Bolm. Zool., Univ. S. Paulo
7:155-169, 1982

DISTRIBUTION OF THE MARINE CLADOCERANS (CRUSTACEA, BRANCHIOPODA) OFF SANTOS, BRAZIL

CARLOS EDUARDO FALAVIGNA DA ROCHA

Departamento de Zoologia, Instituto de Biociências, Universidade de São Paulo, Caixa Postal 20.520, 01000 - São Paulo, Brasil. (recebido em 15.X.1982)

RESUMO - A distribuição e migração verticais, bem como a distribuição segundo as massas de água de quatro espécies de cladóceros marinhos (*Penilia avirostris* Dana, *Evadne tergestina* Claus, *E. spinifera* P.E. Müller e *Podon intermedius* Lilljeborg) foram estudadas em amostras de plancton coletadas sucessivamente a 45-47 m, 20-25 m e 0-1 m, em intervalos de 4 horas, durante 24 horas nas seguintes datas: 8-9/04/60, 22-23/09/60, 6-7/07/61 e 7-8/11/61. *P. avirostris*, espécie euritérmica, mais abundante no verão-outono e sem preferência por qualquer massa d'água, realizou migrações verticais diárias entre a superfície e a meia-água controladas pelas condições de luminosidade. *E. spinifera* e *E. tergestina* foram superficiais e não apresentaram migração vertical. *E. spinifera* foi estenotérmica, preferindo águas de 20,0 a 23,0 °C e desaparecendo quando a superfície foi ocupada por águas mais quentes. *E. tergestina* foi euritérmica apresentando as mesmas preferências que *P. avirostris*. *P. intermedius* foi estenotérmico psicrófilo e se distribuiu preferencialmente próximo do fundo, associado com a Água Subtropical. Sua migração entre o fundo e a meia-água foi controlada pela luz e termoclina. A presença de aglomerações de *Oscillatoria* sp na superfície e a distribuição agregada dos cladóceros foram outros fatores que interferiram na distribuição vertical destes animais.

ABSTRACT - The vertical distribution, migration and habitat preferences of four cladocerans (*Penilia avirostris* Dana, *Evadne tergestina* Claus, *Evadne spinifera* P.E. Müller and *Podon intermedius* Lilljeborg) were studied in a series of samples collected in four different periods at 24° 16 8' Lat S -46° 0.4' Long. W. Informations on their life cycle were added.

INTRODUCTION

Cladocera distribution has been intensely searched , mainly in the North Atlantic Ocean, North Sea, Mediterranean Sea, Black Sea and Indian Ocean. In the South Atlantic it is little known up to now. A summary of the geographic distribution of cladocerans, with the most important pertaining literature is provided by Della Croce (1974).

The distribution of cladocerans off Brazil was never studied in detail. There are some data furnished by oceano - graphic expeditions and trips (Dana, 1852-55; Hansen, 1899 ; Rammner, 1933; Seguin, 1965; Fontes, 1971, 1973a and b; Ramirez & De Vreese, 1974) and by surveys of the zooplankton in some areas (Almeida Prado, 1962; Teixeira *et al.*, 1965; Santos, 1973 and Castello, 1978). The Figure 1 shows the occurrence of the species of cladocerans registered in Brazilian waters according to the mencioned literature.

Little in known about the diel vertical migration of these animals. The nyctimeral rhythms of the species considered in this paper have been investigated in the Black Sea (Porumb & Porumb, 1965), in the Mediterranean (Leveau, 1965; Thiriot, 1972-73), off the coast of Madagascar (Frontier , 1973), in the Gulf of Guinea (Binet, 1975) and in the Inland Sea of Japan (Onbé, 1977). Lee (1974) and Bosch & Taylor (1973) studied the vertical migration of *E. nordmanni* and *P. polyphemoides* respectively.

The purpose of this paper is to determine ecological preferences of cladocerans in Brazilian waters It will be taken in consideration the relations between some abiotic factors and the vertical distribution and migration, as well as the preferences of each species to the different water masses.

MATERIAL AND METHODS

The material studied belongs to the Plankton Collec - tion Series V, taken off Santos (24^{o} 16.4' S - 46^{o} 0.4 W) on April 8-9, 1960, September 22-23, 1960, July 6-7, 1961 and November 7-8, 1961.

During 24 hours' periods, every 4 hours, plankton was sampled with a standard net no. 3 (0.5 m of mouth diameter , 1.8 m length and bolting silk with 64 meshes/inch) during fifteen minutes, at a velocity of approximately 0.5 knot.The hauls were consecutive and made in three levels: near the bottom (45 or 47 m), in midwater (20 or 25 m) and near to the surface (1.0 m). The filtrated volume of water was estimated using the $\pi.r^2.h$ formula. All the samples were fixed with formaline at 10 %.

For each series of samples, the temperatures and salinities were measured at depths previously fixed.

