Universität Bremen

ZOOPLANKTON AS BIOINDICATOR OF ENVIRONMENTAL QUALITY IN THE TAMANDARÉ REEF SYSTEM (PERNAMBUCO - BRAZIL): ANTHROPOGENIC INFLUENCES AND INTERACTION WITH MANGROVES

Dissertation zur Erlangung des akademischen Grades *Doctor rerum naturalium* (Dr. rer. nat.)

von Fernando de Figueiredo Porto Neto

vorgelegt am
Zentrum für Marine Tropenökologie (ZMT) innerhalb
des Fachbereichs 2 der
Universität Bremen.

Bremen 2003

Fernando de Figueiredo Porto Neto

Erster Gutachter: Prof. Dr. ULRICH-SAINT PAUL, ZMT an der Universität Bremen

Zweiter Gutachter: PROF. DR. WERNER EKAU, ZMT an der Universität Bremen

Dissertationsdatum: 12.11.1003

Universität Bremen
Zentrum für Marine Tropenökologie (ZMT)
2003

Acknowledgements

Danksagung - Agradecimentos

"*Nothing can survive in the vacuum*"

I would like to thank some persons that enrich our atmosphere:

I am forever grateful to Prof. Dr. *Ulrich Saint-Paul* and Dr. *Werner Ekau* for 3½ years of mentoring. They made information, guidance, and opportunity to work with ZMT Bremen, in Germany. Their contributions are reflected throughout this text. I am sincerely grateful for the great assistance.

I owe a large thank-you to Dr. *Sabine Dittmann*, for reviewing the draft manuscript, for providing many good suggestions and inspiring discussions, and for steering me to important literature.

Thanks to *Sabine Kadler* for the "logistical support", and to all my German colleagues from ZMT.

I am grateful to Prof. Dr. *Mauro Maida* and Prof. Dr. *Beatrice Padovani Ferreira* for their support and patience during the field work, and the *Oceanography Department* of the Federal University of Pernambuco State (DO/UFPE). Also, I would like to acknowledge the *Centro de Pesquisa e Extensão Pesqueira do Nordeste* (CEPENE - Center for Research and Fishery) for the logistical support at Tamandaré.

Thank-you to Prof. Dr. *Ralf Schwamborn*, that has been a mentor, a friend, and a fellow zooplankton enthusiast through the trials and tribulations of my limited publishing career.

Also, thank-you to my "indefatigable" Brazilian colleagues: Prof. Dr. *Lúcia Gusmão*, Prof. Dr. *Dilma Nascimento-Vieira*, Prof. Dr. *Tamara Almeida*, M.Sc. *Andréa Pinto Silva*, M.Sc. *Mauro de O. Moura*, Dr. *Girlene Fábia Viana*, and *Zinaldo Ferreira* that have supported my field works. Thanks to Prof. Dr. *Sílvio Macêdo* and his crew for the chemical analysis. Thank you very much to M.Sc. *Ana Paula Losada*, Prof. Dr. *Fernando Feitosa*, and Dr. *Isabella Galvão* for all the help with the samples from mangrove area and phytoplankton, and Prof. Dr. *Cátia Fernandes Barbosa* for the help with Foraminifera identifications. Thanks to M.Sc. *Janaina de Araújo* for the help with bibliography.

I gratefully acknowledge the financial support to this thesis by the *Deutscher Akademischer Austauschdienst* (DAAD). Thank you Maria Salgado, for the "Betreuung".

I would like to express my "warmest" thanks to Prof. Dr. *Denilson Luz da Silva*, Dr. *Nils Edvin Asp Neto* and Dr. *Maurício Brichta* (and Familly), *Sandra Spiegel*, and *Anette Fargel* for friendship, support, excellent food, and all the "*German Weekend-tickets Advanced Rucksackurlauber Tours*" - a todos os meus "*melhores desejos*". Also thanks to Dr. *Unggul Aktani* ("*Obrigado*") and Dr. *Carlos Jimenez*, Dr. *Anneken Reise*, *Inga Nordhaus*, *Kerstin Kober*, *Gabriele Boehme* and *Silke Meyerholz*, *Gonzalo Olivares*, *Jenny Leal-Florez* and *Ursula Mendoza*, *Sílvio Veloso* and *João Mendonça* for friendship and support.

A very special thanks to Prof. Dr. *Sigrid Neuman-Leitão*. She also contributed immeasurably to this text, and to my understanding of marine affairs. I have cherished her camaraderie as we try to "save the ocean". She also gave me moral support, ideas, the knowledge she shared, her love of the ocean, and her belief in the importance of the vast variety of life in the sea. She is one of a very few human beings who really understands the seaworld. Her scientific and personal impressions of that realm give credence to my belief that precaution and protection are essential for the entire interactive network of ecosystems that make up the world's ocean.

Finally, thanks to my Family, God and friends, for strenght, optimism, and putting up with me throughout this endeavor.

Content

Abstract

Zooplankton studies carried out in the Tamandaré Bay (Brazil) were aimed at elucidating the role of bioindicators of anthropic impacts, mangrove on zooplankton production, and to see how nutrients, temperature, salinity, dissolved oxygen and seasonal patterns affect the zooplankton community in the reef area. Samples were collected from the two biotopes (mangrove and reef) using 64 µm mesh size plankton net towed at a constant speed, at surface. At mangrove area the collection was taken twice at the same day a month during high and low tide (full moon), from February 1998 to Januar 1999. At reef area the collection was taken in winter (between 10-11/07/2000) and summer (between 17-18/01/2001), in a 6 hours interval at neap tide (in the course of 24 hours, representing 2 low- and 2 high-tide samples per station/season). The two biotopes were demarcated as station M1, M2, M3 and M4 (mangrove area) respectively beginning from the coastal station (Tamandaré Bay) to the innermost mangrove stations, and R1, R2, R3, R4 respectively beginning from the "Closed Area" (at the non-urbanized area from Tamandaré City) to the reefs in front of the urbanized area. Moreover, samples were taken in two stations between the reefs and the beach at the reef area (C1 and C2), and also one sample at the Maceió River mouth (Tamandaré urban area) was taken. Collected samples were preserved in 4% formaline/sea water solution for later laboratory work. Hydrographic parameter measured were temperature, salinity, and dissolved oxygen. In the laboratory, sorting was done under a stereo microscope. Identification was done up to species level where possible and major taxons recorded. Subsampling for counting was done using a stempel pipette. Where samples were sparse (in terms of biologic material), the entire samples were counted. During the rainy season, salinity dropped to 0 at some mangrove stations, from the previous 35 PSU (in Dezember/Januar during the dry season). At reef stations the salinity values were constant (about of 34 PSU). Temperatures vary from 24 to 29°C in the reef and mangrove stations. During the rainy season temperature varied from 24-27°C. Dissolved oxygen readings ranged between 5.73 mg $O_2.L^{-1}$ in the reef area to 0.42 mg $O_2.L^{-1}$ in one mangrove station. Highest zooplankton densities were recorded in general during the summer at mangrove and reef stations. However, on a spatial scale the rainy season was not favourable for zooplankton production in the river stations (in this case the mangrove stations). But, in general the total productivity was high during the rainy and dry season. Copepoda and copepods nauplii emerged as the most dominant groups forming up to 80% of total zooplankton at mangrove area, and about of 70% and 60% of total zooplankton at non- and urbanized area. *Oithona hebes*, *Oithona nana*, *Oithona oswaldocruzi* and *Parvocalanus crassirostris* were the dominant and most abundant taxa. Holoplankton groups dominated the samples making about of 90% of total zooplankton groups. Other important groups which occurred frequently were Foraminifera, Tintinnina, and also fish eggs and larvae, other Crustaceaa and Molluscan larvae. Taxonomic abundance and spatial distribution of zooplankton are analysed in the two zones of the reef complex, as well as in the mangrove area; ecological subsystems are delimited and exchanges between them are explicited. Bioindicators of anthropic impacts (Rotifera and Nematoda) are very found at the urbanized area of Tamandaré coast, where the nutrients concentrations were also higher. This is an indication of organic pollution in the reef area, through the Maceió River. This river has high densities of Rotifera and Nematoda, and only Polychaeta larvae, *Oithona hebes* and copepods nauplii were also found in the sample from this river. It suggests that the reef in front of the Tamandaré urban area is a "impacted sector" of the Tamandaré reef complex. Moreover, the mangrove area is a important source of species and biomass, once the dominant and more abundant identified groups have mangrove/estuarine origin. Zooplankton species diversity calculated using Shannon index revealed high diversity in mangrove and coral reef stations respectively. Distribution of zooplankton in these biotopes also indicates an even distribution.

Zusammenfassung

In der Tamandaré Bay (Brasilien) wurden Untersuchungen am Zooplankton durchgeführt, um einerseits seine Rolle als Bioindikator für anthropogene Einflüsse zu untersuchen und andererseits den Einfluß von Mangrovengebieten auf diese Gemeinschaft zu erfassen. Zwei Gebiete wurden hierzu beprobt: das Mangrovengebiet und das Riffgebiet. Neben den Planktonproben (Maschenweite 64µm), die bei konstanter Geschwindigkeit aus dem Oberflächenwasser entnommen wurden, wurden auch Nähstoffgehalt, Temperatur, Salinität und Sauerstoffgehalt des Wassers bestimmt und saisonale Schwankungen erfasst. Das Mangrovengebiet wurde zwischen Februar 1998 und Januar 1999 monatlich beprobt, indem zu Vollmond zwei Proben, jeweils zu Hoch- und Niedrigwasser desselben Tages, genommen wurden. Das Riff-Gebiet wurde an zwei Terminen (Winter: 10/11.07.2000, Sommer: 17/18.01.2001) mit je einer 24-Stunden-Probennahme untersucht, in deren Verlauf alle 6 Stunden eine Planktonprobe genommen wurde. Außerdem wurde eine Referenzprobe im stark anthropogen beeinflußten Maceió Fluss genommen. Die Proben wurden in 4% *Formalin/Meerwasser* für spätere Laboruntersuchungen aufbewahrt. Das Zooplankton wurde wenn möglich bis zu Art, sonst bis zur nächst höhere taxonomische Gruppe bestimmt. Die Salinität schwankte im Mangrovengebiet zwischen 35 PSU (Trockenzeit) und 0 PSU (Regenzeit). Im Riffgebiet blieb sie hingegen konstant bei 34 PSU. Die Temperaturen variierten in beiden Gebieten zwischen 24 - 29°C. Der Sauerstoffgehalt des Meerwassers betrug zwischen 5.73 mg $O_2.L^{-1}$ im Riffgebiet und 0.42 mg $O_2.L^{-1}$ im Mangrovengebiet. Die höchsten Zooplankton-Dichten wurden in beiden Gebieten im allgemeinen während des Sommers gefunden. Zur Regenzeit war die Zooplankton-Produktion im Mangrovengebiet stark reduziert. Bis zu 80% des gesamten Zooplankton des Mangrovengebietes bestand aus Copepoden und Nauplius-Larven von Copepoden. In den nicht-anthropogen beeinflussten Gebieten lag dieser Wert über von 70%, in den anthropogen beeinflussten Gebieten bei 60%. *Oithona hebes*, *Oithona nana*, *Oithona oswaldocruzi* und *Parvocalanus crassirostris* waren insgesamt die dominierenden und abundantesten Taxa. Circa 90% des gesamten Zooplankton bestand aus holoplanktischen Arten. Andere wichtige Gruppen die häufig vorkamen waren Foraminifera, Tintinnina, Fischeier und -larven, andere Crustacea und Molluskenlarven. Die Anzahl von Arten und ihre räumliche Verteilung wurde sowohl in zwei Zonen des Riff-Komplexes als auch im Mangrove-Gebiet analysiert und Zooplanktongemeinschaften wurden beschrieben. In anthropogen beeinflussten Gebieten an der Tamandaré Küste wurden erhöhte Nährstoff-Konzentrationen durch organische Verunreinigungen festgestellt. Hier kamen auch Rotifera und Nematoda in erhöhtem Maße vor und wurden als Bioindikatoren für anthropogene Einflüsse identifiziert. Im Maceió Fluß, der durch besonders starke Verunreinigungen gekennzeichnet ist, kamen neben den Bioinidkatoren nur noch Polychaetenlarven, *Oithona hebes* und Nauplius-Larven von Copepoden vor. Es wurde herausgefunden, dass das Riff zumindest in Teilen unter anthropogenem Einfluß steht. Überdies ist das Mangrove-Gebiet eine wichtige Quelle für Planktonarten, da die dominierenden und abundanten Arten der Riff-Gebiete ihrem Ursprung nach aus den Mangroven oder dem Ästuar stammen. Sowohl im Mangroven-Gebiet als auch im Riff-Gebiet wurde eine hohe Diversität (Shannon Index) festgestellt. Weiterhin wurde in beiden Gebieten eine hohe Äquität (eveness) festgestellt.

Resumo

Estudos sobre a comunidade zooplanctônica foram realizados na região da Baía de Tamandaré (Brasil), visando a elucidação de aspectos ecológicos, como a presença de bioindicadores de impactos antrópicos, influência de manguezais na produção zooplanctônica, e também avaliar os padrões sazonais de nutrientes, temperatura, salinidade, oxigênio dissolvido e seus efeitos na distribuição da comunidade zooplanctônica. Amostras foram tomadas nos dois ambiente (manguezal e recifal) usando uma rede de plancton com 64 µm de abertura de malha, arrastada na superfície, a uma velocidade constante. Na região de manguezal as amostras foram tomadas duas vezes por mês (durante uma preamar e uma baixa-mar do mesmo dia, em maré de sizígia), entre fevereiro de 1998 a janeiro de 1999. Na área recifal as amostras foram feitas no inverno (entre 10-11/07/2000) e no verão (entre 17-18/01/2001) em marés de quadratura, e em intervalos de 6 horas ao longo de 24 horas, representando 2 preamares e 2 baixa-mares. Os dois ambientes foram delimitados em estações no manguezal (M1, M2, M3 e M4, da Baía de Tamandaré para o interior dos manguezais, respectivamente), e estações nos recifes (R1, R2, R3 e R4, começando da "Área Fechada" até os recifes próximos da área urbana de Tamandaré). Estações entre a praia e os recifes também foram delimitadas (C1 e C2). Uma amostra foi feita na foz do Rio Maceió (área urbana de Tamandaré). As amostras foram conservadas imediatamente após coleta com formol a 4%, mais água do mar. Os parâmetros ambientais analisados foram nutrientes, temperatura, oxigênio dissolvido e salinidade. Em laboratório análise das amostras se deu em microscópio, e a identificação dos organismos foi realizada até o nivél de espécie, considerando-se a menor unidade possível de se identificar. Sub-amostras foram realizadas para contagem dos organismos, e algumas amostras foram contadas em seu volume total, devido a escassez de material biológico. Durante o período chuvoso a salinidade chegou a cair de 35 (dezembro-janeiro, período seco) para 0 PSU na área de manguezal. Na área recifal a salinidade se mostrou constante (em torno dos 34 PSU). Temperatura variou de 24 a 29°C nos ambientes estudados. Durante o período chuvoso a temperatura se manteve entre 24 a 27°C. Oxigênio dissolvido variou entre 5.73 mg $O_2.L^{-1}$ na área recifal a 0.42 mg $O_2.L^{-1}$ em uma estação no manguezal. Os mais altos valores de densidades zooplanctônicas foram registrados durante o período seco. Contudo, em uma escala espacial, a estação chuvosa nao parece ser favorável para a produção zooplanctônica nas estações nos rios (no caso da área de manguezal). Entretanto, a produtividade zooplanctônica foi alta nos dois períodos estudados. Copepoda e naúplios de Copepoda foram os grupos dominantes, representando cerca de 80 % da densidade total na área de manguezal, 70% e 60% da densidade total nas áreas não urbanizada e urbanizada de Tamandaré, respectivamente. *Oithona hebes*, *Oithona nana*, *Oithona oswaldocruzi* e *Parvocalanus crassirostris* foram os mais abundantes e dominantes taxa. Grupos holoplanctônicos dominaram as amostras em cerca de 90% do total. Outros importantes grupos, e que ocorreram com frequência foram Foraminifera, Tintinnina, larvas e ovos de peixes, além de outros Crustacea e larvas de moluscos. Abundância e distribuição espacial do zooplanctôn foram analisados em dois setores da área recifal, assim como da área de manguezal; sub-sistemas foram delimitados e as interações entre eles explicitadas. Bioindicadores de impactos antrópicos (Rotifera and Nematoda) foram amplamente encontrados na área urbanizada de Tamandaré, onde as concentrações de nutrientes foram em geral muito altas. Isso é uma indicação de poluição orgânica na área, através do rio Maceió. Este rio apresenta altas densidades de Rotifera e Nematoda, e somente larva de Polychaeta, *Oithona hebes* e naúplios de Copepoda foram também encontrados na amostra. Este fato sugere que o recife em frente da área urbanizada de Tamandaré é um "setor impactado" do sistema recifal. A área de manguezal é uma importante fonte de organismos com origem estuarina/mangual para a produtividade da área recifal. Os índices de diversidade para a comunidade recifal e mangual foram altos, e os valores de eqüitabilidade foram em geral eqüitativos.

Figures

Tables

Appendix

1 Introduction

1.1 Statement of the problem

Coral Reefs, in their entirety, constitute the very foundation of immensely complex marine coastal communities, being one of the most productive marine ecosystems (New, 1995). They protect many low-lying shores from erosion, support fisheries, and favor tourism (Karlson, 1999). It has been estimated that 5% of all described species on earth occur on tropical coral reefs (Goreau *et al*., 1971; Reaka-Kudla, 1995; Putten 2000; Henderson, 2001).

However, reefs do not stand alone. They have close ecological linkages to other shallow-water tropical marine systems (Hatcher *et al*., 1989). Often nearby shores are mangrove lined, preventing coastal erosion and consequent silting of adjacent reefs. Mangrove areas and estuaries are nurseries for some fishes and crustaceans that are found on coral reefs as adults (Odum, 1969).

One of the most significant tropical wet ecosystems are mangrove forests, mainly which respect to productivity and as nursery. Mangroves are less species-rich than coral reefs, but they are also very productive and important for coastal protection as well as fish and crustacean reproduction (Hamilton & Snadeker, 1984).

In some cases there is a close relationship between coral reefs and mangroves at times: mangroves prevent nutrients and sediments from reaching the corals growing in deeper waters and, the latter protect the mangrove forests from erosion by surf from the open sea (Wilkinson & Buddemeier, 1994). Energy flows between these habitats in the form of animal movements. Some reef fishes and crustaceans may be among those that use mangrove habitats as nursery areas, and fishes and invertebrates move between reefs and mangroves, as between seagrass beds and mangroves (Hogarth, 1999). Individuals might migrate periodically to feed, or use the mangrove environment as a refuge from predators; or the mangal might provide a key habitat for certain stages of the life cycle. Species may also alternate between mangrove and other habitats at different stages of their life cycle (Epifanio, 1988). Zooplankton and a great number of larvae could be exported from mangroves to off-shore area, and also adjacent coral reefs (Schwamborn, 1997; Schwamborn *et al.*, 2001).

Coastal environments, as coral reefs and mangroves, support many of the world's most naturally productive and biologically diverse ecosystems, produce most of the world's fish catch, and support innumerable water-dependent and water-enhanced industries and activities. For these reasons, people are attracted to the coast, and worldwide coastal populations are expected to double by 2050 (Wilkinson, 2002). Some two-thirds of the Earth's population are living within 50 miles of the sea; nine of the world's 10 largest cities are in tropical countries, and in coastal zones; and coastal populations are growing faster than the global population as a whole (Vitousek, 1997). Approximately 80% of the world's largest cities are in developing countries, and several of the largest mega-cities in developing countries will reach or be close to 20 million inhabitants by the year 2010 (Henderson, 2001). Population growth and the developmental pressure connected with it, have resulted in environmental degradation, and overuse of natural resources.

Land-based sources of marine pollution pose some of the greatest threats to coral reefs because of their widespread impact on water quality. Accounting for 80% of all marine pollution, land-based sources of marine pollution include coastal development, agricultural practices, industrial activities, and inland deforestation. The growth of coastal cities, towns, tourist resorts, and industries, along the coast generates a range of direct and indirect threats to nearby reefs (Öhman, 1993). In fact, the coral reefs become ever more popular sites for tourist activities. However, evaluations on ecosystem damages by tourism and urban expansion are still scarce (Viles & Spencer, 1995).

Coastal problems also include beach pollution, shoreline erosion, coastal flooding and the reduction of biodiversity in mangroves and coral reefs. These factors have ecological, economic, and social dimensions. In simple terms, we can regard coastal problems as resulting from "stress" on "coastal systems". The way that people interact with, and use, the coast has important consequences for the nature of coastal problems. There is a huge range of human activities along the world's coastline, but in general terms these tend to produce relatively localized coastal problems. All the biotics and abiotics components of coastal ecosystems are in a fragile balance, controlled by physical and biological processes which can easily be upset by human-induced pertubations. Damage to one system may affect others, and sadly reef and mangrove systems are rapidly lost, and both these ecosystems have been seriously reduced in extent (Viles & Spencer, 1995).

Globally, 58% of all reefs were found to be threatened by human activity, with 30% classified as threatened by coastal development and 22% by inland pollution and erosion. In the Caribbean and Atlantic Ocean almost two-thirds of the reefs are at risk, with four of the five major threats from land-based sources of pollution (Wilkinson, 2002), and the mangroves are being destroyed by many of the same activities that threaten coral reefs and seagrasses (Talbot, 1995; Wilkei, 1995). Without mangroves too much chemical fertilizers, herbicides and pesticides could be very toxic to coral reefs (Viles & Spencer, 1995; Epstein & Rapport, 1996).

Indirect effects of development are often the most damaging and widespread, including loss of coastal water quality and increased nutrient and sediment run-off into coral ecosystems. On a worldwide scale, only a fraction of the total domestic waste receives proper treatment, and disposal and ultimately is deposited untreated in coastal waters. Nutrient-rich run-off from improperly treated sewage, agriculture, and mariculture increases the growth of algae, which can overgrow corals. Industrial effluents and agricultural and urban run-offs can pollute coastal waters, poisoning reef communities. Shoreline construction and upland activities increase soil run-off, which can also harm corals (Öhman, 1993). Threats to coral reefs from coastal development are also exacerbated by the loss of coastal wetlands, particularly mangrove forests, which serve as buffer zones that absorb excess nutrients, sediments, and pollutants from coastal run-off (Wilkinson, 2002).

One way to assess the environmental situation in coastal areas in tropical countries is to study two important ecosystems: coral reefs and mangrove forests. In addition, the great richness in species diversity in tropical coastal areas is often tied to these ecosystems, and the basis of all conservation measures is a comprehensive inventory and assessment of biodiversity (Barrett & Rosenberg, 1981; Chapin, 1998, 2000).

In Latin America, the comprehension of the organizational patterns, the behavior and function, and the rapidly changing nature of coastal marine ecosystems is still lagging behind and, without the pertinent knowledge, sustainable management of ecosystem resources is in jeopardy (Hallock *et al.*, 1993).

Brazil is the land of South America with larger environmental problems (Leão, 1994). According to the latest Brazilian census in 2000 (IBGE, 2000), the northeast coastal area of Brazil (from Rio Grande do Norte State to Bahia State), which is bordered by sandstone reefs (with great coral diversity), has a population of almost 17 million people, with an estimated increase of 9 million people until 2010. As a result of such growth in population and development on the Brazilian coast, among other factors, coastal environments are coming under increasing pressure, and the consequences could include damaged coastal economies, pollution, increased frequency and virulence of harmful algal blooms, dead zones off major river mouths, human health concerns, and diseases of marine organisms (Pernetta & Milliman, 1995; Vitousek, 1997). Human activities that affect the Brazilian reefs and mangroves are the same as those that threaten coral reefs and mangroves elsewhere in the world (Maida & Ferreira, 1997), from land use practices that contribute to sedimentation (including mangrove deforestation) to uncontrolled tourism, that growth with an average annual rate of 5.5% worldwide (BFN, 1997).

The reefs around large cities in Brazil, such as the state capitals, have become depauperate as a result of domestic pollution and other human activities. Due to the proximity, most of the coastal reefs are heavily exploited by both artisanal and commercial fisheries. As a result of the environmental stress, the Brazilian reef systems have become progressively degraded. A major factor contributing to ecological degradation is extensive physical restructuring in the coastal area, which includes loss of mangrove and rain forest habitats, and nutrient enrichment due to run-off from farming and human settlements (Maida & Ferreira, 1997). In coastal reefs, eutrophication has primarily anthropogenic causes resulting directly from population growth and development (Hallock *et al.*, 1993).

Damage due to poor land use practices likely started with European colonization, beginning 500 years ago. The flow of sediment into the coastal sea increased significantly due to the growing erosion of coastal areas, caused by the clearing of the Atlantic rain forest for timber exploration and sugarcane plantations (Leão *et al.*, 1988; Leão, 1994;). The Northeastern Brazilian coast, particularly the Ceará, Rio Gande do Norte, Pernambuco, and Bahia States, witnessed rapid economic growth during the last two decades pushed by irrigated agriculture, intensive aquaculture and tourism (Leão *et al.*, 1994), also leading to increased urbanization of a formerly rural population and migration to the coast, where population density reaches 108 inhabitants.km^{-2} (MMA, 1996). At the present time, sugarcane plantations form a 60 km wide and almost 1000 km long belt. This extensive monoculture is located only a few kilometers inland along the northeast coast where the coastal reefs are most numerous. Sedimentation and agricultural pollution originating from these plantations probably are the major factors producing the reef degradation observed in Brazil. The fluvial inputs provide a major source of nutrients for many coastal ecosystems. Manipulation of both river water quality and quantity may be the major ways in which human activity can influence coastal processes (Viles & Spencer, 1995). The rivers that drain along the Pernambuco State coast have signs of ecological disturbance (Braga, 1992; Farias, 2002). They receive all the types of discharges from the agriculture and industry, as well as domestic wastes, and the mangrove forests destruction in Brazil (mainly in Pernambuco State) has resulted in the loss of important environmental and economic functions and products (Neumann-Leitão, 1986). The major threats to mangroves from Pernambuco State is the rapidly increasing urban expansion (Porto Neto, 1998, 1999; Porto Neto *et al*. 2000).

Marine ecosystems may be the major capital asset in some parts of the Brazilian coast. At Tamandaré Bay area (south coast of Pernambuco State), evidence of collapse of the fisheries, the increasing pollution by relentlessly expanding coastal populations, decline of reefs and mangroves, and tourist activities have raised alarm and pointed to the need for priorities in research, management, and conservation (Porto Neto, 1995, 1999). Moreover, in the coastal reef zone there are many tourist attractiveness, and a great fisher colony. The waters of Tamandaré Bay are at risk, as a result of the destruction of mangrove trees along rivers that flow into the Atlantic (Porto Neto, 1999). The trees from adjacent mangroves and the native Atlantic rain forest were cut to provide space for tourism development. Increasing development of land immediately adjacent to coral reefs, often promoted by tourism, is also a growing threat to the health of many reef ecosystems (Viles & Spencer, 1995; Maida & Ferreira, 1997). There is no information regarding the role of eutrophication and no published literature addressing the problem of nutrient enrichment in the Tamandaré reef system (Porto Neto, 1999).

Intense touristic activity and urban expansion at Tamandaré area are more intense close to Campas Beach, where tourism activities include the transportation of people by motor boats over the reefs, breaking the fragile structures (Figure 1-A), besides litter discharge (cans, plastic glasses, bags, dishes, etc.). In addition, domestic wastes from Tamandaré City comes to the reef area, and coliform contamination in this area tends to be high (CPRH, 2002). The Maceió River becomes a major source of organic pollution into the reef area (Figure 1-B and Figure 2). Moreover, garbage is accumulated in the coastal areas (promoted mainly by tourist activities), and the garbage represents danger for the reefs (Figure 1-C). Garbage is also brought to the beaches (and to the reefs) through marine currents, after they habe been drained by rivers into the sea (Figure 1-D).

The environmental pressures due to the urbanization process and the increasing installation of tourist equipment causes environmental degradation, exceeding the capacity of the ecosystem to absorb impacts. The exact nature of reef response to the stresses in Tamandaré beach is until now unknown (Porto Neto *et al*., 1999). Management and conservation schemes have been designed to ensure that human stresses are kept to minimum levels (Maida & Ferreira, 1997).

The Tamandaré reef-complex is inserted in one "Area of Environmental Protection" (A.E.P.), created by the Brazilian Federal Government in 23.10.1997 (International Year of the Reefs). This is the first national conservation area for coastal coral reefs of Northeastern Brazil, and was defined between the cities of Recife (Pernambuco State) and Maceió (Alagoas State). The Tamandaré-Paripueira reef system is an A.E.P., called *"Costa dos Corais*'' (Coral Shore A.E.P.), that covers 413 ha (from 33 m on land to 33 km offshore), and embraces 10 municipal districts between Pernambuco and Alagoas States (Figure 3). It is considered to be the largest federal unit for marine area of conservation in Brazil. The local communities of 130 thousand people rely on sporadic work in tourism and agriculture, and exploitation of the reef resources. The traditional and subsistence fishery is intense, targeting a large variety of fishes, lobsters and octopuses, with an average daily catch of 2 kg (Wilkinson, 2002).

Their initial tasks involved environmental assessments to characterise the coral reefs through mapping, biodiversity evaluation, fisheries assessment, population assessments of important species, as well as socioeconomic assessment. In addition to subsistence fishing, there is the commercial capture of prawns, lobster and reef and pelagic fishes. However, the reefs have been damaged through poor land use practices that increase sedimentation, domestic and agricultural pollution, overexploitation of reef resources, uncontrolled tourism and urban development. Coral mining had been intense until the 1980s, when it was banned throughout Brazil (Maida & Ferreira, 1997).

The "Coral Shore" is a multiple use A.E.P., that permits subsistence and commercial activities. However, Fully Protected Zones ("Closed Areas") were included in 1998, and preliminary results indicate significant increases in exploitable resources, and spill over effects, with increased catches in adjacent areas (Maida & Ferreira, 1997).

These are being monitored with the help of fishers, and hopefully will encourage the communities to support the protected area as a management tool, both for tourism and fisheries.

Figure 1: A - Tourist overload in the Tamandaré reefs;
B - Amount of domestic wastes and garbage in the Maceió River;
C - Little bark of garbage (red box) at Tamandaré area, and the total of garbage accumulated after a typical summer day;
D - Example of garbage brought to the beach through rivers and marine currents.

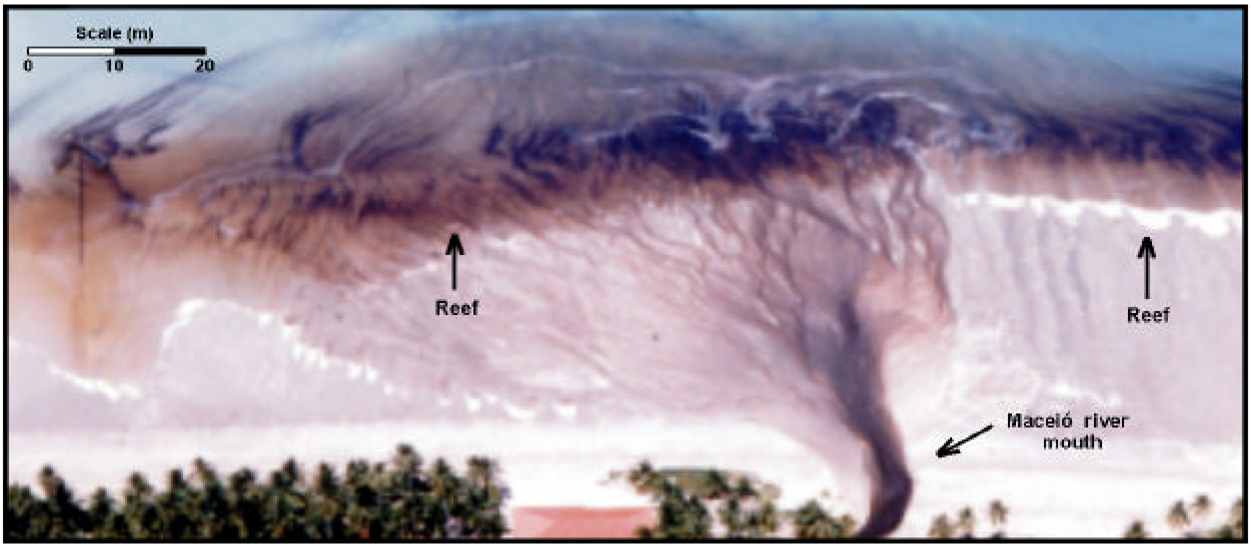


Figure 2: Aerial view from Maceió River mouth, showing discharge of domestic wastes (dark waters) into the reef area.

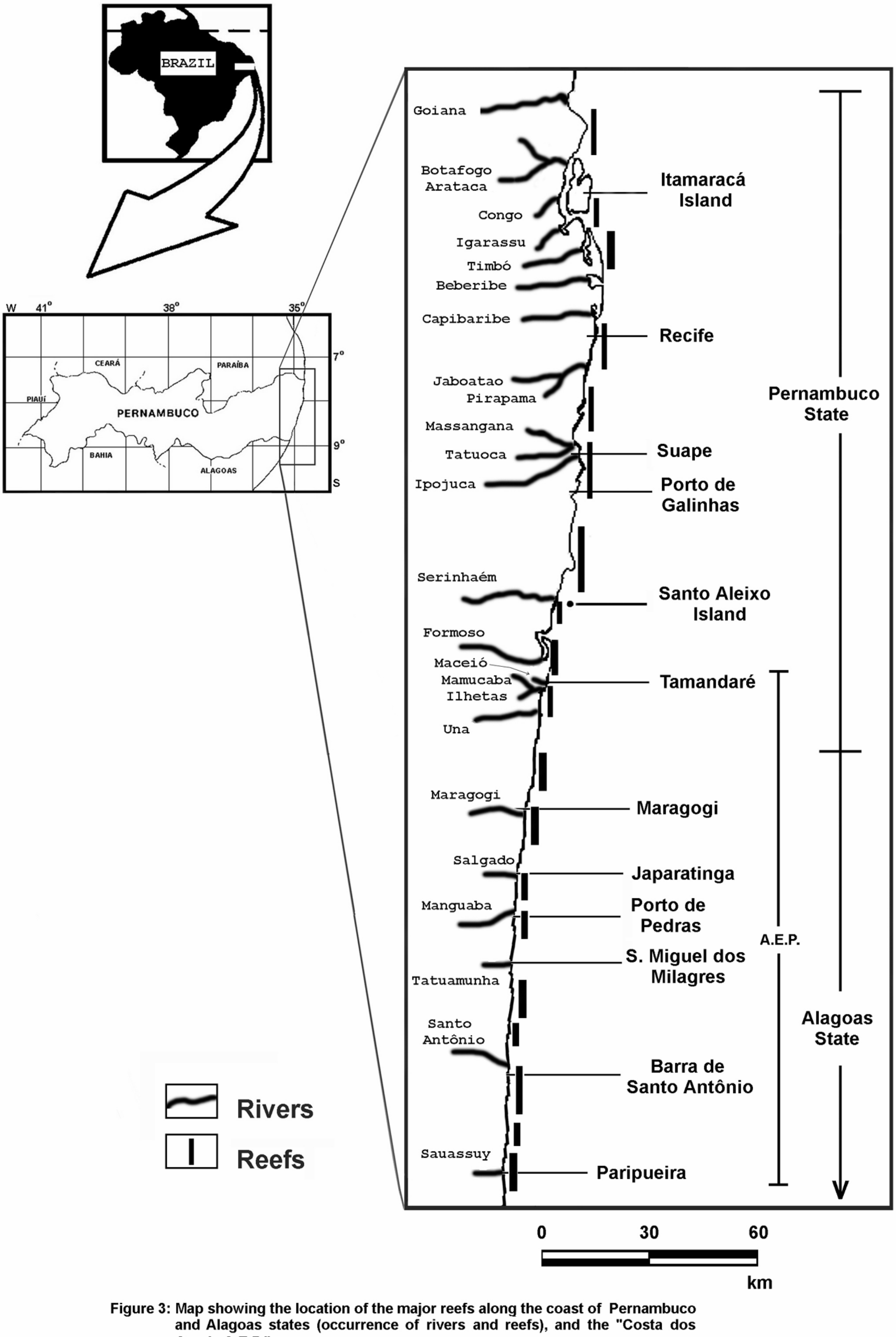


Figure 3: Map showing the location of the major reefs along the coast of Pernambuco and Alagoas states (occurrence of rivers and reefs), and the "Costa dos Corais A.E.P."

The establishment of "areas of environmental protection" is seen as the best possibility for preserving particularly valuable species and ecosystems (*in-situ* protection). The existence of a "Closed Area" on Tamandaré coasts is, first of all, an indication that particularly valuable ecosystems exist there, but also a reaction to a potential threat.

1.2 Zooplankton and disturbance assessment

Some aquatic organisms, both plants and animals, are valuable indicators of pollution in aquatic systems. However, changes in communities of macro-organisms are often observed too late to reverse (*e.g*. fish and coral mortality). In comparison, micro-organisms possess morphological, physiological and genetic characteristics making them very good "early warning indicators" for environmental problems. They can to signal negative environmental changes, when these environmental changes could still be reversed (Bianchi & Colwell, 1985; Jones & Kaly, 1996).

The importance of micro- and macro-invertebrates as indicators of water conditions has been the basis of large amount of hydrobiological works during the last half century. Pollution zones were demarcated and have been analysed for physical, chemical and biological data. Valid conclusions have been drawn from such surveys whereby it has been possible to correlate the fauna and flora with the chemical nature of waters (Sladecek, 1973). Physical and chemical analyses have certain disadvantages: they involve long drawn out processes and may stretch over a number of days; the physical and chemical characteristics of clean water vary a great deal so that it is difficult to precise them down to a simple standard and hence it becomes difficult to proclaim a water healthy merely on the basis of chemical analysis; and a simple chemical constituent never acts independently as a limiting factor but it is the interaction of many factors that constitutes an environment (Karr, 1996).

The way in which physical and biological events interact to control the distribution and abundance of aquatic organisms has been reviewed by a number of authors (*e.g*. Angel, 1977; Tett & Eduards, 1984; Mackas *et al*., 1985). Legendre & Demers (1984) have also surveyed the literature and pointed out that most studies: "...*recognize hydrodynamics as the driving force of aquatic ecosystems, so that the various physical, chemical, and biological factors of the environment are considered as the proximal agents through which hydrodynamic variability is transmitted to living organisms*." Indeed, Risk *et al*. (1994) and Edinger & Risk (1999) have argued that reef monitoring programs are most effectively designed as a combination of “sciences", with biomonitoring techniques used to detect ecologically-relevant stresses (presence of bioindicators) to the reef, followed by geochemical analytical techniques to determine the exact stressor(s). Habitat characterization measurements will also be critical in diagnosing specific causes of degradation. These measurements include but are not limited to: habitat type, watershed land use, population density, pollution discharges, salinity, dissolved oxygen, temperature, nutrients, depth, and sediment grain size (Gibson *et al*., 1997).

Bioindicators are organisms (or groups of organisms) that characterize special conditions of an ecosystem, and indicate natural modifications, or induced modifications (New, 1995). Some species may contribute disproportionately to the structure and dynamics of the ecosystem. The identification of these species may provide an indicator of ecosystem health, and an early warning to implement intensive conservation efforts in advance of a collapse (Paine, 1966; Chapin, 1998, 2000). However, the notion of "indicatory species" is a little more complex. They could not depend only of one single factor, but a whole set of factors defined by global situation of a ecosystem. Obviously, collections of abiotic data are very useful in the studies of bioindication (Pourriot, 1976).

Results of "bio-indication approaches" should also include a taxonomically-diverse group of indicator organisms, that shows a unique response to several different broad categories of stressors, as well as a select few organisms which are able to detect specific stresses of particular concern to individual monitoring programs (Karr, 1991, 1996). For example: specific bioindicators of nutrient enhancement, *e.g*. Foraminiferida and Rotifera (Arora, 1966), and specific bioindicators of organic pollution, *e.g*. Nematoda and Polychaeta (Amjad & Gray, 1983), as organic nutrients throughout fluvial drainage, *e.g*. Rotifera (Arora, 1966). However, analysis of regional human activity (as tourism, urban expansion, agriculture, and sewage) in the adjacent terrestrial seascape/landscape will more likely be associated with changes in biological condition than a few narrow chemical parameters (Karr, 1996).

