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CAPTURE EFFICIENCY FOR SMALL DOMINANT MESOZOOPLANKTERS (COPEPODA, APPENDICULARIA) OFF BUENOS AIRES PROVINCE (34ºS-41ºS), ARGENTINE SEA, USING TWO PLANKTON MESH SIZES

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ABSTRACT

Two plankton mesh sizes of 67 µm and 220 µm were compared to evaluate their efficiency in the capture of the smallest copepods and appendicularians present in the Buenos Aires coastal area (Argentine Sea). A total of 12 copepod species and one appendicularian species were recorded in this study. The copepods were separated into 4 groups: harpacticoids, cyclopoids, small calanoids and large calanoids and their developmental stages. Among the cyclopoids, *Oithona nana* was the most abundant species, being 96.29 % underestimated by the 220 µm mesh, whereas *Microsetella norvegica* dominated the harpacticoids and was captured exclusively by the smaller mesh. Similar results were found for copepodites I-III of small calanoids, whose net sampled underestimation reached 99.70%. On the other hand, no significant difference between meshes was found for adults and copepodites IV-V of small calanoids or any of the developmental stages of large calanoids. A great loss of biomass was observed for *O. nana* when applying the larger mesh. In regards to the appendicularian *Oikopleura dioica*, all size ranges below 1,000 µm length were better estimated by the 67 µm mesh in terms of abundance and biomass. Our results clearly show that the 67 µm mesh was more efficient in the capture of early stages of small copepods thus providing a more accurate estimation of the fish larvae prey field.

RESUMO

Compararam-se os copépodos e apendiculárias coletados, na zona costeira do Estado de Buenos Aires (Argentina), com duas redes de plâncton, tipo mini-bongo, de abertura de malha de 67 µm e 220 µm. Registraram-se 12 espécies de copépodos e uma de apendiculária. Os copépodos foram separados de acordo com as categorias: harpaticoides, ciclopoides, e calanoides pequenos e grandes. O cálculo da abundância de *Oithona nana*, que foi a espécie mais abundante no material analizado, demonstrou que a coleta com rede de 220 µm teve uma subestimativa de 92,29%, em relação à coleta com a rede de 67 µm, o que resultou numa alta perda de biomassa, dessa espécie, quando usada a rede de 220 µm. Outro dado relevante, foi a dominância de *Microsetella norvegica*, dentro dos harpaticoides, e a presença da mesma somente no material coletado com a rede de 67 µm. De igual forma, quando se analisou a abundância dos copepoditos I-III dos pequenos calanoides, a rede de 220 µm demonstrou uma subestimativa de 99,70%, em comparação com a rede de 67 µm. Não foram encontradas diferenças significativas na coleta de adultos e copepoditos IV-V dos pequenos calanóides e todos estagios grandes calanóides. Para as apendiculárias, no que diz respeito à abundância e biomassa, as variações de tamanho menores que 1,000 µm, foram melhor estimadas com a malha de 67 µm. Os resultados demonstraram que a malha de 67 µm foi mais eficiente na coleta dos ciclopoides e dos primeiros estágios de copepoditos dos pequenos calanoides, que por sua vez, constituem a principal fonte de alimento para as larvas de teleostei na área analisada.

Descriptors: Copepoda, Appendicularia, Sampling, Abundance, Biomass, Coastal areas.
Descritores: Copepoda, Apendicularia, Coleta, Abundância, Biomassa, Zona costeira.

INTRODUCTION

Copepods are generally considered the most important metazoan secondary producers in pelagic marine ecosystems and they constitute an important link in the food chain, coupling protists to higher trophic levels (HOPCROFT; ROFF, 1998; HANSEN et al., 2004). A substantial proportion of the copepod assemblage is composed of small-sized species, which generally dominate the mesozooplankton not only in terms of abundance, but also in terms of biomass (GALLIENNE; ROBINS, 2001; TURNER, 2004 and references therein; VIDJAK et al., 2006). These small copepod species are able to feed on small particles and, therefore, they can utilize energy from the microbial food web (HOPCROFT et al., 2001). Other important small mesozooplankton components are the larvaceans. Recently, attention to this size class has been increasing due to its role in the pelagic carbon flow (HOPCROFT; ROFF, 1998; TOMITA et al., 1999; TÖNNESSON et al., 2005). Although copepods and appendicularians are of similar size, their role in the food web is different. The last group is able to feed directly on particles smaller than 5 µm using a mucous house filtration apparatus, whereas copepods, in general, only can filter particles larger than 10 µm using their mandibles (URBAN-RICH et al., 2006). The appendicularians biomass is usually lower than that of copepods, but their production rates can be between 30 and 100% higher in coastal areas (NAKAMURA et al., 1997; HOPCROFT; ROFF, 1998). However, because of the traditional mesh size employed (≥ 200 µm), the abundance and sometimes the biomass of both groups (including their developmental stages) have been either ignored or underestimated in most mesozooplankton studies (TURNER, 2004; JIANG-SHIOU et al., 2007).