P. avirostris was counted in subsamples obtained by the Stempel pipette. For the other species, a Folsom sampler was used. Males, sexual and parthenogenetic females were identified and counted separately. The identification of the

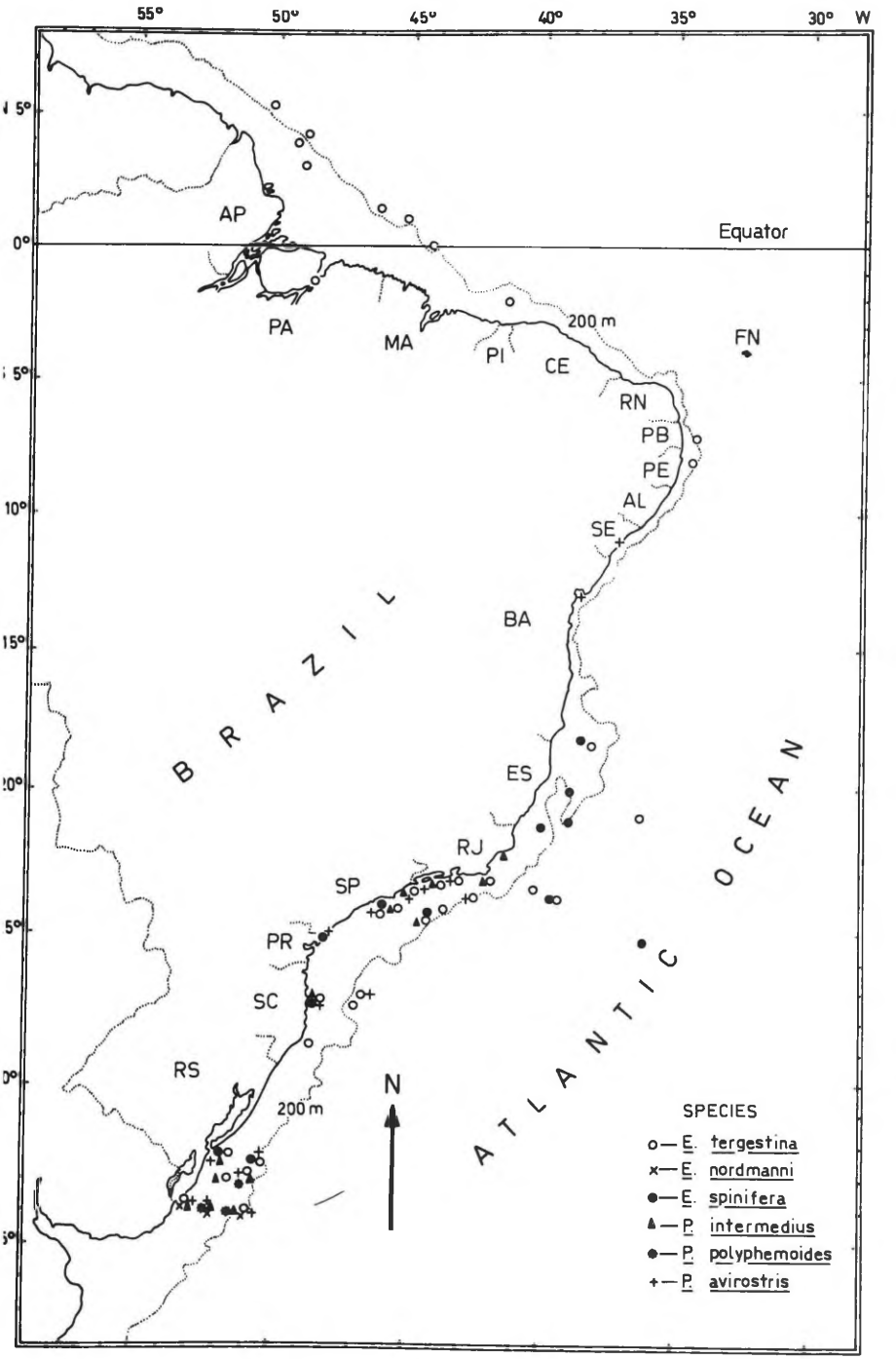

Figure 1 - The occurrence of the Cladocerans off Brazil.

species was made according to Baker (1938), Claus (1877), Rammner (1939) and Steuer (1933)

THE ENVIRONMENT

According to Emilsson (1961), four water masses may occur off Santos:

a) Tropical Water (T), with temperatures above 20.0 °C and salinities higher than 36.0 °/oo.
b) Subtropical Water (ST) with salinities from 35.0 to 36.0 °/oo and temperatures between 10.0 and 20.0 °C flowing northward under the Tropical Water which flows South.
c) Coastal Water (C) with salinities under 35.0 °/oo and variable temperatures.
d) Shelf Water (S) formed by the mixture of the three mentioned waters, having salinities between 35.0 and 36.0 °/oo and temperatures above 20.0 °C.

The water masses found during each hauling period are noted in Table I.

TABLE I - The water masses in the collecting station during the four periods studied, with indications of the limits of depth in which they occurred. C = Coastal Water, S = Shelf Water, ST = Subtropical Water and T = Tropical Water. (*) = Thermocline between 15 and 25 m, (**) = Thermocline between 7 and 15 m.

APRIL 8-9, 1960		SEPTEMBER 22-23, 1960		JULY 6-7, 1961		NOVEMBER 7-8, 1961	
DEPTH (m)	WATER MASSES	DEPTH (m)	WATER MASSES	DEPTH (m)	WATER MASSES	DEPTH (m)	WATER MASSES
0-7	S.	0-25	S.	0-10	C.	0-7 **	S.
7-15 *	T	25-35	T , S.	10-45	S.	15-45	S.T
25-47	S.T	47	T	45	T		

RESULTS

Four species of cladocerans were found: *P. avirostris*, *E. tergestina*, *E. spinifera* and *P. intermedius*.

Evadne costai Fontes, 1971 from the coastal waters off North and Northeast of Brazil is a junior synonym of *E. ter-*

TABLE II - Density (ind/100 m^3) of *Penilia avirostris* at different times and depths during the four periods studied. PH = parthenogenetic females, SF = sexual females; M = males and T = total.