Biological indicators are therefore more dependable and have earned their place in the assessment of water quality. The following considerations are essential and must thoroughly be checked before a water is declared polluted on the basis of biological complex (Arora, 1966):

- the presence of organisms indicating pollution;
- regional abundance of individuals of such forms;
- presence of species that are adapted to live in depleted oxygen conditions of water;
- absence of clean-water species or presence of them in limited numbers;
- presence of species that are adapted to live in increasing nutrients conditions;

Zooplankton as bioindicators is very convenient in providing ecological indices. In aquatic environments, their small size favors their distribution by currents facilitating the recognition of environmental problems, also in adjacent areas (Bianchi & Colwell, 1985). Population size, rather than occurrence becomes a key factor (Krivolutzky, 1985). Due to short life cycles, the zooplankton can quickly respond to environmental modifications, being a excellent key group (Arora, 1966; Green, 1968; Day Jr. *et al*., 1989; Boltovoskoy, 1981, 1999). Zooplankton distributions and regional abundance can serve as indicators of the time and space scales of density- and wind-driven currents, as well as currents associated with tides, internal waves, and estuarine circulation (Allan, 1976; Haury & Pieper, 1988).

Boltovskoy (1986) has expanded on this attempt to discriminate different types of indicator, when using zooplanktonic species. He defines two classes of indicators:

1- *Biological tracers*: are species whose presence in an area would indicate transport by water movement; these species should be restricted to single water masses, but still be able to survive for a period of time when they are dislocated into regions of environmental change.

2- *Biological sensors*: are species that is restricted to a single water mass and is not tolerant of changing environmental conditions.

Although their application can be strongly interrelated, the desired characteristics of each can be very different.

Moreover, advantages of zooplankton sampling (for bioindication approaches) are similar to phytoplankton and include the following (Gibson *et al*., 1997):

. The rapid turnover of the assemblage provides a quick response indicator to water quality perturbation. The challenge will be to sort out the rapid turnover due to human influences from the rapid and normal seasonal turnover in species composition and abundances;

. Sampling equipment is inexpensive and easily used;

. Compared to phytoplankton, sorting and identification is fairly easy;

Reef plankton is composed of hundreds of species, many of which are undescribed, and probably many more remain undiscovered. At present, the planktonic community from the Brazilian reefs is practically unknown, mainly the microzooplankton (Porto Neto, 1999; Porto Neto *et al*., 2000).

The effects of disturbance on reef organisms other than corals are poorly known, and zooplankton is no exception. The role of zooplankton in coral reef communities is not yet clear (Haury & Pieper, 1988; Roman *et al*., 1990). The energy contribution of planktonic organisms is very important (Alldregde & King, 1977), and in addition, the zooplankton represents a significant part of the diet for various coral reef organisms. Their predators are reef fishes, larger crustaceans or filter feeders that are associated with the coral habitat, like mussels or sessile worms and of course corals. Up to 17% of the total coral metabolic requirements may be covered by predation on zooplankton compared to about 71% from primary production by the symbiotic algae within the coral and 12% from absorption of dissolved organic matter present in the seawater (Robichaux *et al*., 1981).

Most coral reef species also have planktonic larvae (meroplankton), many of which may drift for weeks before settling far (perhaps hundreds of kilometers) from the parental site. Thus, a gross human-induced impact on one reef may have an effect on distant reefs. The different ecological processes is until now unknown, and is of great importance to reef conservation (Smith, 1978). The meroplankton are much more diverse than the holoplankton and consist of the larvae of polychaetes, barnacles, molluscs, bryozoans, echinoderms, and tunicates as well as the eggs, larvae, and young of crustaceans and fishes. Zooplankton populations are subject to extensive seasonal fluctuations reflecting hydrologic processes, recruitment, food sources, temperature, and predation. They have considerable importance as early indicators of trophic shifts in the aquatic system (Gibson *et al*., 1997).

According to Porter & Porter (1977), the reef zooplankton forms a specific community, which differs from the zooplankton populations of the surrounding pelagic areas of open ocean in species composition, behavior and abundance. On the microscale, corals are well adapted to hunt small zooplankton using their arms and their sting cells. Many organisms of the reef community other than corals are active and passive filter-feeders, which concentrate both plankton and dead particulate organic matter (Karlson, 1999).

Numerous species often share limited areas or volumes (in the case of plankton) of habitat. The residents also interact within the shared environment, killing, eating, excluding, facilitating and breeding. When observable properties of mixed species populations, or characteristics of the seascape, are being described, studies of community structure are very important (Paine, 1994).

A large number of estuarine zooplankton species may be widely spread in the reefs, and they may also be subject to highly variable recruitment. Without a thorough understanding of the mechanisms and conditions underlying negative interactions between the ecosytems and human activities, it is unlikely that we will be able to develop effective strategies for ecosystem management to meet the challenges posed by global change, and finally it is important to acknowledge that the value of nature to human society might be even more fundamental (Norse, 1993).

The old vision of the reefs as "energy self-sustainable" ecosystems, that occur in oligotrophic waters with low environmental variations (Odum & Odum, 1955), are being reviewed through new scientific researches. At present, is recognized that a great part of the reef zooplanktonic population cames from external sources, located in the surrounding waters (Russ, 1984; Munro & Williams, 1985; Hammer *et al*., 1988; Sorokin, 1990).

Among the communities associated with coral reefs and mangroves, the zooplankton community has fundamental importance, serving as a link between phytoplankton and many carnivorous species, including several crustaceans and fishes of commercial interest; zooplankton also regulates the phytoplankton populations through the "grazing" (Stoecker & Evans, 1985). Directly or indirectly, the planktonic resources are used as part of the coastal communities alimentary diet. A great number of nectonic and benthonic organisms spend part of their life cycle as planktonic larvae, influencing the future adult populations (Allan, 1976). The zooplankton also has great importance for the nutrient cycle (Vourinen & Ranta, 1987).

Moreover, the reef zooplankton is a component of the reef community, which uses reef resources and is included in the trophic reef relationships. A main specific feature of the reef zooplankton, which differentiates it from the zooplankton of the open ocean, is the domination of the populations by species connected with benthic biotopes. If one of the coral reef resources is changed, the hole ecosystem tends to self modify (Sorokin, 1990).

The study of ecological aspects of the reef zooplankton has been facilitated due to the recognition of an "endemic zooplankton" belonging to the reef (Emery 1968; Ohlhorst 1982). Abundance and seasonality of reef zooplankton have been associated with physical changes of the environment (Mc Williams *et al*., 1981), biomass and morphological characteristics of the reef (Lefevre, 1984), precipitation (Glynn, 1973), patchiness of Copepoda (Moore & Sanders, 1976), differences in the substrate composition (Alldregde & King, 1977; Porter & Porter, 1977; Birkeland & Smally, 1981), lunar periodicity (Alldregde & King, 1980), and predation (Alldregde & King, 1985). However, informations concerning the horizontal patterns and the importance as bioindicators, also the influence from mangroves and fresh water, are scarce (Sale *et al*., 1978). In spite of this scarcity, some studies have demonstrated the importance of the zooplanktonic net in relation to the reef, and the difference in abundance, composition and behaviour between near- reef and open-reef communities (Ferraris, 1982; Echelman & Fishelson, 1990). At Tamadaré area only little is known about the zooplanktonic species present and their population sizes. Only a few researches were made between 1981 and 2000 at Tamandaré area (*e.g*. Santana-Barreto *et al*., 1981; Santana-Barreto, 1986; Santana-Barreto & Moura, 1986; Nascimento-Vieira, 2000). However, there are no researches about the ecological processes that shape the reef zooplanktonic communities, and about the microzooplankton (Porto Neto, 1999; Porto Neto *et al*., 2000; Nascimento-Vieira, 2000.

From the obvious abundance of planktivorous animals in coral-reef communities, could be deduced that plankton must be an important component of the reef ecosystem. Among the reef animals feeding on plankton there are numerous planktonic and benthic feeding invertebrates (including corals themselves), benthic deposit feeders, abundant populations of planktivorous fishes, and all fish larvae. Still, the reef plankton has been studied less than the plankton of the open oceanic waters (Sorokin, 1990).

Planktonic organisms, as rotifers, can be reliably used as continuous indicators for the evaluation of physical processes (Arora, 1966; Ruttner-Kolsko 1971; Bratkovich, 1988; Neumann-Leitão & Matsumura-Tundisi, 1988; Gallegos & Dolan, 1992; Espino *et al.*, 2000). The role of Rotifera in impacted areas has received very little attention, probably because of their low numbers relative to the Protozoa (Liebmann, 1962). Yet their biology, their opportunistic exploitation of a suitable environment and their relative inability to respond even to small environmental changes, make them ideal indicator species (Arora, 1966; Ruttner-Kolisko, 1971, 1972). This group is therefore particularly well suited to survive in transient environments, and their contribution to the overall balance of an ecosystem cannot be overlooked (Doohan, 1975). But not only the notion of presence-abundance ("static notion") provide an environmental indication. The abundance of Rotifera species must be not neglectful (Pourriot, 1976). The knowledge of populational dynamics of Rotifera provides some precise indications, that alone can not make an instantaneous view of the ecosystem, being necessary complementary environmental informations of the study area (Pourriot, 1965; Bezinš & Pejler, 1989).

The predominant Rotifera family of Monogononta in waters with high levels of organic pollution (as sewage) is the Brachionidae, particularly the genus *Brachionus*, which contributes five of the seven species recorded from this family. *Brachionus* together with the genus *Lecane* are very found in activaded sludge, where there is a substantial amount of suspended material and detritus. Monogonont rotifers can reach remarkable densities in eutrophic waters (Starkweather, 1996), and counts of thousands of individuals per liter are not uncommon under eutrophic conditions (Starkweather, 1987). The nature of the available food material may also play some part in restricting the distribution of Rotifera. *Brachionus* can survive on bacteria alone, but this genus and the genus *Lecane* are largely detritivores, feeding on suspended and flocculated organic matter (Doohan, 1975).

Moreover, some organisms of the meroplankton (or not planktonic, but frequently found in plankton samples), that appear in unhealthy communities with high densities (such as nereid polychaete larvae), often appear to indicate polluted conditions in marine soft sediments, where the water quality is also certainly low (Henrikkson, 1969; Grassle & Grassle, 1974; Rodrigues Capítulo *et al*., 1997).

Also, it has been suggested that Nematoda and Copepoda exhibit differential survivorship in polluted and unpolluted areas, with nematodes favoring polluted areas (Jones & Kaly, 1996). Raffaeli & Mason (1981), Amjad & Gray (1983), and Platt *et al.*, (1984) used the Nematoda/Copepoda ratio as an indicator of pollution. Hence, these meiofaunal organisms (found too in plankton samples) may be important indicators in pollution studies (Platt *et al*., 1984; Jones & Kaly, 1996). Zullini (1976), reports that numbers of nematodes greatly increased at sites receiving not only sewage discharges, but also sites receiving heavy industrial pollution of several kinds, and Rodrigues Capítulo *et al*., (1997), suggests that Nematoda and Harpacticoida are associated with organic matter-rich sediments.

In general, the evaluation of zooplankton importance as bioindicators, their participation in the total reef ecosystem, and the estimation of major functional parameters of the main species are becoming an important new field in reef studies. The role of planktonic communities of the reef waters as one of the most important functional components of reef ecosystems becomes more and more obvious (Sorokin, 1990).

1.3 Focus, Objectives, Research Frame and Relevance

This study is embedded in the bilateral co-operation program "*Management of the reef coastal system from Tamandaré (Pernambuco State) to Paripueira (Alagoas State)*" between the Department of Oceanography of the Federal University of Pernambuco (DO/UFPE) in Recife (Brazil) and the Brazilian Environmental Ministry through IBAMA (Brazilian Institute for Environment and Natural Resources), and the Center for Tropical Marine Ecology (ZMT) in Bremen (Germany). The objective of this program is to establish a continuous coastal management to preserve the marine resources, objectifying the sustainable use of the reefs and biodiversity conservation.

The main objective of this work is identify bioindicators of environmental stress at Tamandaré reefs, in face of the anthropogenic physical-chemical influences, by using zooplanktonic indications. Moreover, this work intents to identify indicators of mangrove productivity at the reef area (positive influence), and the present study is based on the follow assumptions:

1) At present, Tamandaré City has about 12000 inhabitants only in the urban area (directly in the coast) and about 6000 in the rural area (IBGE, 2000). During the tourist summer season (December until March) the urban population in the Tamandaré City increases six times. The resulting human activities (mainly urban processes and tourism) in the coastal area of the Tamandaré City have increased strongly in the past 6 years. Mangroves and native rain forest areas are replaced by residences, hotels, harbours, and commercial facilities. Moreover, a small river in the middle of the Tamandaré City (Maceió River) has been used as a channel for dometic wastes (without treatment of it dilutes).

2) The sandstone lines of the Pernambuco coast run parallel to the shore (Mayal *et al.*, 2000), and they are interrupted irregularly in front of the estuaries of great and small rivers, with extensive mangroves (Figure 1). That proximity between reefs and mangrove systems could represent influences of a system in another. At Present, there are no publications or researches about the interactions between mangrove and reef ecosytems at Pernambuco State.

Based upon these assumptions, the following working hypothesis were developted (a schematical overview of the hypothesis is showed in the Figure 4):

. Hypothesis 1:

Antropogenic influences are perceptible in the zooplanktonic community of the reef area from Tamandaré City, and this negative impact can be recognized by the presence and abundance of some bioindicators, as exemple rotifers and nematods.

. Hypothesis 2:

The mangrove area (at south part of the Tamandaré Bay - Mamucaba and Ilhetas mangroves) has a positive influence in the zooplanktonic community of the adjacent reef area (in terms of zooplanktonic structure and abundance), been source of species and biomass.

To describe the zooplanktonic community and structure in the Tamandaré reef area, and to prove the two hypothesis formulated above, the following studies were carried out:

. Identification of the zooplanktonic species found at the reef and mangrove areas, and also their density, relative and regional abundances, frequency, and diversity.

. Description of the species composition, spatio-temporal density and species abundance pattern.

. Measurements of abiotic parameters (*e.g*. temperature, dissolved oxygen, salinity, nutrients).

Also, this research tries to answer the questions:

. how great is this anthropogenic impact at the reef area of Tamandaré City.

. how zooplankton responds to human influences.

. how effective is the protection promoted by the Fully Protected Zone ("Closed Area"), in terms of planktonic community.

The expected results can elucidate ecological aspects of the zooplanktonic community and offer conclusions to elaborate coming projects, and also promote better knowledge of the Tamandaré reef-complex area.

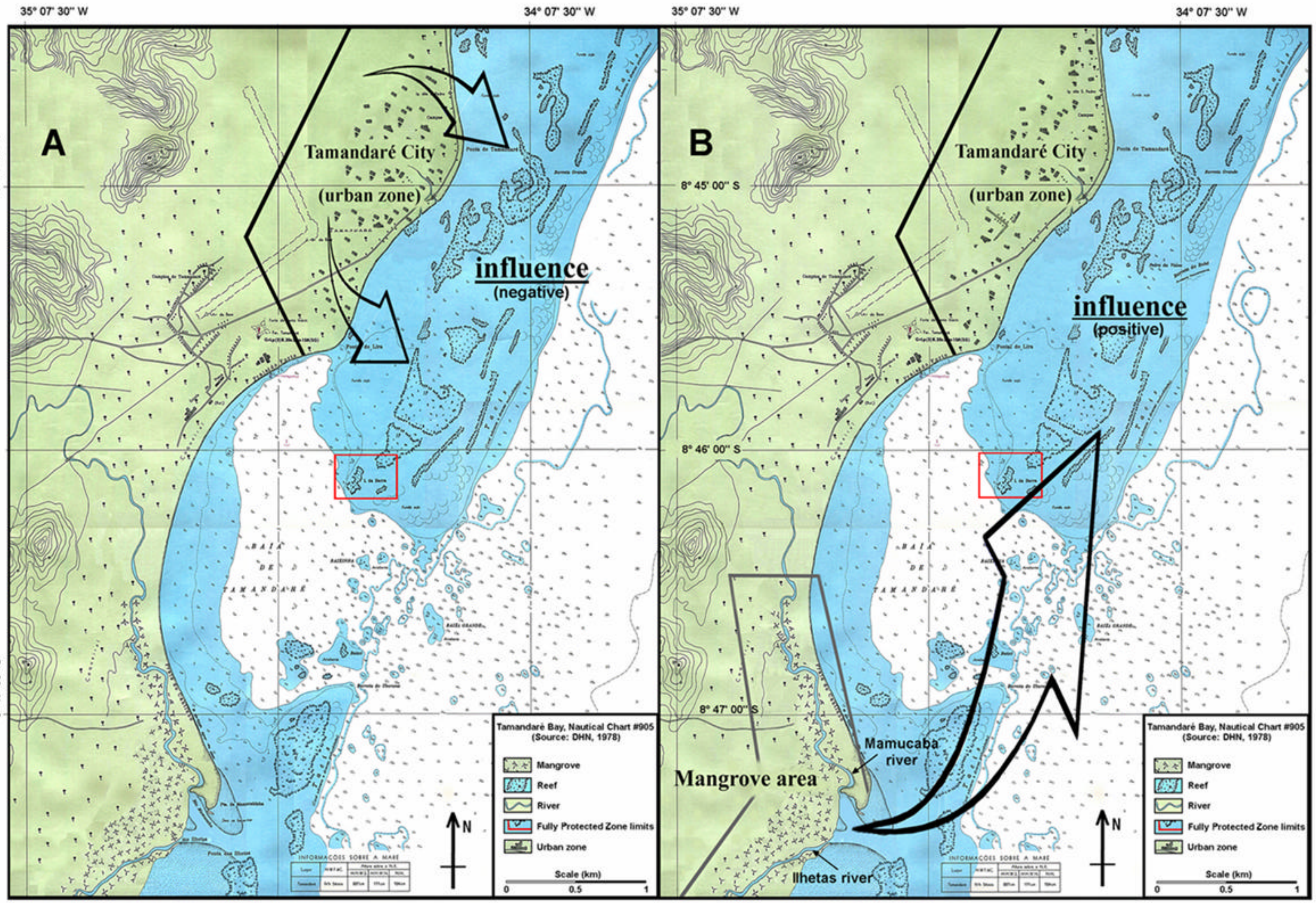


Figure 4: Schematical overview of the two hyphotesis (A: Hypothesis 1; B: Hypothesis 2).

2 Study area

The study area is located on the coastal area of the Tamandaré City, south part of the Pernambuco coast (08º 45’ - 08º 48’ S and 034º 07’ - 035º 07’ W), and about 110 km from Recife City (as shown in Figure 3).

The climate is tropical, hot and humid (Köppen Climate Classification System "As": "A" for tropical humid climates; "s" for dry season in summer, when 70% or more of annual precipitation falls in winter, according to Allaby, 2000). The mean annual air temperature is 24°C, with a maximum of 35°C and a minimum 0f 20°C. The annual rainfall at Tamandaré area is 1300 to 1800 mm (Maida & Ferreira, 1997), concentrated from March to August (the rainy season) (Andrade & Lins, 1971; CPRH & GERCO, 1999). Humidity is higher than 80% and prevailing winds are from southeast (Lira *et al*., 1979). Data of rainfall (measured for eleven years between 1991 to 2001) from the Meteorological Station of "Porto de Galinhas" (about of 40 km North of the Tamandaré City) shows that the years of 1998 and 1999 presented low rainfall (below of normal mean, that was 1830 mm). In the year of 1998 the total rainfall was 917.7 mm, and in 1999 was 917.2 mm. During the study period the monthly rainfall varied from 9.9 mm (November 98) to 212 mm (August 98). The year of 2000 showed high rainfall, 3449 mm, while in 2001 the rainfall was 1984 mm. The monthly mean for 2000 was 287 mm, and for 2001 was 165 mm.

2.1 The Pernambuco coast

Pernambuco State has a coast of 187 km length. This coast is part of the Atlantic Rain forest zone ("Zona da Mata"), and is characterized by coconut plantations, beaches, estuaries with extensive mangrove areas, seagrass beds, and sandstone reefs (Laborel, 1965a; Mabesoone, 1967). Reef and mangrove communities are often in close proximity or even together in Pernambuco State (Andel & Laborel, 1964; Laborel, 1965b; Coelho & Torres, 1982; Lira, 1975; Lira *et al*., 1979).

The sandstone lines are found along the whole coast of Pernambuco, running parallel to the shore. Typical for that coast is also the low altitude, with the appearance of estuaries (Andel & Laborel, 1964; Mabesoone & Coutinho, 1970). Darwin (1841), described the sandstone banks located in front of the city of Recife, which gives that city its name. The first detailed consideration about the Pernambuco reefs came from Branner (1904), being still a basis for later studies.

Pernambuco State is one of Brazilian states that has the smallest coastal extension. In face of this fact the estuarine areas are naturally reduced and they occupy about of 25000 ha, which 17372 ha are mangroves

(Coelho & Torres, 1982). At present, the loss of mangrove coverage in Pernambuco State is estimated in about of 45% (Porto Neto, 1998).

2.2 The Tamandaré Reef-complex and adjacent mangrove

The coastal region of Tamandaré is approximately 9 km long, divided in three bays: Tamandaré, Campas, and Carneiros Bay. Fringing reefs are arranged parallel to the actual coast line, forming fringing structures with shallow lagoons (up to 8 m deep) with reef pinnacles in the back reef. They can also be directly linked to the coast or separated by small lagoons. Four of the endemic Brazilian coral species are found in Tamandaré, *Mussimilia hispida*, *M. harti*, *Favia gravida* and *Siderastrea stellata*, as well as an endemic hydrocoral, *Millepora brasiliensis*. In the study area there are sandstone cords with horizontal stratification, on which corals are developed (Mayal & Amaral, 1990). The fringing reefs of Tamandaré are part of the 3000 km reef formation typical of Northeast Brazil (Maida & Ferreira, 1997). These reefs are characterized by a rich fauna, composed mainly of crustaceans, molluscs, echinoderms and fishes. Most of these organisms have a planktonic larval stage (meroplankton) and contribute to a higher zooplankton productivity at the reef area (Ferreira *et. al.*, 1995). The crustaceans and fishes contribute to the artesanal fisheries, with the highest catches rates of Pernambuco State (Coelho & Ramos-Porto, 1995). Ferreira *et al.* (1995) found 99 reef fish species only in the second reef line, mainly in the sheltered subaquatic caves, and including a lot of resident fishes.

The Tamandaré reef formations are arranged in three lines (Figure 5): the first line of reef (next to the beach) consists of shallow sandstone structures that are exposed at low tide. The second line reef is located in the sandy lagoon between the beach line and the seaward line (third) of emergent reefs. This reef line rises from depths between 1 and 8 m at different distances from the beachline. The third line forms a barrier line that is typical of the Tamandaré complex. This barrier reef formed from isolated columns, the tops of which expanded laterally and coalesced. This pattern of growth created a reef structure with a complex net of interconnected caves below (Maida & Ferreira, 1997).

Tourism (and vacation facilities) is an economic sector that is developing in an accelerated way in the Tamadaré area, having in the last years great real expansion (Porto Neto, 1999). Irreversible damage on Tamandaré coast is caused by those tourism facilities, such as hotel constructions for the "*Costa Dourada Project*" (Golden Coast Project), or small-boats marinas and harbors, directly on the beach (in front of the reef lines), and moreover promoting mangrove deforestation for urban facilities (Multiconsultoria, 1991, 1992). The environmental pressure due to the urbanization process and the increasing installation of tourist equipment causes environmental degradation, exceeding the capacity of the ecosystem to absorb impacts.

At the Southern part of the Tamandaré Bay, the Ilhetas and Mamucaba rivers running parallell to the coast (at their final course), and form a common river mouth called "*Boca da Barra*" ("Barra Mouth"), surrounded by mangroves (confluence of estuaries), as shown in Figures 4 and 5. These estuaries and mangroves are examples of environments with low level of human impact, because they do not receive discharges of industrial and domestic waste (Losada, 2000). They are a little far from the urban area of the Tamandaré City, and not explored by tourism agencies (access difficulties for cars and people).

The Ilhetas and Mamucaba are small rivers, and they are narrow in most part of their courses. According to Bivar (1977), the Mamucaba River shows a maximum width of 31 m. The Ilhetas river is a little wider than the Mamucaba River. At the estuarine area, these rivers have mean depths of 1.50 m (at high tide) and 0.40 m (at low tide).

The sediments are muddy, with a dark color. In the river margins there are a dense vegetation of mangroves, represented by *Rhizophora mangle* Linnaeus (red mangrove), *Laguncularia racemosa* Gaertn (white mangrove), and *Avicennia schaueriana* Stapf & Leichman (black mangrove), with a rich fauna of molluscs and crustaceans (Losada, 2000).

The Mamucaba River originates inside the National Park of Saltinho, located in the Rio Formoso City (about 16 km North of the Tamandaré Bay). This river has several rapids in the course (Lira *et al*., 1978; Moura, 1991). The Mamucaba River is dammed inside the National Park of Saltinho, to supply the Tamandaré City with drinking water (CONDEPE, 1992). That river has the best drinkable water quality of the Pernambuco State (IBAMA, 1989; CPRH & GERCO, 1999). Ilhetas river origin is inside the city of Barreiros (6 km west of the Tamandaré Bay). This river is 9 km long, and the estuarine area is flat and inundated, fringed by mangroves at the margins (Losada, 2000).

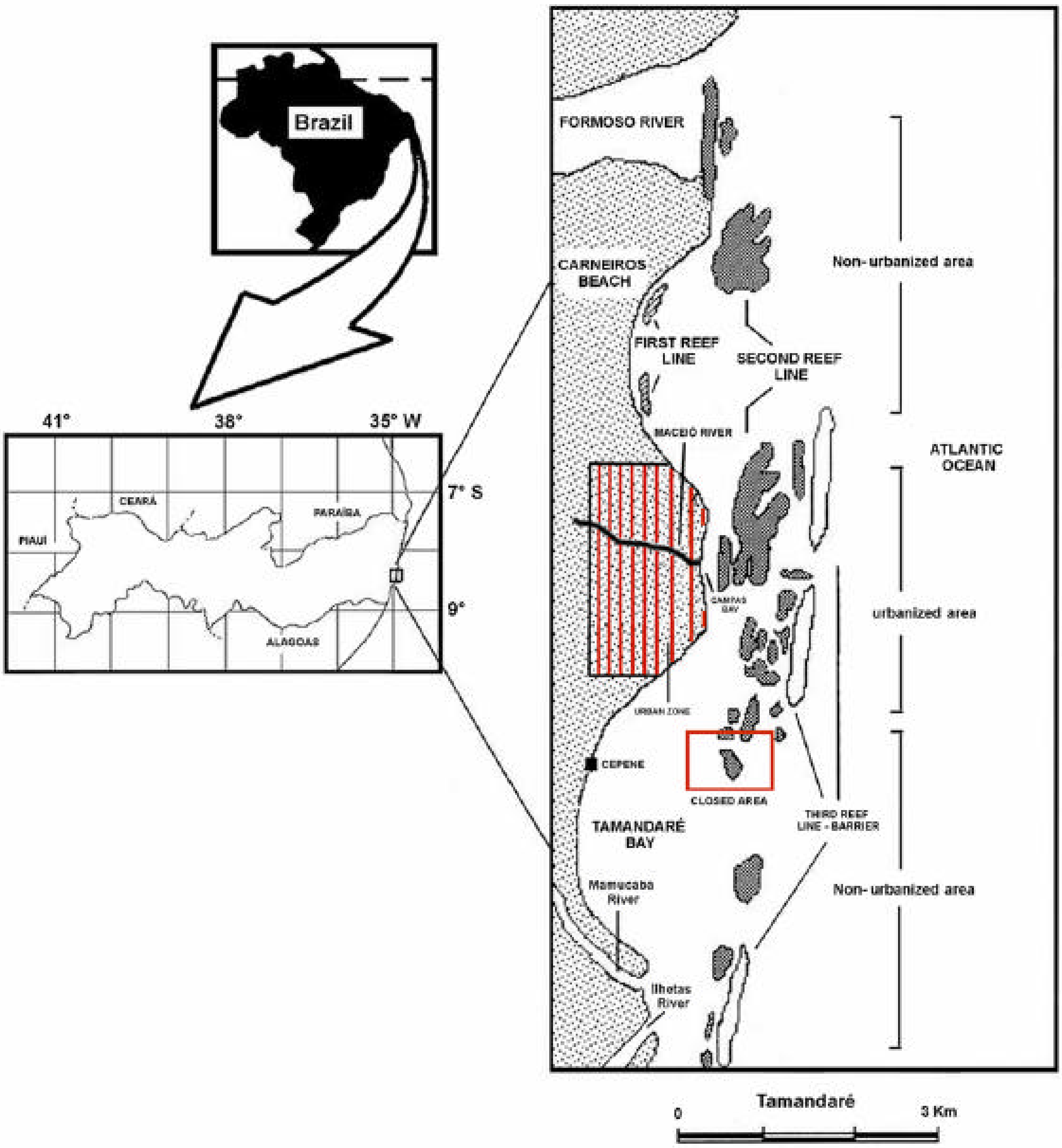


Figure 5: Schematical representation of the Tamandaré shore
(adapted from Maida & Ferreira, 1997).

3.1 Sampling and data collection

3.1.1 Sampling sites

The study area was selected based on the main criteria of the extensives stress pressures and responses over the reefs in a relatively short period of time, and the contrasting nature of the structure and function of the mangrove and reef systems.

Samples were taken in two phases:

. *Phase 1* - Mangrove area

The mangrove area was chosen for that study as a reference area, due to the low indexes of environmental problems found in this area (Losada, 2000).

In order to evaluate the zooplankton community of the Ilhetas and Mamucaba mangroves, samples were surveyed monthly between February 1998 and January 1999 (South part of the Tamandaré Bay).

The stations were chosen in face of the space heterogeneity (Figure 6), and positioned with help of a G.P.S. unit (Global Positioning System) *GP-22/ICOM*, being characterized in the following nomenclature ("M" for mangrove):

. Station M1 - Tamandaré Bay (in front of the confluence of the estuaries)

. Station M2 - "Boca da Barra" (confluence of the estuaries)

. Station M3 - estuary of the Ilhetas River

. Station M4 - estuary of the Mamucaba River

. *Phase 2* - Reef area

Sampling in the Reef area was conducted during the rainy season (July 2000) and the dry season (January 2001) in front of the Tamandaré urban zone (Campas Bay beach) and at the South part of the Tamandaré Bay ("Closed Area", in front of the CEPENE - *Centro de Pesquisa e Extensão Pesqueira do Nordeste* - Center for Research and Fishery).

Four fixed stations were established in the Tamandaré reef complex (one in the "Closed Area", one at the reef close to the "Closed Area", and two in front of the urban zone), being characterized as nomenclature "R" (for reef).

Samples from between the beach and the reefs are characterized by the nomenclature "C" (for channel).

For plankton verification, one sample was taken at the Maceió River mouth, being characterized as nomenclature "MR" (for Maceió River). This sample was taken only during the dry season (18/01/2000), when the number of tourists is high (due to the Brazilian vacation period).

The stations at the reef area (Figure 6) were also positioned with help of the G.P.S. unit:

. Station R1 - "Closed area"

. Station R2 - reef close to the "Closed area" (08° 45' 43'' S and 35° 05' 26'' W)

. Station C1 - channel between the "Closed area" and the CEPENE

. Station R3 - *Pirambú* reef (urban area)

. Station R4 - *Pedra do Picão* ("Picão stone" - urban area)

. Station C2 - channel between the "*Pedra do Picão*" ("Picão Stone") and the urban area of the Tamandaré City

. Station MR - Maceió River mouth

3.1.2 Sampling and samples treatment

In the mangrove area a plankton net with 1 m of length, 0.25 cm of diameter, and 64 µm of mesh size was used. The samples were collected using a small boat, in hauls at surface during approximately 3 minutes. Only the surface water was monthly sampled at one high- and low-tide in the same day (full moon), in the course of 12 hours, representing 1 low- and 1 high-tide samples per station/month, at the 4 fixed stations (in the days: 1998: 11/02; 13/03; 11/04; 11/05; 10/06; 09/07; 07/08; 06/09; 09/10; 04/11; 03/12; and on 03/01/1999). The following parameters was used in the present work: temperature, salinity, dissolved oxygen, nitrite, nitrate, phosphate and silicate.

Studies on daily and seasonal variation were carried out at the reefs of the Tamandaré Bay. The samples were collected in surface hauls for approximately 1.5 minutes, using the same net type as used in the mangrove area (1 m of length, 0.25 cm of diameter, and 64 µm of mesh size). Hydrological and zooplankton data came from the fixed stations, and the zooplankton samples were taken in a 6 hours interval (in the course of 24 hours, representing 2 low- and 2 high-tide samples per station/season - between 10-11/07/2000 and 17-18/01/2001). The samples at Tamandaré reef area were taken during neap tides, because the sea level at the low tides is higher than the sea level during the low tides at full- and new-moon, allowing more close navigation to the reefs. The plankton net was hauled at the boat's sides (and not hauled behind the boat), because of the shallow depth in the reef area, avoiding the turbulence in the substrate through the boat's motor. Moreover, hydrologic parameters were considered in this phase: temperature, salinity, dissolved oxygen, nitrite, nitrate, phosphate and silicate.

Immediately after collection the plankton samples were fixed on board with 4% formaline/sea water solution (Steedman, 1976; Omori & Ikeda, 1984). In the laboratory, each sample was subsampled, using a Folsom splitter (McEwen *et al*., 1954). One aliquot was obtained for quantitative and qualitative determinations. Identification and counting of the microzooplankton was done under a compound *Zeiss* microscope and on a stereomicroscope.

Zooplankton was identified and counted as far as possible with available keys and descriptions until species level. The following keys for identifications were used: Trégouboff & Rose (1957), Newell & Newell (1963), Boltovskoy (1981, 1999), Riedl (1983), Cristi (1986), Todd & Laverack (1991), and Ruppert & Barnes (1994). Specific keys were also be used (Tabel 1).

Table 1: Specific zooplankton identification keys used in this work.

Taxa	Reference
Foraminiferida	Tinoco, 1965/66, 1988; Hemleben *et al*., 1989; Barbosa, 1995;
Tintinnina	Marshall, 1969; Souto, 1981; Nogueira-Paranhos, 1990; Protist Information Server, 1995; Kuylenstierna & Karlson, 1996;
Rotifera	Koste, 1978; Telesh & Heerkloss, 2002;
Copepoda (general taxa)	Björnberg, 1963, 1981; Kasturirangan, 1963; McKinnon, 1991;
Copepoda - Calanoida	Matsumura-Tundisi, 1986; Bradford-Grieve, 2002;
Copepoda - Pseudodiaptomidae	Wright, 1936; Walter, 1989;
Copepoda - Harpacticoida	Coull, 1977; Dussard & Defaye, 1995;
Copepoda - Monstrilloida	Ferrari & Bradley, 1994;
Copepoda - Parasites	Yamaguti, 1963; Kabata, 1992; Gotto, 1993.
Chaetognatha	Pierrot-Bults & Chidgey, 1988;

Data on tidal levels were obtained from the "Board of Tides" (DHN, 1997, 1998, 2000, 2001) for the Suape Port (about 40 km North of the Tamandaré City).

The local water depth was measured with a digital sensor (*LCD Sounder Plastimo Echotest 714700*). During the low-tide, due to the shallow depth of the estuaries and reef areas, depths were measured with a graduated cable (in centimeters).

The water temperature was registered with a common thermometer (of mercury) with scale varying from -10 to 60°C (precision: 0.1°C).

Samples for salinity, dissolved oxygen, nitrite, nitrate, phosphate, and silicate were taken in a middle point between the stations R1 and R2, and the stations R3 and R4. They were taken at the surface, with a

Nansen bottle. Salinity was measured using the Mohr-Knudsen method (Stricland & Parsons, 1965); pH with a *Beckman Zeromatic II* pHmeter; dissolved oxygen by the Winkler method (Strickland & Parsons, 1965); nitrite - $N\text{-}NO_2$, nitrate - $N\text{-}NO_3$, and phosphate - $P\text{-}PO_4$ using the methods described by Strickland & Parsons (1965); silicate ($Si\text{-}SiO_2$) by the method of Grasshoff *et al*., (1983).

Logistic support at Tamandaré was provided by CEPENE, which regularly supports scientific projects performed at UFPE (Federal University of Pernambuco State).

3.2 Data analyses

. Relative abundance (Ra) - calculated with the formula (Omori & Ikeda, 1984):

$$Ra = N.100 / Ns$$

where "**N**" is the total number of organisms of each taxon in the sample. "**Ns**" is the total number of organisms in the sample. The results are presented in percentage (%), being used the following approach:

> 70% - Dominant

70% ⊢ 40% - Abundant

40% ⊢ 10% - Less Abundant

< 10% - Rare

. Frequency (F) - calculated with the formula (Omori & Ikeda, 1984):

$$F = Ts.100 / TS$$

where "**Ts**" is the number of samples in which the taxon is present, and "**TS**" is the total number of samples. The results are presented in percentage (%), being used the following approach:

> 70% - Much Frequent

70% ⊢ 40% - Frequent

40% ⊢ 10% - Less Frequent

< 10% - Infrequent/Sporadic

. Density ($org.m^{-3}$)- the total number of organisms of each taxon in the samples was calculated according to Omori & Ikeda (1984), with the formula:

$$N = Vt.x / Vc$$

where "**Vt**" is the total volume in the sample, "**Vc**" is the volume of the sub-sample (counted volume) and "**x**" is the number of organisms of each taxon. The total number of organisms per volume ($org.m^{-3}$) was obtained with the formula:

$$\textbf{org.m}^{-3} = \textbf{N / V}$$

which "**N**" is the total number of each taxon in the sample, and "**V**" is the volume of filtered water by the plankton net (**V** = **A.d**, where **A** = ¶.r^2 → **r** = 0.25 cm, and **d** = haul distance).

The statistic approach for zooplanktonic community consist first in the evaluation of diversity and evenness, by calculation of the Shannon index (Shannon, 1948). The software "Ecologia" was used for these analyses.

All the calculations for multivariate analysis were accomplished being used the software "NT-SYS" (*Numerical Taxonomy and Multivariate Analysis System*). Multivariate analysis ("*Cluster analysis*") were performed using the W.P.G.M.A. method (*Weight Pair Group Mathematical Average*).

. Diversity and Evenness indixes (*bits*.ind^{-1})

Diversity (H') was calculeted according to Shannon (1948), with the formula:

$$H' = -\Sigma pi \,.\, \log_2 Pi$$

where "**Pi**" = "n_i/N", and "n_i" is the number of individuals of each species ("**i**"), and "**N**" is the total number of indiduals. The results are presented in *bits* per individual (*bits*.ind^{-1}), being "1 *bit*" one information unit (Valentin *et al.*, 1991). More than 3 *bits*.ind^{-1} are considered high diversity, less than 1 *bit*.ind^{-1} is considered as low diversity.

Evenness (J) was calculated according the Shannon Index (Shannon, 1948), using the formula:

$$J = H'max / S$$

where "**S**" is the total number of species of each sample, and "**H'max**" is the number of maximal theoric diversity. More than 0.5 is considered even.

Only data of planktonic organisms were used for the Diversity and Evenness calculations (*e.g.* Tintinnina and Copepoda). Data of Nematoda and others picoplanktonic groups are not used for in these calculations.

. Multivariate analysis

Multivariate analysis was applied to determine differences in relative zooplankton abundances during the study period, and differences between the zooplanktonic groups and the sampling stations, mainly at the reef area.

