COMPOSITION AND SEASONALITY OF AN AMPHIPOD COMMUNITY ASSOCIATED TO THE ALGAE *Bryocladia trysigera*

VALÉRIO-BERARDO, M. T.[1] and FLYNN, M. N.[2]

[1] Faculdade de Ciências Biológicas, Exatas e Experimentais, Universidade Presbiteriana Mackenzie, Rua Itambé, 45, CEP 01239-902, São Paulo, SP, Brazil

[2] Rua Natingui, 494, CEP 05443-000, São Paulo, SP, Brazil

Correspondence to: Maria Teresa Valério-Berardo, Faculdade de Ciências Biológicas, Exatas e Experimentais, Universidade Presbiteriana Mackenzie, Rua Itambé, 45, CEP 01239-902, São Paulo, SP, Brazil, e-mail: valberardo@mackenzie.com.br

Received July 11, 2001 – Accepted September 19, 2001 – Distributed November 30, 2002

(With 3 figures)

ABSTRACT

The monthly fluctuations of amphipods associated to the algae *Bryocladia trysigera* was described from March 1997 to February 1998 at the rocky shore known as Poço de Anchieta in the Peruíbe Beach, Itanhaém, Southeastern Brazil. A total of 75,344 individuals were sampled, belonging to 10 species and 9 families. Three species dominated the phytal in number: *Hyale nigra, Caprella danileviskii* and *Caprella penantis*. Despite the alternation in dominance of the 3 most abundant species, the amphipod species composition remained generally unchanged, so that the majority of the species were observed in all sampling months. The temporally changing pattern of the community structure, with a decline in amphipod abundance in winter followed by an increase in spring, was probably due to a higher predation pressure in winter period.

Key words: amphipods, phytal, Southeastern Brazil.

RESUMO

Composição e variação temporal da comunidade Amphipoda associada à alga *Bryocladia trysigera*

Flutuações mensais de Amphipoda associados à alga *Bryocladia trysigera* são descritas. As coletas foram realizadas no período de março de 1997 a fevereiro de 1998 no costão rochoso do Poço de Anchieta na Praia de Peruíbe, Itanhaém (SP). Foram coletados 75.344 indivíduos, identificados em 9 famílias e 10 espécies. Três espécies dominaram numericamente: *Hyale nigra*, *Caprella danileviskii* e *Caprella penantis*. Embora tivesse sido registrada alternância na dominância dessas espécies, foi observada pequena variação na composição específica nos meses amostrados. A variação temporal na estrutura da comunidade, com o declínio da abundância de Amphipoda no inverno, seguido de aumento na primavera, pode ser causada pela maior pressão de predação no inverno.

Palavras-chave: fital, Amphipoda, Itanhaém.

INTRODUCTION

It has been demonstrated that structural elements such as plant cover strongly influence macrobenthic associations in terms of composition and species densities. Evidence has been provided by studies in sites with different species of seagrass, macroalgae or saltmarsh (Lewis & Stoner, 1983; Lewis, 1984; Virnstein & Howard, 1987; Lana & Guiss, 1991; Schneider & Mann, 1991; Attolini *et al.,* 1997; Flynn *et al.,* 1996, 1998; Dubiaski-Silva & Masunari, 1995, 1998; Chananich & Wilson, 2000).

It has been reported that changes in the density or size of plants lead to varied responses from macro benthic communities (Gunnil, 1983; Edgar, 1990). These alterations are normally attributed to the effect of macrophyta on physical characteristics such as current speed and sediment stability (Peterson *et al.,* 1984) or modifications in biological interactions such as predation (Virnstein, 1977; Nelson, 1979; Heck & Thoman, 1981; Flynn, 1993).

The understanding of the temporal and spatial distribution of the fauna is important in order to establish the natural causes responsible for population and community fluctuations (Underwood & Peterson, 1988). As the coastal ecosystems are under the strong impact of marine pollution, the interest on the dynamic processes of fital associations must increase, since this is an accessible habitat with high density and diversity of organisms.

The results of this study add up to the knowledge of the temporal variation of faunal assemblages associated to algae. Here, monthly fluctuations of amphipods associated to the algae *Bryocladia trysigera* is described and analysed.

MATERIAL AND METHODS

Monthly collections were made at low tide from March 1997 to February 1998 in the infralittoral zone from the algae species *Bryocladia trysigera* at the rocky shore known as Poço de Anchieta in Peruíbe Beach, Itanhaém, Southeastern Brazil (Fig. 1).

