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DISTRIBUTION OF EUCONCHOECIA CHIERCHIAE G. W. MÜLLER (CRUSTACEA, OSTRACODA) OFF SANTOS, BRAZIL

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RESUMO

A distribuição e migração vertical, bem como a distribuição segundo as massas de água do Ostracoda planctônico **Euconchoecia chierchiae** 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. Salinidade e temperatura foram medidas em profundidades previamente estabelecidas. **E. chierchiae** foi eurihalina e euritérmica, mas preferiu águas com salinidades próximas de 36,00 °/oo e temperaturas entre 20,0 °C e 23,0 °C. Distribuiu-se entre 0 e 20 m, realizando migrações noturnas para a superfície e permanecendo no fundo durante o dia. Apenas uma vez, em 6-7/07/61, jovens e adultos migraram diferentemente. A migração vertical foi controlada pela luz, com interferência da termoclina, fitoplancton e massas de água nas diferentes épocas do ano.

ABSTRACT

The vertical distribution and migration, and the distribution per water mass of the planktonic ostracod **Euconchoecia chierchiae** were studied in plankton samples collected successively at 45-47 m, 20-25 m and 0-1 m, at 4 hours intervals during 24 hs in April 8-9, 1960; September 22-23, 1960; July 6-7, 1961; November 7-8, 1961. The salinity and temperature were measured at depths previously established. **E. chierchiae** is euryhaline and eurythermic but it preferred waters with salinities around 36.00°/oo and temperatures between 20.0°C and 23.0°C. It was distributed between 0 and 50 m, migrating vertically to the surface at night and staying in the depth during the day. Only once juveniles and adults migrated differently (July 6-7, 1961). The vertical migration was controlled by light with interference of the thermocline, the phytoplankton, and the water masses at different times of the year.

INTRODUCTION

Except for few species, the planktonic ostracods belong to only one family, Halocyprididae, and they are, for the most part, oceanic. Few neritic species exist like **Euconchoecia chierchiae.**

It is distributed in the warm regions of the Atlantic, Pacific and Indian Oceans between 40° N and 40° S (Deevey, 1970). In Brazilian waters it was registered between 7° S and 28° S (Müller, 1890; Scott, 1912; Skogsberg, 1920 and Seguin, 1965).

E. chierchiae is a surface species and the inferior limit of its vertical distribution is not well established yet. Poulsen (1969) considers **E. chierchiae** characteristic of surface warm water situated between 4 and 50 m. Leveau (1967 and 1968) and Poulsen (1977) found it in abundance between 0 and 100 m. Poulsen (1969) was only one to make references about **E. chierchiae**'s vertical migration.

The vertical migration of neritic plankton off Santos was studied recently by Moreira (1976), through the variations of plankton volume by dislocation. Other authors using material from that region tried to elucidate the vertical migration of the Chaetognatha (Almeida Prado, 1968), of the Copepoda (Bjornberg, 1969), of the Hydromedusae (Moreira, 1973), of the **Lucifer faxoni** (Alvarez, 1976) and of the Appendicularia (Sinque, 1976).

This study aims a better knowledge about the ecological preferences of neritic ostracods in Brazilian waters. The purpose here is to check the relations between some abiotic factors and the vertical distribution and migration, as well as the preferences of the species to the different waters that occur in the region studied during the year.

MATERIAL AND METHODS

The material studied belongs to the Plankton Collection, Series V, collected off Santos (24° 16,4' S — 46° 00,4' W) in April 8-9, 1960, September 22-23, 1960, July 6-7, 1961 and November 7-8, 1961. The method used and described below is found in Moreira (1970).

During 24 hours intervals a Standard net n.° 3 (64 meshes/inch and 0,50 m of diameter per 1,80 m length), was hauled for 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), mid-water (20 or 25 m) and near the surface (1 m). The filtrated volume of water was estimated using the $\pi \cdot r^2 \cdot h$ formula. All the samples were fixed with formaline at 10%.

For each series of collections, the temperature and salinity were measured at a profundity previously fixed.

Depending on **E. chierchiae**' s abundance, the samples were analysed totally or was using a Folsom sampler which divided the sample into four similar parts, of which one was then studied. Males, females and juveniles were counted separately. To identify the species, Skogsberg's descriptions (1920) were used.

