

Diel and seasonal changes in the macrozooplankton community of a tropical estuary in Northeastern Brazil

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ABSTRACT. Studies were carried out to assess the macrozooplankton small-scale temporal and spatial variability at three stations in three hours intervals, during 24 hours in July 1996 (rainy season) and December 1996 (dry season). A plankton net 300 μ m mesh size was hauled at surface during three minutes. Water samples for salinity, temperature, dissolved oxygen and pH were taken simultaneously with the zooplankton samples. Sixty-five macrozooplankton taxa were registered. Copepoda constituted the most common taxon and comprised 58% of the total zooplankton counts. Brachyuran zoeae, cirripedian larvae, Larvacea (*Oikopleura dioica* Fol, 1872), and Gastropoda veligers were abundant at some tidal cycles, mainly during the night. Species diversity average was 2.0 bits.ind⁻¹. The mean density ranged from 23 ind.m⁻³ to 5,201 ind.m⁻³. The rainy season presented greater numerical abundance. A regular temporal zooplankton cycle was not observed. Instead, there was a large stochastic variation between samples.

KEY WORDS. Diurnal variation, estuary, planktonic fauna, tidal variation.

The Santa Cruz Channel (Pernambuco State, Brazil) is a mangrove area with complex hydrographic conditions (MEDEIROS & KJERVE 1993, MEDEIROS *et al.* 2001). It is the core of the Itamaracá estuarine system, one of the most intensively studied water bodies in Brazil (PARANAGUÁ & ESKINAZI-LEÇA 1985, NEUMANN-LEITÃO 1995, BARROS *et al.* 2000, MEDEIROS *et al.* 2001, NEUMANN-LEITÃO *et al.* 2001).

Zooplankton is an important intermediate component in estuarine food webs, acting as a trophic link between small particles (*e.g.* detritus and microalgae) and planktivorous fishes (MORGAN 1990). On the other hand, commercially important fish, shrimp and crab species produce larvae which are part of the macrozooplankton.

Knowledge of the variability of zooplankton communities (*i.e.* abundance and species composition) at different spatial and temporal scales is a prerequisite to understanding their dynamics. In estuaries, environmental conditions which are very variable in both time and space strongly affect the distribution of zooplankton species (DAUVIN *et al.* 1998).

In spite of its great importance, relatively little work has been done on the zooplankton of mangrove habitats (ROBERTSON & BLABER 1992). Even at the Santa Cruz Channel where different aspects of the zooplankton has been studied (SCHWAMBORN 1997, PORTO NETO *et al.* 1999, NEUMANN-LEITÃO & SCHWAMBORN 2000, NEUMANN-LEITÃO *et al.* 2001, SHWAMBORN *et al.* 2001), no detailed studies were developed in the last 20 years on the main rivers flowing into the Channel.

As most estuaries, the Itamaracá estuarine ecosystem is exposed to multiple pressures from industrial pollution, domestic sewage discharge, urban expansion, land reclamation and fisheries (MEDEIROS *et al.* 2001).

The study was designed to yield quantitative data on macrozooplankton from the main polluted estuaries that drain into the Santa Cruz Channel and the area around the bridge in the channel which receives raw domestic sewage, to assess small-scale temporal and spatial variability. The results will enhance our understanding of small scale processes which may also be useful for monitoring pollution effects in tropical estuaries.

MATERIAL AND METHODS

The Santa Cruz Channel is a U-shaped estuarine channel 20 km long with two connections to the South Atlantic Ocean, located at 7°34'00" to 7°55'16"S and 34°48'48" to 34°52'24"W. From north to south the rivers Catuama, Carrapicho, Congo, Arataca, Botafogo, and Igarassú drain into the channel, the last two being the major freshwater sources (MEDEIROS & KJERVE 1993) and most polluted. The Santa Cruz Channel separates Itamaracá Island from the mainland and is the central part of the Itamaracá Estuarine System (MEDEIROS & KJERVE 1993). Tides in this natural Channel are strongly semi-diurnal and the mean tidal range varies between 1.0 and 1.8 m (spring 1.4-2.2 m, neap 0.5-1.1 m) with lower ranges near the hydrographic centre about 1.7 km north of Itapissuma Bridge

(MEDEIROS & KJERFVE 1993). This system sustains 36 km² of mangrove forests, dominated by *Rhizophora mangle* Linnaeus, 1753, *Laguncularia racemosa* C. F. Gaertner, 1788 and *Avicennia* spp. (MEDEIROS & KJERFVE 1993, BARROS et al. 2000). Dense crab populations inhabit the mangrove. Some crab species, such as *Ucides cordatus* (Linnaeus, 1763), *Goniopsis cruentata* (Latreille, 1802), and *Cardisoma guanhumi* Latreille, 1825, are of commercial importance. Molluscs, such as oysters – *Crassostrea rhizophorae* (Guilding, 1828) – are socio-economical important for many fisherwomen (BARROS et al. 2000).