- Multivariate analysis for the mangrove area:

For the mangrove area the data matrix used the Bray & Curtis coefficient and the W.P.G.M.A. method. This is an ideal method for samples with different sizes (in this case with great and small numbers of individuals). The coefficient of resulting correlation (the output value) is called "Cophenetic Correlation Coefficient" ("C"). The magnitude of this value should be very close to 1 for a high-quality solution, and it can be used to measure the validity of the grouping, whose value > 0.7 are considered significant (Rohlf & Fisher, 1968; Pielou, 1984). This measure can be used to compare alternative cluster solutions obtained using different algorithms.

Analyses based on very big data matrix (due to inclusion of species called "rare", and not frequent) supplies doubtful results, because high correlation can be attributed to the rate of the rare species, and those species possess great number of simultaneous absences. To reduce this problem, the species that occur with less than 70% of frequency were excluded from the multivariate analysis. The data matrix was submitted to the following methods for multivariate analysis:

The results of the cluster classification are visualized as dendogram. The cutting level (that defines the groups) was selected along the ecological interpretability (Leps *et al*., 1990; Legendre & Legendre, 1998).

- Multivariate analysis for the reef area

The data matrix for the reef area was analyzed by the multidimensional methods with purpose of evidencing the structure of the data groups for the two sampling seasons (rainy and dry seasons) for the reef areas. The classification method used was the Bray & Curtis coefficient and the W.P.G.M.A. method, as above described.

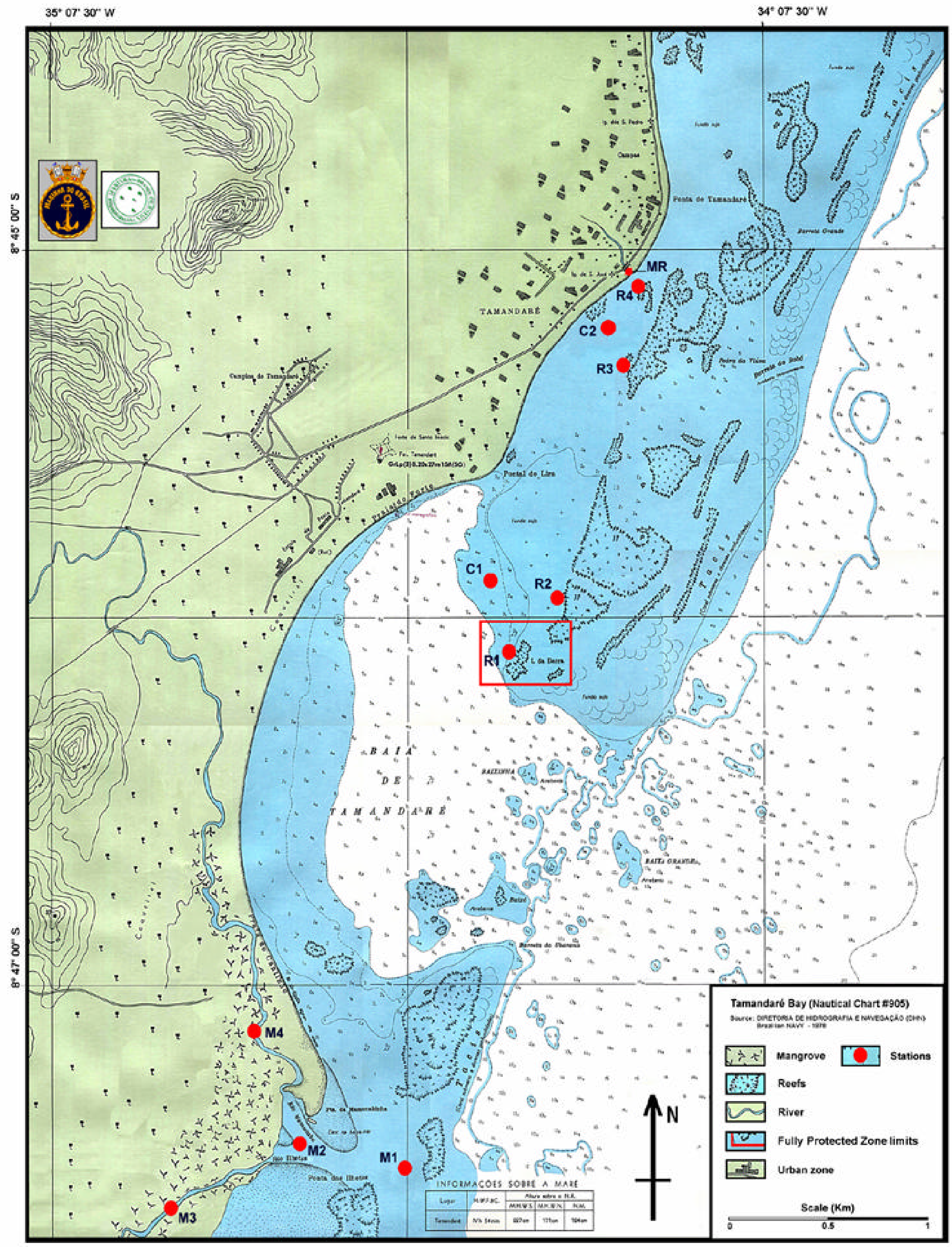


Figure 6: Tamandaré shore and sampling sites.

4.1 Hidrologic data

4.1.1 Phase 1: Mangrove area

Tides and water depth

Tides in the Brazilian coast are semidiurnal, and the tide influences on the coast appears during the spring tides, when the tides present larger ranges (Medeiros, 1991). At Pernambuco State the maximum range is 3 m.

During the studied period, the tidal range was about 2 m. The maximum value was 2.3 m (tide level at high tide), and the minimum was 0.3 m (tide level at low tide), both measured on 9/10/1998, at 06:13 h and 12:26 h.

The minimum water depth in the studied area was 0.3 m, reached at the Mamucaba River estuary (station M4) at low tide, and the maximum was 8 m reached in the Tamandaré Bay (station M1) at high tide. For the estuarine area the maximum water depth was reached at the confluence of estuaries with 3 m, at high tide.

Temperature records

The surface temperature records for the estuarine stations (during high tides) has a discreet geographical decrease, from station M1 (Tamandaré Bay) to station M4 (Mamucaba River estuary). Seasonal differences were observed with the minimum values during the rainy season, and maximum values during the dry season.

The Tamandaré Bay presented a thermal range of 4°C, and the estuarine zone presents thermal range of 6°C. The maximal temperature registred was 32°C (February 98) at stations M2 and M4. The minimum was 26°C at station M3 (August and September 98), M2 (September 98), and M4 (August 98).

Salinity

At the four stations the variation of salinity during the high tides was low (except for some months during the rainy season), what shows a marine influence in terms of salinity in the mangrove area. During the low tides a decreasing gradient was observed from the Tamandaré Bay in direction to the stations into the estuarine area. The estuarine area has lower salinity values at low tides. A discrete seasonal pattern of salinity was observed, with higher values during the dry season and lower values during the rainy season (Figure 7).

For station M1 (at Tamandaré Bay) the salinity mean for the high tides was 33.82 (high tides range of 3), and for the low tides was 32.92 (low tides range of 6).

At stations M2 (confluence of estuaries), M3 (Ilhetas River estuary), and M4 (Mamucaba River estuary) the average value of salinity at high tides was about 31 (high tides range of 8 for station M2; 9 for station M3; and 10 for station M4). For low tides the means salinity registred were 18.17 at station M2 (low tides range of 31), 6.33 at station M3 (low tides range of 21), and 8 at station M4 (low tides range of 26).

The minimum salinity values were 1 at station M2 (August 98 - low tide), 0 at stations M3 (May and August 98 - low tide) and M4 (May, August and September 98 - low tides). At station M1 the minimum was 30 (May, August and September 98 - low tides). The maximum salinity was 36 at station M1 (February and March 98 - low tide), and 35 at station M2 (January 99 - high tide), M3 (January 99 - high tide), and M4 (January 99 - high tide).

Oxygen concentration (0_2)

The content of dissolved oxygen presented the higher values at high tides, except for the station M1 (at Tamandaré Bay), that presented the highest values at low tides. The dissolved oxygen showed geographic differences at low tides, with higher values at the station M1, decreasing from the Tamandaré Bay (station M1) to the Mamucaba River (station M4). There was not a seasonal variation for the dissolved oxygen values. However, in the stations M2 (confluence of estuaries), M3 (Ilhetas River estuary) and M4 (Mamucaba River estuary) there is a great decrease in the O_2 concentration values at low tides, in May and August 98 (rainy season), and also at station M4 in September 98 (Figure 8).

Average values of dissolved oxygen at the four mangrove stations were about 4.72 - 4.92 ml $O_2.L^{-1}$, during the high tides, and during the low tides the means were about 3.28 - 5.17 ml $O_2.L^{-1}$.

The maximum reached value for dissolved oxygen was 5.77 ml $O_2.L^{-1}$ at station M2 (November 98 - high tide). The minimal reached value was 0.42 ml $O_2.L^{-1}$ at station M3 (May 98 - low tide).

Nutrients

- Nitrite

Nitrite did not present a clear geographic variation, although the stations M2 (confluence of estuaries) and M3 (Ilhetas River estuary) had larger ranges than the others stations. The maximum reached value was 0.99 µmol.L^{-1} at station M3 (August 98 - high tide). The values among the tides were in general similar (Figure 9).

For the station M1 (at Tamandaré Bay) the mean for the high tides was 0.05 µmol.L^{-1}, and for the low tides was 0.04 µmol.L^{-1}. The minimum value was 0 µmol.L^{-1} (March and Dezember 98) at low tides, and the maximum was 0.14 µmol.L^{-1} (June 98) at high tide.

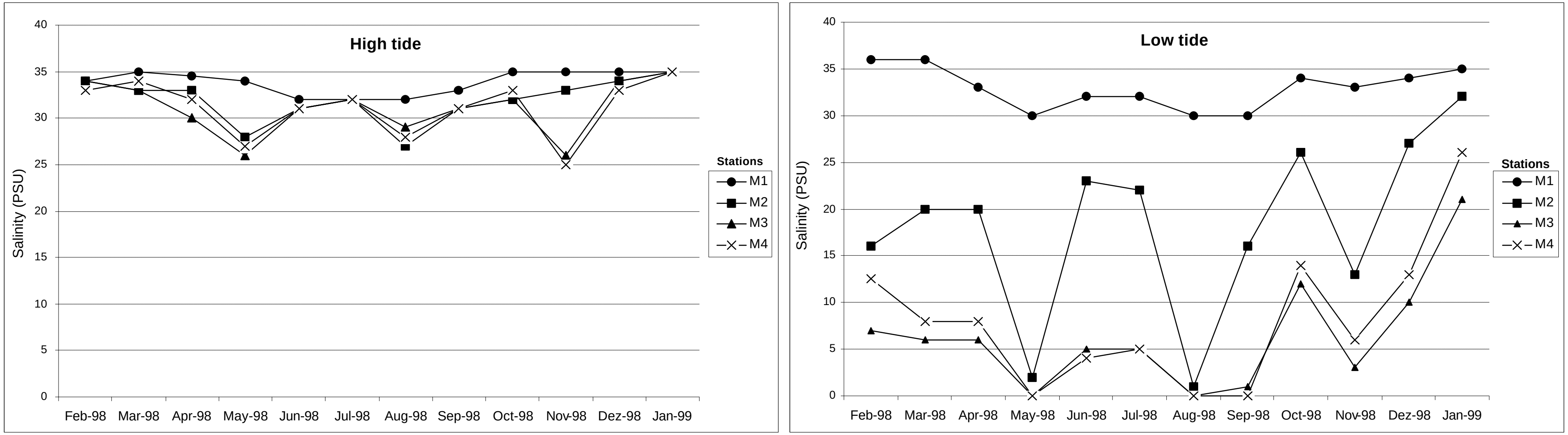


Figure 7: Salinity (PSU) at the mangrove area (high and low tide).

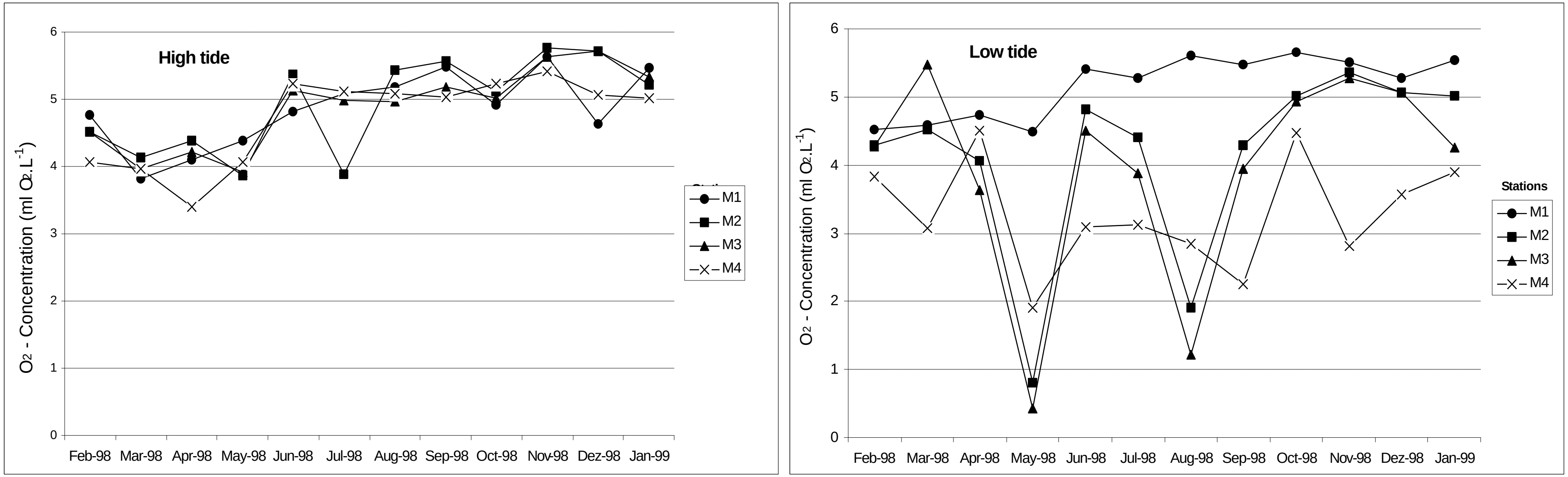


Figure 8: Oxygen concentration (ml O_2.L^{-1}) at the mangrove area (high and low tide).

At station M2 (confluence of estuaries) the mean for high tides was 0.1 μmol.L^{-1}, and for low tides was 0.06 μmol.L^{-1}. The mimimum value registered was 0 μmol.L^{-1} (April and November 98, January 99) at high tides, and the maximum 0.16 μmol.L^{-1} (May 98) at low tide.

The station M3 (Ilhetas River estuary) has a mean for high tides of 0.12 μmol.L^{-1}, and for low tides was 0.08 μmol.L^{-1}. The values varied among 0 μmol.L^{-1} (January 99) at low tide, and 0.99 μmol.L^{-1} (August 98) at high tides.

At Station M4 (Mamucaba River estuary) the mean for high and low tides was 0.04 μmol.L^{-1}. The nitrite concentrations varied among 0 μmol.L^{-1} (October and November 98 - high tides; March 88 and Januar 99 - low tides), and 0.11 μmol.L^{-1} (February 98), also at high tide.

- Nitrate

The nitrate presented the largest concentrations between February and September 1998 coinciding with the rainy season, decreasing from October 98 to January 99 (dry season). The maximum value was reached in February 98 at station M1 during the high tide (3.74 μmol.L^{-1}).

There is not an defined nitrate pattern for geographic variation, that monthly oscillated among the four stations. Concentration differences between the tides were more evidenced at station M1 (where nitrate average value was higher at high tides), and M3 (that presented the higher average at low tide). The other stations did not present significant differences (Figure 10).

At station M1 (Tamandaré Bay) the mean for the high tides was 1.15 μmol.L^{-1}, and for the low tides was 0.84 μmol.L^{-1}. The values varied among 0 μmol.L^{-1} (November 98) at low tide, and 3.74 μmol.L^{-1} (February 98) at high tide.

For the station M2 (confluence of estuaries) the mean for high tides was 0.89 μmol.L^{-1}, and for low tides was 0.85 μmol.L^{-1}. The minimum value was 0.02 μmol.L^{-1} (November 98) at low tide, and the maximum value was 1.63 μmol.L^{-1} (September 98) at high tide.

The station M3 (Ilhetas River estuary) has a mean for high tides of 0.9 μmol.L^{-1}, and for the low tides of 1.27 μmol.L^{-1}. The nitrate values varied among 3.02 μmol.L^{-1} (March 98 - low tide), and 0 μmol.L^{-1} (November 98), also at low tide.

For station M4 (Mamucaba River estuary) the mean for high tides was 1.16 μmol.L^{-1}, and for low tides was 1.14 μmol.L^{-1}. The minimum value was 0.37 μmol.L^{-1} (November 98) at high tide, and the maximum nitrate value was 2.51 μmol.L^{-1} (February 98), also at high tide.

- Phosphate

The contents of phosphate presents seasonal variation, with the highest concentrations registered during the dry season. A geographic variation was not observed for phosphate, and the concentrations did not present great differences among the tides (Figure 11).

For the station M1 (Tamandaré Bay) the mean for the high tides was 0.13 $\mu mol.L^{-1}$, and for the low tides was 0.14 $\mu mol.L^{-1}$. The minimum value was 0 $\mu mol.L^{-1}$ (September 98) at high tide, and the maximum was 0.28 $\mu mol.L^{-1}$ (February and November 98) at low tide.

At station M2 (confluence of estuaries) the mean for high tides was 0.13 $\mu mol.L^{-1}$, and for low tides was 0.15 $\mu mol.L^{-1}$. The values varied among 0.06 $\mu mol.L^{-1}$ (August 98) at high tide, and 0.31 $\mu mol.L^{-1}$ (February 98) at low tide.

The station M3 (Ilhetas River estuary) has a mean for high tides of 0.14 $\mu mol.L^{-1}$, and for low tides of 0.16 $\mu mol.L^{-1}$. The values varied among 0 $\mu mol.L^{-1}$ (September 98) at high tide, and 0.31 $\mu mol.L^{-1}$ (January 99) at low tide.

At station M4 (Mamucaba River estuary) the mean for high tides was 0.16 $\mu mol.L^{-1}$, and for low tides 0.12 $\mu mol.L^{-1}$. The minimum value reached was 0 $\mu mol.L^{-1}$ (May 98) at low tide, and the maximum value was 0.27 $\mu mol.L^{-1}$ (February 98) at high tide.

- Silicate

The silicate presented the higher concentrations during the low tides, mainly at the estuarine stations. The Tamandaré Bay did not presents great differences among the tides. It means that there was a decreasing gradient from estuarine stations to the Tamandaré Bay. Also, there is a seasonal pattern, that was better observed at low tides, which concentrations (in general) were higher during the dry season. During the high tides the geographic variation was not evident, but with picks in May, June and November 98. However, the Tamandaré Bay presented the higher concentration in June 98 at high tide, and lower concentrations on the period of lower rainfall (Figure 12).

At station M1 (Tamandaré Bay) the mean for the high tides was 19.03 $\mu mol.L^{-1}$, and for the low tides was 20.24 $\mu mol.L^{-1}$. The values varied among 3.72 $\mu mol.L^{-1}$ (November 98 - high tide; January 99 - low tide), and 53.03 $\mu mol.L^{-1}$ (June 98 - high tide).

For the station M2 (confluence of the estuaries) the mean for high tides was 20.40 $\mu mol.L^{-1}$, and for low tides was 41.29 $\mu mol.L^{-1}$. The minimum value was 3.21 $\mu mol.L^{-1}$ (March 98) at high tide, and the maximum value was 93.44 $\mu mol.L^{-1}$ (November 98) at low tide.

At station M3 (Ilhetas River estuary) the mean for high tides was 26.26 µmol.L^{-1}, and for low tides 57.42 µmol.L^{-1}. The minimum value was 11.47 µmol.L^{-1} (January 99) at high tide, and the maximum value was 112.54 µmol.L^{-1} (October 98) at low tide.

The station M4 (Mamucaba River estuary) has a mean for high tides of 24.54 µmol.L^{-1}, and for low tides of 53.57 µmol.L^{-1}. The silicate concentrations varied among 9.31 µmol.L^{-1} (January 99) at high tide, and 118.8 µmol.L^{-1} (Dezember 98) at low tide.

4.1.2 Phase 2: Reef area

Tides and water depth

At the reef area was verified that the tide levels presented a range of about 1 m. The maximum value for tide levels was 1.8 m (at high tide), and the minimum was 0.7 m (at low tide).

The minimum water depht in the reef area was 0.4 m (at station R1- "Closed area" - at low tide) during the summer (dry season), and the maximum was 6.7 m (at station C1 - channel between the "Closed area" and the CEPENE - at high tide) during the winter (rainy season).

Temperature records

The surface temperature records for the reef waters show discreet seasonal difference, with minimum values during the rainy season and maximum values during the dry season. The Tamandaré reef area has a thermal range of 5°C only. The mean temperature at all stations for high and low tides were about 26°C.

The non-urbanized area presented the following temperature values: at stations R1 ("Closed area"), R2 (reef close to the "Closed area"), and C1 (channel between the "Closed area" and the CEPENE) the minimum was about 24°C in winter, generally at the nocturnal low tides (00:00 h). The maximum values at stations R1 and R2 were about 29°C (summer), both at high tides. At the station C1 the maximum value was 27.5°C (12:00 h) during the summer (at high tide).

For the urbanized area the following values were presented: at station R3 ("*Pirambú* reef"), R4 ("*Pedra do Picão*"), and C2 (channel between the "*Pedra do Picão*" and the urban zone of Tamandaré City) the minimum values were practically the same of the non-urbanized area, 24°C (winter), generally at low tides. The maximum values were about 28°C (summer), generally at high tides.

Salinity

In summer (dry season), there was not at the reef area a great range for salinity among the tides. However, in winter the salinity values were in general higher during the high tides, showing discreet seasonal differences in the area (Figure 13).

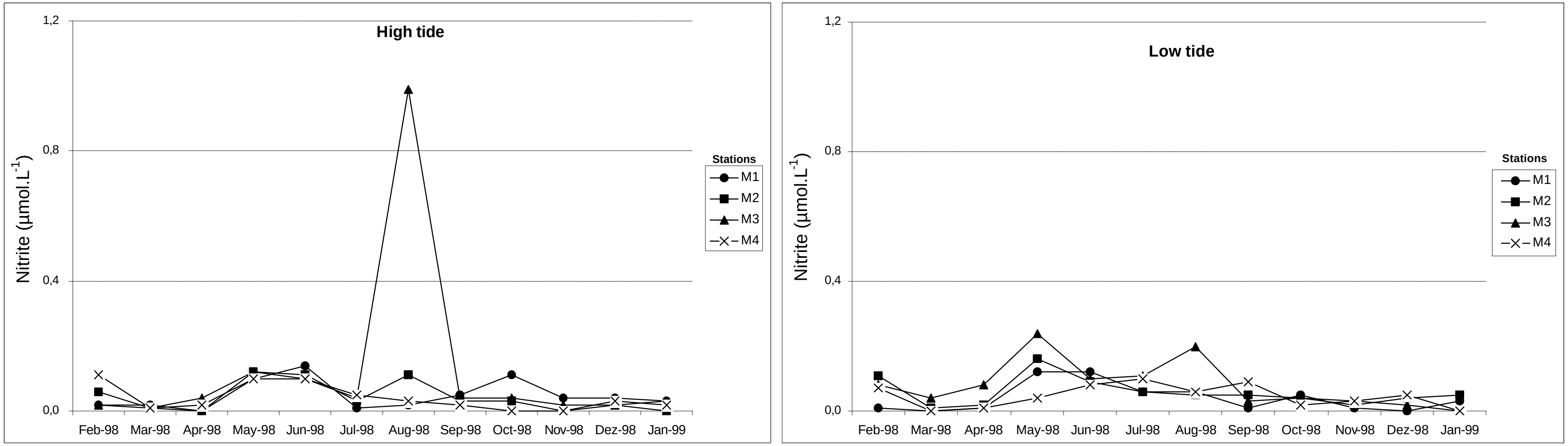


Figure 9: Nitrite (µmol.L^{-1}) at mangrove area (high and low tide).

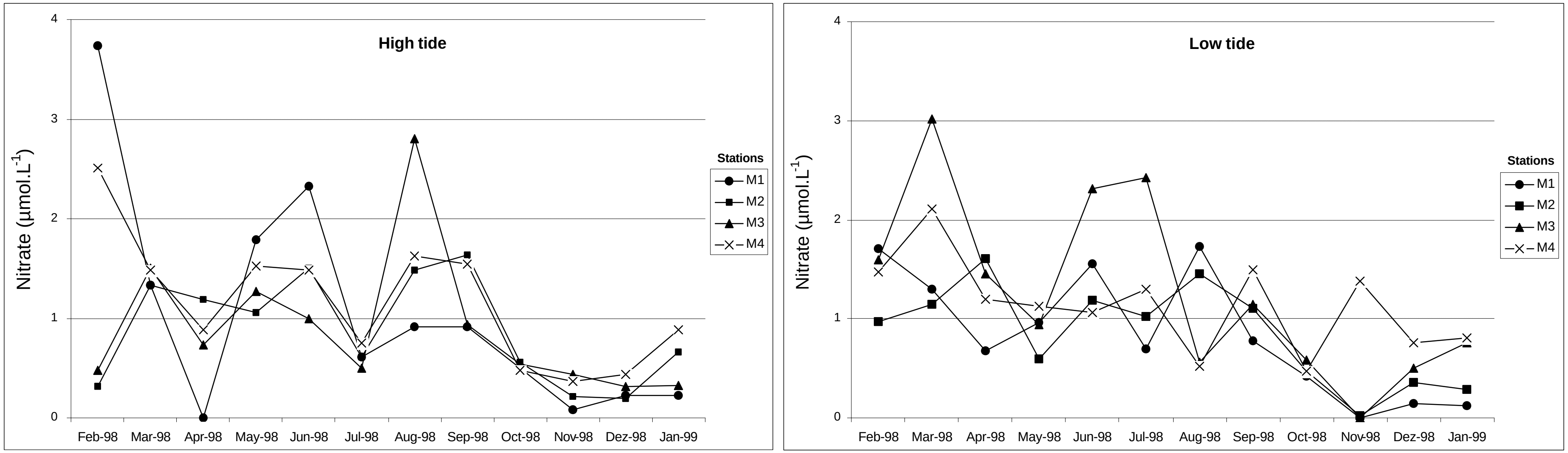


Figure 10: Nitrate (µmol.L^{-1}) at mangrove area (high and low tide).

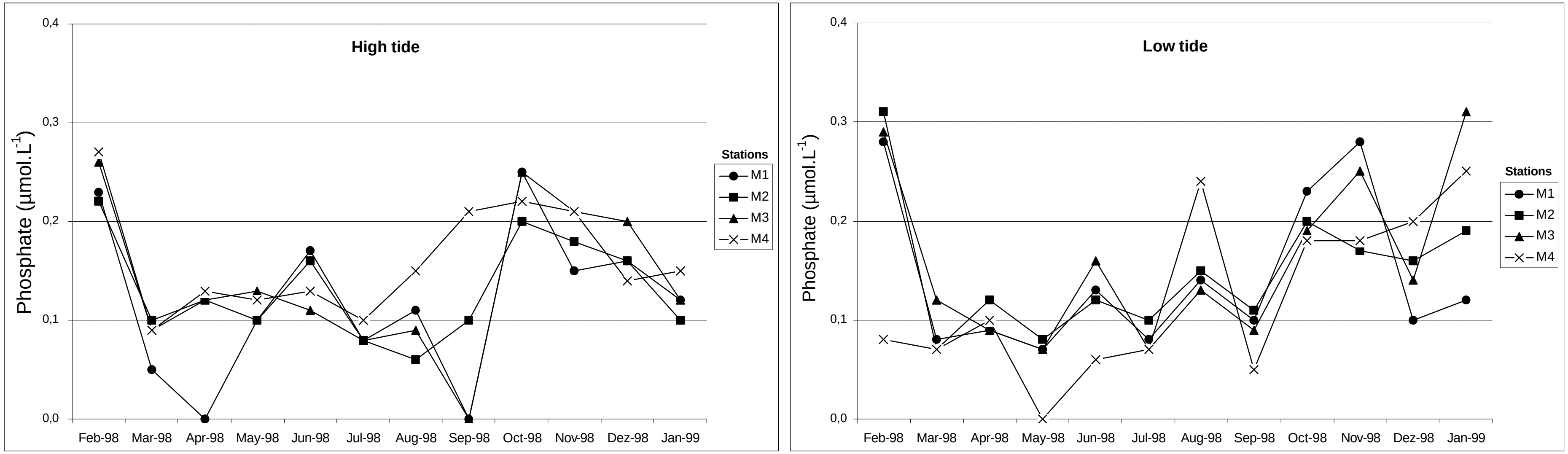


Figure 11: Phosphate (µmol.L^{-1}) at mangrove area (high and low tide).

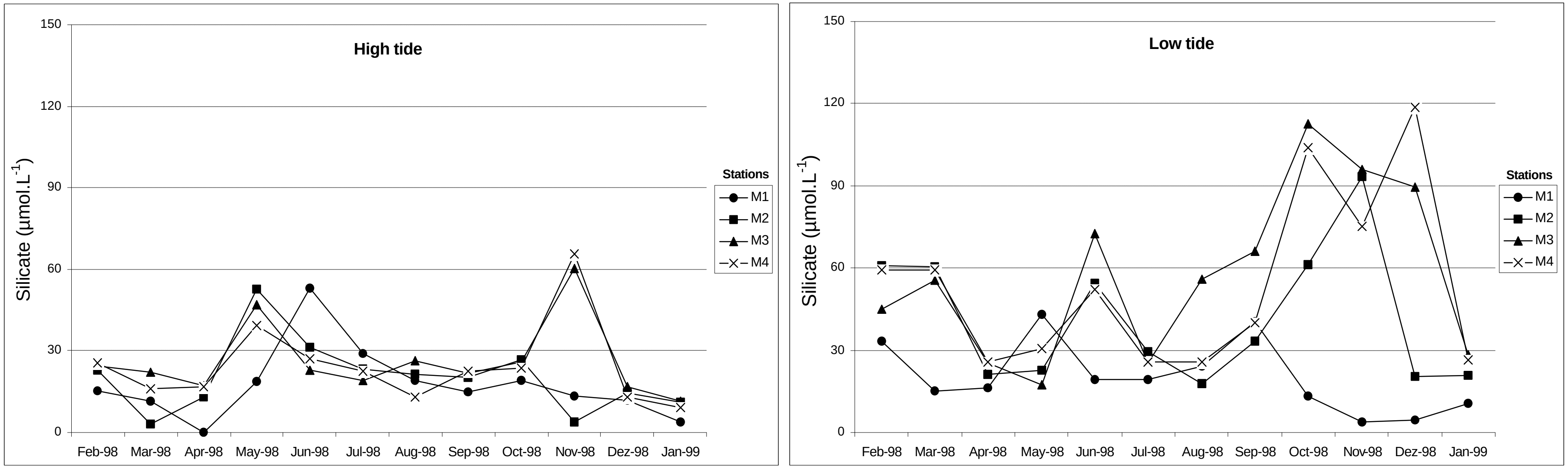


Figure 12: Silicate (µmol.L^{-1}) at mangrove area (high and low tide).

The non-urbanized area (between stations R1 and R2) presented the following salinity values: the minimum value was 28.53 at night (18:00 h - low tide - winter), and the maximum value was 34.45, also in winter, but during the high tide at diurnal period (12:00 h). The winter range was 5.92, and the winter mean was 30.75. The dry season has mean of 32.82, and range of 1.86.

For the urbanized area (between stations R3 and R4) the following values were presented: the minimum value was 29.48 at diurnal period (06:00 h - low tide - winter), and the maximum value was 33.79 during the summer at high tide (12:00 h, also diurnal period). The winter range was 4.24, and the winter mean was 30.81. The dry season has mean of 33.2, and range of 1.66.

Oxygen Concentration (0_2)

In the reef area there was not great seasonal variation of dissolved oxygen (Figure 14).

The middle point between the stations R1 and R2 (non-urbanized area) has mean values for the dissolved oxygen of 5.44 ml $O_2.L^{-1}$ (for the high tides), and 5.16 ml $O_2.L^{-1}$ (for the low tides). The minimum value was 4.84 ml $O_2.L^{-1}$ reached at low tide (diurnal period - 06:00 h) in summer. The maximum value was 5.73 ml $O_2.L^{-1}$ at high tide (nocturnal period - 00:00 h), also in summer. The winter range was 0.43 ml $O_2.L^{-1}$, and the winter mean was 5.28 ml $O_2.L^{-1}$. During the dry season the mean was 5,29 ml $O_2.L^{-1}$, and the range was 0.89 ml $O_2.L^{-1}$.

For the middle point between the stations R3 and R4 (urbanized area) the mean values for dissolved oxygen were practically the same of the non-urbanized area: 5.34 ml $O_2.L^{-1}$ for high tides, and 5 ml $O_2.L^{-1}$ for low tides. The minimum and maximum values for dissolved oxygen were also practically the same of the non-urbanized area, 4.87 ml $O_2.L^{-1}$ reached at low tide (nocturnal period - 18:00 h) in winter, and the maximum value was 5. ml $O_2.L^{-1}$ (at night, 00:00 h), during the high tide in summer. The winter range was 0.44 ml $O_2.L^{-1}$, and the winter mean was 5.09 ml $O_2.L^{-1}$. During the dry season the mean was 5.22 ml $O_2.L^{-1}$, and the range was 0.6 ml $O_2.L^{-1}$ (almost the same ranges and means of the non-urbanized area).

Nutrients

- Nitrite

At the reef area, the highest values for nitrite was observed between the stations R3 and R4 (in front of the Tamandaré urbanized area), in summer and in winter. During the summer, the values for nitrite were higher than winter, showing seasonal pattern (Figure 15).

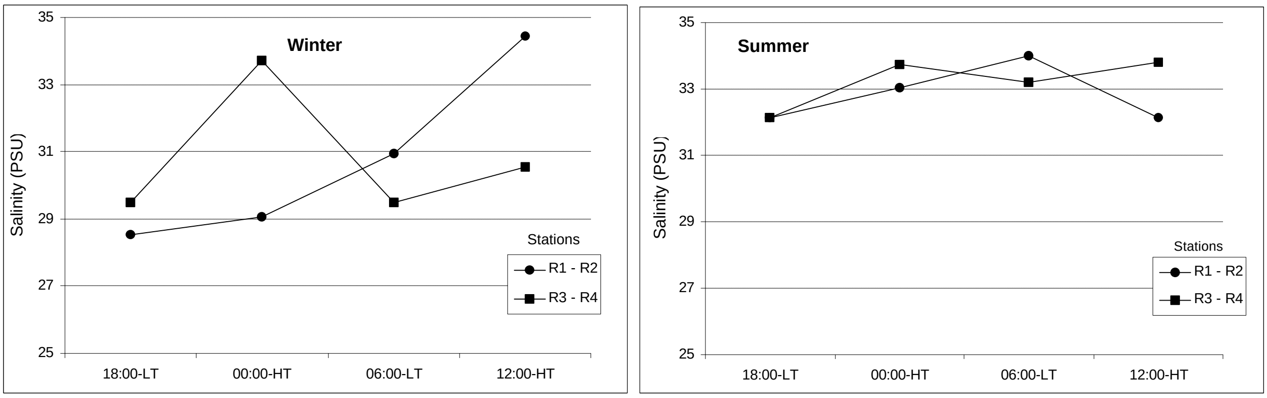


Figure 13: Salinity (PSU) at reef area (winter and summer).

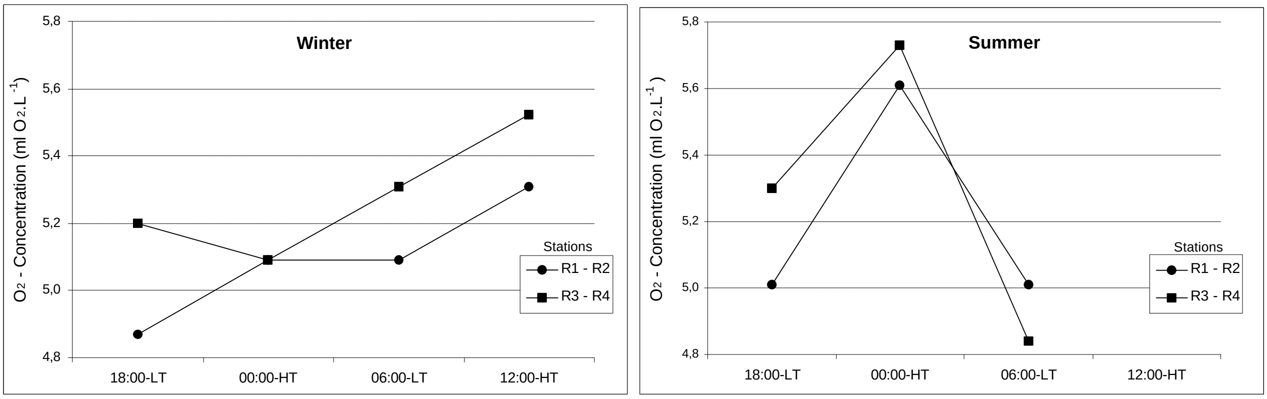


Figure 14: Oxygen concentration (ml $O_2.L^{-1}$) at reef area (winter and summer).

Between the stations R1 and R2 (near to the "Closed Area" - non-urbanized area), the mean for high tides was 0.107 µmol.L^{-1}, and for low tides was 0.276 µmol.L^{-1}. The minimum value reached was 0.0026 µmol.L^{-1} in winter (high tide, 12:00 h), and the maximum was 0.2198 µmol.L^{-1} in summer (low tide, 18:00h). The winter range was 0.11 µmol.L^{-1}, and the winter mean was about of 0.0546 µmol.L^{-1}. The dry season has mean of 0.1805 µmol.L^{-1}, and range of 0.12 µmol.L^{-1}.

In front of the Tamandaré urbanized area (between the stations R3 and R4), the high tide mean was 0.23 µmol.L^{-1}, and the low tide mean was 0.223 µmol.L^{-1}. The mimimum value registered was 0.1406 µmol.L^{-1} in winter (high tide, 12:00 h), and the maximum value was 0.2999 µmol.L^{-1} in summer (low tide, 18:00 h). The winter range was 0.1561 µmol.L^{-1}, with a winter mean of 0.2051 µmol.L^{-1}. During the dry season the mean was 0.2474 µmol.L^{-1}, and the range was 0.0914 µmol.L^{-1}.

- Nitrate

Nitrate in the reef area has higher values between the stations R3 and R4 (in front of the Tamandaré urbanized area), during the winter (Figure 16).

Between the stations R1 and R2 (near to the "Closed Area" - non-urbanized area) the mean for high tide was 0.98 µmol.L^{-1}, and for the low tide was 1.122 µmol.L^{-1}. The mimimum value was registered in summer (0.6543 µmol.L^{-1}), during the high tide (12:00 h). The maximum value was 1.3761 µmol.L^{-1}, also in summer, at night (high tide, 00:00 h). The range in winter was 0.5 $\mu mol.L^{-1}$, and the winter mean was 1.2238 $\mu mol.L^{-1}$. The dry season has mean of 1.0535 $\mu mol.L^{-1}$, and range of 0.72 $\mu mol.L^{-1}$.

The middle point between the stations R3 and R4 (in front of the Tamandaré urbanized area) has a mean for high tide of 1.9094 $\mu mol.L^{-1}$, and for low tide the mean was 1.940 $\mu mol.L^{-1}$. The mimimum value registered was 1.6454 $\mu mol.L^{-1}$ in summer (high tide, 12:00 h), and the maximum value was 1.9912 $\mu mol.L^{-1}$, also in summer (at night, 18:00 h - low tide). The range in winter was 0.1248 $\mu mol.L^{-1}$, and the winter mean was 1.8983 $\mu mol.L^{-1}$. The dry season has mean of 1.8757 $\mu mol.L^{-1}$, and range of 0.3458 $\mu mol.L^{-1}$.