Collections were made as described. As the amphipods are quite strongly attached to the substrata (Muskó, 1990), approximately 200 ml of the algae were scraped carefully from the rock and were placed on plastic bags with sea water. The algae and associated fauna were preserved in 70% alcohol. All amphipod specimens were identified at the lowest possible taxonomic level and counted under a dissecting microscope. The algae were dried for 2 days at 60°C in a stove and weighed. The density data are expressed as number of individuals per 50 gr of the dried algae weight.

The structure of amphipod associations was evaluated by the total number of individuals (n), species richness (s), diversity (Shannon index H´) and eveness (Pielou´s index J´). The formula used was:

$$H' = -\sum \frac{ni}{N}.\log \frac{ni}{N} \quad \text{and } J' = \frac{H'}{\log S}$$

where ni is the number of individuals of the ith species, N the total number of individuals and S the number of species.

The abundance of the amphipod species was plotted against time in order to describe typical temporal fluctuation of the phytal species. For the presentation of part of the data, monthly samples were grouped as follows: autumm (March-May); winter (June-August); spring (September-November) and summer (December-February). Surface water temperature and salinity (PSU = practical salinity units) were measured after each collection.

RESULTS

Table 1 shows the range of the recorded environmental variables. Values of salinity varied from 11 to 35 UPS. In December when the minimum value was taken there was a heavy rain which may certainly have influenced this measure. Water temperature ranged from a minimum of 19°C in July to 28°C in December and January.

A total of 75,344 individuals were sampled. Of this total, 44,002 specimens (58%) belong to the suborder Caprellidea and 31,342 (42%) to Gammaridea. 75,272 specimens were identified to species level comprising 10 species belonging to 9 families. Twenty individuals were identified to genera *Ischyrocerus*, and 52 to families: 25 Aoridae and 27 Dexaminidae. The species identified were *Amphilocus neapolitanus* Della Valle 1893*, Bathea catharinensis* Miller 1865*, Ampithoe ramondi* Audouim 1826*, Hyale nigra* (Haswell 1879)*, Gammaropsis palmata* (Stebbing & Robertson 1891)*, Jassa marmorata* (Holmes 1903)*, Elasmopus pectinicrus* (Bate 1862)*, Stenothoe valida* (Dana, 1853)*, Caprella penantis* Leach 1814 and *Caprella danileviskii* Czerniaskii 1868.

Three species dominated the phytal in number totalizing together more than 94% of all individuals sampled. They were in order of numerical importance *H. nigra* (35.67%), *C. danileviskii* (34.62%) and *C. penantis* (23.77%). *E. pectinicrus* and *A. neapolitanus* were also abundant totalizing together 4.48% (Table 2). Changes of populations were evident (Fig. 2), as shown by variations in the monthly abundance of the 10 species sampled. Some fluctuations displayed a strong seasonal component, with species more abundant in winter (*E. pectinicrus, J. marmorata* and *G. palmata*), in winter and spring (*C. penantis* and *C. danileviskii),* in autumn (*A. neapolitanus*) or in autumn and summer (*H. nigra*).