In particular, in most of the studies performed in the Buenos Aires coastal area (AKSELMAN et al., 1986; SANTOS; RAMÍREZ, 1991; FERNÁNDEZ ARÁOZ et al., 1994; VIÑAS et al., 2002; MARRARI et al., 2004), the use of such coarse meshes has prevented an accurate evaluation of the quantitative importance of small copepods and appendicularians in the field. Only recently, the analysis of a zooplankton time series at a coastal station off Buenos Aires province (38º28'S – 57º41'W) showed the great dominance of the small mesozooplankton fraction (≤1 mm size), mainly represented by the copepods *Oithona nana*, *O. helgolandica*, *Paracalanus parvus* and *Ctenocalanus vanus*, and the appendicularian *Oikopleura dioica* (VIÑAS et al., 2003; CAPITANIO et al., 2008) when a babybongo net (67 microm) was used.

There are many examples in the literature indicating that small copepods and appendicularians are important prey for fish in their different ontogenetic stages (HUNTER; ALHEIT, 1995; VIÑAS; RAMÍREZ, 1996; HANSEN et al., 2004; PURCELL et al., 2004; TAKATSU et al., 2007). Large shoals of *Engraulis anchoita* concentrate off Buenos Aires province during the spring spawning period but their highest spawning intensity occurs on the Río de la Plata estuarine front (HANSEN; MADIROLAS, 1996; MARTOS et al., 2005; PAJARO, 2008). This species is the most abundant pelagic fish in the study area and feeds on zooplankton throughout its entire life cycle (ANGELESCU, 1982; VIÑAS; RAMÍREZ, 1996; CAPITANIO et al., 1997, 2005; PÁJARO, 1998). Variations within the zooplankton community could, therefore, affect their field prey with considerable economic consequences (MANN, 1993).

In the present work a comparison is made between the capture efficiency of two different meshes, (67 µm and 220 µm) regarding the dominant copepod and appendicularian species and all their developmental stages, in terms of abundance and biomass. The quantitative importance of these small mesozooplankters in the Río de La Plata frontal area is particularly evaluated.

MATERIALS AND METHODS

Main Hydrographic Features of the Study Area

The study spans the area between 34.5 – and 41°S. latitude, the hydrography of which has been described by Guerrero and Piola (1997) and Lucas et al. (2005). The present authors have identified the following water masses, on the basis of their salinity and spatial distribution: (1) Low salinity coastal waters (LSCW): 0 – 33. 3, with minimum salinity occurring in the Río de la Plata river and El Rincón estuarine systems; (2) High salinity coastal waters (HSCW): 33.7 - 34.2, with maximum salinity registered originated in the San Matías Gulf; (3) Mid–shelf waters (MSW): 33.4 – 33.6/33.7, and (4) Outer–shelf waters (OSW): 33.7 – 34.0.

The major hydrographic feature of the study area is the estuary of the Río de la Plata, the second most important river system of South America. It is characterized by a strong vertical stratification: freshwater flows seaward on the surface while denser shelf water intrudes along the bottom, taking the shape of a salt wedge (ACHA et al., 2004). Water discharge over the continental shelf is driven by wind stress (GUERRERO et al., 1998).