DATE		April 8-9, 1960				September 22-23, 1960			July 6-7, 1961			November 7-8, 1961				
TIME (hs)	DEPTH (m)	PF	SF	M	T	TIME (hs)	DEPTH (m)	PF	TIME (hs)	DEPTH (m)	PF	TIME (hs)	DEPTH (m)	PF	SF	M	T
	0	50,333	333	2,556	53,222		0	533		0	1,191		0	520	2	-	522
24:00	20	6,833	-	-	6,833	12:00	25	10,833	12:00	25	27,555	08:00	25	3,169	2	-	3,171
	45	582	2	-	584		47	1,049		45	1,555		45	6,817	-	-	6,817
	0	73,600	1,200	5,200	80,000		0	8,200		0	264		0	389	-	-	389
04:00	20	5,150	9	9	5,168	16:00	25	7,445	16:00	25	14,944	12:00	25	5,289	-	-	5,289
	45	9,156	-	180	9,336		47	675		45	444		45	1,295	-	-	1,295
	0	924	9	9	942		0	454		0	9,500		0	17,500	-	-	17,500
08:00	20	5,443	2	-	5,445	20:00	25	8,000	20:00	25	22,611	16:00	25	529	-	-	529
	45	827	7	18	852		47	755		45	240		45	4,835	-	-	4,835
	0	758	-	2	760		0	21,000		0	5,555		0	7,186	-	-	7,186
12:00	20	8,306	9	18	8,333	24:00	25	12,500	24:00	25	22,222	20:00	25	7,671	-	-	7,671
	45	2,338	4	2	2,344		47	258		45	844		45	1,271	-	-	1,271
	0	2,074	9	18	2,101		0	2,560		0	3,722		0	6,244	-	-	6,244
16:00	20	16,857	9	-	16,866	04:00	25	5,778	04:00	25	23,611	24:00	25	2,000	-	-	2,000
	45	192	-	-	192		47	320		45	417		45	2,844	-	-	2,844
	0	79,218	160	89	79,467		0	1,298		0	2,166		0	4,666	-	-	4,666
20:00	20	14,525	9	-	14,534	08:00	25	14,167	08:00	25	35,889	04:00	25	25,066	-	-	25,066
	45	1,780	9	-	1,789		47	1,964		45	329		45	5,166	-	-	5,166
	0	5,827	27	18	5,872		0	800		0	853		0	755	-	2	757
24:00	20	1,129	2	-	1,131	12:00	25	4,111	12:00	25	2,833	08:00	25	1,769	-	-	1,769
	45	3,400	-	-	3,400		47	2,078		45	2,942		45	977	-	-	977
T		289,252	1,800	8,119	299,171			104,778			179,687			105,958	4	2	105,964

TABLE III - Density (ind/100 m^3) of *Evadne tergestina* (E.T.), *Evadne spinifera* (E.s) and *Podon intermedius* (P.i.) at different times and depths during the four periods studied. PF = parthenogenetic females, SF = sexual females, M = males and T = total.

DATE		April 8-9, 1960						September 22-23, 1960					July 6-7, 1961							November 7-8, 1961				
SPECIES		E.t.				E.s.	P.i.			E.t.	E.s.	P.i.			E.t.				E.s.	P.i.			E.t.	E.s.	P.i.
TIME (hs)	DEPTH (m)	PF	SF	M	T	PF	PF	TIME (hs)	DEPTH (m)	PF	PF	PF	TIME (hs)	DEPTH (m)	PF	SF	M	T	PF	PF	TIME (hs)	DEPTH (m)	PF	PF	PF
	0	1,644	2	20	1,666	-	2		0	6,556	2,681			0	844		-	844	116	-		0	4,264	189	11
24:00	20	373	-	-	373	-	-	12:00	25	89	27	-	12:00	25	18	-	-	18	187	-	08:00	25	47	-	1,084
	45	58	4	-	62	-	100		47	44	27	71		45	27		-	27	-	9		45	60	-	718
	0	11,822	35	78	11,935	2	4		0	729	2,160	-		0	689	-	-	689	133	-		0	11,058	260	2
04:00	20	158	2	2	162	-	-	16:00	25	302	62	-	16:00	25	320	-	-	320	-		12:00	25	51	-	1,733
	45	108		2	110	-	27		47	44	62	36		45	27	-	-	27	9	-		45	31	-	231
	0	1,053	-	-	1,053	-			0	11	67	-		0	29	2	-	31	18	-		0	3,333	276	116
08:00	20	144	-	4	148	-	4	20:00	25	44	-	-	20:00	25	338		-	338	-	-	16:00	25	24	-	502
	45	311	2	4	317		218		47	53	18	-		45	44	-	-	44	-	9		45	782	18	1,471
	0	1,613	2	2	1,617	2	-		0	809	1,458	-		0	27	-	-	27	18	-		0	5,038	18	-
12:00	20	169		2	171	-	-	24:00	25	27	9	9	24:00	25	720	-		720	-	-	20:00	25	320	-	818
	45	517	2	11	584	2	276		47	18	36	-		45	27	-	-	27	-	-		45	124	-	53
	0	198	-	2	200		-		0	658	1,307	-		0	800	-	27	827	302	-		0	1,493	27	9
16:00	20	189	-		189			04:00	25	36	-	-	04:00	25	382	-	-	382	-	-	24:00	25	27	-	293
	45	29	-		29	-	20		47	18	44	-		45	62	-		62	-	-		45	356	9	213
	0	271	2	7	280	-	-		0	827	391	-		0	3,556	-	9	3,565	1,911	-		0	4,018	9	-
20:00	20	193	-		193	-	-	08:00	25	27		9	08:00	25	196	-	-	196	18	-	04:00	25	116	-	507
	45	22	-	-	22	-	60		47	169	267	71		45	44	-	-	44	-	-		45	293	-	267
	0	571	2	7	580	-	-		0	98	80	-		0	2,764	-	-	2,764	498	-		0	4,329	89	9
24:00	20	20	2	-	22	-	-	12:00	25	187	18	-	12:00	25	916	-	-	916	18	-	12:00	25	204	9	116
	45	91		-	91	-	100		47	36	62	80		45	124	-	-	124	27	-		45	53	-	187
T		19,608	55	141	19,804	6	811			10,782	8,746	276			11,954	2	36	11,992	3,255	18			36,021	904	8,340

geetina. Its occurrences were included in the Figure 1 related to *E. tergestina*.