- Phosphate

The contents of phosphate show a seasonal variation, with the highest concentrations observed during the rainy season (winter). However, the concentrations did not present great differences among the tides. A geographic variation was observed for phosphate, with higher concentrations reached at the urbanized area (between stations R3 and R4), as shown in Figure 17.

Between the stations R1 and R2, the winter range was 0.0989 $\mu mol.L^{-1}$ and the winter mean was 0.1745 $\mu mol.L^{-1}$. The summer range was 0.1144 $\mu mol.L^{-1}$, and the summer mean was 0.0654 $\mu mol.L^{-1}$. The maximum value reached was 0.2302 $\mu mol.L^{-1}$ in winter, at diurnal low tide (06:00 h). The minimum value was also reached in summer, and at diurnal low tide (0.0001 $\mu mol.L^{-1}$).

For the urbanized area (the middle point between the stations R3 and R4), the winter range was about of 0.1855 $\mu mol.L^{-1}$, and a summer range of 1.1642 $\mu mol.L^{-1}$. The summer mean was 0.657 $\mu mol.L^{-1}$, and the winter mean was 0.4002 $\mu mol.L^{-1}$. The minimum value was 0.3089 $\mu mol.L^{-1}$ (winter) at nocturnal high tide, and the maximum was 1.4856 $\mu mol.L^{-1}$ (summer) at diurnal low tide.

- Silicate

Silicate presents seasonal variation, with the highest concentrations registered during the dry season (summer). However, the concentrations did not present great differences among the tides. A geographic variation was also observed, with higher values reached at the urbanized area, as the phosphate concentrations (Figure 18).

Between the stations R1 and R2 (non-urbanized area) the winter range was 14.0864 $\mu mol.L^{-1}$, and the summer range was 11.1418 $\mu mol.L^{-1}$. The summer mean was 33.2610 $\mu mol.L^{-1}$, and the winter mean was 30.3099 $\mu mol.L^{-1}$. The maximum value was 39.8675 $\mu mol.L^{-1}$ (in summer) at diurnal high tide (12:00 h), and the minimum was 24.643 $\mu mol.L^{-1}$ (winter), at nocturnal high tide (00:00 h).

The middle point between stations R3 and R4 (urbanized area) has winter range of 22.9361 µmol.L^{-1}, and summer range of 18.4296 µmol.L^{-1}. The dry season mean was 72.6591 µmol.L^{-1}, and the rainy season mean was 67.8714 µmol.L^{-1}. The minimum value reached was 53.0072 µmol.L^{-1} (winter) at the diurnal high tide (12:00 h), and the maximum value was 82.1435 µmol.L^{-1} (summer) at the diurnal low tide (06:00 h).

4.2 Biologic Data

4.2.1 Taxa synopsis and density

Zooplankton was represented by a total of 109 taxa identified on the reef and mangrove samples, with different organisms from Foraminifera, Tintinnina, Cnidaria, Rotifera, Copepoda, Amphipoda, Isopoda, Chaetognatha, Appendicularia, Larvacea, Mysidacea, and others (the complete list of zooplankton species is given in Table 2).

Meroplankton larvae (Cnidaria, Polychaeta, Mollusca, Crustacea, Echinodermata, Bryozoa, fish eggs and fish larvae, and others) and Copepoda nauplii, as well as ticoplankton (like Foraminifera and Nematoda), were counted but not determined to species level.

A large number of benthic organisms (*e.g*. Foraminifera and Nematoda) were found in the zooplankton community. In general, there were no seasonal and tidal differences in the ticoplankton rates in the mangrove area (Figure 19). Ticoplankton comprised about of 4% of the total zooplankton community at the mangrove area (Figure 20). Meroplankton was more abundant at stations M3 and M4, mainly during the low tides (Figure 19). Ticoplankton species are more abundant in general in winter at the reef area. The stations R3, R4, and C2 showed rates between 13 and 25% of ticoplankton (more abundant groups were Foraminifera and Nematoda), as shown in the Figures 21 and 22.

The total ticoplankton rate for the reef area was 14% in winter, and 6% in summer (Figure 23). During the high tides the ticoplankton rates are a little higher, as the rates at low tides. Meroplankton (*e.g*. Bivalvia larvae, Gastropoda larvae, Polychaeta larvae) comprise 5% of the total zooplankton community at reef area, and 6% at the mangrove area (Figures 20 and 23). Again, differences in the ticoplankton rates between seasons at the reef area were not noted. Holoplankton was the dominant group, with about of 91% to 92% of the total rates for the mangrove area (Phase 1), and about 81% and 89% of the total rates for the reef area (Phase 2), as shown in Figure 23.

Copepoda are the diverse taxonomical group in the reef area, as well as in the mangrove area. 40 taxa of Copepoda were founded at mangrove and reef areas. The second large group was other Crustacea with total of 17 taxa, followed by Tintinnina with 15 taxa. 7 taxa of Rotifera were identified in the reef area, and Nematoda were counted as a whole group (Table 2).

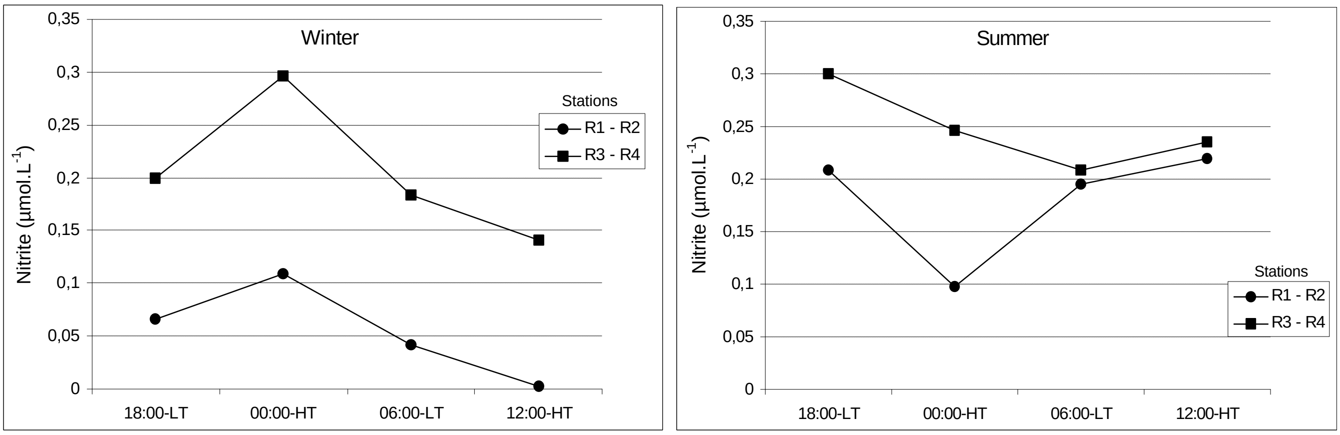


Figure 15: Nitrite ($\mu mol.L^{-1}$) at reef area (winter and summer).

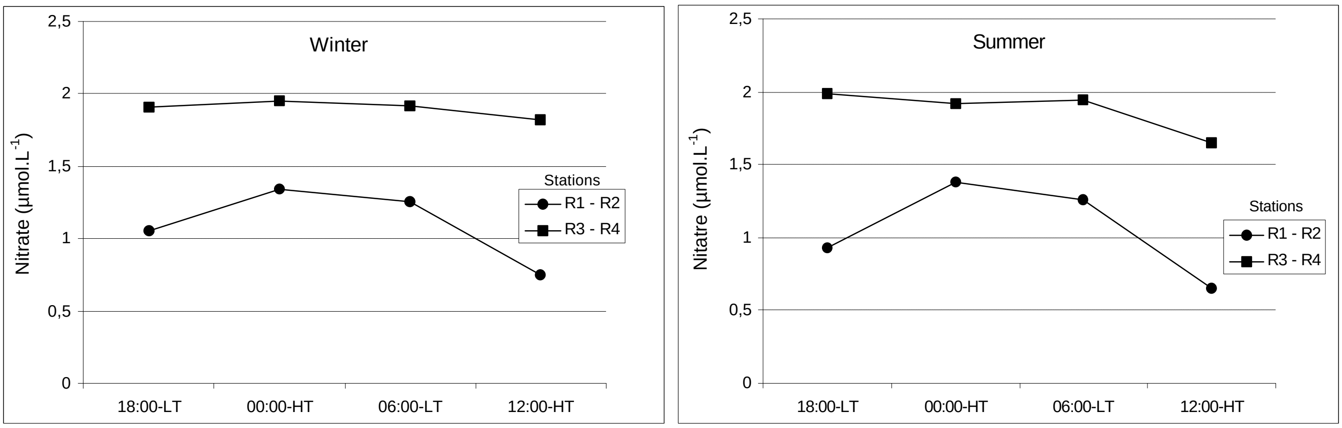


Figure 16: Nitrate ($\mu mol.L^{-1}$) at reef area (winter and summer).

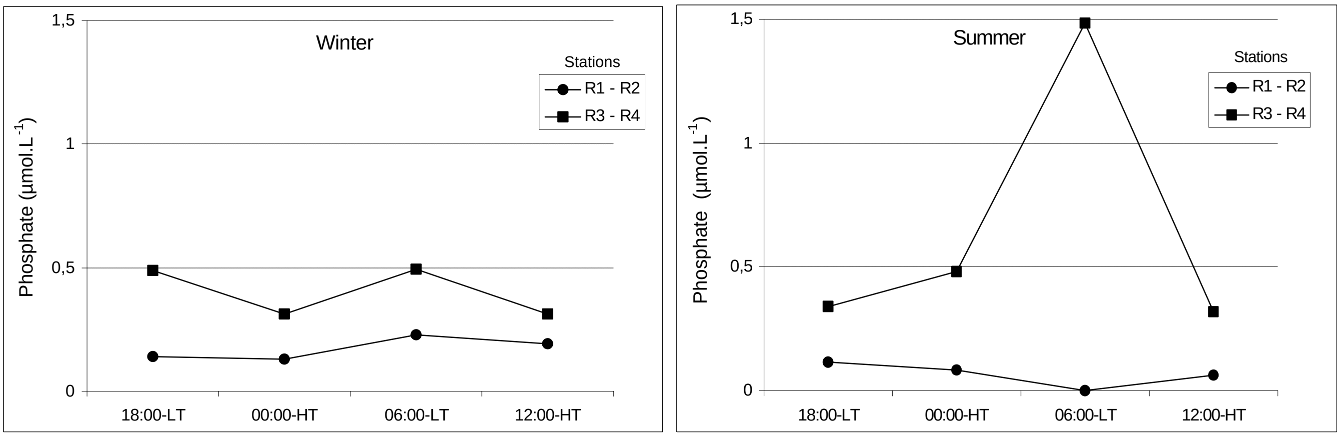


Figure 17: Phosphate ($\mu mol.L^{-1}$) at reef area (winter and summer).

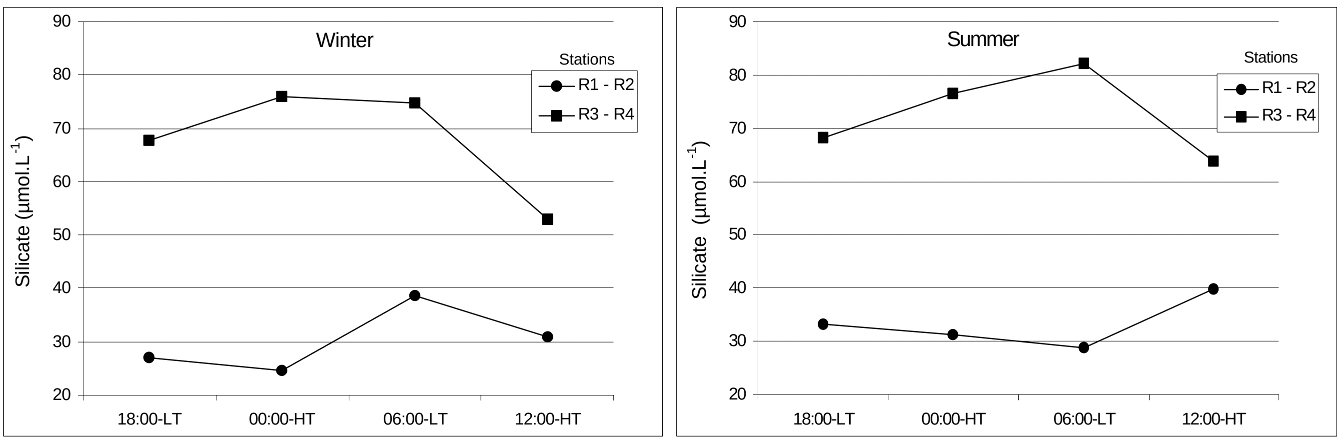


Figure 18: Silicate ($\mu mol.L^{-1}$) at reef area (winter and summer).

Table 2: Taxa synopsis for the zooplankton groups founded in the mangrove and reef areas.

Phylum Sarcodina Schmard, 1871
Order Foraminifera d'Orbigny, 1826
Family Textulariidae Ehrenberg, 1838
Textularia candeiana D'Orbigny, 1839
Textulariidae (others)
Family **Quinqueloculinidae** D'Orbigny, 1839 - **(various)**
Family Trochamminidae de Schwager, 1877
Tretomphalus bulloides D'Orbigny, 1835
***Remaneica* spp.**
Trochamminidae (others)
Family **Spirillinidae** Ehrenberg, 1843 - **(various)**
Family Peneroplidae Schultze, 1854 - ***Peneroplis* spp.**
Foraminifera (others)
Phylum Ciliophora Doflein,1901
Class Polyhymenophorea Jankowski,1967
Order Oligotrichida Butschli, 1887
Suborder Tintinnina Kofoid et Campbell, 1929
Family Codonellidae Kent, 1881
Tintinnopsis aperta Brandt, 1906
Tintinnopsis tocantinensis Kofoid & Campbell, 1929
Tintinnopsis nordqvisti (Brandt, 1906)
Tintinnopsis baltica Brandt, 1996
Tintinnopsis parvula Jorgensen, 1912
Tintinnopsis beroidea *Stein, 1867*
Family Codonellopsidae Kofoid & Campbell, 1929
Codonellopsis morchella* forma *typica Brandt, 1906
Codonellopsis morchella* forma *schabi Brandt, 1906
Codonellopsis pusilla (Cleve, 1900)
Codonellopsis ostenfeldi Jörgensen, 1924
Family Tintinnidae Claparède & Lachmann, 1858
Eutintinnus medius (Kofoid & Campbell, 1929)
Family Undellidae Kofoid & Campbell, 1929
Undella hyalina Jorgensen, 1924
Family Xystonellidae Kofoid & Campbell, 1929
Favella ehrenbergii (Claparède & Laachmann, 1858)
Favella ehrenbergii* forma *coxliella Laval-Peuto, 1981
Family Ascampbelliellidae Corliss,1960
Acanthostomella norvegica (Daday, 1887)
Phylum Cnidaria Verril, 1865
Class Hydrozoa Owen, 1843 - **Hidromedusae (various)**
Class Cubozoa Werner,1975 - **Cubomedusae (various)**
Class Scyphozoa Goette, 1887 - **Ephyra larvae of Scyphomedusae**
Phylum **Nematoda** Lankester,1877 - **(various)**
Phylum Rotifera Cuvier,1798
Class Bdelloidea (Wallace & Snell, 1991)
Order Bdelloida Bartos, 1959
Family Philodinidae Nogrady, 1982- ***Rotaria* spp.**
Class Monogononta Grzimek,1974
Order Ploimida Hudson & Gosse, 1886
Family Brachionidae Wesenberg-Lund, 1899
Brachionus plicatilis (O. F. Muller, 1786)
Brachionus palutus O. F. Muller, 1786
Platyias quadricornis *Ehrenberg, 1845*
Family Trichocercidae Remane, 1933 - ***Trichocerca* spp.**
Family Lecanidae Gosse, 1850
Lecane bulla (Gosse, 1851)
Family Synchaetidae Hudson & Gosse, 1886 - ***Synchaeta* spp.**
Phylum **Kinorhynca** (Reinhard,1887) - **(various)**
Phylum Mollusca Cuvier,1795
Class **Gastropoda** Cuvier,1797 - **(veliger)**
Class **Bivalvia** Cuvier, 1797 - **(veliger)**
Phylum Annelida Lamarck, 1809
Class Polychaeta Grube, 1850
Family Nereidae Johnston, 1865
***Nereis* spp. (adults)**
***Nereis* spp. (Nectochaeta larvae)**
Family Spionidae Grube, 1848 - **Spionid (various)**
Polychaeta (others)
Polychaeta (other larvae)
Polychaeta (eggs)
Phylum Crustacea Pennant, 1977
Class Maxillopoda Dahl, 1956
Subclass Ostracoda Latreille, 1806 - ***Asterope* spp.**
Subclass Copepoda Milne-Edwards,1840
Order Calanoida Sars, 1903
Family Paracalanidae Giesbrecht, 1892
Parvocalanus crassirostris Dahl, 1894
Paracalanus nanus Sars, 1907
Paracalanus indicus Wolfenden, 1905
Paracalanus parvus (Claus, 1863)
Family Eucalanidae Giesbrecht, 1892
Pareucalanus sewelli (Fleminger, 1973)
Family Pseudodiaptomidae Sars, 1902
Pseudodiaptomus acutus (Dahl, 1894)
Pseudodiaptomus richardi Wright, 1936
Family Temoridae Giesbrecht, 1892
Temora turbinata (Dana, 1848)
Temora stylifera (Dana, 1849)
Family Pontellidae Dana, 1853
Calanopia americana F. Dahl, 1894
Labidocera fluviatilis F. Dahl, 1894
Family **Pontellidae** Dana, 1953 **(nauplii)**
Family Acartiidae Sars, 1903
Acartia lilljeborgi Giesbrecht, 1892
Order Cyclopoida Burmeister, 1834
Family Oithonidae Dana, 1853
Oithona simplex Farran, 1913
Oithona nana Giesbrecht, 1892
Oithona hebes Giesbrecht, 1891
Oithona oswaldocruzi Oliveira, 1945
Oithona plumifera Baird, 1843
Order Harparcticoida Sars, 1903
Family Ectinosomatidae Sars, 1903
Microsetella norvegica ***(Boeck, 1864)***
Microsetella rosea (Dana, 1848)
Family Miraciidae Dana, 1846
Macrosetella gracilis (Dana, 1847)
Family Euterpiniidae Brain, 1921
Euterpina acutifrons (Dana, 1852)
Family Longipediidae Brady, 1880 - ***Longipedia* spp.**
Family Harpacticidae Dana, 1846 - ***Tigriopus* spp.**
Family Laophontidae Scott, 1904 - ***Laophonte* spp.**
Family Metidae Boeck, 1872 - ***Metis* spp.**
Family Darcythompsoniidae Lang, 1936
Darcythompsonia radans ***Por, 1983 (Fiers, 1986)***
Harpacticoida (others)
Order Poecilostomatoida Thorell, 1859
Family Oncaeidae Giesbrecht, 1892
Oncaea venustra Philippi, 1826
Family Corycaeidae Dana,1852
Corycaeus speciosus Dana, 1849
Corycaeus giesbrechti F.Dahl, 1894
***Corycaeus* spp.**
Farranula gracilis ***(Dana, 1849)***
Order Siphonostomatoida Thorell, 1859
Family Caligidae Sars, 1901 (Parasite Copepods)
***Caligus* spp.**
***Caligus* spp. (metanauplii)**
Family Asterocheridae Giesbrecht, 1899
***Asterocheres* spp.** (Parasite Copepods)
Parasite Copepods (others)
Order Monstrilloida Sars, 1903
Family Monstrillidae Dana, 1849
***Monstrilla* spp.**
Monstrillidae (others)
Copepoda (nauplii)
Subclass Cirripedia Burmeister, 1834
***Lepas* spp. (nauplii)**
***Balanus* spp. (nauplii)**
Cypris (various)
Class Malacostraca Latreille, 1802
Order **Stomatopoda** Latreille, 1817 - **(pseudozoea)**
Order Decapoda Latreille, 1803
Suborder Dendrobranchiata (Penaeids) Bate, 1888
Superfamily Penaeoidea Rafinesque, 1815
Family Luciferidae Dana, 1852
Lucifer faxoni Borradaile,1915
Suborder Pleocyemata Burkenroad, 1963
Infraorder **Caridea** Dana, 1852 - **(various)**
Infraorder Anomura MacLeay, 1838
Family **Paguridae** Latreille, 1803 - **(larvae - Glaucothoe stage)**
Family **Alpheidae** Rafinesques,1815 - **(various)**
Family **Porcellanidae** Haworth, 1825 - **(zoea)**
Infraorder **Brachyura** Latreille, 1803 - **(zoea)**
Decapoda (megalopa - various)
Order **Misidacea** Boas, 1883 - **(various)**
Order **Cumacea** Kröyer,1846 - **(various)**
Order **Amphipoda** Latreille,1816 - **(various)**
Order **Isopoda** Latreille,1817 - **(adults)**
Suborder Epicaridae Latreille, 1831
Epicaridae (Manca larvae)
Crustacea (protozoea - various)
Phylum Bryozoa Ehrenberg,1831 - ***Membranipora* spp. (Cyphonaute larvae)**
Phylum Chordata Batenson,1885
Subphylum Tunicata Lamarck 1816
Class Ascidiacea Grzimek,1974
Order Phlebobranchia Lahille, 1887
Family **Ascidiidae** Herdman, 1880 - **(larvae)**
Class Larvacea Nielsen,1995
Family Oikopleuridae Lohmann, 1915
Oikopleura dioica Fol, 1872
Phylum Echinodermata Margulis & Schwartz,1982
Class Echinoidea Leske, 1778 - **Pluteus larvae**
Phylum Chaetognatha (Leuckart, 1894)
Class Sagittoidea Claus & Grobben, 1905
Sagitta tenuis Conant, 1896
Subphylum Vertebrata Brusca & Brusca,1990
Superclass Pisces (Linnaeus,1758)
Class Actiopterygii Carroll, 1988
Fish (eggs and larvae)

In the mangrove area (sampling phase 1, between 1998 and 1999), 68 taxa were identified, and the largest share belonged to the Copepoda (mainly *Oithona hebes* and *Oithona oswaldocruzi*) and Copepoda nauplii. In addition, Tintinnina, Mollusca (Bivalvia and Gastopoda), were largely found, which were not determined to species level, as well as larvae and juveniles of Polychaeta. No Rotifera was founded in the mangrove area.

For the reef area (sampling phase 2, between 2000 and 2001), 108 taxa were identified. Copepoda and Copepoda nauplii dominated density and abundance again, followed mainly by Tintinnina and Foraminifera, as well as Nematoda and Rotifera (urbanized area). All the taxa found in the mangrove area were also found in the reef area, except the harparcticoid copepod *Darcythompsonia radans*, tipical Copepoda species from mangrove areas (Porto Neto, 1996), showing likeness among zooplankton composition between both areas.

Maximum value for zooplankton density in the mangrove area was reached at station M1 (mean: 2388.11org.m^{-3}), during low tide. The minimal value was reached at station M3 (mean: 380.19 org.m^{-3}) during low tide. At the reef zone the maximum value was reached in the non-urbanized area at station C1 (mean: 3300.39 org.m^{-3}) during summer, and the minimal value was reached also in the non-urbanized area, at station R1 (mean: 2153.19 org.m^{-3}) during winter.

In the mangrove area was noted general tendence to higher density values during the summer, indicating seasonal differences. The station M1 has higher density values during low tides, and at stations M3 and M4 (Mamucaba and Ihetas rivers) a tendence to higher density values during the high tides was noted, indicating zooplankton exchange between estuarine and coastal zone (Figure 24).

The reef area has also general tendence to higher density values during the summer (seasonal differences), and all the stations have higher density values during high tides (Figures 25 and 26). Nematoda and Rotifera shows higher density at stations R3, R4 and C2 (urbanized area), indicating human influence in the area (domestic wastes through Maceió River).

The reef area presents great number of euryhaline species, with higher values of density. Those species are very found in other mangroves in Pernambuco State, as example *Oithona hebes*, *Oithona nana*, *Oithona oswaldocruzi*, and *Parvocalanus crassirostris* (Porto Neto, 1999; Porto Neto *et al*., 2000), showing great influence from mangroves at the coastal reefs of Pernambuco.

The sample from Maceió River mouth was very poor in terms of taxonomical groups, only 5 taxa were found. The total density was about of 927.78 org.m^{-3}, and Rotifera dominated density and abundance (675.40 org.m^{-3}, representing 72.80% of abundance), followed by Nematoda (135.71 org.m^{-3}), and Copepoda nauplii (with 78.57 org.m^{-3}). Only the cyclopoid *Oithona hebes* was found from the Copepoda gruop at the Maceió River mouth. Polycheta larvae are also founded, but with less density.

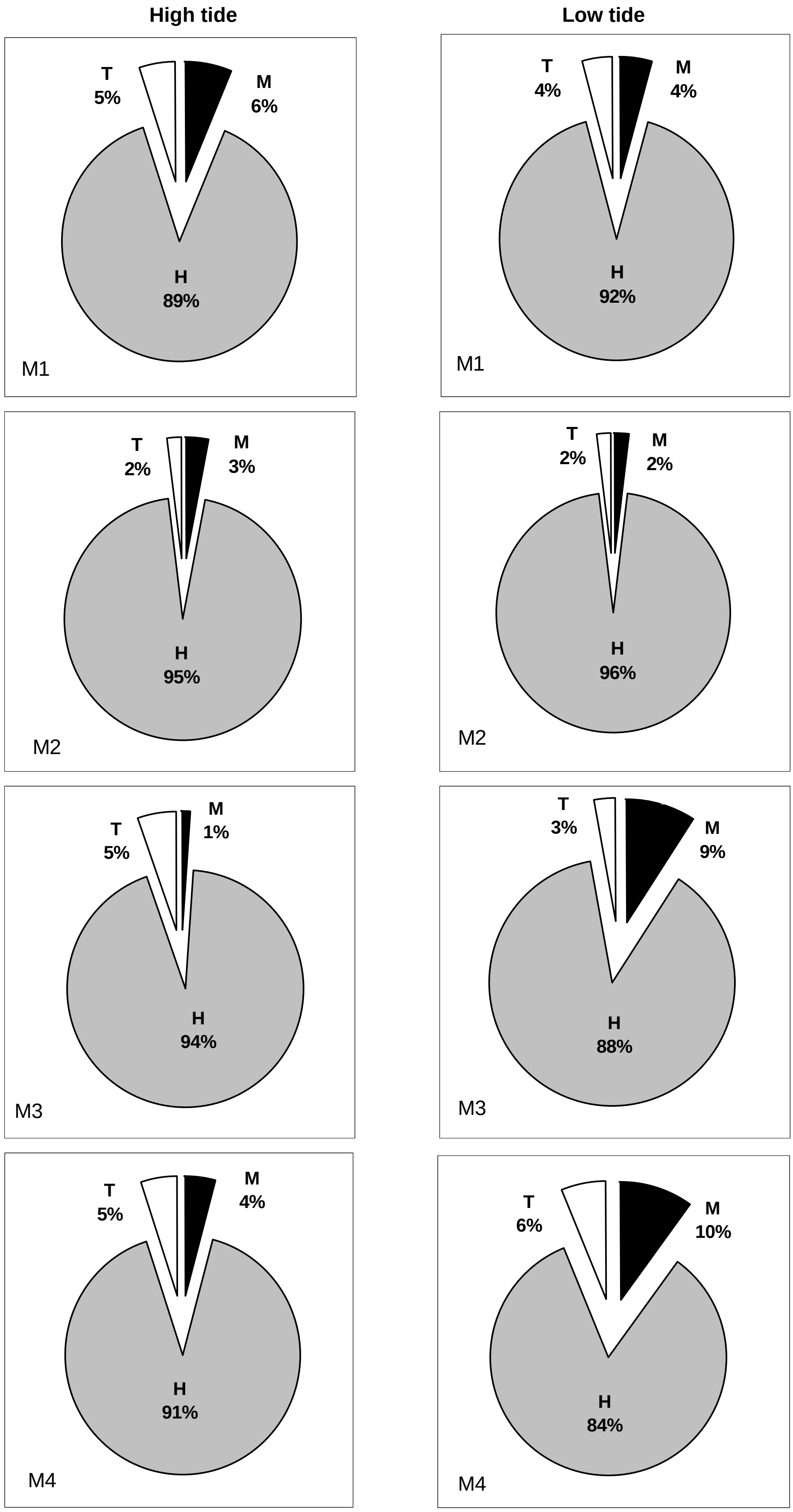


Figure 19: Tico-, mero-, and holoplankton differences between tides at the four mangrove stations (T = Ticoplankton; M = Meroplankton; H = Holoplankton; M1 = Tamandaré Bay; M2 = confluence of estuaries; M3 = Ilhetas estuary; M4 = Mamucaba estuary).

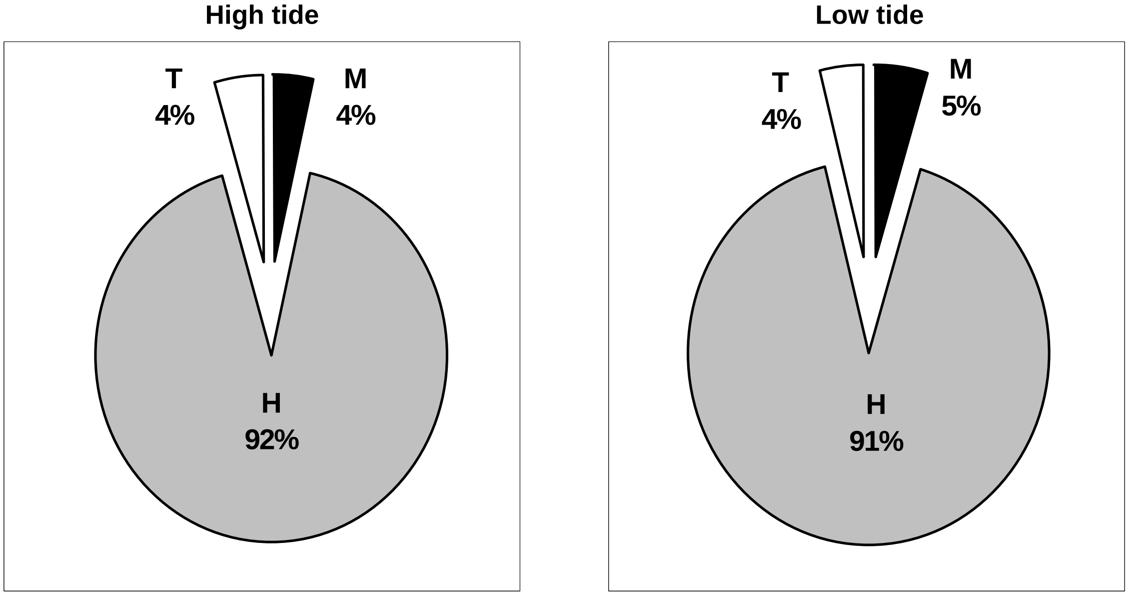


Figure 20: Total annual tico-, mero-, and holoplankton differences between tides at the mangrove area (T = Ticoplankton; M = Meroplankton; H = Holoplankton).

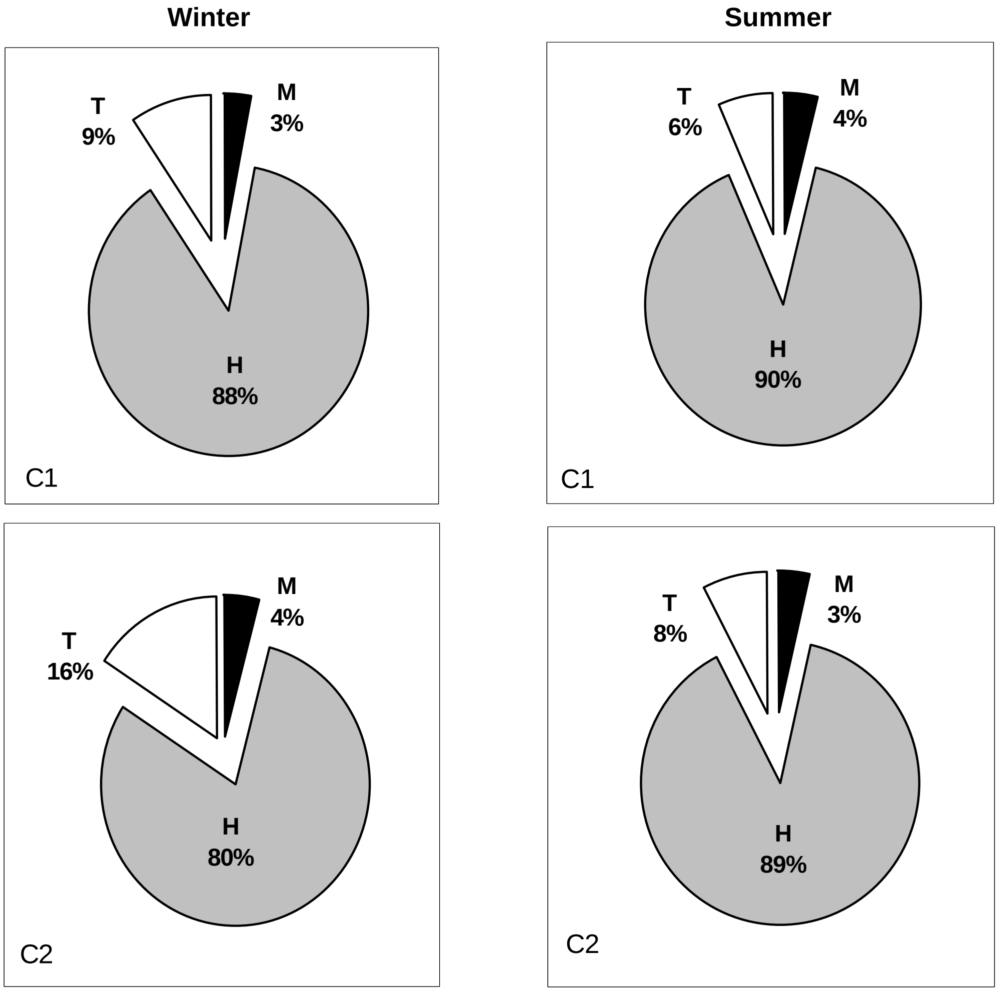


Figure 21: Tico-, mero-, and holoplankton differences between seasons for the stations C1 and C2, on the reef area (T = Ticoplankton; M = Meroplankton; H = Holoplankton; C1 = Channel 1; C2 = Channel 2).

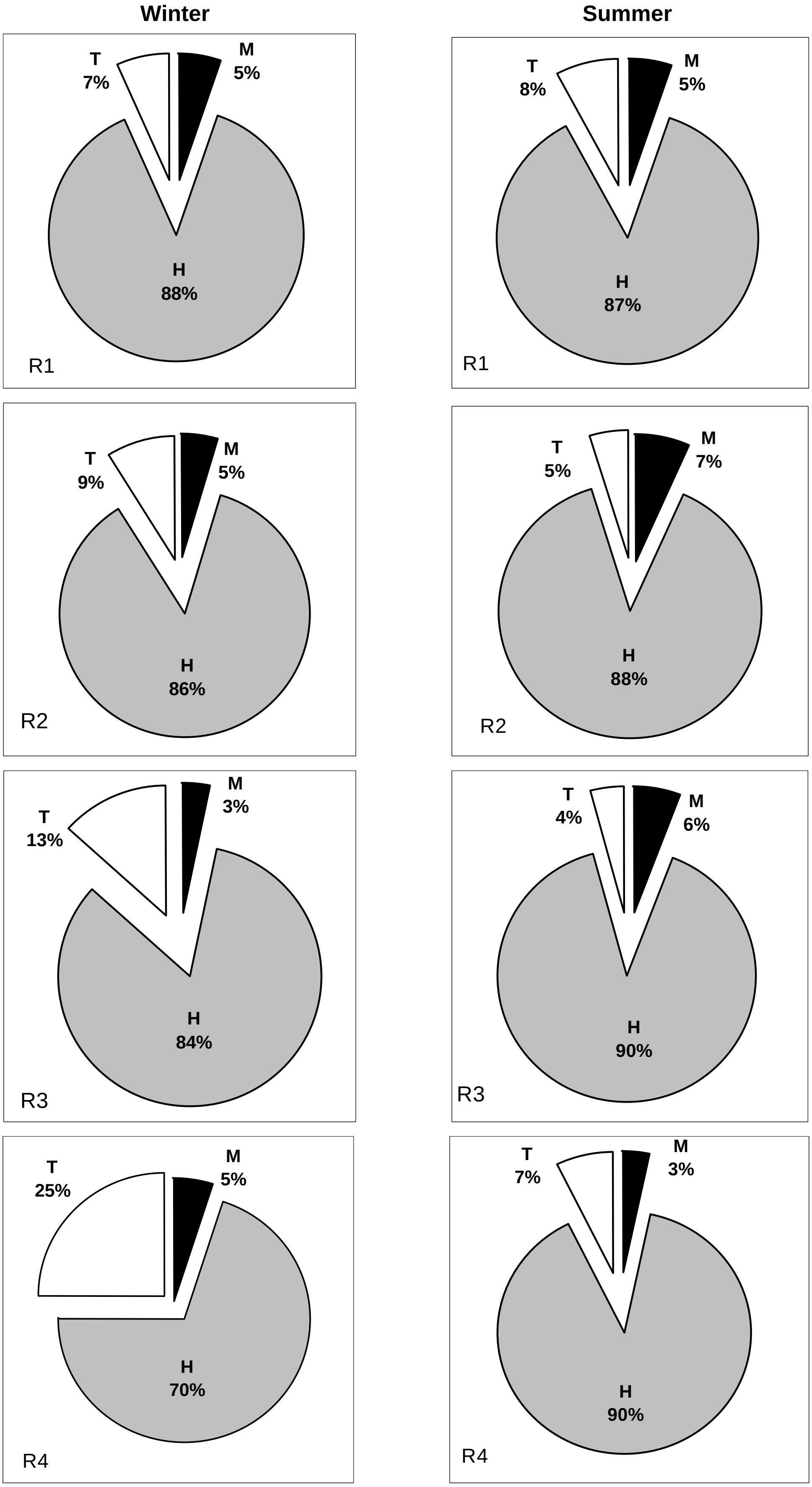


Figure 22: Tico-, mero-, and holoplankton differences between seasons for the stations R1, R2, R3 and R4, on the reef area (T = Ticoplankton; M = Meroplankton; H = Holoplankton; R1 = Closed area; R2 = reef close to the "Closed Area"; R3 = Pirambú reef; R4 = Picão Stone).

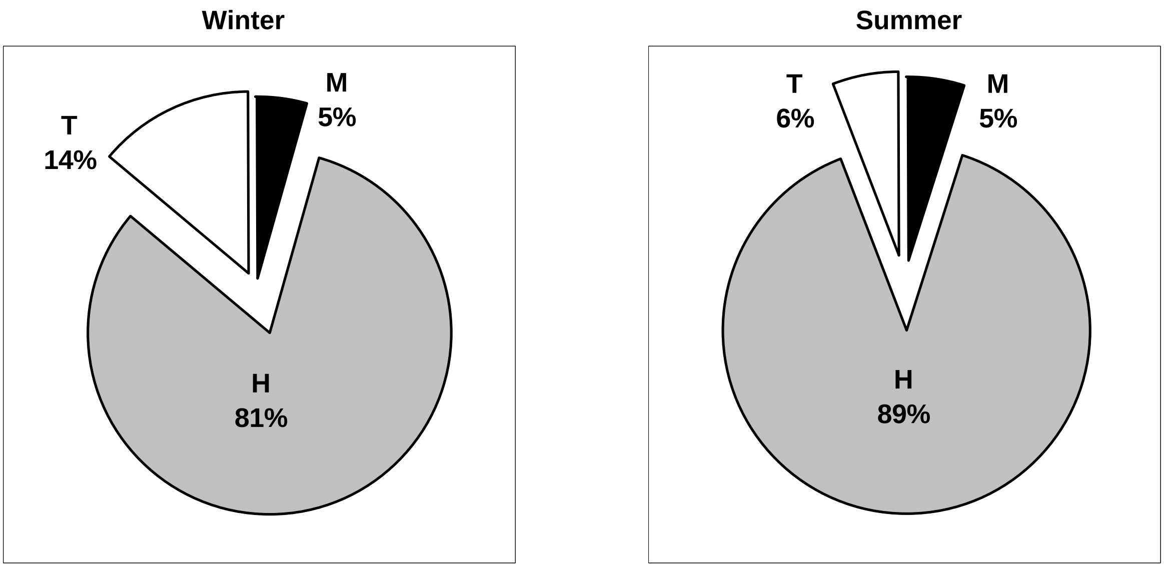


Figure 23: Total tico-, mero-, and holoplankton differences between seasons at the reef area (T = Ticoplankton; M = Meroplankton; H = Holoplankton).