Sample Collection and Laboratory Analysis

Two cruises were conducted over the continental shelf, off Buenos Aires province, during spring (October) 2003 and 2004 as part of the *E.*

anchoita Assessment Project of the Instituto Nacional de Investigación y Desarrollo Pesquero (INIDEP). Sampling stations were arranged in 4 sections across the study area (Fig. 1). A total of 62 samples were collected with a babybongo net, (0.20 m diameter), fitted with two meshes of 220 µm and 67 µm. A Hydrobios flowmeter was mounted in the mouth of the net in order to estimate the filtered water volume (average 4.57 m^3). Oblique trawls were performed from near the bottom to the surface using a trawling winch. The tows were short (towing time: 2 minutes; towing rate: 20 m/minute) and the ship moved at 2 knots speed. No clogging of the net was observed. Samples were immediately preserved on board in 5 % formalin for further analysis.

In the laboratory copepods and appendicularians present in the samples were identified and counted under a compound microscope. For this purpose, a subsample was obtained from each sample and its volume determined in order to include at least 100 adults of the dominant copepod species. Copepods and appendicularians were identified to the lowest taxonomic level in accordance with the specific literature (RAMÍREZ, 1966; BRADFORD-GRIEVE et al., 1999; ESNAL, G. B., 1999). Abundance was expressed as ind.m^{-3}.

The following copepod categories were defined: harpacticoids, cyclopoids, small calanoids (prosome length (PL): 1 - 2 mm), and large calanoids, (PL > 2mm). Within each category, copepods were grouped according to their developmental stages into: copepodites I-III, copepodites IV-V, and adults. Nauplii were only considered in the 67 µm mesh net, given that nauplii of small copepod species are not sampled by coarse meshes (NICHOLS; THOMPSON, 1991; HOPCROFT et al., 1998; GALLIENE; ROBINS, 2001).

The biomass of adults and copepodite stages of *O. nana* (one of the dominant copepod species) was estimated from the following biovolume/size relationship: Biovolume (mm^3) = 3.1745 PW (mm) $^{2.751}$ (r^2 = 0.9897; PW = prosome width) (Viñas et al., submitted). The biovolume of both categories was converted into wet weight (WW) and finally into dry weight (DW) by applying the correction factors of 1.025 (CHOJNACKI, 1983) and 0.186 (HUNT et al., 1981), respectively.

The trunk length of at least 30 individuals of *O. dioica* (the dominant appendicularian species) per sample was measured under a stereoscopic microscope (accuracy: 0.04 mm) and grouped into 100 µm size classes. After that, the biomass was estimated indirectly from the trunk length (TL) /dry weight (DW) relationship: log DW=2.68 log TL – 7.29, established by CAPITANIO et al. (2008) for this species.

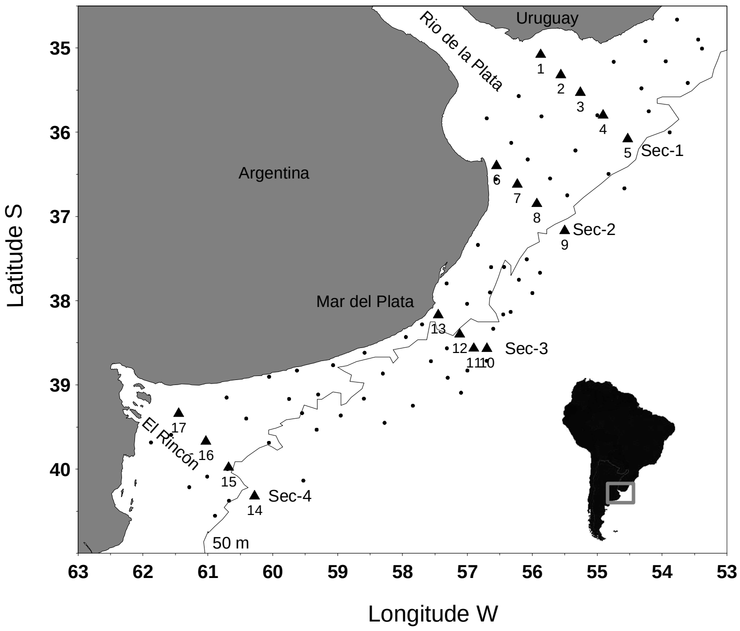

Fig.1. Map of the study area showing the location of CTD (black dots) and zooplankton sampling stations during springs 2003 and 2004 (▲) arranged in four sections (Sec 1 to Sec 4).

The Statistica package 6.0 was used for data analysis, Student's t-test for two paired samples was applied to the abundance and biomass data, previously log (x+1) transformed, to analyze the differences between meshes (SOKAL; ROLHF, 1995).