P. avirostris, the most abundant cladoceran in the area, and *E. tergestina* attaining peaks of density in April. Amphigonic forms of *P. avirostris* were numerous in April and rare in November (Table II), while those of *E. tergestina* appear in April and July (Table III)

E. spinifera (Table III) occurred very sporadically in April. Its population, composed exclusively by parthenogenetic females increased in July and September, decreasing again in November.

P. intermedius (Table III) was the least abundant cladoceran off Santos. It was more numerous in November and April than in September and July. Only parthenogenetic females were collected.

The ranges of salinity and temperature in which the four species occurred were from 34.76 to 36.17 °/oo and from 15.04 to 26.00 °C (*P. avirostris* and *E. tergestina*) or to 25.7 °C (*E. spinifera* and *P. intermedius*)

a) Distribution per water mass

P. avirostris and *E. tegestina* (Figures 2 and 3) ocurred in the four water masses, attaining their density peaks in the Shelf Water. *E. spinifera* (Figure 4) was almost restricted to Shelf and Coastal waters with temperatures between 20.0 and 23.5 °C. *P. intermedius* (Figure 5) shows remarkable preference to Subtropical Water. The densities of the four species diminished in the Tropical Water.

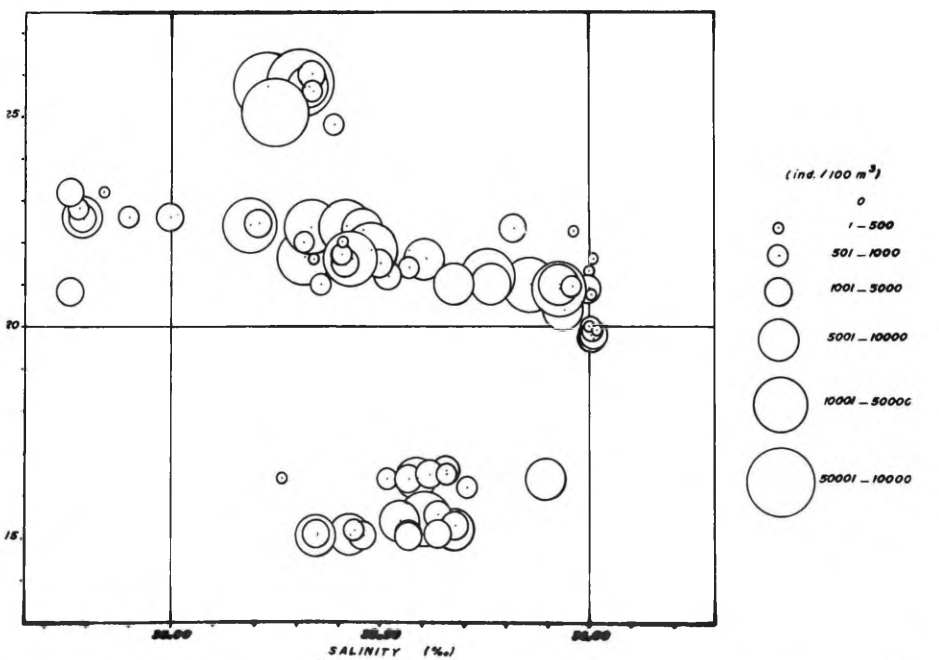

Figure 2 - Density of *Penilia avirostris* according to temperature and salinity.

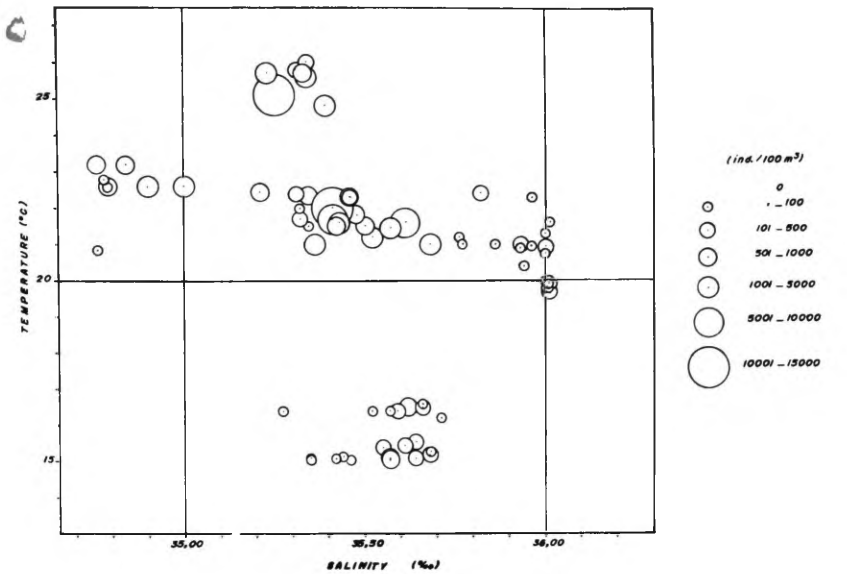

Figure 3 - Density of *Evadne tergestina* according to temperature and salinity.