In the graphics of the daily vertical distribution, the temperatures and salinities, at different profundities, are represented by the daily mean got in each series and for each profundity. The hours correspond approximately to the beginning of the haul.

THE ENVIRONMENT

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

a) **Tropical Water** (T), with temperature above 20.0 °C and salinity higher than 36.00 °/oo, is formed by the mixture of Brazil Current with a water of lower salinity and temperature.

b) **Subtropical Water** (ST) with salinity between 35.00 and 36.00 °/oo and temperature from 10,0 °C to 20.0 °C, flowing northward under the Tropical Water which flows South.

c) **Coastal Water** (C) which results from the mixture of fresh water and the Continental Shelf waters, with a salinity under 35.00 °/oo and variable temperature.

d) **Shelf Water** (S) formed by these three kinds of water having a salinity between 35.00 and 36.00 °/oo and a temperature above 20.0 °C.

The water masses found during each hauling period are related 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. and S.	10-45	S.	15-45	S.T.
25-47	S.T.	47	T.	45	T.		

RESULTS

E. chierchiae was present in the four studied periods, but was less abundant in April. In all other periods it was numerous reaching its highest density (25,429 ind./100 m³) in September, at a salinity of 35.77 °/oo and a temperature of 21.0 °C (Table II). The juveniles were always more abundant than the adults and the females were more numerous that the males in 95.3% of the studied samples.

a) Distribution per Water Mass (Figure 1)

E. chierchiae appeared in all the present water masses, in salinity and temperature varying respectively from 34.76 °/oo to 36.17 °/oo and from 15.04 °C to 26.00 °C. Nevertheless, it preferred the waters with salinity near to 36.00 °/oo and temperatures between 20.0 °C and 23.0 °C (Shelf Water and Tropical Water), showing that the influence of the oceanic water rather than the coastal one on the environmental conditions is better for the species' reproduction.

TABLE II — Density (ind./100 m³) of **Euconchoecia chierchiae** at different times and depths during the four periods studied. F = Female, M = Male, J = Juvenile and T — Total.

DATES	APRIL 8-9, 1960				SEPTEMBER 22-23, 1960								JULY 6-7, 1961								NOVEMBER 7-8, 1961			
STAGES	F	M	J	T			F	M	J	T			F	M	J	T			F	M	J	T		
TIME	DEPTH (m)				TIME	DEPTH (m)					TIME	DEPTH (m)					TIME	DEPTH (m)					TIME	DEPTH (m)
	0	9	7	73	89		0	27	18	418	463		0	9	-	27	36		0	4	-	89	93		
24:00	20	33	20	113	166	12:00	25	596	622	7.500	8.718	12:00	25	98	18	1.862	1.978	08:00	25	242	71	4.389	4.702		
	45	11	2	136	149		47	3.333	1.218	15.111	19.662		45	267	71	4.389	4.727		45	2.147	502	9.278	11.927		
	0	9	4	107	120		0	36	9	542	587		0	2	-	13	15		0	29	2	73	104		
04:00	20	36	4	87	127	16:00	25	684	1.733	16.667	19.084	16:00	25	44	-	613	657	12:00	25	658	113	5.520	6.291		
	45	24	2	91	117		47	1.902	853	11.889	14.644		45	249	124	7.778	8.151		45	951	140	2.729	3.820		
	0	-	-	-	-		0	29	2	38	69		0	409	142	1.000	1.551		0	9	-	338	347		
08:00	20	2	9	104	115	20:00	25	1.200	596	7.667	9.463	20:00	25	71	18	1.222	1.311	16:00	25	64	13	1.460	1.537		
	45	7	7	109	123		47	1.849	364	6.889	9.102		45	98	53	3.111	3.262		45	1.184	167	8.111	9.462		
	0	-	-	2	2		0	213	9	427	649		0	302	62	3.111	3.475		0	151	53	622	826		
12:00	20	4	-	36	40	24:00	25	1.493	631	12.556	14.680	24:00	25	27	9	1.333	1.369	20:00	25	409	27	4.062	4.498		
	45	56	11	504	571		47	560	418	5.000	5.978		45	98	36	6.278	6.412		45	89	9	1.342	1.440		
	0	-	-	7	7		0	160	133	933	1.226		0	80	44	1.147	1.271		0	44	-	267	311		
16:00	20	2	-	24	26	04:00	25	2.249	569	22.611	25.429	04:00	25	27	9	944	980	24:00	25	80	-	551	631		
	45	7	4	120	131		47	1.218	373	5.833	7.424		45	44	9	3.111	3.164		45	649	36	2.818	3.503		
	0	38	2	227	267		0	-	-	116	116		0	-	-	18	18		0	9	9	36	54		
20:00	20	27	16	31	74	08:00	25	329	267	13.167	13.763	08:00	25	9	-	409	418	04:00	25	133	44	1.004	1.181		
	45	13	4	67	84		47	2.836	871	12.444	16.151		45	36	9	533	578		45	89	-	2.009	2.098		
	0	33	18	71	122		0	-	-	80	80		0	-	-	18	18		0	-	-	44	44		
24:00	20	13	-	20	33	12:00	25	18	44	1.004	1.066	12:00	25	18	9	56	83	08:00	25	9	-	71	80		
	45	47	-	98	145		47	1.889	1.004	4.333	7.226		45	53	18	1.722	1.793		45	107	9	418	534		