The spatial distribution of the smallest mesozooplankton categories based on the best estimation for the meshes tested was analyzed for 2003 as an example in relation to the hydrographic conditions, chl-*a* concentration and abundance of *E. anchoita* larvae (sampled with the 220 µm mesh net). On that cruise, oceanographic data were also obtained at 85 stations with a conductivity temperature depth (CTD) system (Kiel Multisonde Compact System, ME Meerestechnik Elektronik, Kiel, Germany). The horizontal distribution of salinity was studied to locate the maximum gradients for that year. Surface water samples were collected at each sampling station for estimation of chlorophyll *a* concentration, using the method of HOLM-HANSEN et al. (1965).

RESULTS

Mesozooplankton Capture Efficiency

The 67 µm and the 220 µm estimations showed different scenarios in terms of copepod and appendicularian abundances. Figure 2 gives the total capture of both meshes for each group in the study area, indicating higher values for the 67 µm mesh, (p= 0.025 and p= 0.006, respectively). However, it was observed that the taxocenosis was similar for both meshes, with the exception of the harpacticoid copepod *Microsetella norvegica* being captured exclusively by the finer mesh.

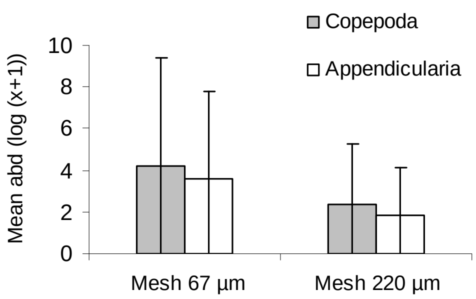

Fig. 2. Mean abundance (log x+1) transformed data of copepods and appendicularians obtained by both meshes. (x) being individuals.m^{-3}.

A total of 12 species of copepods were recorded in this study. In general, the dominant copepods in the study area were the cyclopoids *O. nana* and *O. helgolandica;* the harpacticoid *M. norvegica*, and the small calanoids: *P. crassirostris*, *P. parvus* and *C. vanus* (Table 1). It is clear from this table that the relative contribution of some species to the copepod associations is considerably distorted by the 220 µm mesh size. For example, between the most abundant species in the 67 µm mesh, *O. nana* and *M. norvegica* were the copepods more notably underestimated (> 96 %) by the 220 µm net, *O. nana* being the second most important by abundance, representing 23.95 % of the total adult copepod count. *P. parvus* contributed with 28.16 % of the total adult abundance in the 67 µm mesh, and even higher values (31.67 %) were attained by the 220 µm net. Coincidentally, increasing percentages were also observed for larger species such as *C. vanus* and *A. tonsa,* among others. As was expected, the density of all cyclopoid copepodites and copepodites I-III of small calanoids were underestimated by more than 99 % with the 220 µm mesh, in ratios of 469.75; 191.15 and 333.60, respectively. On average, the 220 µm net captured only 1.33 % of the 5,241,589 copepods.m^{-3} (adults + copepodites) counted in the totality of the samples (see Table 1) and less than 1% of the 4mg DW.m^{-3} total biomass in the case of *O. nana* (Table 2).

Among the appendicularians, the trunk length of *O. dioica* fluctuated between 100 and 1,200 µm. The underestimation of the abundance and biomass was markedly higher in individuals with trunk lengths lower than 600 µm, but the 1,000-1,200 µm size range was only retained by the 220 µm mesh (Table 3, t test, p<0.05 in both cases).

Mesozooplankton Spatial Distribution

Three of the four water masses described previously (GUERRERO; PIOLA, 1997; LUCAS et al., 2005), were identified on the 2003 cruise. LSCW and MSW were found most frequently (at 41 and 52% of the total stations, respectively). Only at 7% of the stations was HSCW present (Fig. 3a). The horizontal distribution of salinity off the Rio de la Plata mouth showed a river runoff towards the southeast, reaching the frontal region at the latitude of 37°S, and extending widely to the northeast (Fig. 3.b). In section 1 (see also Fig. 1), maximum gradients were located between the first and second coastal stations (0.137 km^{-1}) and in section 2, between the second and third stations (0.156 km^{-1}). In the area of El Rincón a minimum salinity value of 33 was observed near the coast, followed by an area of the relatively high salinity value of 33.8 near the 50 m isobath, originating in the San Matias Gulf. MSW (33.4 – 33.7) covered the rest of the area. Maximum Chl-*a* concentrations were detected in the frontal estuarine area (sections 1 and 2) and in shelf waters (section 3), being lowest at all the stations of section 4.