4.2.2 Abundance and regional distribution

Copepoda nauplii and Copepoda (like the dominant *Oithona hebes*), are the principal component of the zooplankton community in the mangrove area, also in the reef area. The total abundance of Copepoda and Copepoda nauplii was 80.9% (mangrove area), 66.9% (reef area - non-urbanized area), and 59.6% (reef area, at the urbanized area). At the Maceió River mouth the total abundance of Copepoda and Copepoda nauplii was 12.06% (Tables 3, 4, and 5).

At mangrove area, Tintinnina has great abundance. The most common Tintinnina was *Tintinnopsis nordqvivsti* (4.45%), followed by *Favella ehrenbergii* (3,52%). Rotifera was not found at the mangrove area. The total abundance for Nematoda was not significant at the four stations in the mangrove area. 44.59% of the total abundance was represented by Copepoda nauplii, followed by Copepoda (36.31%). The most common Copepoda was the cyclopoid *Oithona hebes* (15.04%), followed by the calanoid *Parvocalanus crassirostris* (6.16%), and the cyclopoid *Oithona oswaldocruzi* (5.54%). Others Crustacea were not very abundant, and their highest abundances was about of 1% at station M3 (in summer). Brachyura (zoea) has about 0.1% of the total abundance at the mangrove area.

For the non-urbanized area, Tintinnina has also great abundance. The station R1 ("Closed area") has the large value of Tintinnina abundance, with almost 33% (more than the adult Copepoda). *Favella ehrenbergii* (6.9%), *Tintinnopsis nordqvisti* (3.01%), and *Codonellopsis morchella* forma *typica* (2.32%) were the most common Tintinnina. Rotifera has larger abundance at station R2 in summer (6.44%).

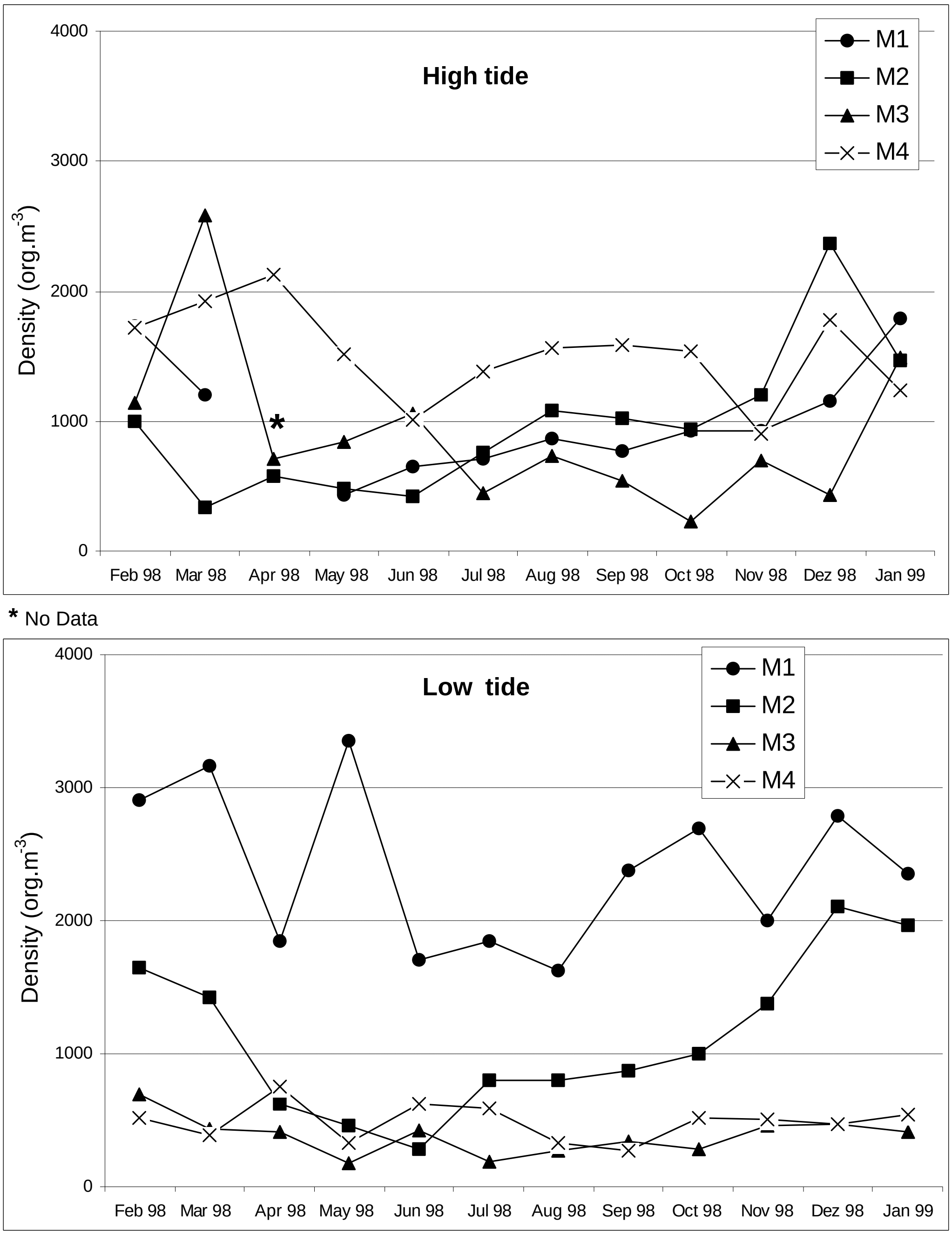


Figure 24 : Zooplankton density at mangrove area (for low and high tides).

The station C1 has also large abundance of Rotifera during winter, with almost 3%. The most common Rotifera were *Brachionus plicatilis* and *Trichocerca* spp*.* The species *Brachionus plicatilis* represents 1.77% and 0.4% of abundance at station C1 (for winter and summer), 0.4% at station R1 (only during the winter), and 3.33% and 0.4% at station R2 (for winter and summer), been more abundant during the winter. *Brachionus plicatilis* was followed by *Trichocerca* spp*.*, with 0.66% and 0.46% (at station C1, during the winter and summer), 0.6% and 0.1% (at station R1 during the winter and summer), and 0.6% and 2.4% (at station R2 during the winter and summer) of abundance. *Rotaria* spp. was not found in the non-urbanized area. Nematoda represent almost 1% of the total abundance in the non-urbanized area. However, at station C1 the abundance of Nematoda was about 4% in summer and winter. Copepoda has abundance between 23% and 31%. Copepoda nauplii were also very significant (between 24 and 46% of the total abundance). The most common Copepoda in the non-urbanized area was *Oithona hebes*, with 8.68% of total abundance, followed by *Parvocalanus crassirostris* (4.92%), and *Oithona oswaldocruzi* (4.69%). Other Crustacea are about 1% and 4.5% abundant. The most common Crustacea (other than Copepoda) are: Cumacea (0.5% of the total abundance), adult Isopoda (0.4% of the total abundance), and Epicaridae larvae (0.3% of the total abundance). Larvacea (*Oikopleura dioica*) was also abundant, mainly at station C1 during the summer, with about of 5% of abundance.

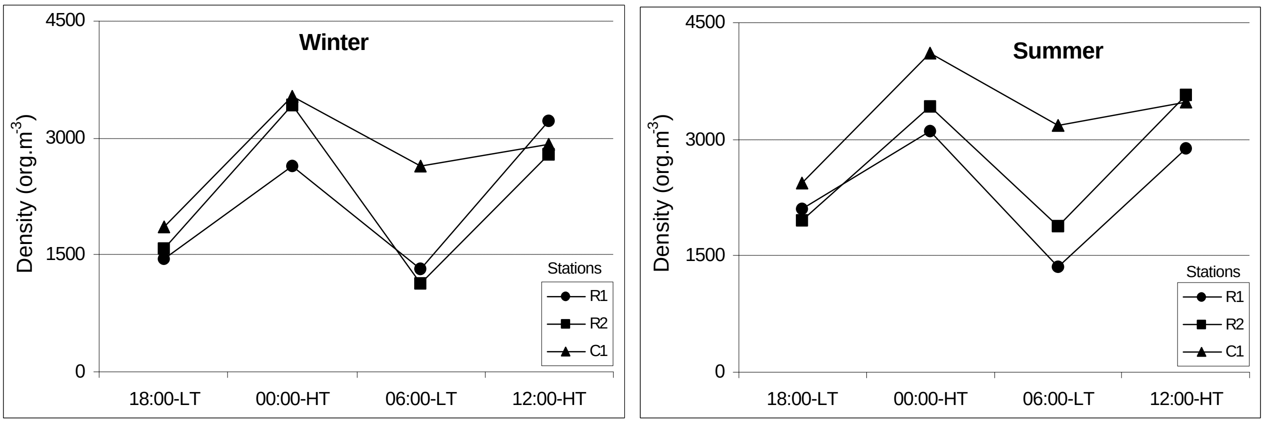


Figure 25: Zooplankton density at the non-urbanized area (LT = low tide; HT = high tide).

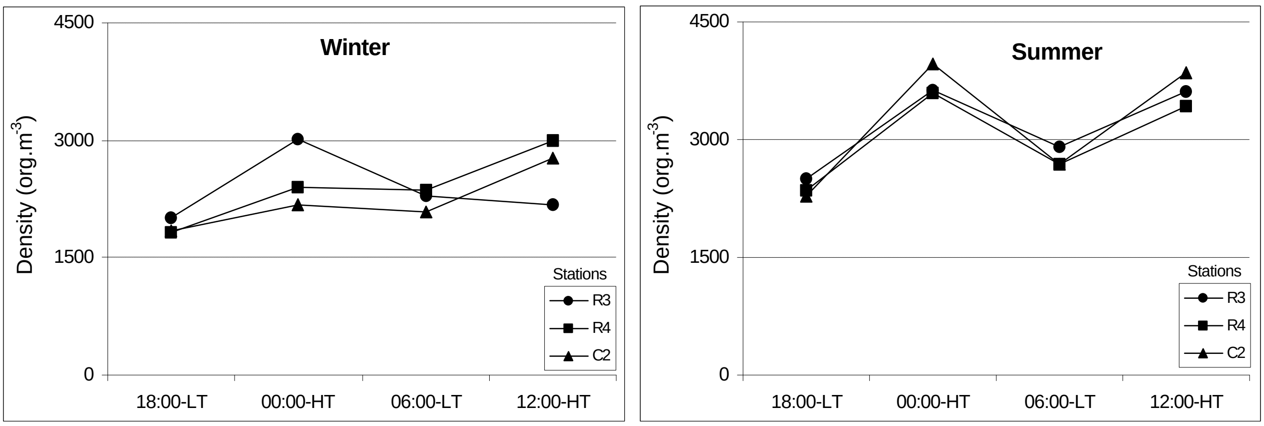


Figure 26: Zooplankton density at the urbanized area (LT = low tide; HT = high tide).

The urbanized area has also larger abundance of Tintinnina (higher than the non-urbanized area), with maximum at station C2 during the winter, 37.62% (more than the double of adult Copepoda abundance at station C2, during the winter). The most common Tintinnina were also the same of the non-urbanized area: *Favella ehrenbergii* (6.41%), *Tintinnopsis nordqvisti* (3,31%), and *Codonellopsis morchella* forma *typica* (about of 3%). Rotifera has larger abundance in this area, 9.38% at station R4 during the winter and 8.80% at station R3 during the summer. The most common Rotifera was also the same of the non-urbanized area: *Brachionus plicatilis* with 1.52% and 0.5% at station C2 (for winter and summer), 3% and 2.9% at station R3 (for winter and summer), and 4.8% and 2.4% at station R4 (for winter and summer), followed by *Trichocerca* spp., with 1.5% and 0.5% at station C1 (for winter and summer), 0.3% and 2.9% at station R3 (for winter and summer), and 4% and 2% at station R4 (for winter and summer). Nematoda represent almost 2% of total abundance in the urbanized area. However, at stations R3 and R4 the abundances of Nematoda represent about of 5% and 6%. At station C2 the abundance of Nematoda was higher only during the winter, about of 3%. Copepoda show abundances between 12% and 30% at the three stations in the urbanized area (less than the non-urbanized area). Copepoda nauplii were also very significant, between 20 % and 49 % of abundance at the three stations in the urbanized area. The most common Copepoda in the urbanized area was also the species *Oithona hebes*, with 7.9% of the total abundance, followed by *Parvocalanus crassirostris* (4.4%), and *Oithona oswaldocruzi* (3.8%). Other Crustacea are about of 2% and 4% abundant, been mainly represented by Cumacea (0.5% of the total abundance), Amphipoda (0.4% of the total abundance), nauplii of *Balanus* spp. (0.2% of the total abundance), and Misidacea (0.2% of the total abundance). *Oikopleura dioica* was not very abundant, been found in the urbanized area with less of 1%, at the three stations.

The Maceió River mouth shows no proportional ratio between taxa. Rotifera represent 72.8% of the total abundance (Table 5). *Brachionus plicatilis* was more abundant (41.65%), followed by *Trichocerca* spp. (23.31%), *Platyias quadricornis* (15.09%), *Lecane bulla* (6.01%), *Brachionus palutus* (5.76%), *Synchaeta spp*. (4.65%), and *Rotaria* spp. (3.52%). Nematoda represent 14.6%, and Copepoda (only *Oithona hebes*) 3.59% of the total abundance. Copepoda nauplii represent about of 8.5% of the total abundance. Moreover, Rotifera represent 4.01% of the total abundance in the whole reef area (maximal value was 9.38% at station R4 during the winter, and the minimal was 0.10% at station R1 during the summer).

Foraminifera have large abundances at the three regions (mangrove, non-urbanized, and urbanized area). This ticoplankton group in the mangrove area has abundances between 1% and 5.6%, with total abundance about of 4%. Foraminifera have abundances between 4% and 7.2% at the three stations in the non-urbanized area, with total abundance of 5.53%. The urbanized area has higher values for Foraminifera abundance: between 3% and 18.5%, with total abundance about of 8%.

The regional distribution for zooplankton shows that the mangrove area has more abundance stability between stations and seasons (Figures 27 and 28). Higher concentrations of Nematoda and Rotifera are more visible at the urbanized area. When the concentrations of Nematoda and Rotifera are higher, a decrease in the concentrations of Tintinnina, Copepoda and Copepoda nauplii was noted in the reef area (Figures 29, 30, and 31). The stations C1 and C2 have less concentrations of Nematoda and Rotifera, possibly due to oceanographic conditions (more turbulence through tides and currents; depth, etc.). Tintinnina are very abundant, mainly during winter at reef area. However, Tintinnina were very found in these stations.

The total abundance values for the reef area (including results from the Maceió River mouth) suggest that the Maceió River represents source of Nematoda and Rotifera for the urbanized area (Figure 31).

Table 3: Zooplankton abundance (%) at the mangrove area.

	M1 Winter	M1 Summer	M2 Winter	M2 Summer	M3 Winter	M3 Summer	M4 Winter	M4 Summer	Total Abundance
Foraminifera	3.87	5.14	2.45	1.70	4.29	3.27	5.63	5.13	3.96
Tintinnina	9.16	8.91	11.91	18.66	4.73	15.00	5.73	5.43	10.19
Nematoda and Polychaeta	0.34	0.45	0.22	0.20	0.31	0.94	1.10	0.96	3.56
Copepoda	39.70	31.45	24.72	36.23	42.11	35.05	36.08	37.98	36.31
Copepoda (nauplii)	41.05	48.71	57.31	41.24	44.76	36.80	45.15	43.89	44.59
Crustacea (others)	0.43	0.89	0.49	0.27	0.46	1.12	0.44	0.64	0.56
Others (*)	5.44	4.46	2.91	1.70	3.36	7.84	5.87	5.98	0.83

* Cnidaria; Bryozoa; Chaetognatha; Fish (eggs and larvae)

Table 4: Zooplankton abundance (%) at the non-urbanized area.

	R1 Winter	R1 Summer	R2 Winter	R2 Summer	C1 Winter	C1 Summer	Total Abundance
Foraminifera	5.48	5.67	7.23	4.27	6.11	4.84	5.53
Tintinnina	32.79	8.02	17.61	14.45	22.70	6.33	16.20
Rotifera	1.09	0.10	1.14	6.44	2.97	0.97	2.19
Nematoda	0.54	0.92	0.96	0.56	3.93	4.48	0.97
Polychaeta	0.81	1.10	0.88	0.64	0.92	0.56	0.80
Copepoda	26.46	30.77	29.43	31.24	23.32	31.66	30.12
Copepoda (nauplii)	24.27	46.23	34.07	35.11	35.94	41.86	36.73
Crustacea (others)	4.45	3.56	4.72	2.19	1.84	2.17	3.01
Larvacea	1.01	0.87	1.03	0.59	0.37	4.79	1.61
Others (*)	3.11	2.77	2.93	4.52	1.88	2.34	2.90

* Cnidaria; Kinorincha; Mollusca; Polychaeta; Bryozoa; Ascidiidae; Equinodermata; Chaetognatha; Fish (eggs and larvae)

Table 5: Zooplankton abundance (%) at the urbanized area, and comparison with the Maceió river.

	R3 Winter	R3 Summer	R4 Winter	R4 Summer	C2 Winter	C2 Summer	Total Abundance	Maceió river
Foraminifera	7.54	3.06	18.51	5.70	11.36	5.54	8.05	-
Tintinnina	20.12	10.03	24.38	15.24	37.62	6.81	17.64	-
Rotifera	3.95	8.80	9.38	7.51	4.40	1.32	5.87	72.80
Nematoda	5.59	3.61	5.36	6.82	2.98	0.50	1.93	14.63
Polychaeta	1.46	0.57	2.43	1.36	0.92	0.97	1.24	0.51
Copepoda	24.75	26.84	12.93	24.55	12.69	30.63	25.14	3.59
Copepoda (nauplii)	31.85	40.08	20.98	33.75	24.16	49.00	34.46	8.47
Crustacea (others)	2.49	2.94	2.03	1.28	2.11	1.82	2.10	-
Larvacea	0.45	0.91	0.55	0.42	0.36	0.98	0.64	-
Others (*)	1.82	3.16	3.44	3.37	3.41	2.44	2.93	-

* Cnidaria; Kinorincha; Mollusca; Polychaeta; Bryozoa; Ascidiidae; Equinodermata; Chaetognatha; Fish (eggs and larvae)

4.2.3 Frequency

The more frequent organisms of the mangrove and reef areas were *Oithona hebes, Oithona oswaldocrusi,* and Copepoda nauplii, with 100% of frequence. They were followed by *Parvocalus crassirostri*, Foraminifera (others), *Favella ehrenbergii*, *Tintinnopsis nordqvivsti*, *Oithona nana*, Harpacticoida (others), *Balanus* spp, with more than 90% of frequency, showing likeness among zooplankton composition between both areas (Figures 32 and 33). Tintinnina was generally very frequent in the both areas (mainly *Tintinnopsis nordqvisti*; *Tintinnopsis tocantinensis*, and *Favella ehrenbergii*).

At the Mangrove area, Nematoda are 44% frequent, but not very abundant. Cnidaria, *Calanopia americana*, Cumacea, Bryozoa, and others are infrequent, with less than 10%. Foraminifera are much frequent at the mangrove area (Figure 32).

At the reef area, Nematoda and Rotifera are very frequent. They were much frequent mainly at stations R3, R4, and C2 (in front of the urbanized zone of the Tamandaré City), between 38% and 100% (Figures 33 and 34). Foraminifera was also much frequent at all the stations.

The zooplankton community has similar frequency values at the non- and urbanized areas (Figures 33 and 34). However, in the non-urbanized area, Rotifera do not reached values above 67% of frequency (for *Brachionus plicatilis* and *Trichocerca* spp.), and Nematoda reached 92% of frequency (Figure 33). In the urbanized area, *Brachionus plicatilis* and Nematoda reached 100% of frequency, and *Trichocerca* spp. reached 92% of frequency (Figure 34).

4.2.4 Cluster analysis

. Samples

The Cophenetic Correlation Coefficient for sample associations of the reef area results in C = 0.8. This value indicates that there are different sample groups at the reef area (Figure 35). The cluster analysis produced two main groups:

. Group 1: was sub-divided in two sub-groups: 1A and 1B.

The sub-group 1A contain a great number of samples taken during the winter (W) and samples taken at the urbanized area (C2, R3 and R4), and samples taken during low tides (LT). These results suggest fluvial influences when the rainfall rates are higher (winter - rainy season). This group suggests also an different group of samples at the urbanized area, where the anthropic influences are more evident.

The sub-group 1B shows arrangements between samples taken during summer (S), high tides (HT) and most from non-urbanized area. At the non-urbanized area the direct fluvial influence of the Maceió River is lower at the non-urbanized area, and during the summer the fluvial influences (from other rivers at the Tamandaré coast) are also lower.

. Group 2: contain only four samples, taken at station R4 (urbanized area), indicating that the station R4 has more differences (comparing with the other stations of the reef area) and more direct influence from the Maceió River. This station has more proximity to the Maceió River mouth, and bioindicators of organic pollution are largely found at this station. Three samples are taken during the summer, when the touristic exploration is more strong at Tamandaré Bay.

. Organisms

Results of the cluster analysis for the mangrove area show a estuarine zooplankton structure, formed by tipical organisms from the Brazilian mangroves. The cluster analysis for organisms was made using the Pearsons coefficient method. The Figure 36 shows three groups, with tipical species of the Pernambuco mangroves:

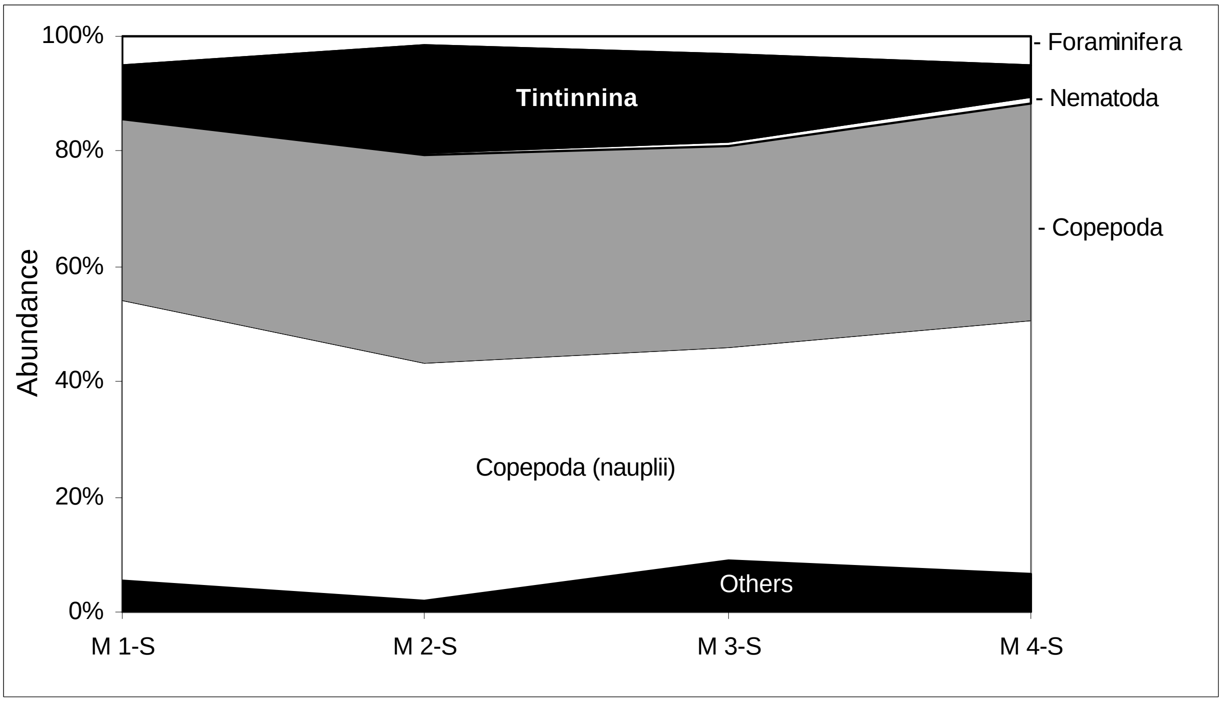


Figure 27: Regional distribution of abundances for the mangrove area (S = summer; M1 = Tamandaré Bay; M2 = confluence of estuaries; M3 = Ilhetas River estuary; M4 = Mamucaba River estuary).

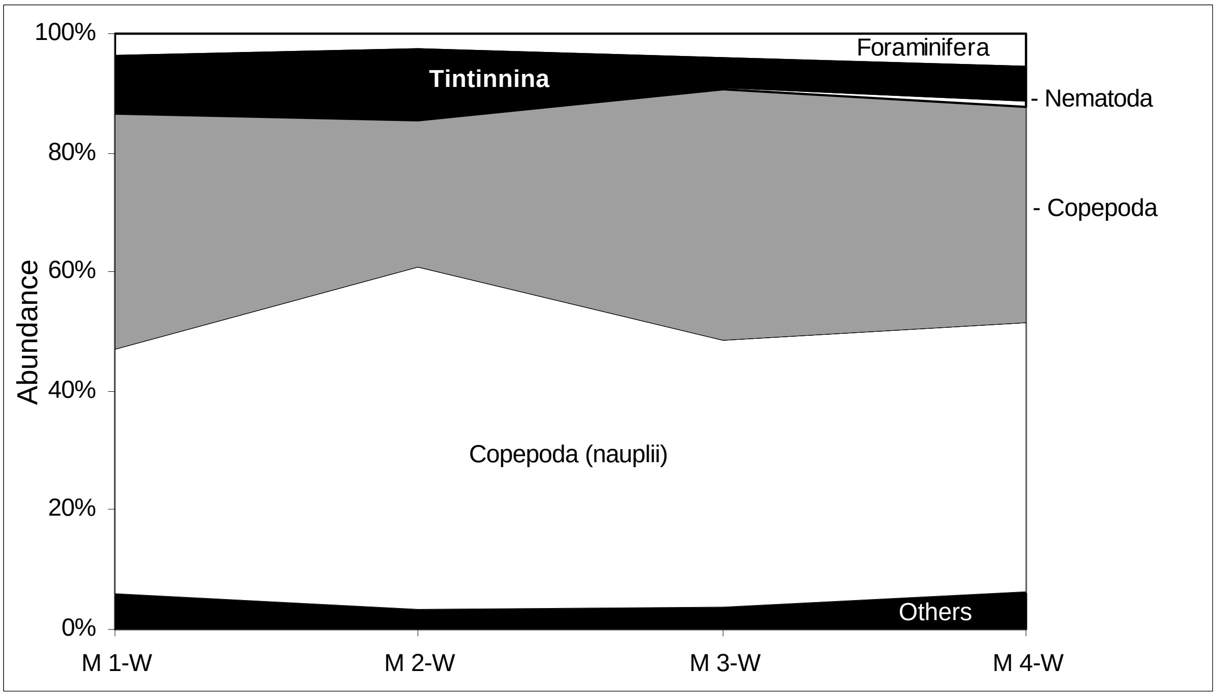


Figure 28: Regional distribution of abundances for the mangrove area (W = Winter; M1 = Tamandaré Bay; M2 = confluence of estuaries; M3 = Ilhetas River estuary; M4 = Mamucaba River estuary).

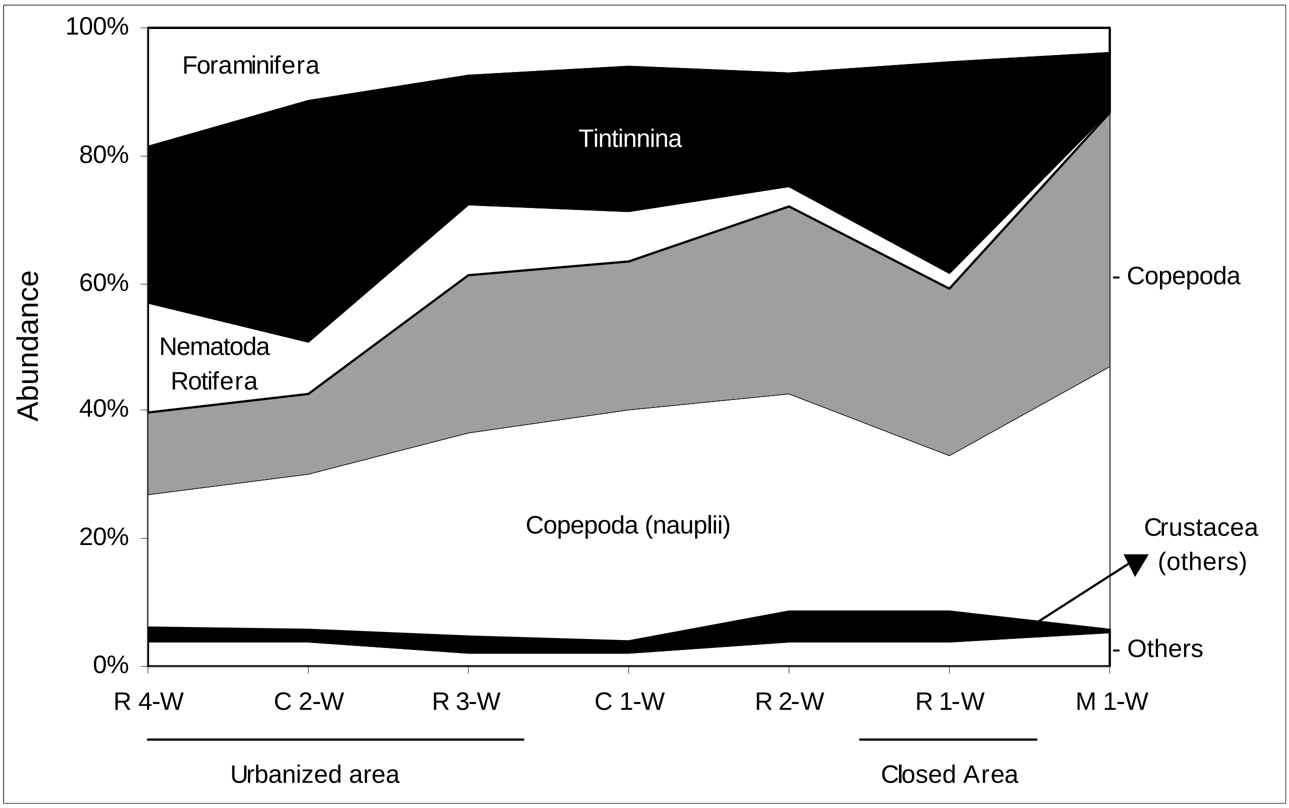


Figure 29: Regional distribution of abundances for the reef area in Winter (W), showed in the geographical sequence of the stations at the reef area: from R4 (Picão Stone), C2 (channel between the Picão Stone and the urban area of the Tamandaré City), R3 (Pirambú reef), C1 (channel between the "Closed Area" and CEPENE), R2 (reef close to the "Closed Area"), R1(Closed Area), to the reference station M1(Tamandaré Bay).

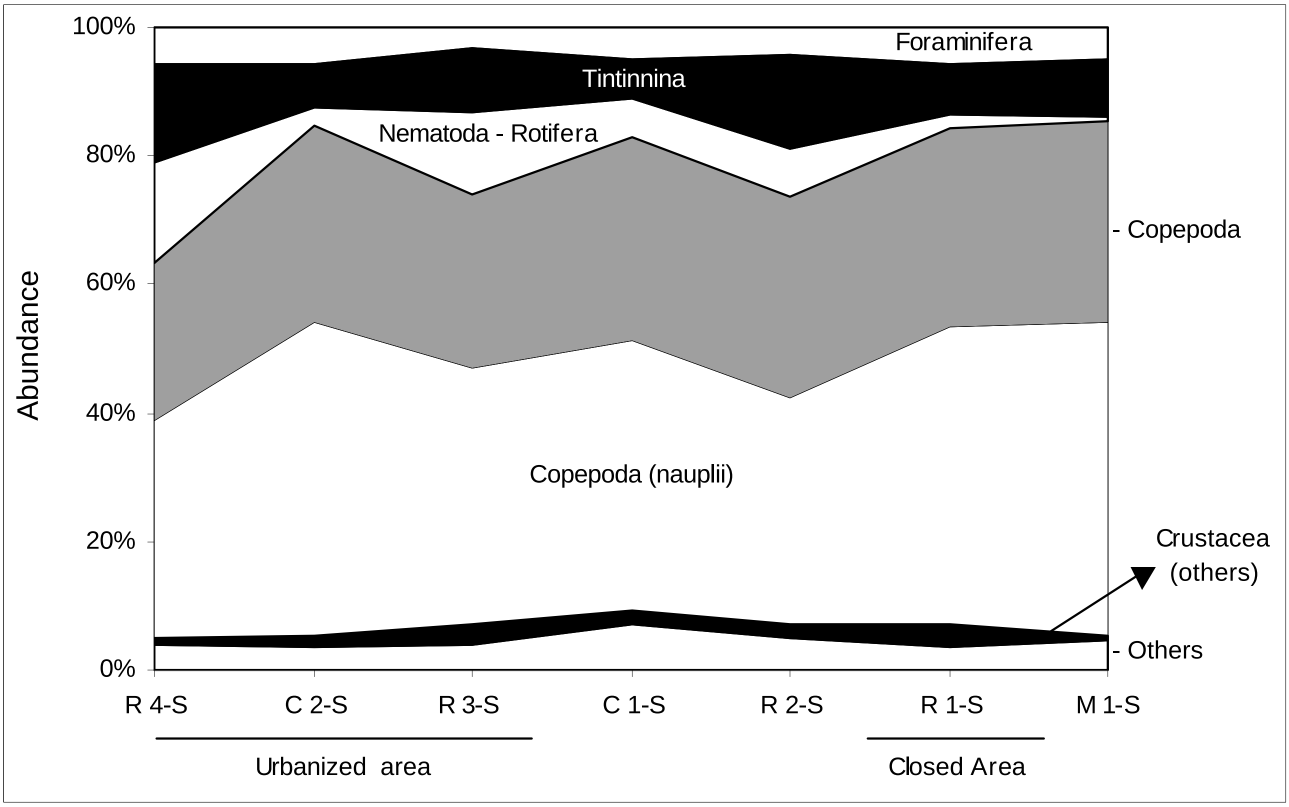


Figure 30: Regional distribution of abundances for the reef area in summer (S), showed in the geographical sequence of the stations at the reef area: from R4 (Picão Stone), C2 (channel between the Picão Stone and the urban area of the Tamandaré City), R3 (Pirambú reef), C1(channel between the "Closed Area" and the CEPENE), R2 (reef close to the" Closed Area"), R1(Closed Area), to the reference station M1(Tamandaré Bay).

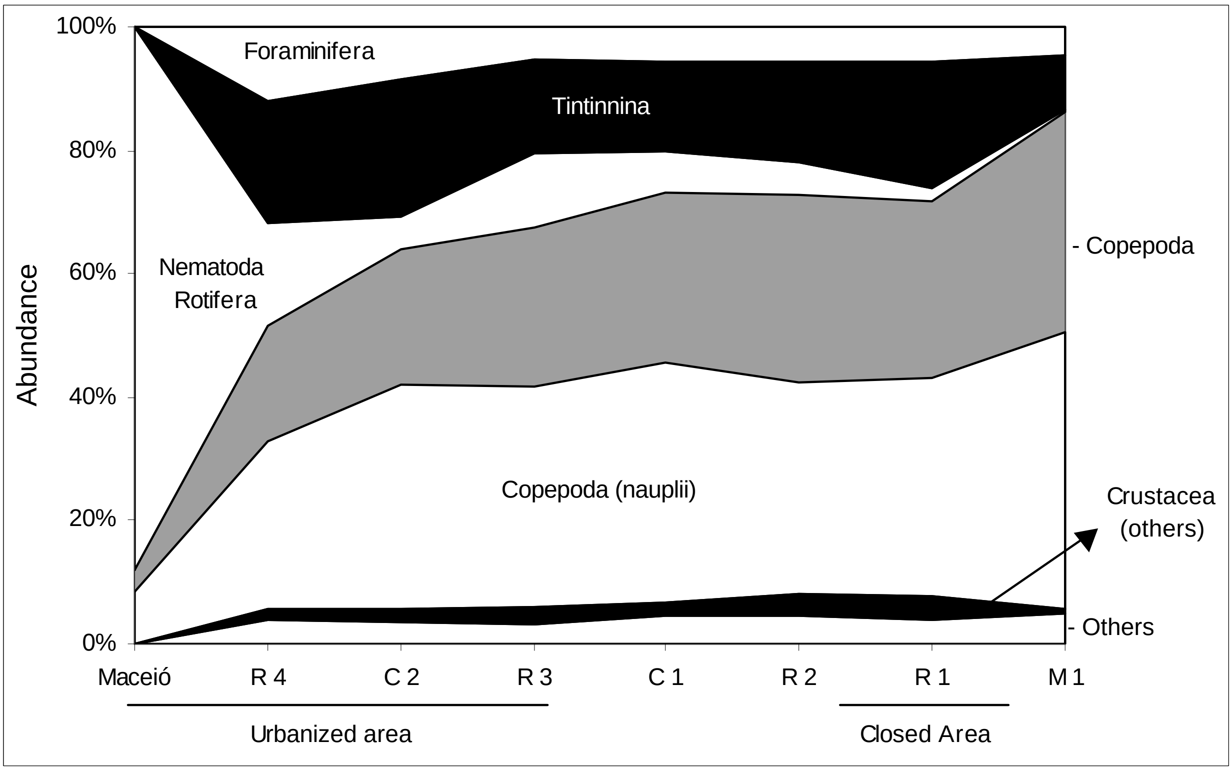


Figure 31: Regional distribution of the total abundances for the reef area (including the Maceió River), showed in the geographical sequence of the stations at the reef area: from R4 (Picão Stone), C2 (channel between the Picão Stone and the urban area of the Tamandaré City), R3 (Pirambú reef), C1 (channel between the "Closed area" and the CEPENE), R2 (reef close to the "Closed Area"), R1 (Closed Area), to the reference station M1 (Tamandaré Bay).

. Group 1: contain the two more abundant and frequent taxa in the mangroves of Tamandaré area, as well as the Pernambuco mangroves (Copepoda nauplii and *Oithona hebes*).

. Group 2: contain tipical euryhaline organisms. The organisms are also found at the reef area.

. Group 3: contain tipical coastal zooplankton groups, like Harpacticoida (others), *Pseudodiaptomus richardi*, *Pseudodiaptomus acutus*, *Acartia lilljeborgi*, *Balanus* spp. (nauplii), and *Oikopleura dioica*.

The characteristic changes of species density and abundance along the reef area (described above) are also expressed at the community analysis. The cluster analysis for the reef area grouped indicators of organic pollution, representing anthropic influence in this area.

Cluster analysis for species from reef area was also performanced with Bray & Curtis coefficient, using the W.P.G.M.A. method of dendrogram connection. The Cophenetic Correlation Coefficient for the association of the species results in C = 0.81, and this value indicate that exist different zooplanktonic groups at the reef area.

For the reef area were identified 6 groups (Figure 37):

. Group 1: is characteristic of the Brazilian northeast estuaries (estuarine euryhaline organisms). The estuarine euryhaline was the dominant group in the area (*Oithona hebes*, *Oithona oswaldocrusi*, *Parvocalus crassirostri* and *Favella ehrenbergii*), showing mangrove influence.

. **Group 2**: is a mix of benthonic euryhaline organisms and coastal zooplankton (Harpacticoida, *Euterpina acutifrons*, *Pseudodiaptomus acutus*, Bivalvia (veliger), *Tintinnopsis tocantinesis*, *Tintinnopsis nordqvisti*).