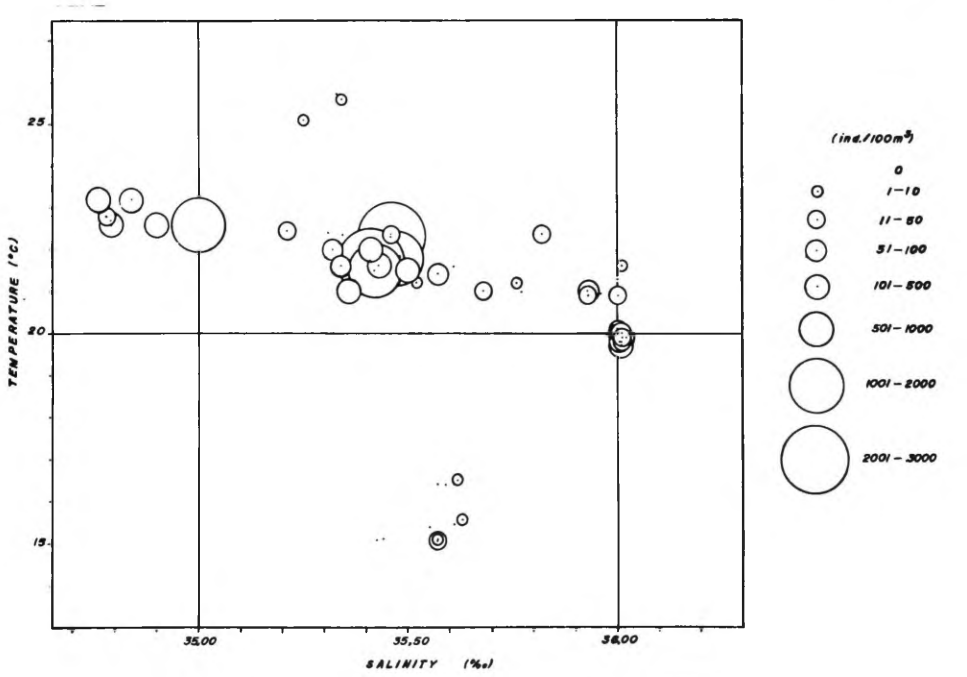

Figure 4 - Density of *Evadne spinifera* according to temperature and salinity.

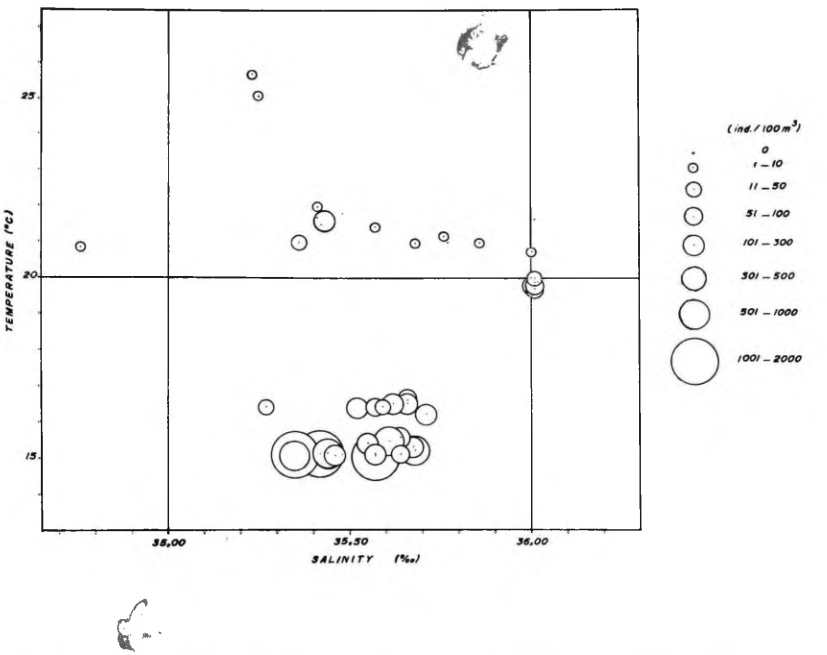

Figure 5 - Density of *Podon intermedius* according to temperature and salinity.

b) Vertical Distribution and Migration

P. avirostris was distributed between 0 m and 50 m,but the migratory movements were accomplished in the upper 25 m (Figure 6a-d) The greater part of its population migrated towards the surface at night and it descended to deeper levels at sunrise, staying there during the day (Figures 6a, b and c) In July (Figure 6d) the greater percentage of the population remained in the midwater during sampling time. After sundown some animals migrated to the surface.

E. tergestina and *E. spinifera* (Table III) showed preference to the surface waters and no daily vertical movements of the animals were registered.

P. intermedius occurred mainly in the cold water below the thermocline. In April (Figure 7a), it was concentrated near the bottom all the time. In November (Figure 7b) it migrated between the bottom and the midwater.

The parthenogenetic females of *P. avirostris* and *E. tergestina* did not show different patterns of migration at different ages. Males and sexual females distributed similarly to the parthenogenetic specimens (Table II and III).

The low densities of cladocerans species in September at 20:00 hours at the surface was caused by a bloom of *Oscillatoria* sp in this layer.