Intensive 24-hour sampling was conducted simultaneously at three fixed stations during spring tide, at intervals of three hours, in the rainy season (July 1996), and in the dry season (December 1996). Stations were located at the Botafogo River inlet, in the middle of Santa Cruz Channel close to the bridge that connects the continent to Itamaracá Island and at the Igarassú River inlet (Fig. 1).

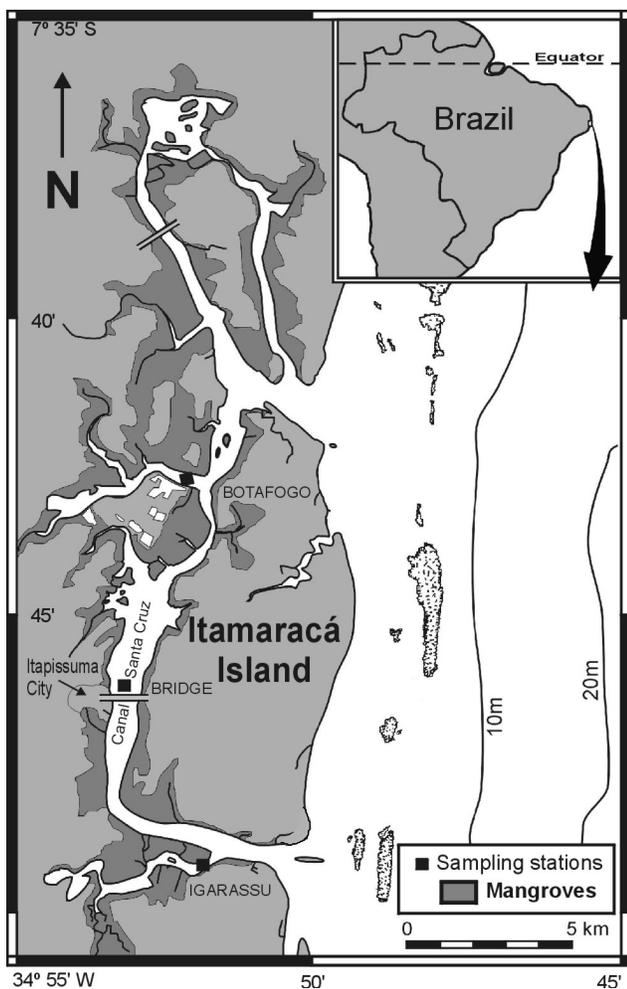


Figure 1. Map of the Itamaracá estuarine system, showing the Santa Cruz Channel and the position of sampling stations.

Hydrological data were collected at surface with a Nansen bottle. Water temperature was recorded with a reversion thermometer fixed to Nansen bottle, salinity was measured with the Mohr-Knudsen method and dissolved oxygen with the Winkler method (STRICKLAND & PARSONS 1965).

Zooplankton was sampled with a plankton net with 300 µm mesh size hauled horizontally for three minutes at sub-surface at each station. A flowmeter (Hydrobios, Kiel) was fitted on the opening of each net used. Samples were preserved in a 4% buffered formaline/seawater solution. Plankton biomass was determined by wet weight (WW) according to OMORI & IKEDA (1984). Macrozooplankton species were identified until the lowest taxonomic unit possible and taxon abundance (per cubic meter) counted under a stereomicroscope, based on 8 ml sub-samples. Three sub-samples were taken with a Stempel-pipette, after the sample was diluted to 500 ml and gently homogenized.

Differences between seasons, stations, tides, night and day were tested for significance using non-parametric Mann-Whitney test (CONOVER 1980).

The Shannon diversity index (H') was applied for the estimation of community diversity based on \log_2 (SHANNON 1948) and the evenness calculated according to PIELOU (1977). Samples cluster analysis on the sample-species data matrix was also performed using the Bray & Curtis index after data standardization and $\log(x+1)$ transformation (IBANEZ 1976). The link method for the dendrogram was the Weighted Pair Group Method-Arithmetical Averages (WPGMA) (LEGENDRE & LEGENDRE 1998). A symmetrical matrix of cophenetic dissimilarity value was produced to test the goodness of fit of the cluster analysis to the data (ROHLF & SOKAL 1981).