b) Vertical Migration

In the samples collected in April, September and November there was no great difference in the migration patterns of the different stages and consequently the phenomenon was studied considering the total population. Only in July, there was a difference between the migration of the juveniles and the adults, and for this reason they will be discussed separately.

In April 8-9, 1960 (Figure 2), after the sunset, **E. chierchiae** was distributed almost uniformely along the water column during the night, leaving the surface at sunrise and concentrating over the bottom of the sea during the day. The thermocline did not influence in the migration.

In September 22-23, 1960 the population migrated vertically but did not reach the surface. It remained between 25 m and the bottom during daytime and, at night, it was collected in great numbers at midwater showing that it migrated to the surface but was stopped probably by the presence of an **Oscillatoria** sp bloom on the surface (Figure 3).

In November 7-8, 1961 (Figure 4), the animals were mostly near the bottom during the morning, then they migrated to 25 m at noon and descended again at 4:00 p.m. A movement towards the surface could be noted at sunset but only a small part of the population reached this level while they stayed mostly at 25 m. After the midnight's descent,

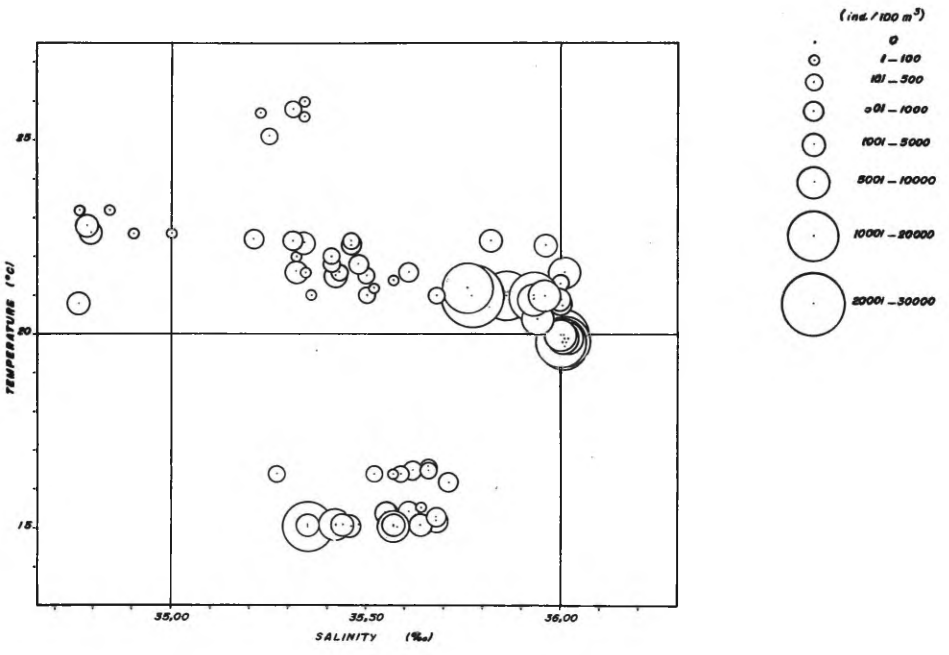

Figure 1 — Density of *Euconchoecia chierchiae* according to temperature and salinity.

they stayed near the bottom with a slight raise before the sunrise. The thermocline existing between 7 and 15 m may have been a barrier to the population's ascension at sunset.