Table 1. Mean abundance (ind.m^{-3}) and Standard Deviation (SD) of adult copepods, copepodites I-III and IV-V captured with babybongo net, 67 µm and 220 µm of pore size. Significant statistical differences between meshes are highlighted in grey. ∑: summation of all specimens captured by each net from the totality of samples in the study area; %Fr: relative frequency of each species within each mesh total count; % Abd: percentage of abundance underestimated by the less efficient mesh. The calculation has been made on the assumption that the most efficient mesh captured 100% of the copepods.

	67 µm				220 µm						
Adults	**∑**	**% Fr**	**Mean**	**SD**	**∑**	**% Fr**	**Mean**	**SD**	**p**	**% Abd**	**Ratio 67/220**
cyclopoids											
O. nana	67,182	23.95	2,239.40	7,320.77	2,491.71	8.79	83	182.66	<0,05	96.29	26.96
O. helgolandica	12,100	4.31	390.32	1,111.99	3,181.04	11.22	106	169.19	ns		
H. thalassius	868	0.31	28.00	85.01	310	1.09	10	29.24	ns		
harpacticoids											
E. acutifrons	26,845	9.57	865.97	3,549.68	934.09	3.29	31	130.32	<0,05	96.52	28.74
M. norvegica	55,197	19.68	1,839.90	5,612.19	0	0.00	0	0.00	<0,0001	100.00	
calanoids											
P. crassirostris	24,075	8.58	802.50	4,013.99	807.5	2.85	27	110.88	ns		
P.parvus	78,983	28.16	2,820.82	11,772.12	8,981.20	31.67	299	517.15	ns		
C. vanus	10,027	3.57	358.11	1,040.64	5,369.90	18.93	179	259.16	ns		
A. tonsa	1,338	0.48	43.16	133.79	1,689.06	5.96	56	184.54	ns		
D. forcipatus	387	0.14	12.48	35.12	1,138.02	4.01	38	131.43	ns		
C. brachiatus	950	0.34	30.65	131.68	1,130.24	3.98	38	133.95	ns		
C. brevipes	2,220	0.79	71.61	316.85	1,996.96	7.04	67	197.49	ns		
Large calanoids	314	0.11	10.13	39.28	333.03	1.17	11	29.79	ns		
Total	280,486				28,362.75						
copepodites											
Cyclopoids I-III	1,057,885	21	36,453.07	175,738.21	2,252	5	78	181	<0,001	99.79	469.75
Cyclopoids IV-V	603,069	12	21,481.68	99,357.06	3,155	8	113	305	<0,001	99.48	191.15
Small calanoids I-III	2,408,283	49	80,183.70	427,836.39	7,219	17	241	748	<0,001	99.70	333.60
Small calanoids IV-V	888,340	18	30,566.93	143,833.60	27,829	67	928	1,672.92	ns		
Large calanoids. I-III	1,727	0	57.57	170.98	126	0	4	15	ns		
Large calanoids. IV-V	1,799	0	58.03	170.62	909	2	29	82	ns		
Total	4,961,103				41,490						
Adults+copepodites	5,241,589				69,852.75						
Nauplii (all species combined)	8,660,351		508,699.41	2,071,226.31							

Table 2. Biomass (µg DW.m^{-3}) of *Oithona nana* (adults and copepodites). Biomass $_{220}$ (%): percentage of capture with the 220 µm mesh in respect to that of the 67 µm mesh.

	DW.m^{-3} *O. nana*				
Stage	67 µm		220 µm		Biomass $_{220}$(%)
	Mean	SD	Mean	SD	
Adult	16.55	57.69	0.16	0.25	0.97
Cop. I-III	89.34	329.63	0.09	0.26	0.10
Cop. IV-V	150.97	544.33	0.79	1.63	0.52

Table 3. Total abundance and biomass of *Oikopleura dioica* according to the size range for both meshes.