RESULTS

Temperature, salinity and dissolved oxygen showed characteristic variation related to the semi-diurnal tidal cycle. Minimum and maximum values of these parameters are presented in table I. Water temperatures lacked horizontal gradients. Temperature always exceeded 25°C, and reached 31°C during the day in the dry season. At Botafogo Station the temperature varied from 25.8°C (01:00 h) to 27.2°C (16:00 h) in the rainy season and from 29°C (04:00 h) to 31°C (13:00 and 16:00 h) in the dry season. At Bridge Station the temperature varied from 25°C (22:00 h) to 28.1°C (13:00 h) in the rainy season and from 29°C (22:00 h) to 31°C (13:00 h) in the dry season. At Igarassú Station the temperature varied from 25.8°C (01:00 h) to 27.2°C (13:00 h) in the rainy season and from 28.6°C (04:00 h) to 30.5°C (13:00 and 16:00 h) in the dry season.

The salinity at Botafogo Station ranged between 17.4 and 30.69 psu in the rainy season and from 23.53 to 33.69 psu in the dry season. At Bridge Station salinity ranged between 25.3 and 26.38 psu in the rainy season and from 29.14 and 31.01 psu in the dry season. At Igarassú Station salinity varied from 22.34 to 33.65 psu in the rainy season and from 24.06 to 35.56 psu in the dry season (Fig. 2). Overall salinity was lower at the rainy season. The Bridge Station showed the least variation.

Dissolved oxygen saturation in the rainy season varied from 55.42% (diurnal low tide – 10:00 h) to 115.15% (diurnal high tide – 16:00 h) both at Igarassú station (Fig. 2). In the dry season dissolved oxygen saturation ranged from 45.89% (diurnal low tide – 10:00 h) to 133.26% (diurnal high tide – 16:00 h).

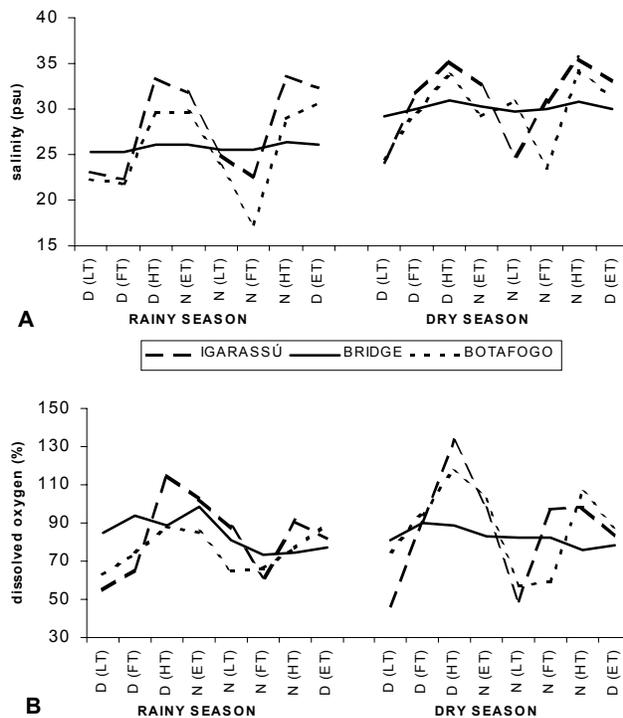


Figure 2. Distribution of the salinity (A) and dissolved oxygen saturation (B) at three stations at Santa Cruz Channel area, Pernambuco, Brazil, during 24 hours in July 1996 (rainy season) and December 1996 (dry season). (D) Day, (N) night, (LT) low tide, (FT) flood, (HT) high tide, (ET) ebb.

h) both at Igarassú Station. Only 12.5% of the samples had more than 100% and approximately 21% of the samples showed less than 60% saturation.

Plankton biomass varied in relation to the tidal cycle. In the rainy season biomass ranged from $1.4 \text{ mg}\cdot\text{m}^{-3}$ (01:00 h) to $375.7 \text{ mg}\cdot\text{m}^{-3}$ (13:00 h) both during flood tide at the Igarassú Station (Tab. I, Fig. 3), with an average biomass of $47.4 \text{ mg}\cdot\text{m}^{-3}$. In the dry season biomass ranged from $0.92 \text{ mg}\cdot\text{m}^{-3}$ (diurnal low tide - 10:00 h) to $408.19 \text{ mg}\cdot\text{m}^{-3}$ (diurnal ebb tide 07:00 h) both at the Igarassú Station (Tab. I, Fig. 3), with an average biomass of $57.9 \text{ mg}\cdot\text{m}^{-3}$.

Sixty-five zooplankton taxa were identified (Tab. II). Copepods dominated most samples although meroplankton larvae dominated in some night samples, mainly at low tide and during the dry season. The most abundant taxa were *Acartia lilljeborgi* Giesbrecht, 1889 in the adult stage (31.2% of the total zooplankton), brachyuran zoeae and megalopae (21%), *Oithona oswaldocruzi* Oliveira, 1945 (10.7%) and *Pseudodiaptomus marshi* Wright, 1936 (8.6%). *Calanopia americana* F. Dahl, 1894, *Pseudodiaptomus richardi* (F. Dahl, 1894), *Temora turbinata* Dana, 1849, *Oikopleura dioica* Fol, 1872, protozoae *Lucifer faxoni* Borraidaile, 1915 and gastropod larvae were important in some samples.

