harpacticus nipponicus* Itô; (3) winter to spring species; *Harpacticus uniremis* Kröyer, *Echinolaophonte oshoroensis* Itô, *Parathalestris areolata* Itô, *P.* sp., *Zaus robustus* Itô and *Diosaccus ezoensis* Itô.

For the explanation of these seasonal appearances, various effects of environmental factors, both biological and non-biological, would be assumed. As the most important factor, if the special locality of Oshoro Bay is considered, a strong influence of two alternate ocean currents upon the environmental condition of this area should be primarily estimated. The warm Tsushima Current entirely dominates during summer to autumn in this area, whilst the cold water of Liman Current is mixed with coastal water in the other seasons (Motoda, 1971). This alternation of two different currents results in the characteristic seasonal appearance of not only various harpacticoid species but also the other shore fauna and flora, and also planktonic organisms in this bay. In a word, among the seasonal species, the summer to autumn species are under the influence of the warm current, whilst the winter to spring ones are under that of the cold current. Anraku (1953) reproted the same phenomenon in the pelagic copepods in Oshoro Bay, that the copepod community in autumn included various species of both tropical and subtropical dwellers, which seemed to be transported by the Tsushima Current to such a northern area.

The effect of these two alternate currents upon the shore fauna and flora in a given area is not simple, because an ocean current has two important phases in its nature. One is strong influence to such the inorganic environmental factors as temperature and salinity, and the other is the significance as an organisms-transporting medium. The both phases affect the resident animals in various manners, and particulary for the latter one the interpretation would be very difficult, because it is related to competitive respects among the residents and transportees.

As one of the inorganic environmental factors, the temperature of sea water is considered to be of particular importance. Beside the problem whether temperature change is primarily affected by the alternation of ocean currents or the

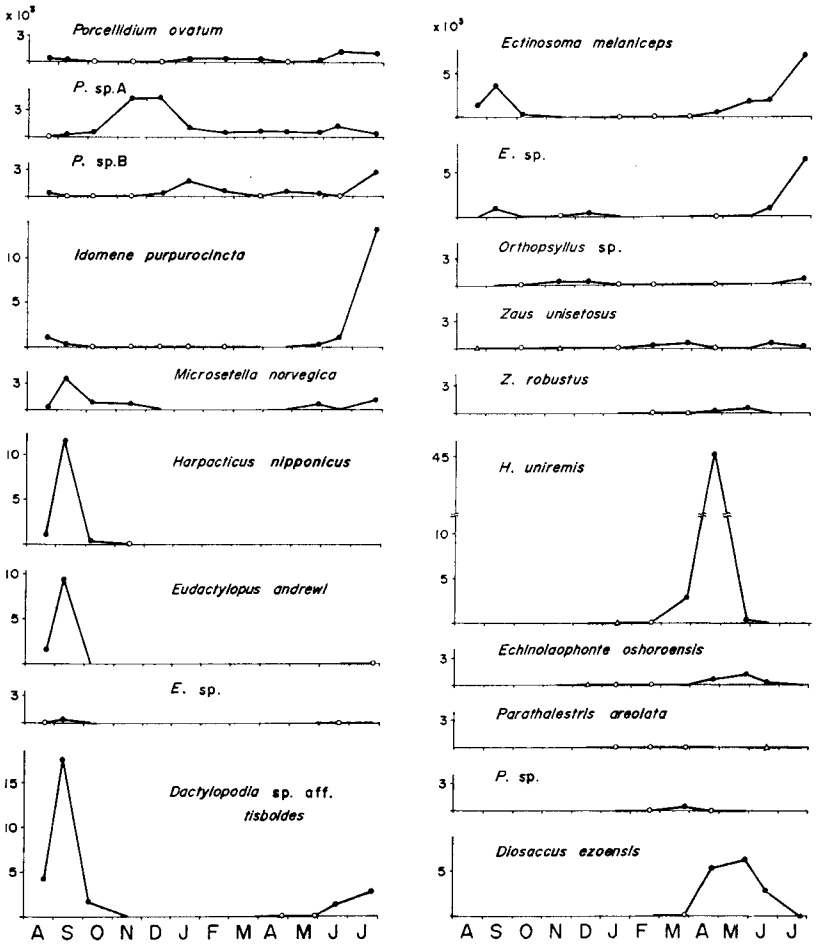

Fig. 1. Seasonal appearance of nineteen harpacticoid species in the *Sargassum* region. Solid circles show the individual number/m² bottom estimated by subsamples. Open circles and triangles represent qualitatively the records found in other samples by Kito and in the literature by Itô, respectively.

fluctuation of air temperature through the four seasons, this factor appears to severely affect the year-round species, because the maximum appearances of *P. ovatum*, *P.* sp. B, *I. purpurocincta* and *Ectinosoma* spp. occurred in a higher

temperature period July, and of *P.* sp. A in a lower period, though the appearance of each the seasonal species can not be simply correlated with the temperature fluctuation.

All the harpacticoid species here reported can be divided into these three groups, but their fluctuation patterns are not always the same to each other. In the winter to spring species, for example, each maximum appearance in most species is slightly different from each other.