Bolm.Zool., Univ.S.Paulo, 7, 1983

ERRATA

Pg. 164. Fig. 6a-b, the upper one must be Fig. 7a-b. Fig. 7c-d must be Fig. 6c-d.

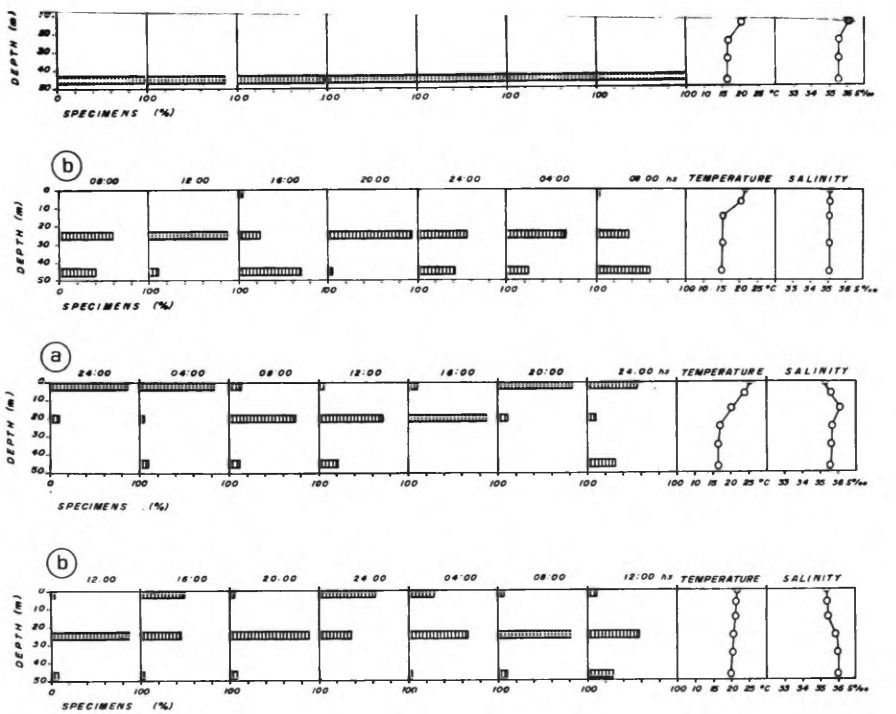

Figure 6 - Vertical distribution of *Penilia avirostris* on April 8-9, 1960 (a), September 22-23, 1960 (b), July 6-7, 1961 (c) and November 7-8, 1961 (d).

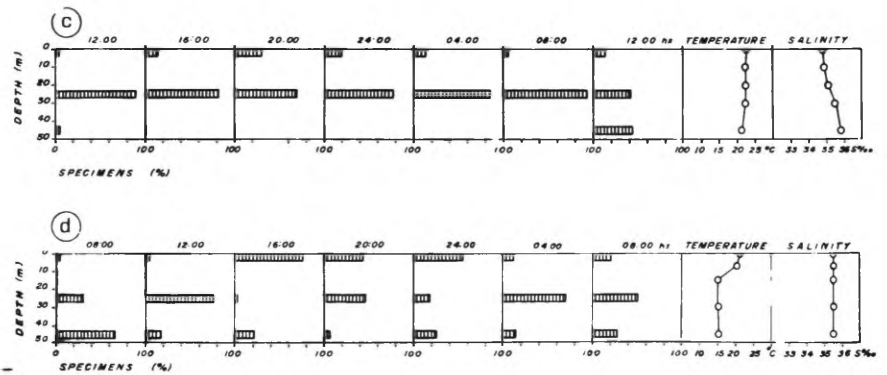

Figure 7 - Vertical distribution of *Podon intermedius* on April 8-9, 1960 (a) and November 7-8, 1961 (b)

DISCUSSION

The occurrence of *P. avirostris* and *E. tergestina* in the four periods, under distinct hydrographic conditions, suggests that they were annual in the studied area. Both species were eurythermic but preferring the waters with temperatures above 21.0 °C. So they can be considered warm water forms, in agreement with Onbé (1977)

E. spinifera was a stenothermic thermophilous species The thermic variation in which it occurred, agrees with that observed by Gieskes (1971) and Specchi *et al.* (1974) The cause of its low density during the Summer and Autumn, and the great number of its congeneric species in this same period in the Shelf Water was probably the progressive warming of this water mass up to 25.0 °C. Onbé (1977) also suggested the important role of the temperature on the control of the seasonal occurrence and succession of the *Evadne* species

The scarcity of *E. spinifera* in the Subtropical Water can be attributed to the low temperatures (15.0 and 16.0°C), which were the same as when this species disappeared in the Mediterranean Sea (Thiriot, 1972 and Specchi *et al.*, 1974).

P. intermedius is a species characteristic of the Subtropical Water, together with *Calanus tenuicornis*, *Calanoides carinatus* and *Ctenocalanus vanus*, as indicated by Björnberg (1963) Ramirez & De Vreese (1974) verified that in the region between the southernmost part of Brazil and Mar del Plata, *P. intermedius* was the most abundant cladoceran when the region was occupied by the Falklands Current and Subtropical Water. The animals are probably brought by the cold water which flows to the north near the bottom, over the South Continental Shelf of Brazil. The influence of the water currents on the horizontal and seasonal distributions of the cladocerans was also pointed out by Baker (1938) and by Specchi (1973).