The most frequent taxa were *Acartia lilljeborgi* (93.8% of the samples), *Oithona oswaldocruzi* (87.5%), zoeae and megalopae of *Brachyura* (85.4%), *Pseudodiaptomus marshi* (79.2%),

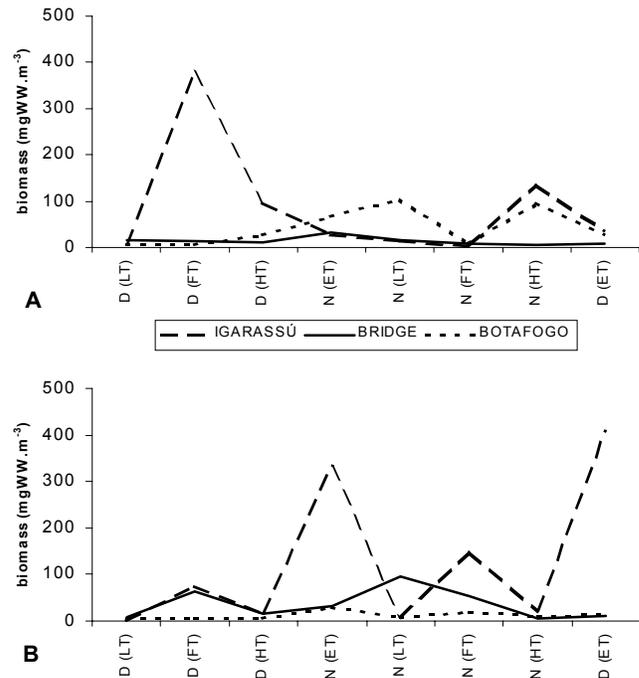


Figure 3. Wet weight (WW) plankton biomass at three stations at Santa Cruz Channel area, Pernambuco, Brazil, during 24 hours in July 1996 (rainy season) (A) and December 1996 (dry season) (B). (D) Day, (N) night, (LT) low tide, (FT) flood, (HT) high tide, (ET) ebb.

nauplii of *Balanus* spp. (60.4%) and *Oikopleura dioica* (56.3%).

Minimum abundance ($23 \text{ ind}\cdot\text{m}^{-3}$) was registered at Igarassú Station (flood tide during dry season), and the maximum abundance ($5,201 \text{ ind}\cdot\text{m}^{-3}$) registered at Botafogo Station (high tide during rainy season) (Tab. I, Fig. 4). Average abundance for both seasons was $1,464 \text{ ind}\cdot\text{m}^{-3}$ (Botafogo Station), $366 \text{ ind}\cdot\text{m}^{-3}$ (Bridge Station) and $1,213 \text{ ind}\cdot\text{m}^{-3}$ (Igarassú Station).

During the rainy season, two peaks were registered for the Botafogo Station both dominated by *Acartia lilljeborgi*, at diurnal ($4,336 \text{ ind}\cdot\text{m}^{-3}$) and nocturnal ($915 \text{ ind}\cdot\text{m}^{-3}$) high tide; average abundance to this station was $1,876 \text{ ind}\cdot\text{m}^{-3}$. The Bridge station had only one peak at nocturnal ebb tide with *Acartia lilljeborgi* being most abundant ($834 \text{ ind}\cdot\text{m}^{-3}$); average abundance was $476 \text{ ind}\cdot\text{m}^{-3}$. The Igarassú Station presented also two peaks at this season, one at low tide, where the most abundant species were *Calanopia americana* ($1,390 \text{ ind}\cdot\text{m}^{-3}$) and *Pseudodiaptomus marshi* ($1,109 \text{ ind}\cdot\text{m}^{-3}$) and the other one at high tide with *P. richardi* ($1,571 \text{ ind}\cdot\text{m}^{-3}$) as most abundant, both at night samplings; average abundance to Igarassú Station was $1,004 \text{ ind}\cdot\text{m}^{-3}$.