	67 µm		220 µm	
Size range (µm)	Abundance (ind.m^{-3})	Biomass (µgC.m^{-3})	Abundance (ind.m^{-3})	Biomass (µgC.m^{-3})
100-200	301.01	1.14	3.90	0.02
200-300	1,225.94	17.88	23.44	1.60
300-400	1,052.63	35.16	80.81	14.58
400-500	450.96	44.33	227.82	86.72
500-600	1,990.18	63.75	120.33	90.96
600-700	85.65	22.69	80.14	100.02
700-800	80.47	30.03	37.10	76.38
800-900	13.94	10.37	12.52	33.89
900-1000	17.26	12.48	6.80	26.32
1000-1100	0	0.00	1.91	7.98
1100-1200	0	0.00	1.91	10.96
Total	5,218.03	237.84	596.69	449.44

As previously shown, the smallest mesozooplankton categories were better estimated by the finer mesh (67 µm). On the 2003 cruise (Fig. 4), all the cyclopoids, small calanoid copepodites I-III, nauplii and *O. dioica* showed maximum densities in the Río de la Plata frontal area (section 1). Nauplii attained a mean value of 1.7 x 10^6 ind.m^{-3} in this section, with a maximum peak value of 8.5 x 10^6 ind.m^{-3} at station 3 (section 1). At this station, 2.35 x 10^6 ind.m^{-3} of small calanoid copepodites I-III, were also detected. No clear distribution pattern could be identified for the other sections. However, increasing values of all copepod categories were observed in the El Rincón area (section 4) near the 50 m isobath (Figs. 1 and 4).

The highest densities of *O. dioica* were detected in association with estuarine waters, reaching a maximum of 64,220 ind.m^{-3} in section 1, at station 3. In the remaining sections, this species was more abundant at coastal stations, except for section 4 (the El Rincon area) in which it occurred near the 50 m isobath as was indicated for the small copepods. Coincidentally with the highest densities of the mesozooplankton categories, *E. anchoita* larvae showed a peak of abundance at station 2 of section 1, associated with the estuarine front. Larvae from this station were measured to standard length by means of an eye micrometer. It was discovered that 84 % of these specimens, ranging in size between 2.30 and 5.50 mm, were first-feeding larvae (yolk absent, mouth and digestive gut opened and pigmented eyes, (VIÑAS; RAMIREZ, 1996).

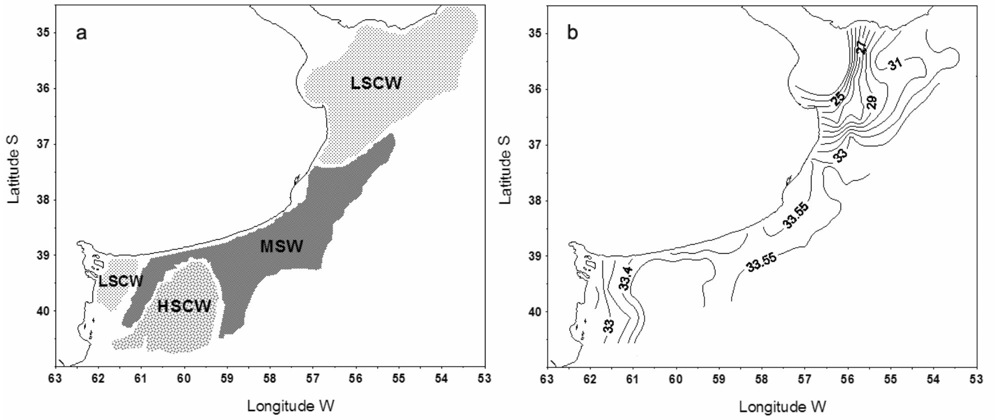

Fig. 3. a- Schematic distribution of the water masses: LSCW; MSW; HSCW (see Materials and Methods for abbreviations), b- surface distribution of salinity.