The light seems to have a controlling role on the diel vertical migration of *P. avirostris* and *P. intermedius*. Although *P. avirostris* has showed no responses to different light intensities under experimental conditions (Lochhead, 1954) and a remarkable positive phototaxis to artificial light (Porumb & Porumb, 1965), it showed a negative phototaxis off Santos. An analogous behaviour was verified by Marano (1970) in the Mediterranean Sea and by Binet (1975) off the Ivory Coast, while the absence of migratory movements was registered by Onbé (1977)

P. intermedius' migration towards the surface after the sundown was registered by Hansen (1951), Furnestin (1957) and Marano (1970). Off Santos, the rise of the species was always prevented by the thermocline that acted as an efficient ecological boundary.

The vertical distribution of the two species of *Evadne* was not influenced by the luminosity conditions. They tolerated high intensities at the surface during the day and no tendency to vertical homogeneity of the distribution after sundown was observed, in agreement with Frontier (1973), Marano (1970) and Furnestin (1957) The variation of the densi

ties in the different depths during the 24 hours' periods was probably caused by the horizontal transport of the population and the distribution in patches as was suggested by Riera & Blasco (1967)

SUMMARY AND CONCLUSIONS

1 - *Evadne costai* Fontes, 1971 is a junior synonym of *E. tergestina* Claus, 1877

2 - *P. avirostris, E. tergestina, E. spinifera* and *P. intermedius* occurred in a decreasing order of abundance.

3 - *P. avirostris* and *E. tergestina* were together, showing the same thermic preferences. They were probably annual species with peaks of abundance in the Summer and Fall, when amphigonic forms appeared. *P. intermedius* also was a Summer-Fall form, but it was related with the deep cold water. *E. spinifera* was a Winter and Spring form, excluded from the area when the temperature over-reached 23.0 °C.

4 - *P. intermedius* is a characteristic species of the Subtropical Water. It is an allochthonous form brought by this cold water to the southern area of the Brazilian Continental Shelf. *E. spinifera* was associated with the surface water, with temperatures between 20.0 and 23.0 °C (Shelf and Coastal Waters). *E. tergestina* was more numerous in the Shelf Water, while *P. avirostris* did not show preference to any water mass. In general, the cladocerans avoided the waters with oceanic influence.

5 - *E. spinifera* and *E. tergestina* were surface species, while *P. intermedius* was distributed mainly between 25 and 50 m. *P. avirostris* was found between 0 m and 50 m, but preferred the upper 25 m.

6 - *P. avirostris* and *P. intermedius* showed negative phototaxis. The former migrated during the night between the midwater and surface. The latter migrated between the bottom and midwater, with homogeneous distribution at midnight. *Evadne* spp did not migrate.

7 - The stimulating factor of the daily vertical migration was the light intensity variation. Besides being a determinant factor of the horizontal distribution and life cycle of the cladocerans, the temperature was another factor which influenced the vertical distribution of these organisms, mainly of the stenothermic species. The presence of blooms of *Oscillatoria* sp at the surface was another factor which interfered with the vertical distribution and migration.

8 - The thermocline only acted as barrier on the vertical distribution of *P. intermedius*.

9 - No influence on the migratory pattern of the species by age or sex could be observed.

ACKNOWLEDGEMENTS - I thank Dr. Tagea K. S. Björnberg and Dr. Scintila P Por for their suggestions concerning this research. Financial support was provided by Universidade Federal de Sergipe and CAPES.

REFERENCES

ALMEIDA PRADO, M.S. de 1962 Sobre o plancton da Enseada do Mar Virado e os métodos de coletas. *Bolm Inst.Oceanogr.*, S Paulo, *12*(3):49-68.

BAKER, H.M. 1938. Studies on the Cladocera of Monterey Bay. *Proc.Calif.Acad.Sci.* (4th ser.), *23:*311-365

BINET, D. 1975. Notes sur l'écologie de quelques taxons du zooplancton de Côte d'Ivoire. I - Ostracods, Cladocères et Cirripèdes. *Doc.Scient. Centre Rech.Oceanogr.Abidjan*, *4*(2):19-39.

BJÖRNBERG, T.K.S. 1963. On the marine free-living copepods off Brazil. *Bolm Inst.Oceanogr.*, S Paulo, *13*(1):3-142

BOSCH, H.F & R. TAYLOR 1973. Diurnal vertical migration of an estuarine cladoceran, *Podon polyphemoides*, in the Chesapeake Bay. *Mar.Biol.*, *19*(2):172-181.

CASTELLO, J.P 1978. Projeto Lagoa; relatório do décimo quarto cruzeiro, 20 a 22/12/1976 e décimo quinto cruzeiro, 10 a 13/1/1977 *Base Oceanogr.Atlântica, ser.rel.*, Rio Grande, *9:*78 p.

CLAUS, C. 1877 Zur Kenntniss des Baues und der Organisation der Polyphemiden. *Denkschr.Akad.Wiss.,Math.-Nat.Kl.B*,Wien, *37:*137-160.

DANA, J.D. 1852-55. Crustacea. *U.S.Explor.Exped.dur. Years 1838, 1839, 1840, 1841 and 1842.* Vol. *13:*1-1618; Atlas: 96 plates.

DELLA CROCE, N. 1974. Cladocera. *Zooplankton Sheet, 143:*1-4.

EMILSSON,I. 1961. The shelf and coastal waters off Southern Brazil. *Bolm Inst.Oceanogr.*, S Paulo, *11*(2):101-112.

FONTES, E.X. 1971. *Evadne costai*, a new species of Cladocera from the brazilian coast. *Atas Soc.Biol.Rio de J*, *14:*165-167

FONTES, E.X. 1973a. Contribution to the study of Cladocera (Crustacea - Branchiopoda) from the brazilian coast. I. Description of *Podon intermedius* (Lilljeborg, 1853) *Atas Soc.Biol. Rio de J*, *17*(1):15-18.