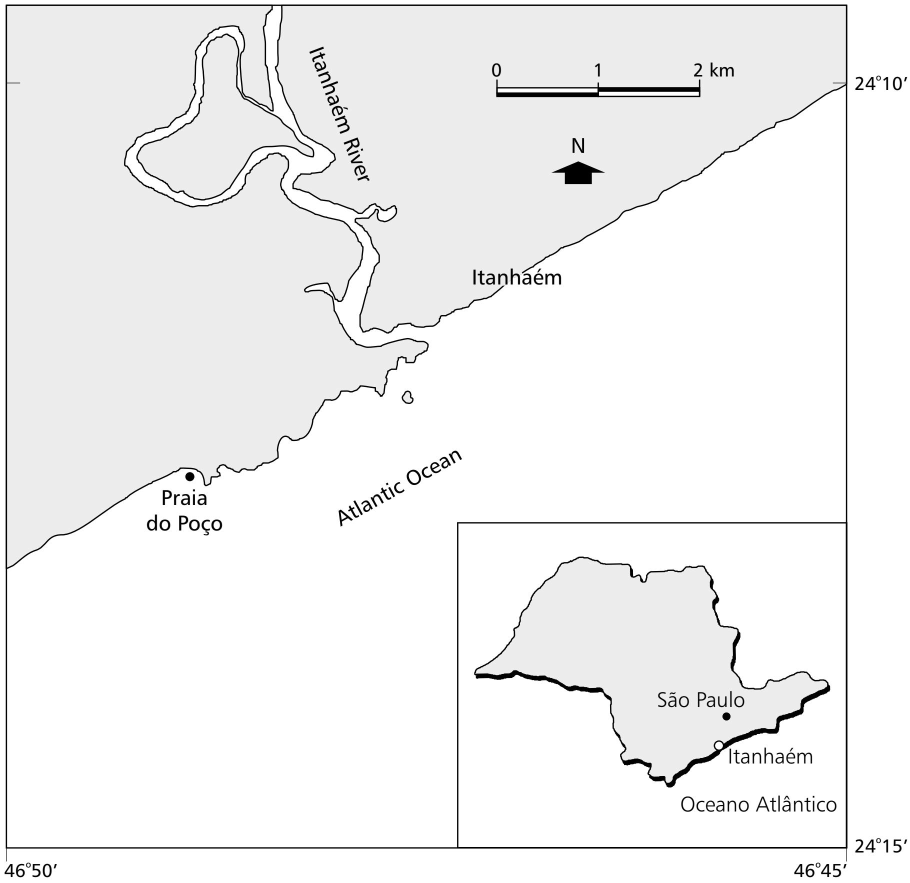

Fig. 1 — Map of the study site.

Other species did not show a clear seasonal pattern in spite of apparently aperiodical fluctuations (*A. ramondi* and *S. valida*).

In relation to the dominance, there is a clear alternation among the three most abundant species *H. nigra, C. danileviskii* and *C. penantis* throughout the year (Table 2). In March and September *C. danileviskii* was clearly the dominant species with 65.76% of the total. In April and May, *H. nigra* was the dominant one with 50.14% and 67.10%, respectively. In June and July *C. danileviskii* is again the dominant species with 43.05% and 39.78%. In August the dominant one is *H. nigra* (33.77%) and in September C. *danileviskii* (44.31%) is again the dominant species. In October *C. penantis* (52.59%) is the dominant one and in November *C. danileviskii* (60.95%). All through the summer, December, January and February, *H. nigra* is the more abundant species (49.26%, 56.84% and 81.82%). It can be remarked that *H. nigra* dominanted in autumn and summer and the species of the genera *Caprella* dominated in winter and spring.

The variations of Shannon diversity, Pielou evenness, species richness and number of individuals are shown in Fig. 3. The diversity values were higher in April, June, July, August and December when the eveness and species richness values were also higher. Mean abundance, species richness, diversity and evenness were calculated for the seasons (Table 3). The diversity and eveness index of the samples had maximal values in winter, when minimal values of abundance were recorded.

TABLE 1
Temperature (T) and salinity (S) parameters measured at each month during the studied period.

Date	T (°C)	S (UPS)
25.03.97	28	34
26.04.97	22	30
22.05.97	21	29
24.06.97	22	35
21.07.97	19	33
19.08.97	22	35
17.09.97	21	31
16.10.97	24	28
14.11.97	27	33
15.12.97	24	11
29.01.98	26	35
14.03.98	28	33

DISCUSSION

All attempts to explain temporal patterns of abundance for individual amphipod species using statistical methods such as multiple regression ended in failure when data on macrophytes and physical-chemical elements (e.g., salinity, water temperature etc.) were used as independent variables (Stoner, 1980). Many authors also found that physical factors played a minor role in the regulation of amphipod abundance (Nelson, 1979).

An increase in epiphytal amphipod abundance during the winter season in southeastern Brazil has been reported for algae associations by Tararam & Wakabara (1981) and for saltmarsh associations by Lana & Guiss (1991) and Flynn *et al*. (1996, 1998). In Hawai, Russo (1989) also reported this density increase in winter and remarked that both Brazil and Hawai are in tropical latitudes. This winter peak in abundance seems to be typical of tropical amphipod species and is followed by a sharp decline in summer (Subrahmanyam *et al*., 1976; Kneib, 1984).