. **Group 3**: is a mix of coastal benthonic organisms (not very abundant) and coastal zooplankton, with benthic influence, like Nematoda and Foraminifera.

. **Group 4**: the bioindicators of organic pollution with continental origin (Rotifera), also founded at the station on Maceió River mouth, were associated in this group.

. **Group 5a**: is composed by oceanic holoplankton, estuarine and benthonic organisms from the reefs. This group are represented by estuarine, marine and benthic groups (*e.g*. *Lucifer faxoni*, Cnidaria, Pluteus larvae, Ascidiacea, *Microsetella rosea*, Bryozoa, *Oithona plumifera,* Polychaeta, Megalopa, and Caridae - Decapoda).

. **Group 5b**: associated coastal zooplankton with dermesal zooplankton (with estuarine, marine, and benthic influences), with organisms very found at stations in the non-urbanized area (*e.g*. Fish larvae, Parasite Copepoda, *Acartia lilljeborgi*, Amphipoda, Cumacea, Isopoda, Brachyura zoea, and Misidacea).

. **Group 6:** associated ticoplankton organisms: coastal benthonic organisms (Foraminifera).

Differences between the zooplankton assemblage of the urbanized area and the non-urbanized area were shown in the cluster analysis. The stations are aligned in a south to north direction (from the non-urbanized area to the urbanized area), which probably reflects the nutrients gradient at the reef area. At the northern stations (MR, R3, R4 and C2 - urbanized area), where the influence of the Maceió River became more prominent, the surface rates of nutrients increase.

4.2.5 Diversity and Eveness

At the mangrove area, the zooplankton diversity shows generally intermediate values. Eveness values are in general even (Figures 38 and 39). The mangrove area shows diversity means about of 2.6 *bits*.ind^{-1}, for summer and winter. Eveness values was practically constant, with values about of 0.56 *bits*.ind^{-1}.

At the reef area, diversity values are in general high owing to the presence of holoplankton, which is largely composed of Copepoda, Arrowworms (Chaetognatha), and Tintinnina. The reef area shows diversity means about of 3.6 and 4.1 *bits*.ind^{-1} for summer and winter (Figure 40). Eveness was also practically constant, with values about of 0.56 *bits*.ind^{-1} (Figure 41).

The Maceió River shows intermediate diversity value. However, this was the lowest value reached, 1.67 *bits*.ind^{-1}. The eveness was high (even), 0.75 *bits*.ind^{-1}.

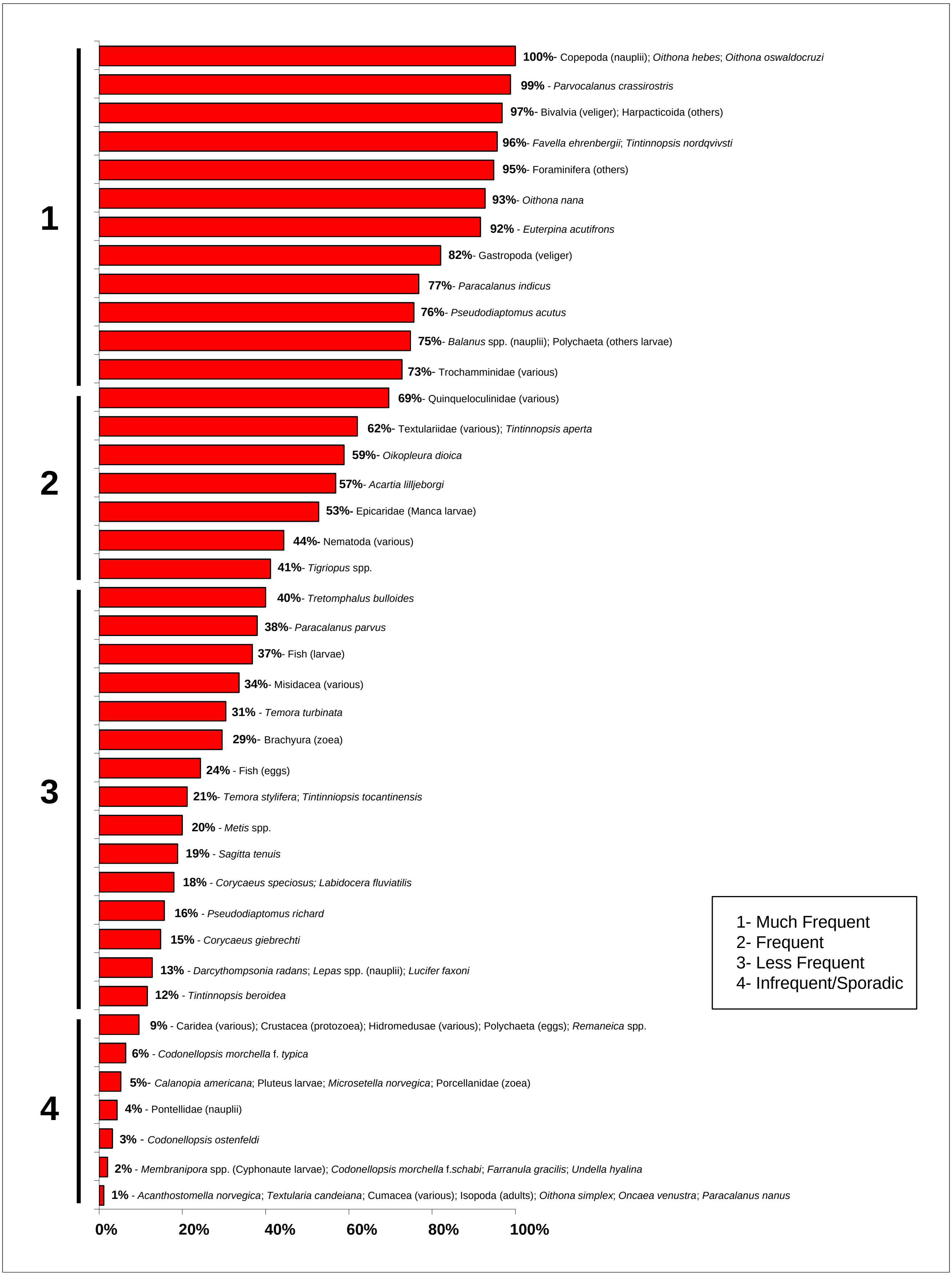


Figure 32: Zooplankton frequency (F) at the mangrove area.

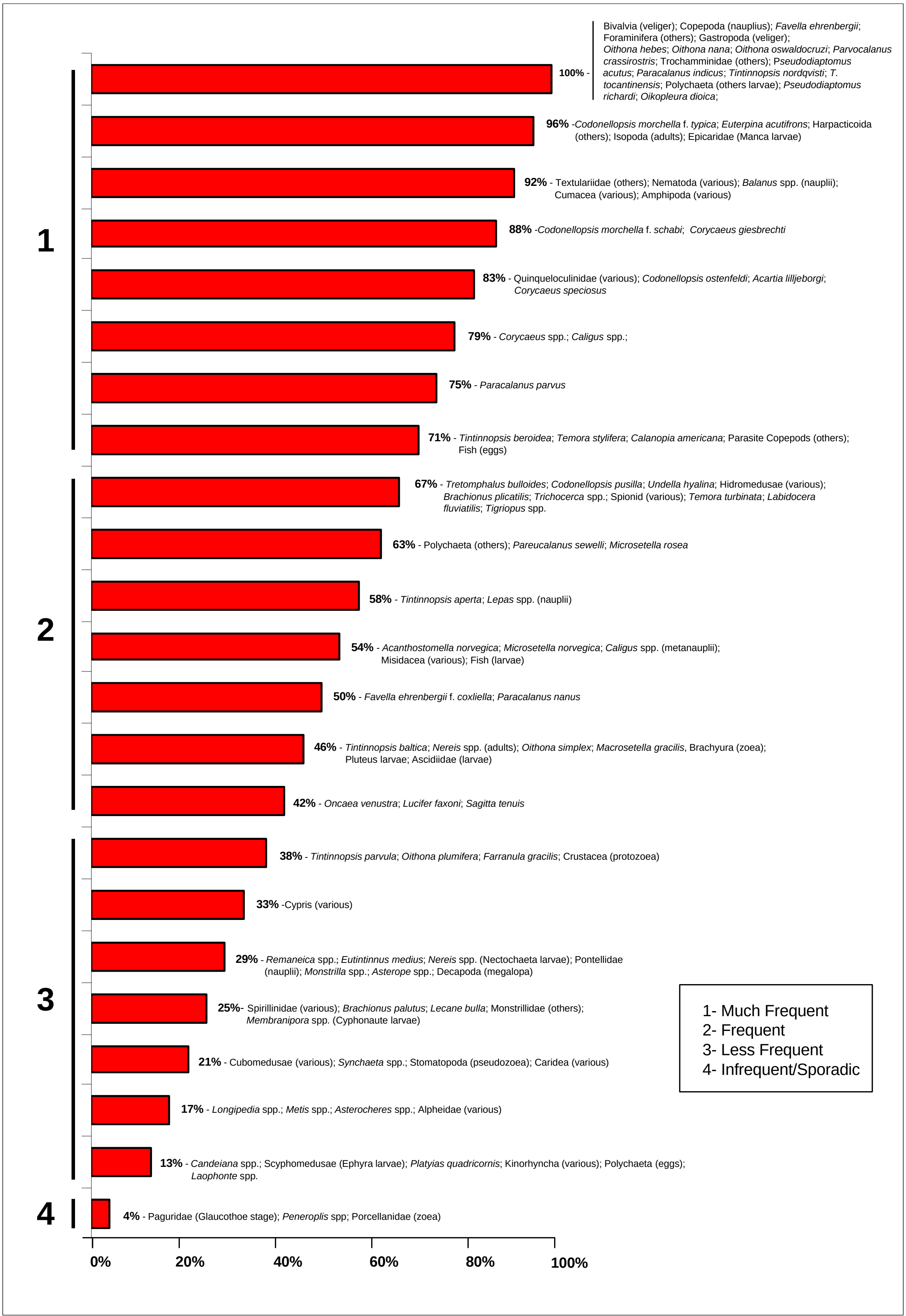


Figure 33: Zooplankton frequency (F) at the non-urbanized area.

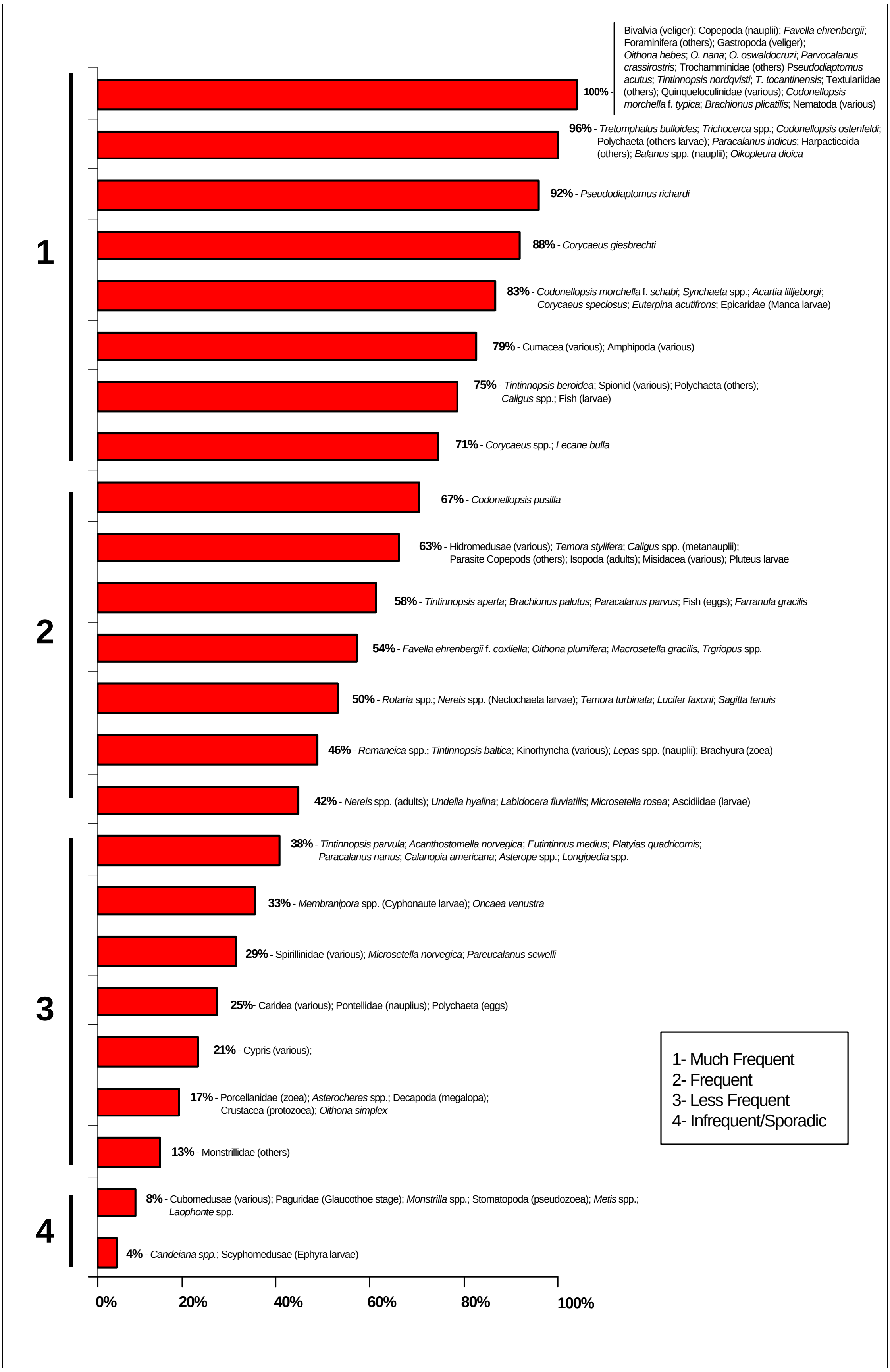


Figure 34: Zooplankton frequency (F) at the urbanized area.

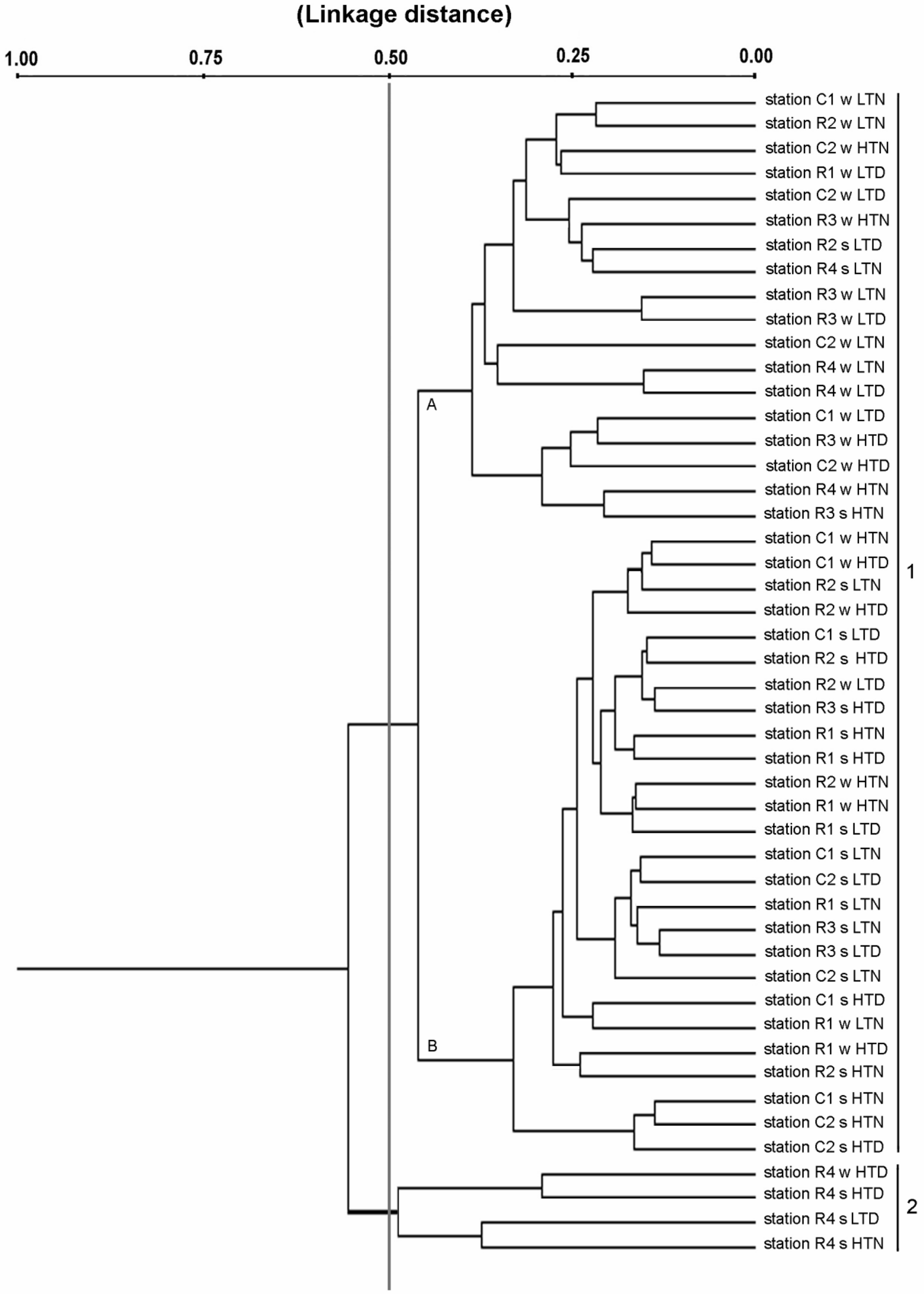
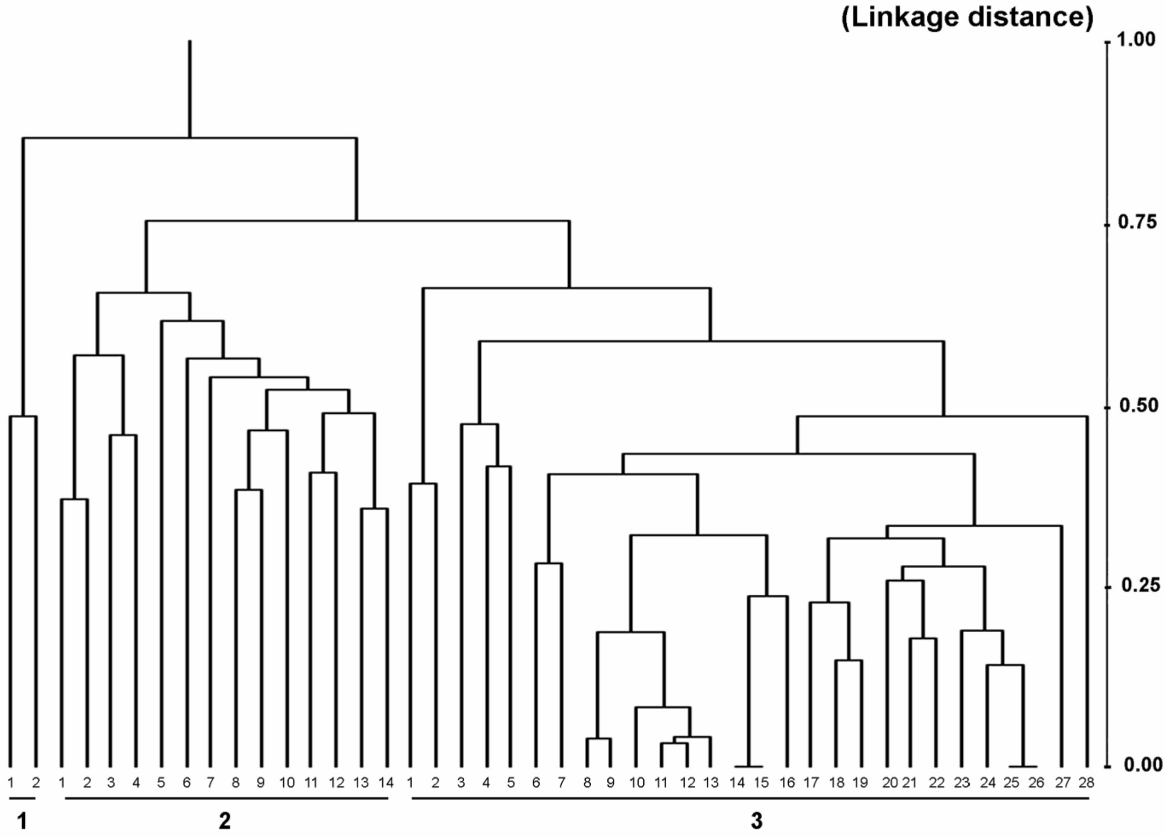


Figure 35: Samples associations at the Tamandaré reef area. (s = summer; w = winter; HT = high tide; LT = low tide; D = diurnal; N = nocturne)



Cluster 1:

1 Copepoda (others nauplii)
2 *Oithona hebes*

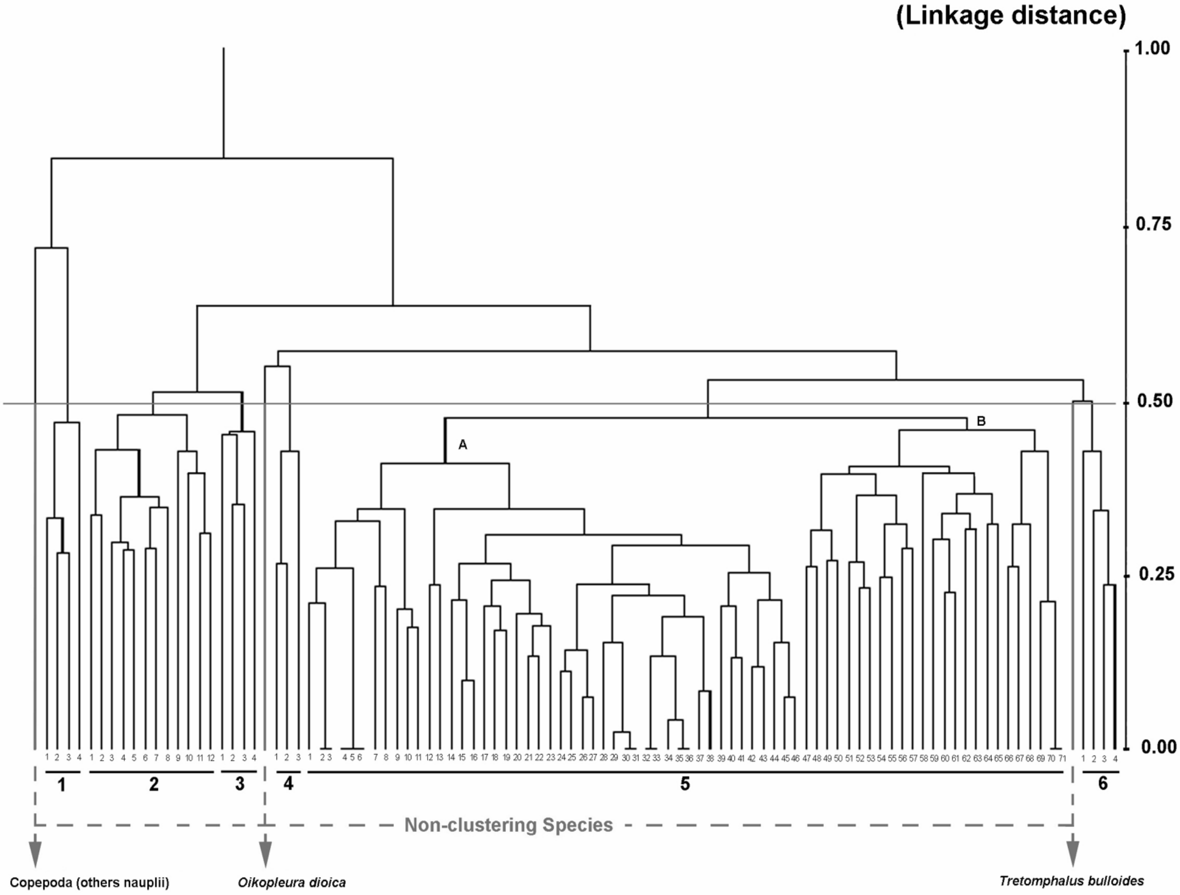
Cluster 2:

1 *Oithona oswaldocruzi*
2 *Parvocalanus crassirostris*
3 *Favella ehrenbergii*
4 *Tintinnopsis nordqvisti*
5 *Tintinnopsis aperta*
6 *Oithona nana*
7 *Euterpina acutifrons*
8 Bivalvia (veliger)
9 Gastropoda (veliger)
10 Foraminiferida (others)
11 *Paracalanus parvus*
12 *Tintinnopsis tocantinensis*
13 *Paracalanus indicus*
14 Trochamminidae (others)

Cluster 3:

1 Harpacticoida (others)
2 Polychaeta (others larvaes)
3 *Acartia lilljeborgi*
4 *Pseudodiaptomus acutus*
5 Quinqueloculinidae (various)
6 Epicaridae (Manca larvae)
7 *Labidocera fluviatilis*
8 Fish (eggs)
9 *Lucifer faxoni*
10 Misidacea (various)
11 Fish (larvaes)
12 *Sagitta tenuis*
13 *Metis* ssp.
14 *Lepas* ssp.
15 *Corycaeus speciosus*
16 *Pseudodiaptomus richardi*
17 *Balanus* ssp.
18 *Temora turbinata*
19 Nematoda (various)
20 *Oikopleura dioica*
21 Brachyura (zoea)
22 *Triguiopus* ssp.
23 *Corycaeus giesbrechti*
24 *Temora stylifera*
25 *Darcythompsonia radans*
26 *Tintinnopsis beroidea*
27 Textulariidae (various)
28 *Tretomphalus bulloides*

Figure 36: Species associations at the mangrove area.



Cluster 1:

1 *Oithona hebes*
2 *Oithona oswaldocruzi*
3 *Parvocalanus crassirostris*
4 *Favella ehrenbergii*

Cluster 2:

1 *Trichocerca* spp.
2 *Brachionus plicatilis*
3 Harpacticoida (others)
4 *Euterpina acutifrons*
5 Gastropoda (veliger)
6 *Pseudodiaptomus acutus*
7 Bivalvia (veliger)
8 *Tintinnopsis tocantinensis*
9 *Oithona nana*
10 *Codonellopsis morchella* f. *typica*
11 *Tintinnopsis nordqvisti*
12 Foraminiferida (others)

Cluster 3:

1 Nematoda (various)
2 *Codonellopsis ostenfeldi*
3 *Codonellopsis morchella* f. *schabi*
4 Trochamminidae (various)

Cluster 4:

1 *Synchaeta* spp.
2 *Lecane bulla*
3 *Brachionus palutus*

Cluster 5A:

1 Polychaeta (others)
2 Caridea (various)
3 *Platyias quadricornis*
4 *Metis* spp.
5 *Rotaria* spp.
6 Cubomedusae (various)
7 Spionid (various)
8 *Eutintinnus medius*
9 *Paracalanus parvus*
10 *Acanthostomella norvegica*
11 *Tintinnopsis beroidea*
12 Pluteus larvae
13 *Pareucalanus sewelli*
14 *Caligus* spp.
15 Decapoda (megalopa-various)
16 *Farranula gracilis*
17 *Microsetella rosea*
18 *Caligus* spp. (metanauplii)
19 *Microsetella norvegica*
20 Fish (larvaes)
21 *Lepas* spp. (nauplii)
22 *Triguiopus* spp.
23 *Oncaea venustra*
24 *Asterope* spp.
25 Monstillidae (others)
26 *Asterocheres* spp.
27 *Macrosetella gracilis*
28 Cypris (various)
29 Cyphonaute larvae
30 Pontellidae (nauplii)
31 Polychaeta (eggs)
32 Crustacea (protozoea - various)
33 *Longipedia* spp.
34 *Oithona plumifera*
35 Stomatopoda (pseudozoea)
36 Kinorhynca (various)
37 *Monstilla* spp.
38 *Tintinnopsis parvula*
39 *Paracalanus nanus*
40 Hidromedusae (various)
41 *Undella hyalina*
42 *Nereis* spp. (adults)
43 *Nereis* spp. (Nectochaeta larvae)
44 Ascidiidae (various)
45 *Lucifer faxoni*
46 *Tintinnopsis baltica*

Cluster 5B:

47 Fish (eggs)
48 Misidacea (various)
49 *Balanus* spp. (nauplii)
50 Parasitic Copepoda (others)
51 Brachyura (zoea)
52 *Corycaeus* spp.
53 *Corycaeus giesbrechti*
54 *Sagitta tenuis*
55 *Oithona simplex*
56 Epicaridae (Manca larvae)
57 *Calanopia americana*
58 *Acartia lilljeborgi*
59 Cumacea (various)
60 Amphipoda (various)
61 Isopoda (adults)
62 *Pseudodiaptomus richardi*
63 *Paracalanus indicus*
64 *Corycaeus speciosus*
65 Polychaeta (others larvaes)
66 *Labidocera fluviatilis*
67 *Temora turbinata*
68 *Temora stylifera*
69 *Favella ehrenbergii* f. *coxliella*
70 Spirillinidae (various)
71 *Remaneica* spp.

Cluster 6:

1 Textulariidae (others)
2 Quinqueloculinidae (various)
3 *Tintinnopsis aperta*
4 *Codonellopsis pusilla*

Figure 37: Species associations at the reef area.

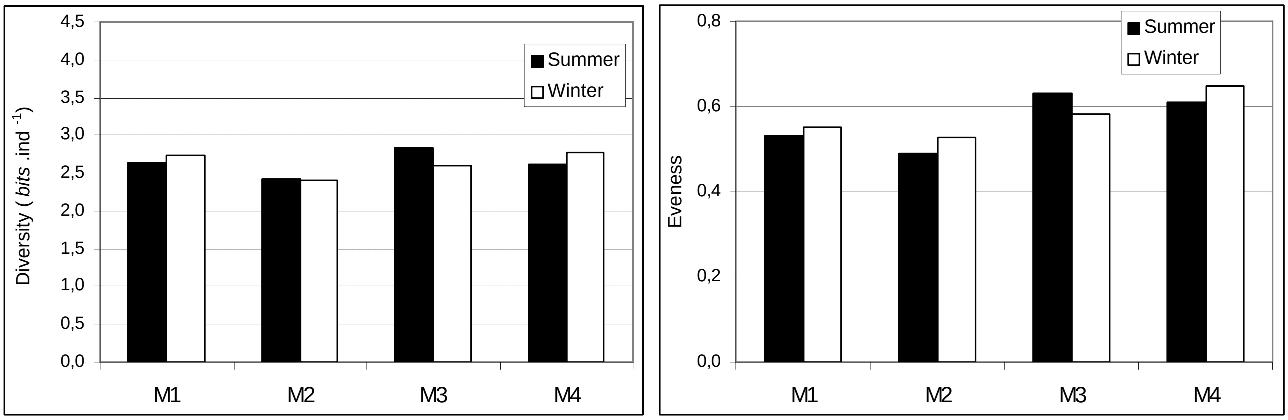


Figure 38: Zooplankton diversity (*bits*.ind^{-1}) and eveness at the mangrove area.

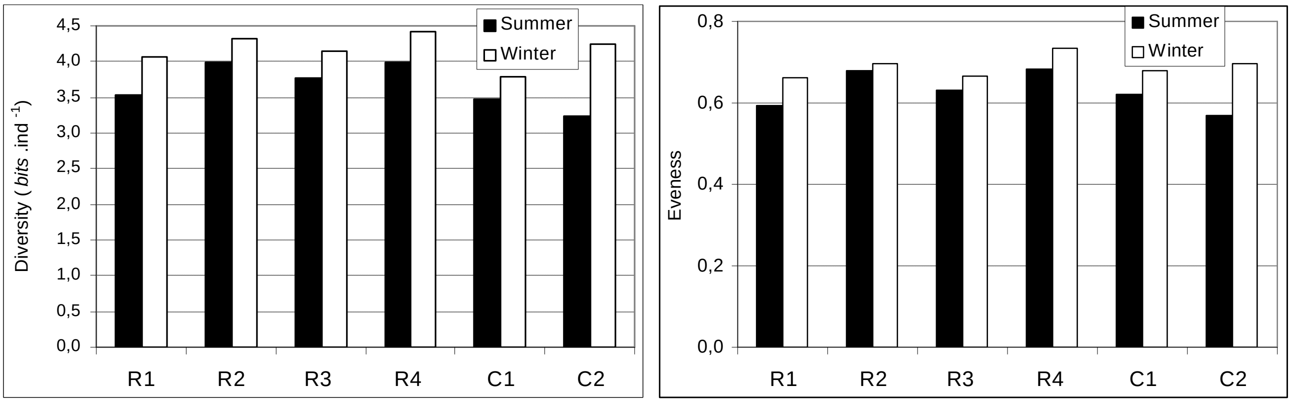


Figure 39: Zooplankton diversity (*bits*.ind^{-1}) and eveness at the reef area.

5 Discussion

5.1 Abiotic conditions

The performance of a reef ecosystem involves complex physical interactions, biochemistries and biological processes. The comparison among areas allows knowledgement about the stress conditions of many systems (Harriott &. Banks, 2002).

The temporary variations of the zooplankton community are conditioned to the environmental components of an ecosystem, that characterize the seasonal cycles (Peterson, 1986).

Temperature is an important factor for the species distribution. However, in tropical estaurine zones the temperature differences are minimum (Green, 1968). According to Kinne, (1967), even in tropical areas, the annual and daily temperature variations in estuaries are more significant than in coastal and oceanic waters, mainly in not very deep estuaries (as the case of the Mamucaba and Ilhetas estuaries).

At Brazilian Northeast coast the seasonal cycles are defined in two climatic stations: dry season, with higher temperatures and smaller rainfall rates, and the rainy season, when the air and water temperatures are not very slower and the rainfall rates increases (Andrade & Lins, 1971).

This difference can be evidenced at the Tamandaré coast, in the gradients obtained for the local physical-chemical and climatological data. At Tamandaré area, the rainy season presented lower temperatures, and during a 24 hours cycle the temperature did not present significant differences, being a little higher during the day. Also, this insignificant difference in the temperature rates promote not significant differences in the zooplankton community at the Pernambuco coast and mangroves, fact also noted by Neumann-Leitão *et al.* (1992) in the Suape area, Porto Neto (1998) in Itamaracá Island, Porto Neto *et al.* (2000) in the Tamandaré reefs, and Nascimento-Vieira (2000) in the Tamandaré coast.

Measurements of the abiotic factors in the Tamandaré area also suggest that the river mouths are exposed to salinities between 0 and 36, indicating penetration of coastal waters during the high tides in the estuary zones. The freshwater discharge at reef area are more noted in the stations close to the mouths, moreover during the low tides and during the rainy season. The Mamucaba and Ilhetas rivers show salinity range of 36 PSU, and at the station close to the confluence of the rivers (M1) the salinity range (between high tides and low tides) is less than 6 PSU. It suggest that the mangrove zooplankton community are typically euhaline. In fact, the great majority of identified organisms are typically euryhaline (estuarine euryhaline, benthonic euryhaline, and also coastal benthonic organisms). This fact was also noted by Silva (1997) and Porto Neto (1998) at the Santa Cruz Channel (South mouth) in Itamaracá Island (Pernambuco State), and also by Santana-Barreto *et al*. (1981) at the Tamandaré Bay.

The mangrove area of the Mamucaba and Ilhetas rivers (and possibly other mangroves at South of the Tamandaré Bay, and North part of Alagoas State), acts as an source of euryhaline species for the reefs at the Tamandaré coast. At Itamaracá Island (Pernambuco State), the export of euryhaline species was noted by Schwamborn (1997) and Schwanborn *et al*. (2001).

The polihaline waters at the river mouths of the Tamandaré Bay constitute the distributional limit for several oceanic-neritic species (like Hidromedusae, Cubomedusae, *Oithona plumifera*, *Lucifer faxoni*) as well as for meroplankton species of the Tamandaré Bay (like Pluteus larvae, pseudozoea of Stomatopoda, Decapoda megalopa).

The dissolved oxygen at Tamandaré Bay did not present large seasonal differences, being the oscillations of dissolved oxigen more associated to the tide movements. During low tides the oxygen values tend to be lower, mainly for the freshwater influence. The freshwater are normally "oxygen poor", when compared wiht coastal waters (Kinne, 1967; Gibson *et al*., 1997).

The dissolved oxygen concentrations of estuarine waters in Pernambuco State tend to increase during flood- and high tides, when circulation and mixing processes (caused by the marine water penetration in the estuaries) renovate the physical-chemical elements (Macêdo & Costa, 1990). The stations at reef area (in summer and winter), present a uniform dissolved oxygen variation along the day, being those waters more mixed during the high tide. This fact was also noted by Moura (1991) and Losada (2000), at the Tamandaré coast.

Mangrove forest structure is positively correlated with high nutritent inputs, and reefs are basically oligotrophic systems, not tolerating high level of nutrient enrichment (Correll, 1981). Reef and mangrove systems are inter-connected in numerous ways, but in undisturbed systems different pathways are more important (Acevedo & Morelock, 1988).

A flow of dissolved nutrients from mangroves at the Tamandaré coast has been shown to enhance primary productivity of reefs (Moura, 1991). Proximity to the coastline and river run-off will affect the nutrient concentrations of waters, and in general inshore waters have higher nutrient concentrations than offshore waters (Crossland, 1983).

The absence of thermal stratification allows a homogeneous distribution of nutrients (Tundisi, 1969). But at Tamandaré urbanized area, the nutrients can be found in high concentrations, due to the freshwater input, nutrients liberation from sediment or by terrestrial drainage. Compared with other reefs worldwide, Tamandaré

Bay shows high concentrations of nitrate and phosphate at the urbanized area (the values are shown in Table 3).

Additionally, faecal coliform data indicate domestic wastewater as the source of river contaminatination (CPRH, 2002). Heterotrophic organisms on the urbanized area, as well as higher concentrations of nutrients in this area, evoke the effects of eutrophication on this reef ecosystem. These data suggest that the high availability of nutrients is affecting the trophic structure in the study area, especially in front of the Tamandaré urbanized area, also suggesting that this area is an "impacted sector" of the Tamandaré reef complex. Bioindicators of anthropic influences were associated to areas with highest rates of nutrients in this work.

Table 6. Comparative nitrate and phosphate values for coastal reefs under land-based nutrient fluxes, including the studied reefs of Tamandaré.

Coral reef sites (and reference)	Nitrate ($\mu m.L^{-1}$)	Phosphate ($\mu m.L^{-1}$)
Tumon Bay, Guam (Marsh, 1977)	4.14 - 8.04	0.14 - 0.55
Guarajuba, Brazil (Costa *et al*. 2000) - polluted area	2.26 - 12.07	0.12 - 1.62
Jakarta Bay, Indonesia (Tomascik *et al*., 1993)	2.71	1.36
Pago Bay, Guam (Marsh, 1977)	0.22 - 3.31	0.15 - 0.23
Papa Gente, Brazil (Costa *et al*. 2000)	0.34 - 2.57	0.09 - 0.32
Barbados (Tomascik & Sander, 1985, 1987a, 1987b)	0.32 - 0.71	0.06 - 0.11
Florida Keys: Inshore (Szmant & Forrester, 1996)	0.46 - 1.07	0.01 - 0.17
Florida Keys: Offshore (Szmant & Forrester, 1996)	0.16 - 0.32	0.01 - 0.11
Bahamas (Ferrer & Szmant, 1988)	0.29	0.08
Eniwetok, Marshall Island (Webb *et al*., 1975; Pilson & Betzer, 1973)	0.10 - 0.30	0.16 - 0.18
Tamandaré reefs: non-impacted area (this work, between stations R1 and R2 - non-urbanized area)	0.65 - 1.37	0.0001 - 0.23
Tamandaré reefs: impacted area (this work, between stations R3 and R4 - urbanized area)	1.64 - 1.99	0.30 - 1.48

According to Méndez *et*. *al*. (1997), mixohaline waters with salinity between 13 and 31 PSU and high silicate concentrations are also characterized by the presence of Copepoda (*e*.*g*. *Oithona hebes*, *Oithona nana*, *Acartia liljeborgi*), Mysidacea, *Sagitta tenuis*, and cirripeds of the genus *Balanus*).