In July 6-7, 1961, males and females had a normal migration, i.e., they ascended to the surface at sunset and stayed there till the sunrise when they descended to deeper water levels (Figures 5 and 6). Only few juveniles migrated to the surface and to 25 m at night, staying mainly at 45 m. (Figure 7).

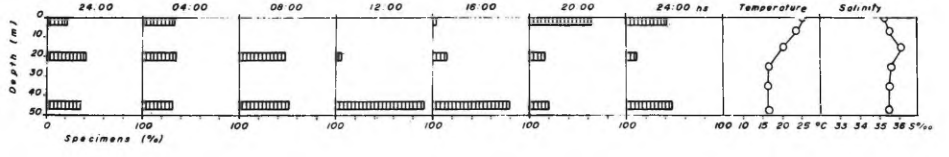

Figure 2 — Variation in the vertical distribution of *Euconchoecia chierchiae* (total population) on April 8-9, 1960.

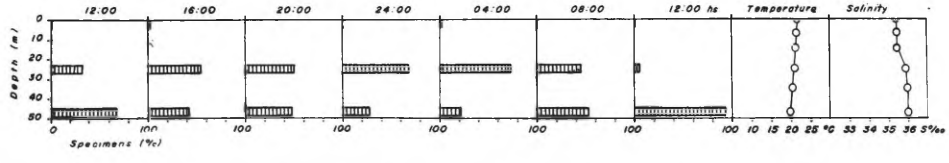

Figure 3 — Variation in the vertical distribution of *Euconchoecia chierchiae* (total population) on September 22-23, 1960.

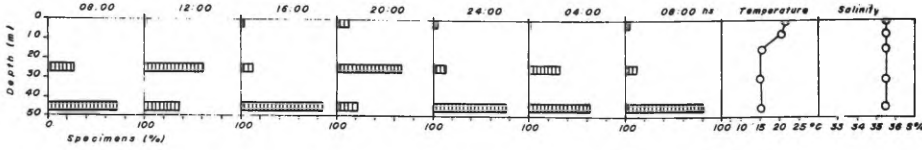

Figure 4 — Variation in the vertical distribution of *Euconchoecia chierchiae* (total population) on November 7-8, 1961.

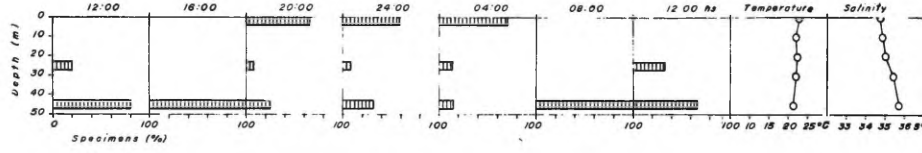

Figure 5 — Variation in the vertical distribution of *Euconchoecia chierchiae* (males) on July 6-7, 1961.

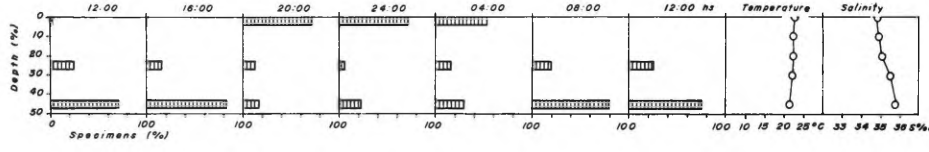

Figure 6 — Variation in the vertical distribution of *Euconchoecia chierchiae* (females) on July 6-7, 1961.

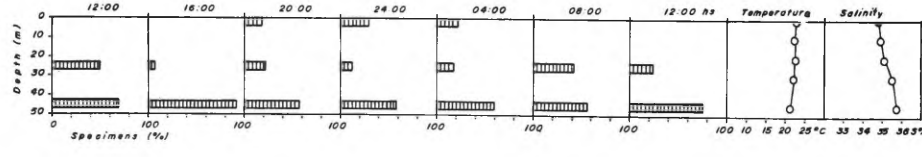

Figure 7 — Variation in the vertical distribution of *Euconchoecia chierchiae* (juveniles) on July 6-7, 1961.