In the present study there was a marked variation in total monthly amphipods abundance with a decrease in abundance in winter followed by an increase in amphipods abundance in spring, Curvelo (1998) also found an increase in abundance at the same period. The temporally changing pattern of community structure is greatly influenced by population dynamics of the dominant species and varying predation pressure. Rapid population increases are explained in terms of an increase in reproduction and rapid growth rates of brooding invertebrates (Edgar & Moore, 1986). The role of fish predation on amphipod populations varies with time and space. For southeastern Brazil the more important predators of amphipods have their maximum abundance in winter while declining in summer (Wakabara *et al*., 1993, 1996) so that lower mean densities in winter could be explained by a higher predation pressure.

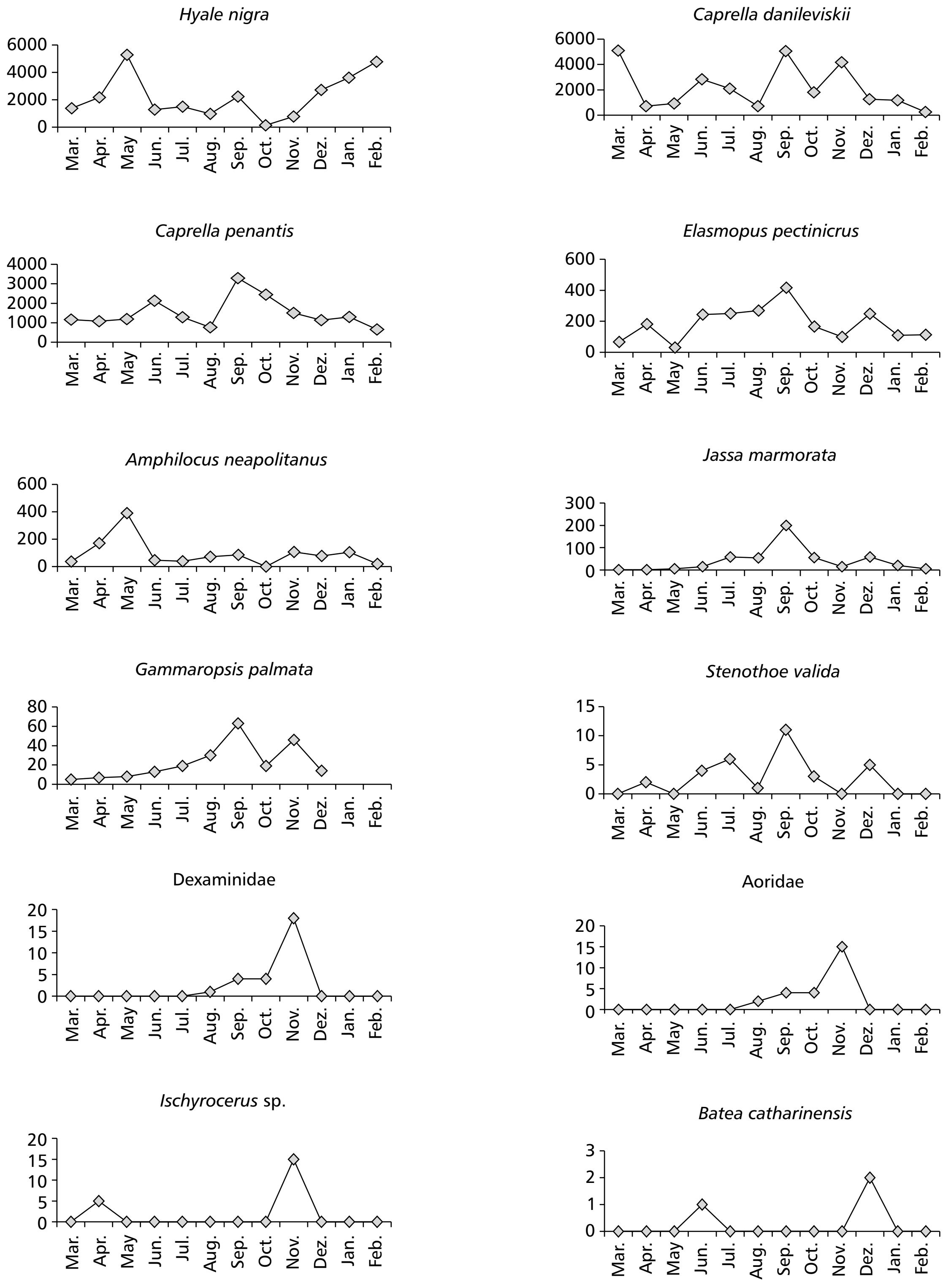

Fig. 2 — Temporal variation in abundance (number of individuals by 50 gr of dry weight of alga) of each species sampled.