Much of the nutrient material is transported elsewhere by water currents, as it is being acted upon by micro-organisms, zooplankton, ciliates, nematodes, and other organisms (Bianchi & Colwell, 1985). These organims break the detritus into ever smaller fragments. Preliminary results of particulate matter from plankton samples of the Tamandaré reef area show detritus fragments, and other organic particules, in high concentrations (Asp Neto, not published).

5.2 Bioindicators of environmental conditions (biological sensors)

The environmental aggressions are increasing at the Brazilian coastal areas, due to destruction of the mangroves, deforestation of rivers margins, increasing pollution by the industrial and urban growth (IBAMA, 1991). All those factors contribute to the physical-chemistry alterations of the water. This increasing of aggressions has negative influences at the adjacent systems, the reefs and mangroves (Rogers, 1985; Acevedo & Morelock, 1988; Alves, 1991). In pratical terms, the more critical impacts flow from land to sea. It is more common for reefs to be damaged by impacts on the other systems than *vice-versa* (French, 1997). Moreover, there are no alternative systems. Corals and reef communities are more sensitive to impacts, and reefs may be transformed to other hard-bottom communities, usually dominated by algae, as example the reefs at Boa Viagem beach (urbanized area of Recife City, circa 100 km North of Tamandaré Bay), where human impacts on the reefs produced several irreversible demages to the natural reef communities (Porto Neto, 1999; Duncan *et al.* 2003).

In spite of the Tamandaré reef system importance, the knowledge of the interactive processes, biotic and abiotic components that act in this area are very scarce, and tends to a segmented and/or restricted character to the description of some taxonomic groups found in this area. At present, the specific scientific knowledge level about of each taxonomic group contributes just a little to the adoption of environmental management strategies, contrary to impact situations.

The micro-zooplankton communities and their seasonal variation was already studied in Pernambuco, but only in estuaries (Paranaguá, 1985/86; Neumann-Leitão, 1986; Neumann-Leitão *et*. *al*. 1992; Silva, 1994; Porto Neto, 1998). Only few works were made about the coastal zooplankton communities in Pernambuco (*e.g*. Gusmão, 2000).

The biological condition of waterbodies within a class often integrates the stratums's functional, physical, chemical, and biological reef characteristics, and thus the identification of biological indicators is a critical component of successful classification systems. Benthic macroinvertebrates (USEPA 1993; TVA, 1994, 1995) and Rotifera (Arora, 1966; Bianchi & Colwell, 1985) assemblages have all been used to varying degrees of success to indicate the environmental status of a waterbody.

Zooplankton indicator metrics such as diversity-based indices (*e.g*. total # of taxa, % contribution of dominant taxon, Shannon diversity), indicator taxa (*e.g*. Rotifera and Nematoda assemblages) are especially powerful, because they integrate numerous water quality parameters (*e.g*. nutrients, salinity, temperature, oxygen concentration) and are relatively easy to sample (Arora, 1966; Amjad & Gray, 1983; Bianchi & Colwell, 1985; Bratkovich, 1988).

Among the indicator taxa, Rotifera is a group that is particularly well suited to survive in transient environments. Also, they can survive in some environments where there is a substancial amount of suspended material, with detritical origin (Doohan, 1975).

At Tamandaré area, all founded species from the Rotifera group are largely detritivores, and feeding on suspended and flocculated organic matter, or phytoplankton. Where the nutrients levels are maintained by a external supply, the rotifer popullations will increase in proportions as can be sustained by the rapid turnover of a very active phytoplankton population. This is essentially the "phytoplankton situation" at the urbanized area (Galvão, not published).

Rotifera also are noted for their resistance to extreme high temperatures (Doohan, 1973, 1975). At field situation, food availability exerts far greater influence than the temperature on the birth rate of rotifers (Doohan, 1973). The temperatures at Tamandaré area were not very different between summer and winter.

However, the nutrient contents was relative high during the two seasons. Detritus are very found in the samples from the reef area, mainly at stations R3 and R4 (urbanized area). This fact suggests that the Maceió River provides nutrients and particulate organic matter (detritus) for the maintenance of the rotifer populations at this area.

Rotifer assemblages in the Tamandaré reef area were comprised by seven taxa (Table 2). *Brachionus plicatilis*, *Lecane bulla*, *Trichocerca* spp. and *Synchaeta* spp. were considered constant at stations R3 and R4 (urbanized area), according to the frequency of occurrence. The genus *Brachionus* and *Synchaeta* and *Lecane* are considered euryhaline and suggested as mesohaline indicators (Attayde, 1996). According to Kozlowsky-Suzuki (1998) and Arcifa *et al*. (1994), these genus are also associated with freshwater input, and they can tolerate high ranges of salinity. *Brachionus* and *Synchaeta* are also associated with low water transparency (Branco, 1998), fact also observed at the urbanized area of Tamandaré (mainly at station R4).

According to Berzinš & Pejler (1989), the most important factor determining rotifer distribution is dissolved oxygen concentrations. At Tamandaré reef area (along the whole Tamandré Bay), the oxygen conditions are very stable (Moura, 1997; Nascimento-Vieira, 2000, Porto Neto, *et al*. 2000; Porto Neto, this work). Still according with Berzinš & Pejler (1989), the distribution and abundance of rotifers in water with stable oxygen conditions are more conditioned to nutrient levels. They also cite the genus *Brachionus* as an indicator of eutrophy.

Despite to the Tamandaré environmental constancy (temperature, salinity and dissolved oxygen), the highest rotifer richness was found only at the urbanized area (also in the Maceió River mouth), where the nutrient levels were high. Among the rotifer taxa, the samples from the stations R3 and R4 have the same Rotifera species composition of the sample from the Maceió River mouth. This findings suggested the use of some rotifer species as indicators of important conditions in the coastal area of Tamandaré, associating this "bioindication" to anthropic influences through nutrients enrichment, and the precarious conditions of the Maceió River freshwater.

The rotifer genus found at Tamandaré area are called "the commonest indicators genus" worldwide, and hence there is a good chance of collecting them, even in one visit (Neumann-Leitão, 1986; Pontin & Langley, 1993), as the case of the sample from the Maceió River.

The abundance of Nematoda communities may be used as bioindicators of bottom health or condition, because composition correlates well with nitrogen cycling and decomposition, two critical ecological processes in bottom (Neher, 2000). Biologically, bottom ecosystems support a diversity of microbes (fungi, bacteria, and algae), microfauna (Protozoa and Rotifera), and mesofauna (arthropods, and nematodes). Although microbial communities are known to play critical roles in ecological processes, such as nutrient cycling, and also respond to environmental disturbances of substratum and waterbodies.

Nematodes possess several attributes that make them useful ecological indicators (Freckman, 1988). They are ubiquitous and certain species are frequently the last animals to die in polluted or disturbed areas (Samoiloff, 1987; Freckman, 1988). Under field conditions, bacterivorous and nematodes are estimated to contribute (directly and indirectly) about 8% to 19% of nitrogen mineralization (Samoiloff, 1987). Nematodes contribute to nitrogen mineralization indirectly by grazing on decomposer microbes, excreting ammonium, and immobilizing nitrogen in live biomass (Freckman, 1988). Nematoda is also associated with coastal waters with high levels of nutrients (Ingham *et al*., 1985). In fact, Nematoda in the Tamandaré area are more associated with the stations in the urbanized area (stations R3 and R4), where high levels of nutrients were noted.

Also in the 1970s, the use of a nematode:copepod ratio (Raffaelli & Mason, 1981) was popular for monitoring of aquatic ecosystem conditions. Both nematodes and copepods are abundant in aquatic systems but they differ in their sensitivity to stress. Generally, nematodes are less sensitive to environmental stress or pollution than are copepods. Therefore, a high ratio indicates pollution, such as oil spills, sewage, and increasing organic enrichment (Amjad & Grey, 1983; Raffaelli & Mason, 1981). At Tamandaré Bay, the nematode:copepod ratio was more elevated (but not high) at the stations in the urbanized area (stations R3 and R4), and high at the station of the Maceió River mouth. However, in general this ratio are not high at the reef area, indicating that the environmental impact comes from the Maceió river.

Nematodes represent a central position in the soil food web and correlate with ecological processes, as nitrogen cycling (Neher, 2000). At Tamandaré area, nematods were very found, also indicating environmental problems.

Indicator taxa are those organisms whose presence (or absence) at a site indicates specific environmental conditions (Bratkovich, 1988). If an organism known to be intolerant of pollution is found to be abundant at a site, high water quality conditions can be inferred. On the other hand, dominance and/or high abundance rates by pollution tolerant organisms implies in degraded conditions. When available, indicator taxa are an important, cost-effective preliminary survey tool for site assessments (Norse, 1993).

In conclusion, and in according to Odum *et al.* (1979), Muller (1992) and Norse (1993), the relative abundance (and regional abundance) of taxa refers to the number of individuals of one taxon as compared to that of the whole assemblage. The proportional representation of taxa is a surrogate measure for assemblage balance that can relate to both enrichment and contaminant problems. Dominance, measured as percent composition of dominant taxon or dominants-in-common, is an indicator of assemblage balance or lack thereof. It is an important indicator when the most sensitive taxa are eliminated from the assemblages and/or the food source is altered, thus allowing the more tolerant taxa to become dominant. Frequency distributions describe the percentage of individuals in a population or assemblage that fall within defined size categories. Skew of these distributions from known baseline distributions can be a sensitive indicator (*e.g.* indicate occurrence of past pulse disturbance that eliminated all adults, etc.) Taxa richness is measured as number of distinct taxa and represents the diversity within a sample. Taxa richness usually consists of species level identifications but can also be evaluated as designated groupings of taxa, often as higher taxonomic groups (i.e. genera, families, orders, etc.) in assessment of invertebrate assemblages. Identity is knowledge of individual taxa and associated ecological patterns and environmental requirements. Key taxa (*i.e*. those that are of special interest or ecologically important) provide information that is important to the condition of the target assemblage. The presence of alien or nuisance species may be an important aspect of biotic interactions that relates to identity. Moreover, the reef organisms respond to differing degrees of stress so that the reef may be progressively and impercebtibly (the Tamandaré case), transformed from a "healthy" reef, to a "sick" reef (actual stand of the Tamandaré reefs), to "dead" reef (case of the Boa Viagem beach, Recife City).

At the Tamandaré case, is now clear that the results of relative abundance (and regional abundance) and frequency of Rotifera and Nematoda (taxa that are of special interest and ecologically important in environmental considerations in this work) are a signal that the environmental impacts may be affecting the taxa richness and the dominance of natural populations of zooplankton organisms, through the anthropic negative influences.

The many numbers of different species should be enough of a reason not to pollute the reefs and estuaries, but unfortunately the Maceió river has been polluted anyway. Every link in the ecosystem has a purpose to serve species in a higher species in the hierarchy, as well as to provide a suitable environment for lower level species. If a part of the chain is eliminated, it causes a domino effect which slowly unravels the chain by harming the closest species and then affecting the higher level ones.

Nevertheless, it is important to point out that Rotifera and Nematoda (as well as other bioindicators) are not "destructive creatures". In fact, the presence of some bioindicators is very useful in "ecological approaches". Then, could the massive presence of "human being" in a natural system is also used as bioindication of environmental problems? And who are in fact the "destructive creatures"?

Moreover, and as pointed out by Nilsson & Grelsson (1995), the most important question is not the classification of a ecosystem in "stable" or "fragile". The most important question is: how much an ecosystem is altered after specific disturbances?

5.3 The mangrove zooplankton community - mangrove influences in the reef area

The estuaries are characterized by the environmental parameters variability, presenting a complex and dynamic mix of salted water and freshwater, what turns the estuary a highly selective ambient with the fauna and flora. The seasonal variation of salinity in estuaries is high, generally decreasing during the rainy period. The estuaries also present daily variations, produced by the tides (Perkins, 1974).

Scientific studies have concentrated on single ecosystems and have generally neglected interconnections between them. Interactions between the two major tropical coastal ecosystems have been perceived, but have rarely been investigated (*e.g*. Ogden & Zieman, 1977).

The zooplankton assemblages in the Tamandaré area are dominated by Copepoda and Copepoda nauplii (about of 70-80% of the total abundance). In concordance with other studies (Johannes, 1974; Moore & Sanders, 1976; Ferraris 1982) copepods are normally the dominant organisms in aquatic systems. Copepoda are followed by Tintinnina (about of 16-17% of the total adundance at the reef area, and 10% at the mangrove area). This holoplankton dominance is a characteristic of the estuary/mangrove communities (Matsumura-Tundisi, 1972).

Tintinnina group was represented by 15 species, and was the second more abundant, frequent and dominant group. According to Villate (1991) and Sassi & Melo (1982), Tintinnina shows "comportamental answers" to the environmental variations, forming "occasional blooms" after an accentuated development of the phytoplankton communities. In fact, high concentrations of phytoplankton in the samples of the reef area were also noted.

According to Pane & Mariottini (2002), in aquatic environments flagellates are an important component within the microbial loop and the food web, owing to their involvement in the energy transfer and flux and as an intermediate link between bacteria and primary producers, and greater organisms, such as other protists and metazoan consumers. In the microbial loop flagellates highly contribute to fast biomass and nutrient recycling and to the production in aquatic environments. In fact, these protists consume efficiently viruses, bacteria, cyanobacteria and pico-phytoplankton, and are grazed mainly by other protists, rotifers and small crustaceans (Sassi & Melo, 1982).

Tintinnopsis nordqvisti, *Tintinnopsis tocantinensis* and *Favella ehrenbergii* are the principal componnents of the "occasional blooms", fact described also by Sassi & Melo (1982) at the Paraíba River estuary (Paraíba State, North of Pernambuco State). These three species were also mentioned with great importance for the Pernambuco estuaries by Paranaguá & Nascimento-Vieira (1984), Neumann-Leitão *et al*. (1996), and Silva (1997).

Favella ehrenbergii is considered a common Tintinnina species at the Brazillian coast (especially at the Northeast coast). This species is marine-euryhaline, and the occurrence of *Favella ehrenbergii* in areas with 0 ml $O_2.L^{-1}$ of dissolved oxygen concentrations suggests that this species has a great capacity to support waters with high pollution levels (Silva, 1994). At the Santa Cruz Channel (Itamaracá - Pernambuco), *Favella ehrenbergii* is found with abundances a little more accentuated during the summer - dry season (Sant'anna, 1993; Nogueira-Paranhos, 1990; Porto Neto, 1998). However, at the Tamandaré reef area, *Favella ehrenbergii* was found with large abundance during the winter. This large abundance in winter could be associated to the nutrients rates (Silva, 1994).

According to Porto Neto (1998), *Tintinnopsis nordqvisti* is more abundant during the winter at the Pernambuco coast. This fact was also noted in the samples from the Tamandaré area.

Tintinnopsis tocantinensis is a typical species from tropical seas, been very abundant and found close to the coast. This species has preferences for higher salinities (Nogueira-Paranhos, 1990). *Tintinnopsis tocantinensis* is also more abundant during the dry period, where the salinity is a little higher. Singarajah (1978), verified that *Tintinnopsis tocantinensis* was also common at the Paraíba River estuary. At Tamandaré area, *Tintinnopsis tocantinensis* has high densities during the winter, when the total density for Tintinnina was in general more high.

Copepoda is frequently mentioned as "holoplankton dominant organisms" in most of the estuaries and coastal areas (Tundisi, 1970; Matsumura-Tundisi, 1972; Miller, 1976; Montú, 1987; Day Jr. *et*. *al*., 1989). Cyclopoid and calanoid Copepoda were numerically dominant in the holoplankton group at the Tamandaré coast (not including Copepoda nauplii), and the genus *Oithona* (cyclopoid) is the most abundant and frequent genus at the Pernambuco coast (Porto Neto, 1999; Porto Neto *et al*., 2000; Nascimento-Vieira, 2000). In this work, three Copepoda species were dominant: *Oithona hebes*, *Oithona oswaldocruzi*, and *Parvocalanus crassirostris*.

In estuaries is common the Copepoda abundance, however with dominance of 5 to 6 species. Goswami & Selvakumar (1977), mentioned the coexistence of species from the families Paracalanidae, Pseudodiaptomidae, Pontellidae, Acartiidae and Oithonidae at Goa estuary system. These families are also registered at the Tamandaré area, being very abundant and/or dominant.

In Pernambuco State, the dominance of Copepoda was confirmed in several works, as Paranaguá & Nascimento (1973), Paranaguá *et al*. (1979), Nascimento (1980), Nascimento & Paranaguá (1981), Por & Almeida-Prado (1982), Paranaguá & Nascimento-Vieira (1984), Silva (1997), and Porto Neto (1998) for the Itamaracá estuarine area (Santa Cruz Channel); Paranaguá (1985/1986) and Neumann-Leitão *et al*. (1992) for the Suape estuarine area; Santana-Barreto & Santos (1984) and Nascimento-Vieira & Sant'anna (1987/1989) for the Timbó River estuary (Olinda); Paranaguá *et al*. (1990), Paranaguá & Nogueira-Paranhos (1982) for the Capibaribe River estuary (Recife); Nascimento-Vieira *et al*. (1988), and Sant'anna (1993) for estaurine area of the Pina Basin (Recife); Santana-Barreto *et al*. (1991) and Neumann-Leitão *et al*. (1993; 1994/1995) for the Formoso River estuary (Tamandaré), and Porto Neto *et al*. (2000) for the Tamandaré area. In synthesis, is concluded that Copepoda is one of the most dominant group in most of the Pernambuco estuaries (and coastal waters), with 40 registered species (Neumann-Leitão *et al*., 1998).

Highest densities of Copepoda occur in the reefs sectors of the Tamandaré Bay (stations R1, R2, R3, and R4). *Oithona hebes*, *Oithona oswaldocruzi*, and *Parvocalanus crassirostris* are grouped at the same cluster for the reef area (Cluster 1 - Figure 37). They are very abundant and frequent at the mangroves from Tamandaré, as well as at the Pernambuco mangroves (Nascimento, 1980; Nascimento & Paranaguá, 1981; Por & Almeida-Prado, 1982; Paranaguá & Nascimento-Vieira, 1984; Silva, 1997; and Porto Neto, 1998). They are also largely founded at the reef area, suggesting zooplankton exchange between the mangrove and reef areas.

At the mangrove area, the most abundant taxa (*Oithona hebes* and Copepoda - nauplii) are grouped at the Cluster 1 (Figure 36), and *Pseudodiaptomus acutus*, *Pseudiaptomus richardi*, Acartia *lilljeborgi*, *Temora turbinata*, *Darcythompsonia radans*, and Harpacticoidas (others) are gouped at the Cluster 3 (Figure 36), representing a important group of euryhaline estuarine species, typical from mangroves and estuaries (Boltovskoy, 1981; Montú *et*. *al*., 1997).

Oithona nana, *Euterpina acutifrons*, *Pseudodiaptomus acutus* and Harpacticoida (others) are gouped at the Cluster 2 (Figure 37) from the reef area, suggesting again the "euryhaline-estuarine Copepoda influence".

Typical organisms from oceanic waters (like *Pareucalanus sewelli*, *Oithona plumifera*, *Oncaea venusta*) are also found, but only in the reef area, showing the oceanic influence. *Pareucalanus sewelli*, *Oithona plumifera* and *Microsetella rosea* (three typical copepods from oceanic waters) are grouped at the cluster for oceanic holoplankton (Cluster 5A - Figure 37), suggesting a clear separation between estuarine and oceanic groups at Tamandaré area.

Evidences indicates that the smaller copepods generally dominate not only in terms of abundance, but also sometimes in terms of biomass and grazing pressure on the phytoplankton (Dam *et al*., 1993; Roman *et al*., 1990, 1993). Because of the universality of medium plankton nets (mesh size 200-330 µm), *Oithona* records of an unsatisfactory nature are widespread throughout the literature (Evans, 1973; Miller, 1995). The family Oithonidae is able to withstand fresh to hypersaline waters and temperatures ranging from 0° to 40°C (Björnberg, 1963). *Oithona hebes* is very common in reef and estuarine waters, indicating presence of mangrove environments, and being frequently found in association with *Oithona oswaldocruzi* (Björnberg, 1981). In this work, *Oithona hebes* was also associated with *Oithona oswaldocruzi*. Neumann-Leitão *et al.*

(1992), also verified the association between these two species in estuaries at Suape area; Porto Neto (1998) noted this species association at Itamaracá Isaland; and Porto Neto *et al.* (2000) also noted this association at Tamandaré mangroves.

Together with Copepoda nauplii, *Parvocalanus crassirostri*, *Oithona oswaldocruzi* (and some Tintinnina species), the abundance of *Oithona hebes* was responsible for the variation in the total number of the zooplankton community at the Tamandaré area (mangroves and reefs). Tafe & Griffiths (1983), also observed the same behavior for species of the *Oithona* genus at Port Hacking estuary (Australia).

The calanoids *Parvocalanus crassirostri*, *Pseudodiaptomus acutus* and *Pseudodiaptomus richardi* represent the dominant holoplankton of oligohaline areas, and they are the only "true" estuarine species below salinities of 15 PSU (Wright, 1936). *Acartia lilljeborgi* (calanoid) and *Oithona oswaldocruzi* (cyclopoid) occur mainly in mesohaline sectors, together with other estuarine species adapeted to strong salinity variations, such as *Oithona hebes*, *Oithona nana*, *Oithona oswaldocruzi*, *Paracalanus indicus* and *Pseudodiaptomus acutus* (Bigelow, 1926; Wright, 1936; Gallienne & Robins, 2001). Reef areas under mangrove-estuarine influences are also characterized by *Acartia liljeborgi*, *Euterpina acutifrons*, *Parvocalanus crassisrostris*, *Paracalanus parvus*, *Oithona hebes*, *Oithona nana*, and *Oithona oswaldocruzi* (Mianzan *et*. *al*., 1994).

Parvocalanus crassirostris was also very abundant in both seasons (dry and rainy seasons). *Parvocalanus crassirostris* is one of the most common and frequent Copepoda in the coastal and estuarine waters along the Brazilian coast (Sant'anna, 1993). Eurytermic and euryhaline, *Parvocalanus crassirostris* is a indicator of coastal waters (Björnberg, 1963). This species has constantly been abundant in estuarine waters of Pernambuco, (Matsumura-Tundisi, 1972; Nascimento, 1980; Feitosa, 1988).

Acartia lilljeborgi is also an indicator of coastal waters (Björnberg, 1963; 1981). *Acartia lilljeborgi* supports a wide salinity variation, being registered in all the Brazilian estuaries (Neumann-Leitão, 1994). Nascimento (1980), registered *Acartia lilljeborgi* in the Botafogo River estuary (Itamaracá Island - Pernambuco State) as the dominant taxa.

Pseudiaptomus acutus and *Pseudodiaptomus richard* have relative importance in the samples. They are also abundant and frequent in estuarine waters, with low salinities (Sant'anna, 1993).

Temora turbinata, *Temora stylifera* and *Calanopia americana* are also significant in terms of abundance. They belong to a group of planktonic Copepoda, dominant in the Caribbean reefs and mangroves (Suarez-Morales & Gasca, 2000).

Euterpina acutifrons was other important Copepoda species, with wide distribution at the Tamandaré coast. *Euterpina acutifrons* is generally found from the estuarine to the coastal areas (Björnberg, 1963). This Copepoda has high abundances at the Brazilian coast (Marques, 1950; Björnberg, 1963), and was very found at Tamandaré mangroves and reefs.

Copepoda nauplii was responsible for the highest abundance indices in the two seasons, stations and tides. The precise identification of the Copepoda nauplii was not possible (Björnberg, 1986). An accurate identification of this Copepoda life stage is quite difficult (Gallienne & Robins, 2001). For over a century, Copepoda have been considered the most important metazoan secondary producers in pelagic marine ecosystems, both in terms of abundance and biomass. However, it has become clear that smaller species (Böttger-Schnack, 1988; Fransz, 1988) and early developmental stages (Björnberg, 1986; Paffenhöfer & Lewis, 1989) are important, understudied components of planktonic communities. Roff *et al*. (1995) recently stressed that nauplii may be critical intermediaries between the classical and microbial food webs, yet little attention has yet been paid to them. The relative importance of small organisms in planktonic communities could be assessed in terms of numbers, biomass or production (*i.e*. their contribution to energy flow). Although small organisms may dominate numerically, they may still contribute little to community biomass. Nauplii, copepodite and adult stages of smaller Copepoda are important grazers of phytoplankton, and are important food source for critical larval stages of many commercial fish (Last, 1980; Miller, 1995). Miller (1995), reports the opinion that "*population analysis that neglects nauplii is losing too much information*", but methods in common use often neglect not only nauplii, but also many copepodite stages and adults species of the micro-zooplankton.

The Larvacea group was represented by the genus *Oikopleura*, and the registered species was *Oikopleura dioica*. This species was very found at the reef are, with significative densities. The genus *Oikopleura* feeds mainly nanoplankton (Flores-Montes, 1996), and is very frequent at the Pernambuco coast (Neumann-Leitão, 1994).

Chaetognatha was represented by the genus *Sagitta*. The species identified was *Sagitta tenuis*, a common coastal and shelf species (Odebrecht & Castello, 1994). According to Boltovskoy (1981), the *Sagitta* genus is euryhaline (being indicator genus of coastal waters), and frequently found in estuarine waters at the Brazilian Northeast coast (Paranaguá, 1985/1986; Nascimento-Vieira & Sant'anna, 1987/1989; Neumann-Leitão *et al*., 1992; Sant'anna, 1993; Silva, 1997; Porto Neto, 1998). *Sagitta* was noted in small amounts mainly during the rainy period, fact also noted by Porto Neto (1998) at the Itamaracá area, and contradictory to reports from other regions (Sammarco & Crenshaw, 1984).

Polychaeta, Gastropoda (veliger) and Bivalvia (veliger), Brachyura (zoea), Cirripedia, Decapoda and fish (eggs and larvae) are the meroplankton organisms more abundant in the samples. According to Raymont (1983), the occurrence of meroplankton larvae is associated to the reproductive period of benthic organisms. Still according to Raymont (1983), high densities of meroplankton larvae occur during larval recruitment in tidal mangrove creeks, and also at the mouth of the small rivers in the euryhaline area. At Tamandaré area, the meroplankton was in a general distributed in the two studied periods (summer and winter).

Polychaeta larvae are generally described as a estuarine zooplankton component (Perkins, 1974). At the Brazilian Northeast coast, Polychaeta larvae were already mentioned by Pereira (1980), Santana-Barreto *et al*. (1991), Alves (1991), Neumann-Leitão *et al*. (1992), Silva (1994), Silva (1997), and Porto Neto (1998). According to Perkins (1974), these larvae are frequent in the estuarine waters, being resistant to low salinities and anaerobic conditions (and/or high pollution levels). At Tamandaré area, they did not present accentuated seasonal defferences, fact also noted by Porto Neto (1998) at the Santa Cruz Channel (Itamaracá Island - Pernambuco State), and Porto Neto *et al*. (2000) at the Tamandaré area. The distribution of Polychaeta larvae in the the Brazilian Northeast estuaries is practically uniform along the year, without seasonal differences noticed (Nascimento-Vieira & Sant'anna, 1987/1989; Neumann-Leitão *et al*., 1992; Porto Neto, 1998).

Bivalvia (veliger) has in general high densities during the dry season (summer). This fact is also described in Pernambuco by Sant'anna, 1993 (Recife City coastal waters), Porto Neto, 1998 (Itamaracá Island - Pernambuco State), and Neumann-Leitão, 1994 (in the Suape estuarine complex). Gastropoda (veliger) occurs with relative high abundances in the two periods (summer and winter). The veliger of Gastropoda were also registered in the Pernambuco estuaries by Neumann-Leitão *et al*. (1992), Sant'anna (1993), Silva (1994), Silva (1997), and Porto Neto (1998).

Cirripedia larvae is one frequent meroplankton group at the Tamandaré area, been present in almost every stations and seasons at the reef area. The Cirripedia larvae were represented by the genus *Balanus* and *Lepas*. Raymont (1983) mentioned the Cirripedia larvae as common organisms in estuarine and coastal waters, with high abundance rates. The Cirripedia larvae were also registered in Pernambuco State by Nascimento-Vieira & Sant'anna (1987/1989), Neumann-Leitão *et al*. (1992), Sant'anna (1993), Silva (1994), and Porto Neto (1998). Cirripedia cypris was also found. However, not very frequent and abundant.

Brachyura (zoea) were very frequent, fact also verified in Pernambuco coast by Sant'anna (1993), Silva (1994), and Porto Neto (1998). According to Boschi (1981), temperature is an decisive factor for the development of estuarine crab larvae. In experimental studies was proved that the complete development of Brachyura only takes place in estuarine waters, with high temperatures and salinities (Sant'anna, 1993). According to Schawmborn (1997), Brachyura (zoea) are exported from the Santa Cruz Channel mangroves (Itamaracá Island) to the coastal areas, being found (with great abundance) at the Pernambuco shelf.

Other Crustacea and Decapoda larvae have been found with frequency in estuaries, associated to the adult populations recruitment (Xiao & Grenwood, 1992). At Tamandaré area, the Decapoda larvae were frequent, however they were not very abundant. Sant'anna (1993), also registered reduced abundance and lower frequency of those larvae at Recife City coast.

Fish eggs and fish larvae were not very abundant. In general, fish eggs were more abundant during the dry season, while the larvae where more abundant in winter. In other estuaries from Pernambuco State fish eggs and larvae have been frequently registered, always with insignificant abundances (Nascimento, 1980; Paranaguá & Nascimento-Vieira, 1984; Paranaguá, 1985/1986; Neumann-Leitão *et al*., 1992; Sant'anna, 1993; Silva, 1994; Porto Neto, 1998.

In the ticoplankton group, Foraminifera are in general founded with significative frequency and abundance. Neumann-Leitão (1994), associated organisms from the families Textulariidae and Quinqueloculinidae (and also other benthic organisms) to the high tide periods. In the case of Tamandaré reef area, the strongest tides currents could promote a great turbulence at substratum level, bringing different benthic taxa from the bottom to the pelagic level. The fluctuations of Foraminifera densities are difficult to explain, and they may be representing a succesional state (Hatcher *et al.*, 2002). More investigations on these topic are required. Moreover, importance of the Harpacticoida copepods, Foraminifera, and Nematoda in microbentic-, meiobenthic- and planktonic associations of Tamandaré Bay is virtually unknown.

Mangrove systems are highly productive and they export detritus and living organisms which may be transferred to adjacent coastal waters (Jennerjahn & Venugopalan, 2002). Also, mangrove detritus is a significant food source for the Copepoda-rich holoplankton (Schwamborn, 1997). Copepoda and zoeae are important food sources for various species of fish (Vasconcelos *et al*. 1984; Morgan, 1990; Sautour *et al*. 1996), their export is likely to fuel the reef and coastal food web (Schwamborn, 1997).

In conclusion, the major zooplankton groups at Tamandaré reef area have linkages with mangrove and estuarine zones. The massive presence and abundance of those species (biological tracers), and their cluster linkages, are evidences of the "relationship" between the reefs and mangroves at Tamandaré coast.

5.4 Zooplankton productivity

The dry season presented zooplankton productivity more elevated. This aspect was also reported in several zooplankton population works at the Northeast Brazilian coast (Pernambuco State coast: Neumann-Leitão, 1992; Sant'anna, 1993; and Silva, 1994; Sergipe State coast: Pereira, 1980; Rio Grande do Norte State coast: Medeiros, 1983; and the Paraíba State coast: Singarajah, 1978). However, zooplankton densities at Carribean reefs increasing significantly in the start of the rainy season (Glynn; 1973). Hallock *et al.* (1993), found more zooplankton after a hurricane event on the Puerto Rico coast, associating this zooplankton abundance with increasing nutrient concentrations.

A estuary (or reef) can present alternated periods of larger productivity, depending on the predominant factors (Neumann-Leitão, 1994). According to Nordi (1982), a large zooplankton abundance during the rainy season can occur, due to high levels of rainfall that decrease the salinity, promoving death or escape of organisms, and promoting vertical migrations. According to Neumann-Leitão (1994), maybe the only possible affirmative to explain the alternated periods of productivity is "*that the quantitative flotations involves several* *factors, as larval recruitment, food sources and physical processes, that export (or import) organisms of one system*". Density rates of phytoplankton may also influence the growth of the zooplankton community (Flores Montes, 1996).

In general, high tide periods present larger amount of marine organisms, typical fact of the estuarine zooplankton communities. At Tamandaré area, during the low tide periods were found *Brachionus plicatilis* and other rotifers in more high abundance rates, resultanting of the fluvial flow. The variations in the zooplanton abundances in different tide levels could evidence the transport type, as well as the alterations in the physical-chemical conditions. According to Neumann-Leitão (1994), the zooplankton organisms in coastal areas are exposed to the dominant horizontal and vertical gradients. The horizontal transports are generally accentuated than the vertical migrations, once that the estuaries are not very deep (*e.g.* Mamucaba and Ilhetas estuaries). Schawmborn (1997) verified movements of horizontal transport of Brachyura (zoea) and other Decapoda in the Santa Cruz Channel (Itamaracá), that are responsible for the abundance of these organisms in certain tide levels.

In general, at Tamandaré area the zooplankton productvity was higher than previous estimates for tropical coastal waters, but comparable to other eutrophic tropical embayments and many productive temperate ecosystems. Far from being regions of low productivity, tropical zooplankton communities may have significant production and deserve greater research attention than they currently receive.

5.5 Diversity

Worldwide, exists a great controversy regarding ecological maturity and stability (Nilsson & Grelsson, 1995). Catastrophic events determine a faunal substitution in the affected areas, favoring a higher species diversity (Connell, 1978). Normally, a "high stability" is usually attributed to high diversity environments, mainly for vary possibilities of the energy flow ways (Telles, 1998).

Ecological theory suggests that dominance of a community by one or a few species leads to the exclusion of other species from the community in the absence of disturbances that remove the dominant species (Paine 1966, Sousa 1979). Under these models, diversity is predicted to be greatest at intermediate levels of stress or disturbance, because at low disturbance (or stress or predation) levels, communities are monopolized by a competitive dominant, and where stresses are intense, only a few species are tolerant enough to persist. However, this pattern may not occur in communities where competition affects growth but not mortality (Hannon, 1973).

The diversity indices based on the zooplankton density at the Tamandaré coast, varied from middle to high, being the major zooplankton composition of the Tamandaré area (mangroves and reefs) similar to others Pernambuco estuaries. At the reef area, the eveness values are relative higher, because more taxa are sharing the environmental conditions, representing low dominance peaks of some species or taxa (Neumann-Leitão, 1994).

However, according to Farran (1936), Michael & Foyo (1976) and Raymont (1983), the Tamandaré diversity indices could be considered "low", when compared with the zooplankton diversity of other reef areas worldwide, as example the Caribbean coastal sea (with about of 20 calanoid taxa, 17 cyclopoid taxa, and 11 harpacticoid taxa) and the Great Barrier Reef, Australia (with about of 40 calanoid taxa, 20 cyclopid taxa, and 12 harpacticoid taxa). The Copepoda diversity at Tamandaré area was represented by 14 calanoid taxa, 5 cyclopoid taxa, and 9 harpacticoid taxa.

The absence of great natural destructive environmental factors in the mangrove and reef areas determines this "low diversity", or evolutionary factors associated to the environmental parameters favoring this condition? Perhaps, this question will remain without answer for a long time.

5.6 The "Closed Area" - protection and perspectives

Weiss (1971) defined the ecological systems as complex units, in space and in time, acting in way to maintain the structural and functional configurations after disturbances. The systems are composed by units, (that togehter form sub-systems) and for relationships that are interactions among the unit elements. They can energy and information exchange with the environment that they belong, being classified of "open systems" (Muller, 1992).

Still according with Muller (1992), all the "living systems" are organized into a hierarchy. Thus, the "observer" allows himself to define sub-systems in agreement with the objectives of his investigation ("hierarchy structure"). In dynamic systems there are certain physical and chemical processes that help the system to self guide in the way to the " state of order ", or to follow an sequence of order ("self organization"), starting from wide band of initial conditions. The interactions between all variables (that act in the many processes) provide the "high complexity state" (Hannon, 1973).

The systems are also able to react to some transformations, restoring soon after to theirs specific "referential states" ("self regulation"). In the nature, anything that can have yours limits defined arbitrarily, thus as the limit definitions of the sub-systems (Margalef, 1968).

The "Closed Area" (Fully Protected Zone) provide protection for the Tamandaré fauna and flora. In fact, high densities of Crustacea larvae and fish eggs and larvae (sensible and fragile organisms) are found close to the Fully Protected Zone, and also at the Fully Protected Zone. However, is also very important to point out that minimally disturbed sites are used as reference sites from which to compare monitoring sites, and that great part of the populations of the coastal districts (near to Tamandaré area) uses the fishing activites as subsistence form and employment. With the growing degradation of the marine, reef, and estuarine resources, and the consequent decrease of available stocks for fishing capture, a growing pressure for the use of the biological patrimony of the "Coral Shore A.E.P." can occur.

Aggravating this situation, normaly in the conservations units does not exist a generic methodology, that facilitates the easy, fast and objective integration of the existent informations. The Fully Protected Zone is only a "unit" of the great Tamandaré reef system, that have also linkage with the adjacent mangrove systems. Together, they acts not only as systems and sub-system, but also as a important ecological reef "complex".

Comparing the Tamandaré environmental situation with the actual Australian reefs situation, a great difference in terms of management is noted. According to Done & Wilkinson (1998), in Australia there is strong recognition by government that the tourism and resource values of coral reefs are particularly high, which means that management receives sufficient attention. This fact is a important difference between the Brazilian environmental policy (and education) and the Australian policy. Moreover, the major stresses to Australian reefs are natural, such as cyclones, coral bleaching and crown-of-thorns starfish. Human stresses are minimal, except on some reefs close to the land, because population density is low, the economic status is high, and there is low fishing pressure. Most towns along the coast are upgrading sewage treatment to secondary level and all tourist resorts are now required to treat sewage so as to avoid any runoff, and to manage the areas of reefs that they use.

That the Tamandaré coast area is stressed is obvious, and there are no proper estimates of its carrying capacity. In general, environmental and organismic tolerance levels in the area have been investigated only at the one factor level. For management purposes, there is therefore urgent need to assay environment tolerance limits at the multi-factorial level. Of no less importance, though the import may be less obvious, are the biogeochemical importance of the mangrove-reef interrelationships in land formation and maintenance of coastal stability.

Starting from a systematic characterization through ecological evaluations, new planning of environmental management can be implemented, in an agile and appropriate way. The application possibility of new methodologies in the Tamandaré reefs can propitiate useful informations for environmental management, and also for the fishing of the existent explored stocks. Much more works need to be done to understand the tolerance and intolerance of the reef organims to specific human activities and mixes of human activities. Once obtained, this understanding will provide useful diagnostic tools to reef managers in Brazil and result in the acquisition of management information, and not just the collection of monitoring data.

6 Conclusions

The mangroves of Mamucaba and Ilhetas rivers have no perceptible human influence, and bioindicators for anthropic impacts (Rotifera and Nematoda) are not founded in these areas. The run-off of nutrients from these mangrove area to the Tamandaré Bay is used to say normal.

A tendency of higher zooplankton densities at the reef area, and at stations M3 and M4, was verified in periods of high tides, showing a horizontal transport. The stations M1 and M2 have higher densities during the low tides, when the fluvial input from the Mamucaba and Ilhetas rivers are higher.

Holoplankton was the most abundant group (summer and winter), and this dominance is a typical characteristic of a "mangrove-estuarine community".

Oithona hebes, *Oithona nana*, *Oithona oswaldocruzi*, *Parvocalanus crassirostris*, *Euterpina acutifrons*, Copepoda nauplii, *Favella ehrenbergii* and *Tintinnopsis tocantinensis* were the most abundant and frequent organisms at all the stations, in summer and winter.