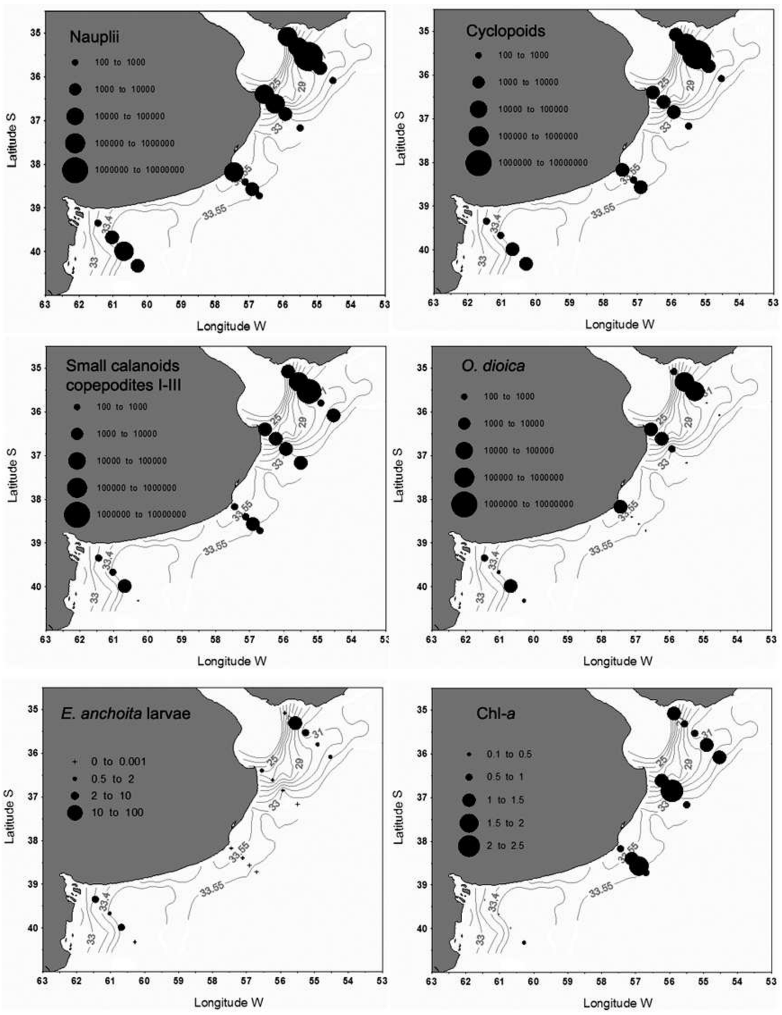

Fig. 4. Spatial distribution of the mesozooplankton groups successfully captured by the 67 µm mesh, *E. anchoita* and Chl-*a*. References for copepods and *O. dioica* are expressed in ind.m^{-3}; references for *E. anchoita* larvae are expressed in ind.m^{-2} and for Chl-*a* values are expressed in µg.l^{-1}.

DISCUSSION AND CONCLUSIONS

The small species *Oithona nana*, *Paracalanus parvus* and *Ctenocalanus vanus* were dominant in the study area, as previously stated by other authors (RAMÍREZ, 1981; SANTOS; RAMÍREZ, 1991; FERNÁNDEZ ARÁOZ et al., 1994; VIÑAS et al., 2002; MARRARI et al., 2004; BERASATEGUI et al., 2006). Nevertheless, present findings indicate that the abundance of some copepod species in these studies have been underestimated by more than 95% due to the size of the meshes employed (≥ 220 µm) and that *O. nana* was one of the most undersampled species. Similar results were found in tropical waters of Jamaica (Kingston Harbour) by HOPCROFT et al. (1998). The authors explored the biases in abundance and biomass estimates of the copepod community determined by two plankton nets (64 and 220 µm) and found that the 220 µm net captured only 7.5 % of total copepods, of which *O. nana* was one of the most undersampled species.

Many authors emphasize that *O. nana* is one of the most common and abundant copepods in coastal areas (JAMET et al., 2001) and brackish waters (GAUDY, 1971) and that it can contribute up to 90% of the total abundance of zooplankton (LAMPITT, 1978). In particular, in the Río de la Plata estuarine area this is the first accurate estimation of *O. nana* abundance because most of its copepodite stages were not retained in previous studies in which a 220 µm mesh size was employed.

Taking sections 1 and 2 as examples (Table 4) it may be observed that the utilization of the smaller mesh size of 67 µm substantially improved the abundance estimation of copepods and appendicularians by 1 to 3 orders of magnitude. In the same way, the comparison of the present findings with previous results obtained by CEPEDA (2006) in the same area and season, using the Babybongo sampler but fitted with a 220 µm mesh, corroborates the benefit of using a finer mesh.