TABLE 2
Numerical abundance of the amphipod species sampled at Poço do Anchieta, Southeastern Brazil, represented at each month by number of individual by 50 g of algae dry weight.

	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Total
A. neapolitanus	37	171	391	46	38	71	86	0	107	77	104	19	1147
A. ramondi	14	25	59	18	10	20	30	4	69	10	36	0	295
Aoridae	0	0	0	0	0	2	4	4	15	0	0	0	25
B. catharinensis	0	0	0	1	0	0	0	0	0	2	0	0	3
C. danileviskii	5107	705	913	2838	2090	706	5051	1808	4169	1264	1178	259	26088
C. penantis	1155	1072	1182	2131	1287	759	3292	2448	1501	1127	1299	661	17914
Dexaminidae	0	0	0	0	0	1	4	4	18	0	0	0	27
E. pectinicrus	67	181	31	244	250	270	416	166	99	249	110	113	2196
G. palmata	5	7	8	13	19	30	63	19	46	14	0	0	224
H. nigra	1378	2183	5281	1281	1495	976	2242	142	785	2725	3620	4771	26879
Ischyrocerus	0	5	0	0	0	0	0	0	15	0	0	0	20
J. marmorata	2	2	5	15	58	54	200	56	15	58	21	5	491
S. valida	0	2	0	4	6	1	11	3	0	5	0	0	35
	7765	4353	7870	6591	5253	2890	11399	4654	6839	5531	6368	5831	75344

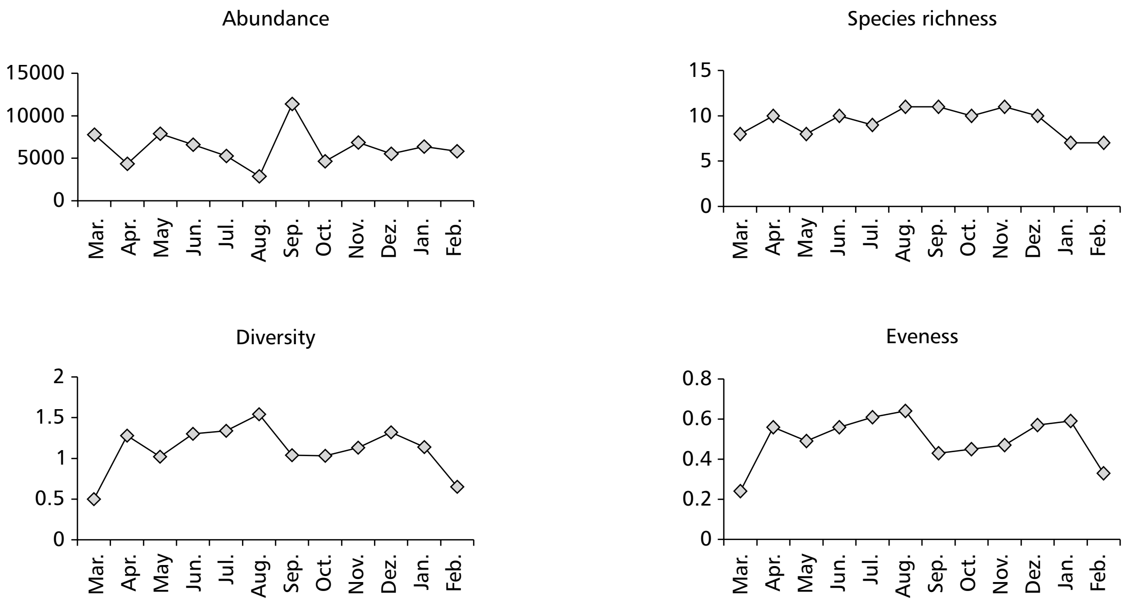

Fig. 3 — Temporal variation of total abundance, species richness, diversity and evenness.

TABLE 3
Mean abundance (N), species richness (S), eveness (J') and diversity (H') for each season.