At the dry season one peak was observed for the Botafogo Station, at nocturnal low tide with brachyuran zoeae attaining $3,480 \text{ ind}\cdot\text{m}^{-3}$, average abundance in this station was $1,178 \text{ ind}\cdot\text{m}^{-3}$. At the Bridge Station, two small peaks were registered at diurnal and nocturnal high tide with *Oithona oswaldocruzi*

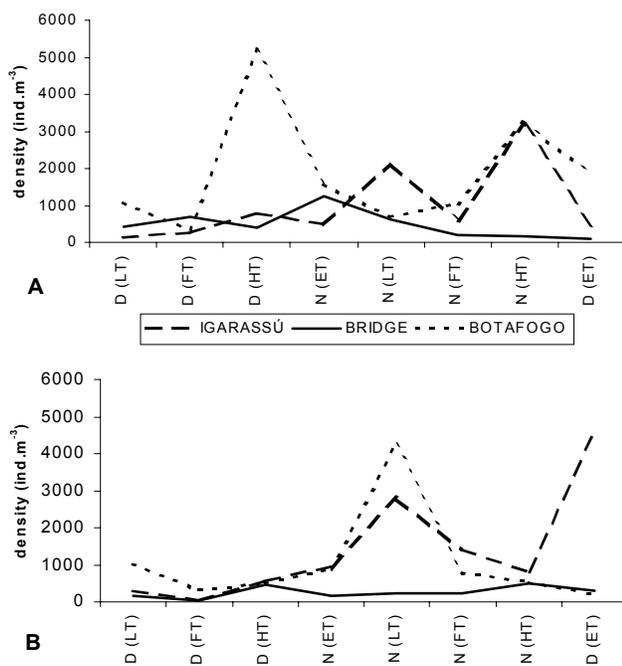


Figure 4. Zooplankton numerical abundance at three stations at Santa Cruz Channel area, Pernambuco, Brazil, during 24 hours in July 1996 (rainy season) (A) and December 1996 (dry season) (B). (D) Day, (N) night, (LT) low tide, (FT) flood, (HT) high tide, (ET) ebb.

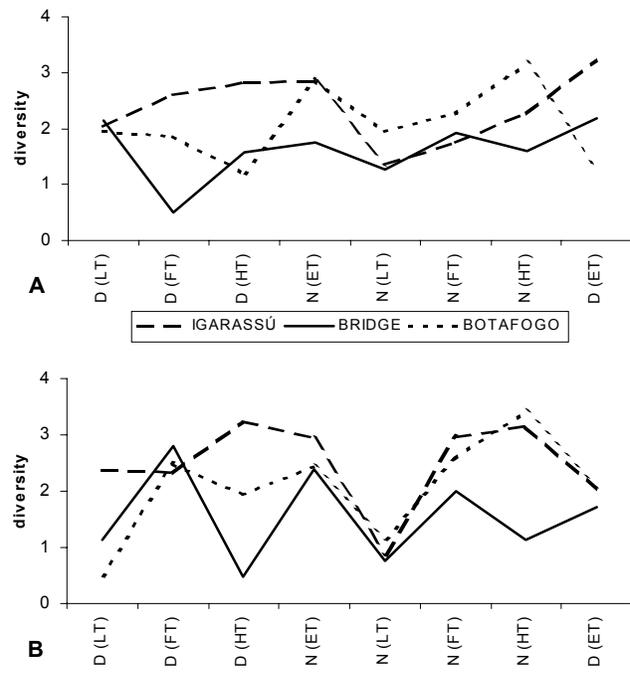


Figure 5. Zooplankton species diversity at three stations at Santa Cruz Channel area, Pernambuco, Brazil, during 24 hours in July 1996 (rainy season) (A) and December 1996 (dry season) (B). (D) Day, (N) night, (LT) low tide, (FT) flood, (HT) high tide, (ET) ebb.

Table I. Minimum (MIN) and maximum (MAX) data of the main parameters at three stations in the Santa Cruz Channel area, Pernambuco, Brazil, during 24 hours in July 1996 (rainy season) and December 1996 (dry season).

Parameters	Stations											
	Botafogo				Bridge				Igarassú			
	Rainy		Dry		Rainy		Dry		Rainy		Dry	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Temperature (°C)	25.8	27.2	29	31	25	28.1	29	31	25.8	27.2	28.6	30.5
Salinity (psu)	17.36	30.69	23.53	33.69	25.3	26.38	29.14	31.01	22.34	33.65	24.06	35.56
Dissolved oxygen (ml.l ⁻¹)	3.09	4.26	2.78	5.1	3.62	4.36	3.42	3.95	2.71	5.32	2.12	5.77
Dissolved oxygen saturation (%)	62.8	89.68	59.15	117.78	72.98	98.16	75.83	89.77	55.42	115.15	45.89	133.26
Biomass (mgWW.m ⁻³)	5.65	104.52	4.24	29.66	4.24	31.07	4.24	94.63	1.42	375.71	0.92	408.19
Density (ind.m ⁻³)	316	5,201	317	4,228	191	1,244	30	487	131	3,174	23	4,565
Diversity	1.19	3.17	0.50	3.41	0.51	2.18	0.47	2.79	1.35	3.24	0.88	3.25
Evenness	0.24	0.67	0.26	0.80	0.18	0.69	0.16	0.88	0.35	0.78	0.22	0.89

with 410 ind.m⁻³ and 396 ind.m⁻³, respectively; average abundance was 487 ind.m⁻³. At the Igarassu Station, two peaks were registered, caused by a high abundance of *O. oswaldocruzi* one at nocturnal low tide (2,365 ind.m⁻³) and the other at diurnal ebb tide (2,908 ind.m⁻³), with general average abundance of 1,422 ind.m⁻³.