Table 4. Comparison of mean mesozooplankton abundances (abd) estimated in this study with those of previous records.

References	Year	Mesh size (µm)	Section 1 Mean abd. ($ind.m^{-3}$)		Section 2 Mean abd. ($ind.m^{-3}$)	
			Copepoda	Appendicularia	Copepoda	Appendicularia
This study	2003	67	1,012,185	22,122	13,271	1,136
This study	2003	220	5,520	167	3,806	17
Cepeda, 2006	2002	220	1,344	619	2,170	156

Previous records mention *O. dioica* as particularly dominant in the Río de la Plata estuarine area and showing a marked preference for brackish waters (ESNAL, G., 1972; CAPITANIO; ESNAL, G. B., 2000). In agreement with our findings, Paffenhöfer (1975) and Esnal, G. et al. (1997) have mentioned that individuals of *O. dioica*, with trunk lengths smaller than 500 µm are not captured efficiently by a 200 µm mesh, thus leading to an incorrect description of the population size structure.

The spatial distribution of the selected mesozooplankton categories for spring 2003 revealed that major abundances were located in the Río de la Plata estuarine area. This area has received considerable attention over past years because it is considered a highly productive system that sustains valuable artisanal and coastal fisheries off Uruguay and Argentina (ACHA et al., 2008 and references therein). It has been stated that this frontal zone plays a major role in ecological processes allowing for a large primary production and offering adequate feeding and reproductive habitats for several fish species and acting as a retention areas for larvae (ACHA et al., 2004).

Maximum abundances of mesozooplankton were registered in the frontal area (section 1) of the four sections of the study area. There it was that the highest densities of copepodites I-III and nauplii were recorded, indicating active reproduction of the copepods *O. nana* and *P. parvus* that dominated the cyclopoid and small calanoid categories, respectively. Abundance of first-feeding anchovy larvae was highest in the same section, thus suggesting that active feeding might be occurring in those locations due to the great availability of adequate zooplankton prey in type and density. In fact, nauplii of the small copepods *P. parvus* and *O. nana* are the main food source of anchovy when they start to feed (VIÑAS; RAMIREZ, 1996). Since *Oithona* spp. are found in high concentrations in other frontal areas of the world ocean, interest in an effort to understand the role of cyclopoids in copepod associations as support for local fisheries has grown (NIELSEN; SABATINI, 1996; GALLIENNE; ROBINS, 2001). These authors have stressed the importance of cyclopoids as a link between smaller phytoplankton and larger zooplankton or fish larvae. The other dominant species, *P. parvus,* has also been found to have higher production rates than other small calanoids in frontal areas (ZERVOUDAKI et al., 2007).

In the present investigation, the pattern of Chl-*a* distribution agreed with previous reports from the same area (CARRETO et al., 1986, 2008; VIÑAS et al., 2002), with maximum values being detected in the frontal estuarine area and in shelf waters. However, the highest values of Chl-*a* were not coincident with mesozooplankton peaks of abundance in section 1. It seems that small copepods are not only feeding upon phytoplankton, but also upon other alternative food. During this study we have not estimated the abundance of bacteria, heterotrophic flagellates, and other protozooplankton components. However, the highest values of biomass (57.17 µg Cl^{-}

[1]) and abundance ($2.86x10^6$ cel.ml^{-1}) of bacteria have been registered on the surface salinity front (COSTAGLIOLA et al., 2003), thus suggesting the possible development of an important microbial food web. In particular, *O. nana,* one of the dominant copepods in this frontal area, has been reported as an opportunistic species with a wide-ranging diet, able to consume particles from detritus to phytoplankton, ciliates, copepod nauplii and even calanoid faecal material (LAMPITT, 1978; NIELSEN; SABATINI, 1996; WILLIAMS; MUXAGATA, 2006 and references therein; ZERVOUDAKI et al., 2007).

The quantitative importance of small copepods and appendicularians in the Río de la Plata frontal area and their possible link with the components of the microbial food web highlight the importance of including the protozooplankton fraction in future studies to improve our understanding of this productive system.

Present results showed the advantages of incorporating a net with small pore mesh size for the regular sampling of mesozooplankton in order to obtain an accurate estimation of the abundance of the smallest fraction which in turn will lead to a better comprehension of the role of this important fraction in the energy transfer to higher trophic levels.

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