	N	S	H'	J'
Autumn	6663	8.7	0.93	0.43
Winter	4911	9	1.39	0.60
Spring	7631	10.7	1.07	0.45
Summer	5910	8	1.04	0.5

Diferences in abundance of the three most abundant species *H. nigra, C. penantis* and *C. danileviskii*, were clearly due to differences in reproductions peaks. The species that are part of the phytal communities present as a rule continuous reproduction (Imada & Kikuch, 1984). This is due mainly to adjustments in their reproduction cycles in order to be able to quickly explore favourable environmental conditions. The biology of each species, i.e., their reproductive strategies, life cycles, incubation periods and fecundity, contributes to the alternation of the numerical dominance of each species population (Tararam & Wakabara, 1981; Edgar, 1983; Jacobucci, 2000), so that the difference in population flutuations of dominant species indicates an attempt to distinguish an ecological niche by means of a reproductive strategy.

Despite the alternation in dominance of the 3 most abundant and dominant species, the phytal amphipod species composition associated to the algae *Bryocladia trysigera* remained generally unchanged along the year and the species richness values practically constant, so that the majority of species were observed in all sampling months.

Acknowledgments — We are grateful for the financial support offered by MACKPESQUISA (Universidade Presbiteriana Mackenzie – São Paulo, SP).

REFERENCES

ATTOLINI, F. S., FLYNN, M. N. & TARARAM, A. S., 1997, Influence of *Spartina alterniflora* and tide level on the structure of polychaete associations in an euryhaline salt marsh in Cananéia lagoon estuarine region (SE Brazil). *Rev. Bras. Oceanogr.*, *45*(1/2): 25-34.

CHANANICH, S. & WILSON, K. A., 2000, Rocky intertidal zonation of gammaridean amphipods in Long Island South, Connecticut. *Crustaceana, 73*(7): 815-834.

CURVELO, R., 1998, *A meiofauna vágil associada a* Sargassum cymosum *C. Agardh, na Praia do Lásaro, Ubatuba, SP.* M.Sc. Thesis, Instituto Oceanográfico, Universidade de São Paulo, SP, 50p.

DUBIASKI-SILVA, J. & MASUNARI, S., 1995, Ecologia populacional dos amphipoda (Crustacea) dos fitais de Caiobá, Matinhos, Paraná, Brasil. *Rev. Bras. Zool.*, *12*(2): 373-396.

DUBIASKI-SILVA, J. & MASUNARI, S., 1998, Estrutura populacional de *Hyale media* (Dana) (Amphipoda, Gammaridea, Hyalidae), habitante dos fitais de Caiobá, Matinhos, Paraná, Brasil. *Rev. Bras. Zool.*, *15*(1): 59-71.

EDGAR, G. J., 1983, The ecology of Southeast Tasmanian phytal animal communities. I. Spatial organization on a local scale. *J. Exp. Mar. Biol. Ecol.*, *70*: 129-157.

EDGAR, G. J., 1990, The influence of plant structure on the species richness, biomass and secondary production of macrofaunal assemblages associated with Western Australian seagrass beds. *J. Exp. Mar. Biol. Ecol., 137*: 215-240.

EDGAR, G. J. & MOORE, P. G., 1986, Macro-algae as habitat for motile macrofauna. *Monogr. Biol.*, *4*: 255-277.

FLYNN, M. N., 1993, *Aspectos ecológicos das associações de espécies e avaliação do efeito da predação sobre a estrutura da macrofauna bentônica de bancos de* Spartina *(Cananéia, SP, Brasil).* Ph.D. Thesis, Universidade de São Paulo, Instituto Oceanográfico, 84p.

FLYNN, M. N., TARARAM, A. S. & WAKABARA, Y., 1996, Effects of habitat complexity on the structure of macrobenthic association in a *Spartina alterniflora* marsh. *Rev. Bras. Oceanogr.*, *44*: 9-21.

FLYNN, M. N., WAKABARA, Y. & TARARAM, A. S., 1998, Macrobenthic associations of the lower and upper marshes of a tidal flat colonized by *Spartina alterniflora* in Cananéia lagoon estuarine region (Southeastern Brazil). *Bull. Mar. Sci.*, *63*(2): 427-442.

GUNNIL, F. C., 1983, Seasonal variations in the invertebrate fauna of *Pelvetia fastigiata* (Fucaceae): effects of plant size and distribution. *Mar. Biol., 14*(4): 304-337.

HECK, K. L. & THOMAN, T. A., 1981, Experiments on predatory-prey interaction in vegetated aquatic habitats. *J. Exp. Mar. Biol. Ecol., 53*: 125-134.