Average species diversity was 2.01 during the rainy season and 2.03 during the dry season, values ranging from low (0.5) to high values (3.25) (Fig. 5). Minimum and maximum values for each station were 0.50 and 3.41 (Botafogo Station), 0.47 and 2.79 (Bridge Station), and 0.88 and 3.25 (Igarassú Station) (Tab. I). Average evenness was 0.55 to the rainy season

Table II. Zooplankton composition at three stations in the Santa Cruz Channel area, Pernambuco, Brazil, during 24 hours in July 1996 (rainy season) and December 1996 (dry season).

Foraminifera	<i>Oncaea media</i> Giesbrecht, 1891
<i>Globegerinoides ruber</i> (d'Orbigny, 1839)	<i>Corycaeus (Onychocorycaeus) giesbrechti</i> F. Dahl, 1894
<i>Globorotalia</i> sp.	<i>Tisbes</i> sp.
<i>Planispirillina</i> sp.	<i>Hemicyclops thalassius</i> Vervoort & Ramirez, 1966
<i>Amphistegina</i> sp.	<i>Euterpina acutifrons</i> (Dana, 1852)
<i>Textularia</i> sp.	<i>Tigriopus</i> sp.
<i>Quingueloculina</i> sp.	<i>Caligus</i> sp.
Tintinnina	Ostracoda
<i>Favella ehrenbergii</i> (Claparède & Laachmann, 1858)	<i>Conchoecia</i> sp.
Cnidaria	Mysidacea
<i>Obelia</i> sp.	Amphipoda
Ephyra (larvae)	<i>Synopia</i> sp.
Nematoda	<i>Turbergella</i> sp.
Polychaeta	Isopoda (larvae Epicaridae)
Spionidae (larvae)	Cumacea
<i>Lanice</i> sp. (larvae)	Euphausiacea
Other larvae (diverse stages)	Decapoda
Mollusca	<i>Lucifer</i> (protozoa)
<i>Cavolinea</i> sp.	<i>Lucifer</i> (mysis)
Gastropoda (veliger)	<i>Lucifer faxoni</i> Borraidele, 1915
Bivalvia (veliger)	<i>Acetes</i> sp.
Crustacea	<i>Panaeus</i> sp. (larvae)
Crustacea (nauplius)	Caridea (larvae)
Cirripedia	Paleomonidae (larvae)
<i>Balanus</i> spp. (larvae)	Porcellanidae (zoeae)
Copepoda	Brachyura (zoeae and megalopa)
<i>Nanocalanus minor</i> (Claus, 1863)	<i>Callianassea</i> sp.
<i>Parvocalanus crassirostris</i> (F. Dahl, 1894)	Alpheidae (larvae)
<i>Clausocalanus furcatus</i> (Brady, 1883)	Paguridae (larvae)
<i>Centropages velificatus</i> (Oliveira, 1947)	Processidae (larvae)
<i>Centropages gracilis</i> (Dana, 1849)	<i>Albunea</i> sp. (larvae)
<i>Temora stylifera</i> (Dana, 1949)	Bryozoa
<i>Temora turbinata</i> (Dana, 1949)	<i>Membranipora</i> sp. (larvae)
<i>Calanopia americana</i> F. Dahl, 1894	Chaetognatha
<i>Pontellopsis brevi</i> (Dana, 1849)	<i>Sagitta friderici</i> Ritter-Zahóny, 1910
<i>Acartia lilljeborgi</i> Giesbrecht, 1892	Echinodermata (pluteus)
<i>Pseudodiaptomus marshi</i> Wright, 1936	Larvacea
<i>Pseudodiaptomus richardi</i> (F. Dahl, 1894)	<i>Oikopleura dioica</i> Fol, 1872
Calanoida (others)	<i>Oikopleura rufescens</i> Fol, 1872
<i>Oithona oswaldocruzi</i> Oliveira, 1945	Asciacea (larvae)
<i>Oithona hebes</i> Giesbrecht, 1891	Pisces (egg and larvae)

and 0.52 to the dry season, with minimum of 0.16 and maximum of 0.89 for both in the dry season (Fig. 6). Minimum and maximum evenness values for each station were 0.24 and 0.80 (Botafogo Station), 0.16 and 0.88 (Bridge Station), and 0.22 and 0.89 (Igarassú Station) (Tab. I).