Note: *M. norvegica* and *H. uniremis* have been frequently found in the pelagic copepods in this bay and, according to a personal communication by Dr. Itô, *E. oshoroensis* is found among the detritus in the *Sargassum* region through the year round.

Total fluctuation

The quantitative fluctuations of the total harpacticoid fauna, consisting of adults, copepodids and nauplii (as the number of individuals/m^2 bottom), and the relative abundance of each stage are shown in Fig. 2. The total harpacticoid population increased slightly in September and decreased toward February. After passing the lowest density period during three months, December to February, it gradually increased and reached the maximum number in June.

The individual numbers of the adults and copepodids fluctuated by almost the same pattern as that of total harpacticoids, with two peaks a year, September and July. The nauplii irregulary increased and decreased through the year, and this fluctuation of the nauplii does not seem to reflect real one, because it is probable that some sampling errors were present due to the nylon gauze used (0.094 mm meshes) which was maybe so gross that small nauplii passed out through the meshes. If this sampling error for collecting of small nauplii is fairly conspicuous, the figure of the total density attained would be rather underestimated.

In relative abundance the adults dominated in a period, December to February and in July when the abundance of the total harpacticoids was not high, and in the other months including September and June when the harpacticoid population was in peak, the copepodids and nauplii were far abundant rather than the adults. Thus, the adults were less abundant in the population, and their fluctuation accords with that of the total harpacticoids.

Consequently, the seasonal fluctuation of harpacticoid population is explained in the relation to the specific nature of seasonal appearance as mentioned in the former section. Remarkably high density found in September would be explained by the simultaneous occurrence of their peaks of most the summer to autumn species and, after the disappearance of these species, the total harpacticoid population is maintained by the year-round species alone at a lower level. Since April, the winter to spring species begin to appear and their number reaches the maximum in May to June. This increase, however, is rather gradual because of the slight differences in the time of appearance of each species. The disappearance

of the winter to spring species follows remarkable increase of the year-round species in July, though the increase scarcely influences on the fluctuation of the total harpacticoid number, because their amount is fairly small rather than the extremely great amount of the winter to spring species including the copepodid stage.

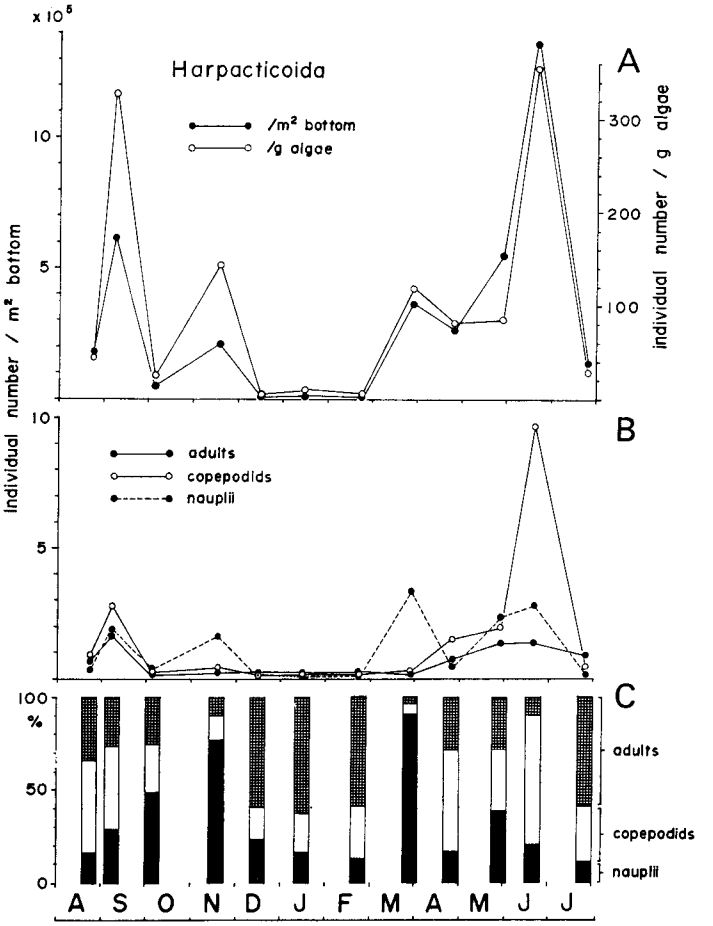

Fig. 2. Seasonal fluctuations of total harpacticoids (A), adults, copepodids and nauplii (B) and relative abundance of each stage (C).

Summary

1) As the second report of the serial work on phytal animals in the *Sargassum* region in Oshoro Bay, Hokkaido, carried out from August, 1973 to July, 1974, phenology of harpacticoid copepods was described.

2) Nineteen species were arranged in following three groups, based upon their seasonal appearances in this area; (1) year-round species, (2) summer to autumn species and (3) winter to spring species.

3) The seasonal species, group (2) and (3) seemed to occur in a definite period under the influence of the warm Tsuchima Current and the cold Liman Current, respectively.

4) The fluctuation of the total harpacticoid population could be explained by the correlation of these three groups; low density during December to February and high densities in September and July were roughly characterized by the group (1), (2) and (3), respectively.

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