KNEIB, R. T., 1984, Patterns of invertebrate distribution and abundance in the intertidal salt marsh: causes and questions. *Estuaries, 7*: 392-412.

IMADA, K. & KIKUCHI, T., 1984, Studies on some reproductive traits of three caprellids (Crustacea: Amphipoda) and their seasonal fluctuations in the *Sargassum* bed. Publications of Amakusa Marine Biology Laboratory, Jyushu University, *7*(2): 151-172.

JACOBUCCI, G. B., 2000, *Distribuição vertical e flutuação sazonal da macrofauna vágil associada a* Sargassum cymosum *C. Agardh, em uma praia do litoral do Estado de São Paulo.* M.Sc. Thesis, Instituto de Biociências, Universidade Estadual de Campinas.

LANA, P. C. & GUISS, C., 1991, Influence of *Spartina alterniflora* on the structure and temporal variability of macrobenthic associations in a tidal flat of Paranaguá Bay (southeastern Brazil). *Mar. Ecol. Prog. Ser.*, *73*: 231-244.

LEWIS, F. G., 1984, Distribution of macrobenthic crustaceans associated with *Thalassia*, *Halodule* and bare sand substrata. *Mar. Ecol. Prog. Ser.*, *18*: 101-113.

LEWIS, F. G. & STONER, A. W., 1983, Distribution of macrofauna within seagrass beds: an explanation for patterns of abundance. *Bull. Mar. Sci., 33*: 296-304.

MUSKÓ, I. B., 1990, Qualitative and quantitative relationships of Amphipoda (Crustacea) living on macrophytes in Lake Balaton (Hungary). *Hydrobiologia, 191*: 269-274.

NELSON, W. S., 1979, Experimental studies of selective predation on amphipods. Consequences for amphipod distribution and abundance. *J. Exp. Mar. Biol. Ecol.*, *38*: 225-245.

PETERSON, C. N., SUMMERSON, H. C. & DUNCAN, P. B., 1984, The influence of seagrass cover on population structure and individual growth rate of a suspension-feeding bivalve, *Mercenaria mercenaria. J. Mar. Res., 42*: 123-138.

RUSSO, A. R., 1989, Fluctuations of epiphytal gammaridean amphipods and their seaweed host on an Hawaiian algal reef. *Crustaceana, 57*(1): 25-37.

SCHNEIDER, F. I. & MANN, K. H., 1991, Species specific relationship of invertebrates to vegetation in a seagrass bed. I. Correlational studies. *J. Exp. Mar. Biol. Ecol., 145*: 101-117.

STONER, A. W., 1980, The role of seagrass biomass in the organization of benthic macrofaunal assemblages. *Bull. Mar. Sci., 30*: 537-551.

SUBRAHMANYAM, C. B., KRUCZYNSKI, W. L. & DRAKE, S. H., 1976, Studies on the animal communities in two North Florida salt marshes. II. Macroinvertebrate communities. *Bull. Mar. Sci.*, *26*: 172-195.

TARARAM, A. S. & WAKABARA, Y., 1981, The mobile fauna-especially Gammaridea-of *Sargassum cymosum*. *Mar. Ecol. Prog. Ser., 5*: 157-163.

UNDERWOOD, A. J. & PETERSON, C. H., 1988, Towards an ecological framework for investigating pollution. *Mar. Ecol. Prog. Ser., 29*: 279-288.

VIRNSTEIN, R. W., 1977, The importance of predation by crabs and fishes on benthic infauna in Chesapeake Bay. *Ecology., 58*: 1199-1217.

VIRNSTEIN, R. W. & HOWARD, R. K., 1987, The motile epifauna of marine macrophytes in the Indian River lagoon, Florida. II. Comparison between drift algae and three species of seagrass. *Bull. Mar. Sci., 41*: 13-26.

WAKABARA, Y., TARARAM, A. S. & FLYNN, M. N., 1993, Importance of the macrofauna for feeding of young fish species from infralittoral of Ponta do Arrozal, Cananéia lagoon estuarine region. *Bolm Inst. Oceanogr.*, São Paulo, *41*(1/2): 39-52.

WAKABARA, Y., FLYNN, M. & TARARAM, A. S., 1996, Ingestion and selection of suprabenthic crustaceans by small-sized fishes in a lower saltmarsh system. *Rev. Bras. Oceanogr, 44*: 89-103.