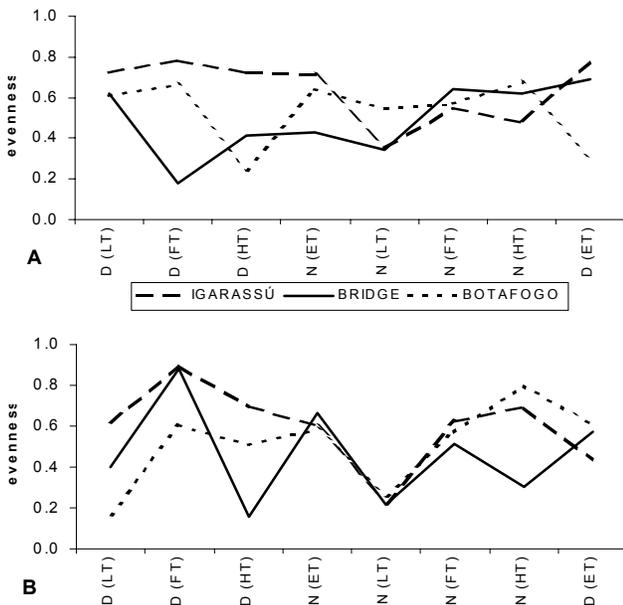


Figure 6. Zooplankton evenness at three stations at Santa Cruz Channel area, Pernambuco, Brazil, during 24 hours in July 1996 (rainy season) (A) and December 1996 (dry season) (B). (D) Day, (N) night, (LT) low tide, (FT) flood, (HT) high tide, (ET) ebb.

Differences in total abundance between day and night samples was significant to Igarassú (Mann-Whitney test, $p = 0.01$) and Botafogo (Mann-Whitney test, $p = 0.04$) Stations. Significant differences were also found between the rainy and dry seasons (Mann-Whitney test, $p = 0.04$); between the Igarassú and Bridge Stations (Mann-Whitney test, $p = 0.01$), and the Botafogo and Bridge Stations (Mann-Whitney test, $p = 0.01$). No difference was found between Igarassú and Botafogo Stations (Mann-Whitney test, $p = 0.18$).

The cophenetic analysis presented a $r = 0.83$ indicating a good fit of the data. Samples clustering produced three groups, indicating the importance of seasonal changes: Group 1) formed by the flood and low tide samples from Igarassú and Botafogo Stations of both rainy and dry seasons. Group 2) characterised by all samples from the dry season except for those in group 1. Group 3) characterised by all samples from the rainy season, except for those in group 1 (Fig. 7).

DISCUSSION

At the Santa Cruz channel greatest variation of salinity was registered during the rainy season, mainly at the Botafogo Station. According to MEDEIROS *et al.* (2001), seasonal differences in rainfall and freshwater runoff are significant at Santa

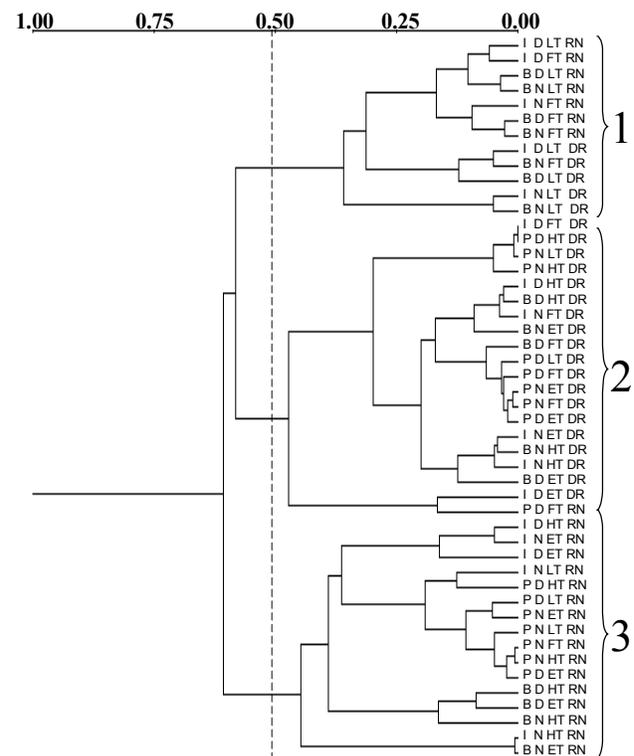


Figure 7. Dendrogram resulting from the Bray & Curtis analysis of 48 zooplankton samples at Santa Cruz Channel area, Pernambuco, Brazil, during 24 hours in July 1996 (rainy season = RN) and December 1996 (dry season = DR). (D) Day, (N) night, (LT) low tide, (FT) flood, (HT) high tide, (ET) ebb, (I) Igarassú, (B) Botafogo, (P) Bridge.