DISCUSSION

The variation of E. chierchiae in abundance observed at the different times off Santos, leads to the conclusion that the distribution of this species is influenced in its seasonal cycle by the water masses among other factors. The population seems to grow in proportion to the homogeneity of the waters and to decrease and even disappear in late Spring, when the descontinuity layer is restored, following Deevey's (1968) observation in the Sargasso Sea. Mensah (1966) and Bainbridge (1972) found the species population maximum in the Guinea Gulf during the Winter, when the thermocline disappears and the waters's productivity has grown.

Little is known about its tolerance for salinity and temperature variations. Deevey (1968) collected **E. chierchiae** in the Sargasso Sea on similar temperatures to that in which it was registered off Santos (16.6 to 27.3 °C). In the Guinea Gulf, it occurred in the Guinea Water (T > 24.0 °C e S < 35.0 °/oo) or when there was three different water masses: Colder Water (T < 24.0 °C and S > 35.0 °/oo), Tropical Water (T > 24.0 °C and S < 35.0 °/oo) and Guinea Water (Poulsen, 1969). These facts and the results obtained in this paper allow to say that **E. chierchiae** is a euryhaline and eurithermic species. Nevertheless, its great densities in the waters with salinities near to 36.0 °/oo, show the preference of this species to neritic waters with oceanic influence.

The diel variations in the vertical distribution (except on November 7-8, 1961) showed that **E. chierchiae** stays in the depth during the day and moves to the surface at night. Poulsen (1969) suggested a similar migration of this species in Guinea Gulf. Ascendant movements by night were already observed in fourteen **Conchoecia** species from Canary Islands Region (Angel, 1969).

The ascent at noon in November, 1961 seems to be an exceptional behaviour, since in other observations the ostracods usually occurred near the bottom at noon. The plankton and the medusae **Ectopleura dumortiere, Euchysora gracilis, Turritopsis nutricula, Proboscidactyla ornata** and **Liriope tetraphyla** realized similar movements in this date. This exception could not be related to any measured physical or chemical parameters, because in other dates, in like hidrographic conditions, no reversed migration was observed (Moreira, 1973 and 1976).

The light seems to be the most important environmental factor in the vertical migration of **E. chierchiae. Euconchoecia** does not have a differenciated photoreceptor organ. This, plus the inexistence of studies about the sensitivity of marine ostracods to light, led Angel (1968) to question the light controller role on the daily vertical movement of these animals.

The zooplankton responses to light can be modified by internal and external factors, among them we can cite: age, sex, salinity and temperature (Forward, 1976). No change in the **E. chierchiae** phototaxis, caused by age and sex could be noted. The divergences existing on the migrations of juveniles and adults in July, 1961 could be due to the presence of Coastal Water on the surface. In the same time and under similar conditions of salinity, Binet (1975) found the same behaviour in juvenile ostracods off the Ivory Coast. In the other periods here studied no salinity influence was noted in the **E. chierchiae** vertical migration.

The thermocline interference on the distribution and vertical migration of the zooplankton has been very much discussed. Its effect seems to depend on the intensity of the gradient and the temperature variation supported by the species. Petipa et al. (1960, in Angel, 1968) verified that 0,6 °C/m was the intensity point of the gradient in which the thermocline ceased to be an efficient ecological barrier. On November, 1961, off Santos, the calculated intensity was 0,67 °C/m, and this perhaps interfered with the animals' ascension to the surface. On April, 1960, when the temperature decreased 0,4 °C/m in the thermocline region, the migration was normal.

CONCLUSIONS

Euconchoecia chierchiae is an euryhaline and eurythermic species preferring waters with salinities near to 36.00 °/oo and temperatures between 20.0 and 23.0 °C.

The species density is related to the water masses, being greater when the descontinuity layer is lacking.

The vertical migration observed is of the nocturnal type. The greater part of the population stays in the depth during all the day and moves towards the surface at night. A tendency to the nightly homogenizing of the distribution was observed in April, 1960.

The environmental factor controlling the migration was the light, but its effect can be changed by the presence of great concentration of **Oscillatoria** sp or because of the Coastal Water at the surface.

No changing in the species phototaxis caused by sex or age, could be noted.

The thermocline can be an ecological barrier to the ostracods rising to the surface, depending on the decreasing intensity of the thermic gradient in the descontinuity layer.

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