FONTES, E.X. 1973b. Contribution to the study of Cladocera (Crustacea - Branchiopoda) from the brazilian coast. 2 Description of *Evadne tergestina* Claus, 1877 *Atas Soc. Biol. Rio de J.*, *17*(1):27-30.

FRONTIER, L. 1973. Zooplancton de la région de Nosy-Bé. V Cladocères. Contribution à l'étude d'une baie eutrofique tropicale. *Cah.O.R.S.T.O.M., sér. Oceanogr.*, *11*(3): 259-272.

FURNESTIN, M.L. 1957 Chaetognathes et zooplancton du secteur Atlantique et Marrocain. *Revue Trav.Inst. (scient. tech.) Pêches marit.*, *21*(1/2):1-356.

GIESKES, W.W.C. 1971. Ecology of the Cladocera of the North Atlantic and North Sea, 1960-1967 *Neth.J Sea Res.*, *5*:

342-376.
HANSEN, H. 1899 Die Cladoceren und Cirripedien der Plankton -Expedition, *Ergebn. Deutch Planktonexped.Humboldt-Stift., II*(G2):1-55.
HANSEN, K.V. 1951. On the diurnal migration of zooplankton in relation to the discontinuity layer. *J.Cons.perm.int Explor.Mer, 17*(3):231-241.
LEE, J.W. 1974. The vertical distribution and diurnal migration of Cladocera, *Evadne nordmanni* Lovén at different stations in the Irish Sea. *J.Oceanol.Soc.Korea, 9*(1/2):1-9.
LEVEAU, M. 1965. Contribution à l'étude des ostracodes et cladoceres du Golfe de Marseille. *Recl.Trav.Stn mar. Endoume, 37*(53):161-243.
LOCHHEAD, J.H. 1954. On the distribution of a marine cladoceran *Penilia avirostris* Dana (Crustacea, Branchiopoda),with a note on its reported luminescence. *Biol.Bull.mar.biol. Lab. Woods Hole, 107:*92-105.
MARANO, G. 1970. Distribuzione stagionale dei cladoceri lungo il litorale barese. *Atti Soc. pelorit.Sci.fis.mat.nat., 17*(3/4):203-215.
ONBÉ, T 1977 The biology of marine cladocerans in a Warm Temperate Water. *Proc.Symp. Warm Water Zooplankton, Spec. Publ.Natn.Inst.Oceanogr.Goa,* p. 383-398.
PORUMB, F.I. & I.I. PORUMB 1965. Recherches concernant la migration nyctémerale du zooplancton marin d'été. *Revue roum.Biol.,Zool., 10*(5):361-371.
RAMIREZ, F.C. & P. DE VREESE 1974. Taxonomia y distribucion de los cladoceros (Crustacea, Phyllopoda) de un sector de la Plataforma Bonaerense y adyacencias. *Physis, secc. A, 33*(87):511-526.
RAMMNER, W. 1933. Die Cladoceren der 'Meteor' Expedition. *Wiss.Ergebn.dt.Atlant.Exped.'Meteor', 1925-27,* Berlin & Leipzig, *12:*111-121.
RAMMNER, W. 1939. Cladocera. *Zooplankton Sheet, 3:*1-4.
RIERA, T & D. BLASCO 1967 Plancton superficial del Mar de Baleares em Julio de 1966. *Investigacion pesq., 31*(3):463 -484.
SANTOS, J.J. 1973. Estudo preliminar, principalmente do plancton, das águas da Baía de Todos os Santos. *Bolm Zool e Biol.mar.,N.S., 30:*419-447
SEGUIN, G. 1965. Contribution à la conaissance du plancton des eaux côtiers du Brésil (Copépodes et Amphipodes excep tés) et comparison avec celui du Sénegal. Campagne de la 'Calypso' Janier-Février 1962 *Pelagos, 2*(3):5-44.
SPECCHI, M. 1973. Osservazioni sui cladoceri raccolti dall'' Argonaut' nel Quarnero. Alcune comparizioni con la cladocerofauna del Bacino Occidentale dell'Alto Adriatico.*Boll. Pesca Piscic.Idrobiol., 28*(1):45-57.
SPECCHI, M.; L. DOLLINAR & S. FONDA-UMANI 1974. I cladoceri del genere *Evadne* nel Golfo di Trieste. Notizie sul ciclo biologico di *Evadne nordmanni, Evadne tergestina* ed *Evadne spinifera. Boll.Pesca Piscic.Idrobiol., 29*(2):107-122
STEUER, A. 1933. Zur Fauna des Canal de Leme bei Rovigno. *Thalassia, 1*(4).4-44.

TEIXEIRA, C.; J. TUNDISI & M.B. KUTNER 1965. Plankton studies in a mangrove environment. II. The standing stock and some ecological factors. *Bolm Inst.Oceanogr.*,S Paulo, *14:*13-41.

THIRIOT, A. 1972. Influence de la température sur les caractéristiques des populations des cladocères du genre *Evadne* dans le Golfe du Lion (Méditerranée Occidentale). In: FIFTH EUROPEAN MARINE BIOLOGY SYMPOSIUM. Padova. Piccin Ed., p- 197-206.

THIRIOT, A. 1972-73. Les cladocères de Méditerranée Occidentale. 3. Cycle à Banyuls-sur-mer (Golfe du Lion). Synthèse des Années 1965-1969. *Vie Milieu, 23*(2B):243-295.