Cruz Channel, with total average river discharge varying between $55.9 \text{ m}^3\text{s}^{-1}$ at the peak of the rainy season and $0.8 \text{ m}^3\text{s}^{-1}$ at the peak of dry season. The cluster of samples showed that prominent differences occurred between dry and rainy seasons.

Principal dominant parameters in the Santa Cruz ecosystem are salinity and dissolved oxygen, which are controlled by the tides. According to MEDEIROS & KJERFVE (1993), overall salinity in the Santa Cruz area is lower in the rainy (27 psu) than in the dry season (34 psu). During the dry season, hypersaline conditions (37 psu) at both entrances of Santa Cruz Channel are due to evaporation, evapotranspiration by mangroves, and reduced flow from the rivers (MEDEIROS *et al.* 2001). The estuary is well mixed and salinity differences from surface to bottom are less than 1 psu. During the rainy season, the northern channel tends to be stratified at neap tide. Specially at the confluence of the Botafogo river, large freshwater discharge and reduced tidal mixing energy favour stratification with a surface to bottom salinity gradient of 12 psu (MEDEIROS *et al.* 2001).

According to the classification of estuarine plankton given by BOLTOVSKOY (1981, 1999), the macrozooplankton community collected in the Santa Cruz area may be defined as an

euryhaline marine assemblage. It was largely dominated by coastal neritic species including the calanoid copepods *Acartia lilljeborgi*, *Calanopia americana* and the appendicularian *Oikopleura dioica*, together with estuarine mangrove species *Pseudodiaptomus marshi*, *P. richardi*, *Oithona oswaldocruzi* and brachyuran larvae. This composition is very similar to the results from other northeastern Brazilian estuaries (NEUMANN-LEITÃO 1995).

The decrease in zooplankton diversity with decreasing salinity indicated the major role of this parameter in the occurrence and distribution of euryhaline species, mainly sampled during high tide, like the copepods.

Within the Santa Cruz stations, temporal variations in the species composition and densities were mainly due to the semi-diurnal tidal cycle. For most species, higher densities were observed around high tide, when the intrusion of marine waters is maximal, while just a few species (e.g. Brachyuran larvae, *Oithona oswaldocruzi* and *Pseudodiaptomus richardi*) were more abundant around low tide. The amplitude of such variations over one tidal cycle were quite variable among taxa and varied between two and more than 50-fold. The predominant role of instantaneous tidal currents in zooplankton variability within tidal estuaries has also been reported by several authors (LEE & MCALICE 1979, CRONIN & FORWARD 1986, SCHLACHER & WOODDRIDGE 1995, DAUVIN *et al.* 1998, NEUMANN-LEITÃO & MATSUMURA-TUNDISI 1998, among others).

The highest densities of brachyuran larvae around low tide could be related to the high biomass of adult crabs in the mangroves existing along the Channel and riverside (COELHO 2000). Taxonomic composition, distribution and food web dynamics of brachyuran zoeae presented by SCHWAMBORN (1997) and SCHWAMBORN *et al.* (1999a) support the assumption that high abundance of this larvae off Itamaracá are due to export from mangroves. MEDEIROS *et al.* (2001) mention an overall tidal export from the Santa Cruz inlets to the adjacent shelf of 1.5×10^8 zoeae per day. Since decapod larvae and copepods are an important food for many fish species (VASCONCELOS *et al.* 1984, MORGAN 1990, SAUTOUR *et al.* 1996), the export of these groups from mangroves to the shelf means an important input to marine food webs.

Besides tidal changes, short-term variations in the zooplankton community also resulted from diurnal changes. The calanoid *Calanopia americana* which is benthic during the day (BJÖRNBERG 1981) attained high densities in the plankton during the night at Igarassú Station.

At the Itamaracá estuary, *Acartia lilljeborgi* had an important role and this may be related to the high amount of detritus occurring in the area that is consumed by this species, as has been demonstrated through stable isotope measurements and feeding experiments performed in the laboratory and *in situ* (SCHWAMBORN 1997, SCHWAMBORN *et al.* 1999b).

The zooplankton community decreased in density and diversity in the last twenty years when comparing with data from PARANAGUÁ & NASCIMENTO-VIEIRA (1984) and PARANAGUÁ & ESKINAZI-LEÇA (1985), affecting the fisheries production in the area.

It can be concluded that the main difference between the dry and the rainy seasons in the zooplankton community was in composition. The larvae of several taxa, mainly benthic decapods were abundant in the dry season, while calanoid copepods dominated in the rainy season. In general, night

samples presented higher density of decapod larvae in the dry season and higher density of copepods at the rainy season. No differences were observed in composition between Igarassú and Botafogo Stations. Bridge Station presented lower zooplankton density and diversity, probably due to the decrease in the mangrove area and higher pollution from Itapissuma Town.

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