The reef area has a great abundance and density of typical estuarine zooplankton species (estuarine euryhaline organisms), suggesting mangrove influences (exportation of estuarine zooplanktonic biomass from the Mamucaba and Ilhetas mangroves, and also from great mangrove areas in the near from Tamandaré City). The mangrove destruction could be dangerous to the maintenance of the reef diversity. However, this "ecologic approach" for the fringe reefs of Tamandaré is not complete and definitive, in face of the countless difficulties in several different levels (taxonomic, quantitative and qualitative ecologic aspects, population dinamics, etc.).

In general, the dry season was a little more productive, where factors as larval recruitment, food sources, physical processes of plankton export/import, rainfall, and phytoplankton abundances could influence the zooplanktonic community.

The relative abundance (and regional abundance) of zooplankton did not presented defined seasonal pattern. Only the Tintinnina group has higher abundances during the summer at the mangrove area, and during the winter at the reef area.

Temperature, dissolved oxygen and salinity vary little in the course of the year at the Tamandaré reef area. However, nutrient concentrations differ significantly among the stations at the Tamandaré reef area. Between the stations R3 and R4 (urbanized area) the nutrients values are higher than the others stations at Tamandaré reef and mangrove (Mamucaba and Ilhetas) areas. It suggests that the Maceió River are the source of high nutrient levels at stations R3, R4 and C2.

At the reef area, in front of the urbanized area of the Tamandaré City, bioindicators of anthropic influences are largely founded. Rotifera, Nematoda, and also Polychaeta are founded in high densities at the stations R3, R4 and C2 (urbanized area). In these stations the densities of bioindicators are higher than the densities at the non-urbanized area.

The species diversity varied from middle to high, with values from 2.399 *bits*.ind^{-1} (mangrove area) to 4.418 *bits*.ind^{-1} (reef area). The species diversity at the mangrove area was a little lower, and high diversity taxa were found at the reef area, suggesting a mix between the mangrove, oceanic and marine communities. The eveness presented values from 0.529 (mangrove area) to 0.774 (reef area). In the reef area the eveness are relative higher, because more taxa are sharing the environmental conditions, representing low dominance peaks of some species or taxa.

The densities of Copepoda, fish larvae and fish eggs, and other meroplankton taxa in the urbanized area are in general lower than the densities of the non-urbanized area. At the stations R1, R2 and C1, (non-urbanized area) the bioindicators densities are generally lower. Fish larvae and fish eggs, and also Decapoda larvae, are more abundant and frequent in this sites, showing that the closed area are also maintaining the reef diversity.

7 Recomendations

Enhanced capacity building, public education, integrated coastal resource management, and establishment of additional protected areas are recommended to help protect reef systems. Fisheries development, mariculture, and eco-tourism would be also compatible if properly planned and implemented.

The primary means to address this problem is through coastal development based upon integrated coastal and water resource management. Promote an integrated coastal management which strives to:

. Improve the governance of coastal ecosystems, and to improve and maintain the quality of coastal regions to ensure that they can provide sustained flow of benefits to human societies.

. Develop local capacity for integrated coastal management as a fundamental part of sustainable development, so that local communities and national governments have the political will and expertise to sustainably develop and manage their own resources.

. Promote the development and implementation of comprehensive, integrated coastal zone management and water resource management plans (very important for the Maceió River case) which minimize the potential impact of human activities, including urban infrastructure, agriculture, tourism, population increases, health and sanitation, and site-specific local uses.

. Strengthen regional capacities to plan, develop, and manage urban infrastructure related to wastewater and pollution prevention.

. Solutions and approaches to address land-based sources of marine pollution can also be adopted at local levels:

. Promote integrated water and coastal management programs, which integrate land and sea-based activities into ecosystem-based management programs, that will better address the negative impacts of land-based sources of pollution on the reef and mangrove environments.

. Minimize the runoff from sewage disposal, mangrove deforestation, and erosion through best-use practices.

. The mangrove destruction may be very dangerous to the maintenance of the reef diversity. Protection of mangrove sites must be included in the reef management program.

Moreover, in the future research strategies must be included a few taxa abundance attributes (in the spirit of keeping an open but cautious mind) in the endangered species category, but predict that the taxa richness and relative abundance measures will most likely yield the strongest environmental signals (Muller, 1992). Recognition of those taxa considered to be threatened or endangered provides additional legal support for remediation activities or recommendations.

8 References

ACEVEDO, R.; MORELOCK, J. (1988). Effects of terrigenous sediment influx on coral reef zonation in Southwestern, Puerto Rico. *Proceed. 6th Int. Coral Reef Symp.*, *Australia*, *2*: 189-194.

ALLABY, M. (2002). Climate classification. *Encyclopedia of weather and climate*. New York. Facts On File, Inc., Science Online (www.factsonfile.com - 10/2002).

ALLAN, J.D. (1976). Life history patterns in zooplankton. *Am. Nat.*, *110*: 165-180.

ALLDREGDE, A.; KING, J.M. (1977). Distribution, abundance and sustrate preference of demersal zooplankton at Lizard Island Lagoon, Great Barrier Reef. *Mar. Biol.*, *41*: 317-333.

ALLDREGDE, A.; KING, J.M. (1980). Effects of moon light on the vertical migration patterns of demers al zooplankton. *J. exp. mar. Biol. Ecol.*, *44*: 133-156.

ALLDREGDE, A.; KING, J.M. (1985). The distance demersal zooplankton migrate above the benthos: implications for predation. *Mar. Biol.*, *84*: 253-260.

ALVES, M. S. (1991). *Macrofauna do fital Halodule wrightii Aschers (Angiospermas - Potomogetomacea) da praia de Jaguaribe, ilha de Itamaracá - PE, Brasil*. Universidade Federal de Pernambuco, C.T.G., Departamento de Oceanografia. Recife. Master's Thesis. 316 p.

AMJAD, S.; GRAY, J.S. (1983). Use of nematode-copepod ratio as an index of organic pollution. *Marine Environmental Research*, *28*: 459-464.

ANDEL, T.H. van; LABOREL, H. (1964). Recent high sea level stand near Recife, Brazil. *Science*, *145*: 580-581.

ANDRADE, G. O.; LINS, R. C. (1971). Os climas do Nordeste. In: VASCONCELOS-SOBRINHO, J. (ed.). *As regiões naturais do nordeste, o meio e a civilização*. Recife, CONDEPE. p. 95-138

ANGEL, M.V. (1977). Windows into a sea of confusion: sampling limitations to the measurement of ecological parameters in oceanic mid-water environments. In: ANDERSON, N.R.; ZAHURANEC, B.J. (eds.). *Oceanic Sound Scattering Prediction*. Plenum Press, New York. p. 171-248.

ARCIFA, M.S.; CASTILHO, M.S.M.; CARMOUZE, J.P. (1994). Composition et évolution du zooplankton dans une lagune tropicale (Brésil) au cours d'une période marquée par une mortalité de poissons. *Rev. Hydrobiol. Trop.*, *27*: 251-263.

ARORA, H.C. (1966). Rotifera as indicator of trophic nature of environments. *Hydrobiol.*, *27*: 146-159.

ATTAYDE, J.L. (1996). *Limnologia da lagoa de Carapebus e a estrutura de sua comunidade zooplanctônica.* Depto. de Ecologia. Universidade Federal do Rio de Janeiro. Master's Thesis. 92 p.

BARBOSA, C.F. (1995). Foraminifera e Arcellacea ("Thecamoebia") recentes do Estuário de Guaratuba, Paraná, Brasil. *An. Acad. Bras. Ci.*, *67*: 465-492.

BARRETT G.W.; ROSENBERG R. (1981). *Stress Effects on Natural Ecosystems.* New York. John Wiley & Sons. 212 p.

BERZINŠ, B.; PEJLER, B. (1989). Rotifer occurrence in relation to oxigen content. *Hydrobiol.*, *183*: 165-172.

BFN (BUNDESAMT FÜR NATURSCHUTZ) - German Federal Agency for Nature Conservation. (1997). *Biodiversity and tourism*: *Conflicts on the world's seacoasts and strategies for their solution*. Berlin; Springer-Verlag. 343 p.

BIANCHI, M.; COLWELL, R.R. (1985). Microbial indicators of environmental water quality: the role of microorganisms in the assessment and prediction of changes in the marine environment induced by human activities. In: SALANKI, J. (ed.). *Biological monitoring of the state of the environment: Bioindicators*. IRL Press, Oxford, Uk. p. 5-15.

BIGELOW, H.B. (1926). Plankton of the offshore waters of the Gulf of Maine. *Bull. US Bur. Fish.*, *40*: 1-507.

BIRKELAY, C.; SMALLEY, T.L. (1981). Comparison of demersal plankton from comparable substrates from a high island and an atoll. In: GOMEZ, E.D. (ed.). *Proceed. 4th Int. Coral Reefs Symp.* University of Phillipines. Marine Sciences Center. Quezon City, Phillipines. p. 437-442.

BIVAR, F.C. (1977). *Estuário do Mamucaba, sedimentos e massa d'água.* Recife. Universidade Federal Rural de Pernambuco (UFRPE). 132 p.

BJÖRNBERG, T.K.S. (1963). On the free-living Copepods of Brazil. *Bol. Inst. Oceanogr.*, *15(4)*:361-373.

BJÖRNBERG, T.K.S. (1981). Copepoda. In: BOLTOVSKOY, D. (ed.). *Atlas del zooplancton del Atlantico Sudoocidental y métodos de trabajos com el zooplancton marino*. INIDEP. Mar del Plata. 936 p.

BJÖRNBERG, T.K.S. (1986). The rejected nauplius: a commentary. In: SCHRIEVER, G; SCHMIKE, H.K.; SHIH, C.T. (eds.). *Proceeedings of the 2th international conference on Copepoda, Ottawa, Canada. Syllogeus Series 58*, National Museums of Canada, Ottawa. p. 232-236.

BOLTOVOSKOY, D. (1981). *Atlas del zooplancton del atlantico sudocidental y metodos de trabajo com el zooplancton marino*. INIDEP. Mar del Plata. 936 p.

BOLTOVOSKOY, D. (1986). Biogeography of the southwestern Atlantic: overview, current problems and prospects. In: SPOEL, S. van der; PIERROT-BULTS, A.; ZAHURANEC, B.; JOHNSON, R. (eds.). *Pelagic Biogeography*. UNESCO, Paris. p. 14-24.

BOLTOVOSKOY, D. (1999). *South Atlantic zooplankton. Vol. 1* and *Vol. 2*. Backhuys Publishers. Leiden. Netherlands. 1705 p.

BOSCHI, E.F. (1981). Larvas de Crustacea Decapoda. In: BOLTOVSKOY, D. (ed.). *Atlas del zooplancton del Atlantico Sudoocidental y métodos de trabajos com el zooplancton marino*. INIDEP, Mar del Plata. 936 p.

BÖTTGER-SCHNACK, R. (1988). Observations on the taxonomic composition and vertical distribution of cyclopoid copepods in the central Red Sea. *Hydrobiologica*, *167/168*: 311-318.

BRADFORD-GRIEVE, J.M. (2002). *Key to calanoid copepod families*. National Institute of Water and Atmospheric Research. Wellington. New Zealand. 134 p.

BRAGA, R.A.P. (1992). *Caracterização Ambiental, Usos atuais e potenciais das zonas estuarinas de Serinhaém e Rio formoso*. Projeto Costa Dourada: C.I.T. Barra-Guadalupe.

BRANCO, C.W.C. (1998). *Comunidades zooplanctônicas e aspectos limnológicos de trés lagoas costeiras da região norte Fluminense*. Int. De biofísica. Universidade Federal do Rio de Janeiro. 232 p. Doctor's Thesis. 145 p.

BRANNER, J.C. (1904). The stone reefs of Brazil, their geological and geographical relations with a chapter on the coral reefs. *Mus. Comp. Zool. Bull., Harvard College, Cambridge*, *41 (geol. Ser. 7)*. 231 p.

BRATKOVICH, A. (1988). The use of planktonic organism distribution as an indicator of physical variability in marine environments. In: SOULE, D. F.; KLEPPEL, G. S. (eds.). *Marine Organisms as Indicators*. Spriger-Verlag. N.Y. p. 13-34.

CHAPIN, F.S. (1998). Ecosystem consequences of changing biodiversity. *Bio-Science*, *48*: 45-52.

CHAPIN, F.S. (2000). Consequences of Changing Biodiversity *Nature*, *405*: 234-242.

COELHO, P.A.; TORRES, M.F.A. (1982). Áreas estuarinas de Pernambuco. *Trab. Oceanogr., Univ. Fed. Pernambuco, Recife*, *17*: 67-80.

COELHO, P.A.; RAMOS-PORTO, M. (1995). Crustáceos da Região de Tamandaré, Estado de Pernambuco, Brasil. *Bol. Técn. Cient. CEPENE (Centro de Pesquisa e Extensão Pesqueira do Nordeste)*, *Tamandaré*, *3(1)*: 57-80.

CONDEPE (INSTITUTO DE PLANEJAMENTO DE PERNAMBUCO) - Planning Institute of Pernambuco - (1992). *Série Monografias Municipais: Rio Formoso*. Governo do Estado de Pernambuco. Secretaria de Planejamento, Ciência, Tecnologia e Meio Ambiente. Recife-PE. 98 p.

CONNELL, J.H. (1978). Diversity in tropical rain forest and coral reefs. *Science*, *199*: 1302-1310.

CORRELL, D.L. (1981). Eutrophication trends in the water quality of the Rhode River (1970-1978). In: NEILSON, B.J.; CRONIN, L.E. (eds.). *Estuaries and nutrients*. Humana Press, Clifton, N.J. p. 425-435.

COSTA, O.S.Jr.; LEÃO, Z.M.A.N.; NIMMO, M.; ATTRILL, M.J. (2000). Nutrification impacts on coral reefs from northern Bahia, Brazil. *Hydrobiologia*, *440*: 307-315.

COULL, B. C. (1977). *Marine fauna and flora of the northeastern United States. Copepoda: Harpacticoida*. U.S. Dept. of Commerce, National Oceanographic and Atmospheric Administration Technical Report, NMFS Circular 399. 113 p.

CPRH (COMPANHIA PERNAMBUCANA DO MEIO AMBIENTE) - Environmental Agency of Pernambuco (2002). *Balneabilidade nas praias de Pernambuco*. (http://www.cprh.pe.gov.br/sec-monit/frme-secund-nitbaln. html - 07/2002)

CPRH (COMPANHIA PERNAMBUCANA DO MEIO AMBIENTE) - Environmental Agency of Pernambuco; GERCO (PROGRAMA DE GERENCIAMENTO COSTEIRO DE PERNAMBUCO) - Coastal Management Program of Pernambuco. (1999) *Diagnóstico Sócio-ambiental e Zoneamento Ecológico-Econômico Costeiro do Litoral Sul do Estado de Pernambuco*. Recife. 109 p.

CRISTI, W.S. (1986). *Marine fauna and flora of Bermuda. A systematic guide to the identification of marine organisms.* USA, Wiley - Interscience Publications. 742 p.

CROSSLAND, C.J. (1983). Dissolved nutrients in coral reef waters. In: BARNES, D.J. (ed.). *Perspectives on coral reefs*.. Australian Institute of Marine Science, Townsville, p. 56-68.

DAM, H.G.; MILLER, C.A.; JONASDOTTIR, S.H. (1993). The trophic role of mesozooplankton at 47° N, 20° W during the North Atlantic Bloom Experiment. *Deep-Sea Res. II*, *40*: 197-212.

DARWIN, C. (1841). On a remarkable bar of sandstone of Pernambuco on the coast of Brazil. *London, Edinburgh, Dublin Philos. Mag. & Journ. Sci.*, *19*: 257-261.

DAY Jr., J.W.; HALL, C.A.S.; KEMP, W.M. (1989). *Estuarine ecology*. New York: J. Wiley Editors. 337 p.

DHN (DIRETORIA DE HIDROGRAFIA E NAVEGAÇÃO) - Directorate of Hydrography and Navigation - Brazilian Navy (1978). CARTA Nº 905 - Baía de Tamandaré (CHART # 905 - Tamandaré Bay). Ministério da Marinha, Rio de Janeiro.

DHN (DIRETORIA DE HIDROGRAFIA E NAVEGAÇÃO) - Directorate of Hydrography and Navigation - Brazilian Navy (1997). *Tábuas de marés para o ano de 1997 (Porto de Suape) - online edition*. Ministério da Marinha, Rio de Janeiro (http://www.dhn.mar.mil.br/ - 019/1997).

DHN (DIRETORIA DE HIDROGRAFIA E NAVEGAÇÃO) - Directorate of Hydrography and Navigation - Brazilian Navy (1998). *Tábuas de marés para o ano de 1998 (Porto de Suape) - online edition*. Ministério da Marinha, Rio de Janeiro, 1998 (http://www.dhn.mar.mil.br/ - 01/1998).

DHN (DIRETORIA DE HIDROGRAFIA E NAVEGAÇÃO) - Directorate of Hydrography and Navigation - Brazilian Navy (2000). *Tábuas de marés para o ano de 2000 (Porto de Suape) - online edition*. Ministério da Marinha, Rio de Janeiro (http://www.dhn.mar.mil.br/ - 01/2000).

DHN (DIRETORIA DE HIDROGRAFIA E NAVEGAÇÃO) - Directorate of Hydrography and Navigation - Brazilian Navy. (2001). *Tábuas de marés para o ano de 2001 (Porto de Suape) - online edition*. Ministério da Marinha, Rio de Janeiro, 2001 (http://www.dhn.mar.mil.br/ - 01/2001).

DONE, T.; WILKINSON, C. (1998). Status of coral reefs of Australia: Great Barrier Reef and western Australia. In: AUSTRALIAN INSTITUTE OF MARINE SCIENCE*. Status of coral reefs of the world: 1998.* 87 p.

DOOHAN, M. (1973). Energetics of planktonic Rotifera applied to populations in reservoirs. University of London. Ph.D.' Thesis. 112 p.

DOOHAN, M. (1975). *Ecological aspects of used water treatment: Vol. 1. Rotifera*. *The organisms and their ecology*. Academic Press, London. 234 p.

DUNCAN, B.; FLEMING, B.; GRAHAM, R.; SLOPEK, S.; TEICHMAN, W.; WALKER, D.; WALKER, N.; COSTA, M. (2003). *Preliminary Analysis: Boa Viagem Erosion Prevention and Beach Renourishment Project*. Environmental Studies Program Washington and Lee University in Collaboration with the Departamento da Oceanografia da Universidade Federal do Pernambuco (UFPE). 51 p.

DUSSARD, B.H.; DEFAYE, D. (1995). Introduction to the Copepoda. In: DUMONT, H.J. (ed.). *Guides to the identification of the micro-invertebrates of the continental waters of the world*. Academic Publishing. Amsterdam. p. 123-156.

ECHELMAN, T.; FISHELSON, L. (1990). Surface zooplankton dynamics and community structure in the Gulf of Aqaba (Eilat), Red Sea. *Mar. Biol.*, *107*: 179 - 190.

EDINGER, E.N.; RISK, M.J. (1999). Reef classification by coral morphology predicts coral reef conservation value. *Biological Conservation 92*:1-13.

ELLIS, J.I.; SCHNEIDER, D.C. (1997). Evaluation of a gradient sampling design for environmental impact assessment. *Environ. Monit. Assess.*, *48*: 157-172.

EMERY, A.R. (1968). Preliminary observations on coral reef plankton. *Limnol. & Oceanog. 13*: 293-303.

EPIFANIO, C. (1988). Trasport of crab larvae between estuaries and the continental shelf. In: JANSSON, B.O. (ed.). *Lecture notes on coastal and estuarine systems*, *22*: 291-305. Springer-Verlag, Berlin.

EPSTEIN P.R.; RAPPORT D.J. (1996). Changing coastal marine environments and human health. *Ecosystem Health*, *3*: 166-176.

ESPINO, G.L.; PULIDO, S.H.; PÉREZ, J.L.C. (2000). *Organismos indicadores de la calidad del agua y de la contaminación (bioindicadores)*. Plaza y Valdés S.A., Mexico. 237 p.

EVANS, F. (1973). The permanent zooplankton of Northumberland coastal waters. *Proc. Univ. Newc. Philos. Soc.*, *2*: 25-68.

FARIAS, F. S. (2002). Tamoindaré - A dinâmica de suas praias frente às novas tribos repovoadas do século XX. Universidade Federal de Pernambuco (UFPE), Recife, PE. Master's Thesis. 124 p.

FARRAN, G.P. (1936). Copepoda. *Scientific Reports of the Great Barrier Reef Expedition*, *(1928-29) 5*: 73-142.

FEITOSA, F.A.N. (1988). Produção primária do fitoplâncton correlacionada com parâmetros bióticos e abióticos na Bacia do Pina (Recife - Pernambuco - Brasil). Recife, Universidade Federal de Pernambuco, C.T.G., Departamento de Oceanografia. Master's Thesis. 270 p.

FERRARI, F.D.; BRADLEY, B.P. (1994); Nomenclature, redescription, and new record from Okinawa of *Cymbasoma morri* Sekiguchi, 1982 (Monstrilloida). *Hydrobiological*, *292/293 (Ecology and Morphology of Copepods)*: 23-29.

FERRARIS, J.D. (1982). Surface zooplankton at Carrie Bow Cay, Belize. *Smith. Cont. Mar. Sci.*, *12*: 239-251.

FERRER, L.M.; SZMANT, A.M. (1988). Nutrient regeneration by the endolitic community in coral skeletons. In: *Proceedings of international coral reef symposium, 6, Townsville, 1988, Australia*, *3*: 1-4.

FERREIRA, B.P.; MAIDA, M.; SOUZA, A.L.T. (1995). Levantamento inicial das comunidades de peixes recifais da região de Tamandaré-PE. *Bol. Técn. Cient. CEPENE (Centro de Pesquisa e Extensão Pesqueira do Nordeste)*, *Vol. 3(1)*: 211-230.

FINN, J.T. (1976). Measures of ecosystem structure an fundtion derived from analysis of flows. *J. Theor. Biol.*, *56*: 363-380.

FLORES-MONTES, M. J. (1996). *Variação nictemeral do fitoplâncton e parâmetros hidrológicos no Canal de Santa Cruz, Itamaracá, PE*. Recife, Universidade Federal de Pernambuco, C.T.G., Departamento de Oceanografia. Master's Thesis. 178 p.

FRANSZ, H.G. (1988). Vernal abundance, structure and development of epipelagic copepod populations of the eastern Weddell Sea (Antarctica). *Polar Biol.*, *9*: 107-114.

FRECKMAN, D.W. (1988). Bacterivorous nematodes and organic-matter decomposition. *Agriculture, Ecosystems and Environment*, *24*: 195-217.

FRENCH, P.W. (1997). *Coastal and estuarine management*. Routledge Environmental Management Series, London. 346 p.

GALLEGOS, C.C.; DOLAN, J.R. (1992). Trophic role of planktonic rotifers in the Rhode river estuary, spring-summer 1991. *Mar. Ecol. Prog. Ser.*, *85*: 187-199.

GALLIENNE, C.P.; ROBINS, D.B. (2001). Is *Oithona* the most important copepod in the world's ocean? *Jour. Plankt. Res.*, *23(12)*: 1421-1432.

GIBSON, G.R.; BOWMAN, M.L.; SNYDER, B.D.; GERRITSEN, J. (1997). *Draft estuarine and coastal waters bioassessment and biocriteria technical guidance.* USEPA, Office of Science and Technology, Health and Ecological Criteria Division, Washington, DC.

GLYNN, P. (1973). Ecology of a Caribbean Coral Reef. The Porites reef - flat biotipe: Part II. Plankton community with evidence for depletion. *Mar. Biol.*, *22*: 1-21.

GOREAU, T.; GOREAU, N.I.; YOUNGE, C.M. (1971). Reef corals: autotrophs or heterotrophs?. *Biol. Bull.*, *141*: 247-260.

GOSWAMI, S. C.; SELVAKUMAR, R. A. (1977). Plankton studies in the estuarine system of Goa. In: *Proceed. of the Symposium on warm water zooplankton, Goa, 1976. Goa, National Institute of Oceanography*. p. 226-241.

GOTTO, V. (1992). Commensal and parasitic copepods associated with marine invertebrates (and whales). *Synopses of the British Fauna (New Series) No. 46*. Universal Book Services, London. 237 p.

GRASSLE, J.F.; GRASSLE, J.P. (1974). Opportunistic life histories and genetic systems in marine benthic polychaetes. *Journal of Marine Research*, *32*: 253-284.

GRASSHOFF, K.; ROMAM, M.R.; DEGOBBIS, D. (1983). *Methods of seawater analysis. Second ed*. New York. Verlag Chemie. 317 p.

GREEN, J. (1968). *The biology of estuarine animals*. Sidwick & Jackson. London. 452 p.

GUSMÃO, L.M.O. (2000). Comunidade zooplanctônica nas províncias neríticas e oceânica do estado de Pernambuco, Brazil. Recife, Universidade Federal de Pernambuco, C.T.G., Departamento de Oceanografia. Doctor's Thesis. 108 p.

HALLOCK, P.; MULLER-KARGER, F.; HALAS, J.C. (1993). Coral reef decline - anthropogenic nutrients and the degradation of Western Atlantic and Caribbean coral reefs. *Research and Exploration*, *9(3)*: 358-378.

HAMILTON, L.S.; SNADEKAR, S.C. (1984). *Handbook for mangrove area management*. Environment and Policy Institute, East-West Center (Honolulu, Hawai) - International Union for the Conservation of Nature and Natural Resources (Switzerland /UNESCO), Paris. 378 p.

HAMMER, W.M.; JONES, M.S.; CARLETON, J.H.; HAURI, I.R.; WILLIAMS, D.M. (1988). Zooplankton, planktivorous fish, and water currents on a windward reef face: Great Barrier Reef, Australia. *Bull. Mar. Sci.*, *42*: 459-479.

HANNON, B. (1973). The structure of ecosystems. *J. Theor. Biol.*, *41*: 535-546.

HARRIOTT, V. J.; BANKS, S. A. (2002). Latitudinal variation in coral communities in eastern Australia: a qualitative biophysical model of factors regulating coral reefs. *Coral Reefs*, *21*: 83-94.

HATCHER, B.G.; JOHANNES, R.E.; ROBERTSON, A. (1989). Review of research relevant to the conservation of shallow tropical marine ecosystems. In: BARNES, M. (ed.). *Occanogr. Mar. Biol. Annu. Rev.*, *27*: 337-414.

HAURY, L.R.; PIEPER, R.E. (1988). Zooplankton: scales of biological and physical events. In: SOULE, D.F.; KLEPPEL, G.S. (eds.). *Marine Organisms as Indicators*. Spriger-Verlag. N.Y. p. 34-72.

HEMLEBEN, C.; SPINDLER, M.; ANDERSON, O.R. (1989). *Modern planktonic Foraminifera*. Springer-Verlag. New York. 398 p.

HENDERSON, C. (2001). Coral decline: the world's coral reefs face extinction if radical action isn't taken. *The Ecologist*, *34*: 34-45.

HENRIKKSON, R. (1969). Influence of pollution on the bottom fauna of the Sound (Oresund). *Oikos*, *20*: 507-523.

HOGARTH, P. (1999). *The biology of mangroves*. Oxford University Press. London. 228 p.

IBAMA (INSTITUTO BRASILEIRO DO MEIO AMBIENTE E DOS RECURSOS NATURAIS RENOVÁVEIS) - Brazilian Iintitute for Environment and Natural Resources. (1989). *Unidades de conservação do Brasil. Parques Nacionais e Reservas Biológicas*. *Vol.1*. Brasília. 236 p.

IBAMA (INSTITUTO BRASILEIRO DO MEIO AMBIENTE E DOS RECURSOS NATURAIS RENOVÁVEIS) - Brazilian Iintitute for Environment and Natural Resources. (1991). *Plano de manejo: Parque natural marinho de Abrolhos*. Brasília. 154 p.

IBGE (INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA) - Brazilian Institute of National Statistics and Geography. (2000). *Censo demográfico 2000: resultados preliminares*. Brasília. 45 p.

INGHAM, R.E.; TROFYMOW, J.A.; COLEMAN, D.C. (1985). Interactions of bacteria, fungi, and their nematode grazers: Effects on nutrient cycling. *Ecological Monographs*, *55*: 19-140.

JAMESON, S.C.; ERDMANN, M.V.; KARR, J.R.; GIBSON, G.R.Jr.; POTTS, K.W. (in press). Charting a Course Toward Diagnostic Monitoring: A Continuing Review of Coral Reef Attributes and a Research Strategy for Creating Coral Reef Indexes of Biotic Integrity. *Bull. Mar. Sel.* (online edition: http://www.epa.gov/owow/oceans/coral/charting/sect1.pdf – 10/2003).

JENNERJAHN, T.C.; VENUGOPALAN, I. (2002). Relevance of mangroves for the production and deposition of organic matter along tropical continental margins. *Naturwissenschaften*, *89*:23–30

JOHANNES, R.E. (1975). Pollution and degradation of coral reef communities. In: WOOD, E.J.F.; JOHANNES, R.E. (eds.). Tropical marine pollution. Elsevier, Amsterdam. p. 13-51.

JONES, G.P.; KALY, U.L. (1996). Criteria for selecting marine organisms in biomonitoring studies. In: SCHMITT, R.J.; OSENBERG, C.W. (eds.). *Detecting Ecological Impacts: Concepts and Applications in Coastal Habitats*. Academic Press, Inc. San Diego. P. 67-98.

KABATA, Z. (1992). Copepods parasitc on fishes. *Synopses of the British Fauna (New Series) No. 47*. Universal Book Services. London. 87 p.

KARLSON, R.H. (1999). *Dynamics of coral communities*. Kluwier Academic Publishers. New York. 308 p.

KARR, J.R. (1991). Biological integrity: a long-neglected aspect of water resource management. *Ecol. Appl.*, *1*: 66-84.

KARR, J.R. (1996). *Ecological integrity and ecological health are not the same*. National Academy Press, Washington, DC. 175 p.

KASTURIRANGAN, L.R. (1963). *A key for the identification of the more common planktonic Copepoda of Indian coastal waters*. Council of Scientific & Industrial Research. New Delhi. 95 p.

KINNE, O. (1967). Physiology of estuarine organism with special reference to salinity and temperature; general aspects. In: LAUFF, G.H. (ed.). *Estuaries*. Washington, American Association for the Advancement of Science.

KOSTE, W. (1978). *Rotatoria: die Rädertiere Mitteleuropas. Vols. 1 & 2*. Gebrüder Borntraeger, Berlin. 1583 p.

KOZLOWSKY-SUZUKI, B. (1998). *O efeito do enriquecimento artificial e das aberturas de barra sobre a dinâmica das variáveis abióticas e sobre a estrutura da comunidade zooplanctônica na lagoa Imboassica, Macaé, Rio de Janeiro*. Depto. De Ecologia. Universidade Federal do Rio de Janeiro. Master's Thesis. 94 p.

KRIVOLUTZKY, D.A. (1985). Animals as bioindicators. In: SALANKI, J. (ed.). *Biological monitoring of the state of the environment: bioindicators*. IRL Press, Oxford, Uk. 453 p.

KUYLENSTIERNA, M.; KARLSON, B. (1996). *Plankton Database. An illustrated checklist of Skagerrak plankton (protists and cyanobacteria), with pictures and information on species found in the area*. Department of Marine Botany of the Göteborg University, Göteborg - Sweden (http://www.marbot.gu.se/SSS/SSShome.htm - 08/2000).

LABOREL, J. (1965a). On Brazilian coral reefs. *An. Acad. Bras. Ciên.*, *37 - Suplemento: 258*.

LABOREL, J. (1965b). Note prèliminaire sur les rècifs de grès et rècifs de coraux dans le Nord-Est brèsilien. *Rec. Trav. Stat. Marine Endoume*, *37(53)*: 341-344.

LAST, J.M. (1980). The food of twenty species of fish larvae in the west-central North Sea. Fish. Res. *Tech. Rep. 60*. MAFF Directorate of Fisheries Research, Lowestoft. 162 p.

LEÃO, Z.M.A.N. (1994). Threats to coral reef environments. In: HETZEL, B.; CASTRO, C.B. (eds.).*Coral reefs of southern Bahia. Nova Fronteira, Rio de Janeiro*. p. 177-181.

LEÃO, Z.M.A.N.; ARAÚJO T.M.F.; NOLASCO, M.C. (1988). The coral reefs of the coast of Northeastern Brazil. *Proceed. 6th Int. Coral Reefs Symp.*, *3*: 339-348.

LEÃO, Z.M.A.N.; ARAÚJO, T.M.F.; NOLASCO, M.C. (1994). Impact of tourism developtment on the coral reefs of the Abrolhos area, Brazil. In: GINSBURG, R.N. (ed.). *Global aspects of coral reefs: health, hazards and history*. Rosenstiel School of Marine and Atmospheric Science, University of Miami, Florida. p. 254-260.

LEFEVRE, M. (1984). Repartition de la biomasse zooplanctonique autaur de l'ile de Moorea (Polynesie Francaise). *J. Rech. Oceanogr.*, *9*: 20-22.

LEGENDRE, L.; DEMERS, S. (1984). Towards dynamic biological oceanography and limnology. *Can. J. Fish. Aquat. Sci.*, *41*: 2-19.

LEGENDRE, P.; LEGENDRE, L. (1998). *Numerical ecology. 2nd*. English Edn. Elsevier, Amsterdam. 870 p.

LEONTIEF, W. (1951*). The structure of American Economy, 1919-1939*. 2th ed. Oxford. University Press, New York. 57 p.

LEPS, J.; STRASKRABA, M.; DESORTOVA, B.; PROCHÁZ-KOVÁ, L. (1990). Annual cycles of plankton species composition and physical chemical conditions in Slapy Reservoir detected by multivariate statistics. *Asch. Hydrob. Beih. Ergebn. Limol.*, *33*: 933-945.

LEWIS Jr., M.W. (1989). *Zooplankton Community Analysis: studies on a tropical system*. Springer-Verlag. New York. 256 p.

LIEBMANN, H. (1962). *Handbuch der Frishwasser-und Abwasser-biologie. Vol. 2.*, *R*. Oldenburg, Munich. 142 p.

LIRA, L.G.G. (1975). Geologia do canal de Santa Cruz e praia adjacente a ilha de Itamaracá. Rio Grande do Sul, Universidade Federal, Departamento de Geologia do Instituto de Geociências, UFRGS. Master's Thesis. 107 p.

LIRA, L.G.G.; ZAPATA, M.C.; FALCÃO, I.M. de M.; OLIVEIRA-JÚNIOR, A.V. (1978) Material em suspensão, temperatura e salinidade no estuário do rio Mamucaba-PE. *Cad. Ômega da Universidade Federal Rural de Pernambuco, Recife*, *2(1)*: 97-116.

LIRA, L.G.G.; ZAPATA, M.C.; FONSECA, V.G. (1979). Aspectos da dinâmica do estuário do Rio Formoso, PE. *Cad. Ômega da Universidade Federal Rural de Pernambuco, Recife*, *3(1)*: 133-156.

LOSADA, A.P.M. (2000). *Biomassa fitoplanctônica correla-cionada com parâmetros abióticos, nos estuários dos rios Ilhetas e mamucaba, e na baía de Tamandaré (Pernambuco - Brasil)*. Universidade Federal de Pernambuco (UFPE) - Departamento de Oceanografia. Master's Thesis. 134 p.

MABESOONE, J.M. (1967). Os "recifes" do Brasil. *Bol. Soc. Bras. Geol.*, *15(3)*: 45-49.

MABESOONE, J.M.; COUTINHO, P.N. (1970). Littoral and shallow marine geology of northeastern Brazil. *Trab. Oceanogr., Univ. Fed. Pernambuco, Recife*, *12*: 1-214.

MACÊDO, S.J.; COSTA, K.M.P. (1990). Condições hidrológicas do estuário do rio Igarassu - Itamaracá - Pernambuco. *Trab. Oceanogr., Univ. Fed. Pernambuco, Recife*, *21*: 7-32.

MACKAS, D.; DENAM, K.; ABBOTT, M. (1985). Plankton patchiness: biology in the physical vernacular. *Bull. Mar. Sci.*, *37*: 652-674.

MAGEAU, M.T.; COSTANZA, R.; ULANOWICZ, R,E. (1995). The development and initial testing of a quantitative assessment of ecosystem health. *Ecosystem Health*, *1*: 201-213.

MAIDA, M.; FERREIRA, B.P. (1997). Coral reefs of Brazil: an overwiew. *Proceed. 8th Int. Coral Reefs Symp.*, *1*: 263-274.

MARGALEF, R. (1968). *Perspectives in Ecological Theory*. Chicago: University of Chicago Press. 443 p.

MARQUES, E. (1950). *Breves considerações sobre plâncton. Copepodos da Guiné*. Lisboa, Ministério das Colônias, Junta de Investigações Coloniais. 121 p.

MARSH, J.A.Jr. (1977). Terrestrial inputs of nitrogen andphosphorus on fringing reefs of Guam. In: *Proceedings of international coral reef symposium, 3, Miami, 1977, Florida, 1*:331-336.

MARSHALL, S.M. (1969). Protozoa. Order: Tintinida., Zooplankton Sheets 117-127.*Cons. Inst. Explor. Mer*. 54 p.

MATSUMURA-TUNDISI, T. (1972). *Aspectos ecológicos do zooplâncton da região lagunar de Cananéia com especial referência aos Copepoda (Crustacea)*. São Paulo. Universidade de São Paulo, Instituto de Biociências. Doctor's Thesis. 191 p.

MATSUMURA-TUNDISI, T. (1986). Latitudinal distribution of Calanoida Copepods in freshwater aquatic system of Brazil. *Rev. Bras. Biol., 46(3)*: 527-553.

MAYAL, E.M.; AMARAL, F. (1990). Ecomorfose em alguns escleractínios da costa pernambucana. *Trab. Oceanogr., Univ. Fed. Pernambuco, Recife*, *21*: 239-251.

MAYAL, E.M.; GOMES, P.B.; AFONSO, A.P.S.; PEREIRA, L. C.C. (2000). Reefs of Pernambuco - Brazil, Part 1: Scleractinia common in the region of Tamandaré (south coast of the State of Pernambuco. *Trab. Oceanogr., Univ. Fed. Pernambuco, Recife*, *28(2)*: 51- 65.

McEWEN, M.W., FOLSOM, J.; FOLSOM, T.R. (1954). A statistical analysis of the perfomance of the Folsom Plankton Sample Splitter, based upon test observations. *Arch. Met. Geophys. Klimatol.*, *7*: 502-527.

McKINNON, A.D. (1991). *A Toolbook for the Practical Identification of Pelagic Copepods* (unpublished pamphlet).

McWILLIAMS, P.S.; SALE, P.F.; ANDERSON, D.T. (1981) Seasonal changes in resident zooplankton sampled by emergence traps in one tree lagoon, Great Barrier Reef. *J. exp. mar. Biol. Ecol.*, *52*: 185-203.

MEDEIROS, C. (1991). *Circulation and mixing process in the Itamaracá estuarine system, Brazil*. Columbia. University of South Carolina. Doctor's Thesis.

MÉNDEZ, S.; GÓMEZ, M.; FERRARI, G. (1997). Planktonic studies of the Río de la Plata and ist oceanic front. In: WELLS, P.G.; DABORN, G.R. (eds.). *The Río de la Plata. An environmental overview. An EcoPlata project background report*. Dalhausie University, Halifax, Nova Scotia. p. 85-112.

MIANZAN, H.; LASTA, C.; ACHA, E.; GUERRERO, R.; MACCHI, G. (1994). The Río de la Plata estuary, Argentina-Uruguay. In: SEELIGER, U.; KJERFVE, B. (eds.). Coastal marine ecosystems of Latin America. Springer, Berlin Heidelberg New York. P. 185-204.

MICHEL, H.B.; FOYO, M. (1976). *Caribbean Zooplankton. Part I. Siphonophora, Heteropoda, Copepoda, Euphausiacea, Chaetognatha and Salpidae*. Office of Naval Research, Department of the Navy. United States. 209 p.

MILLER, C.B. (1976). The zooplankton of estuaries. In: KENTCHUM, B.H. (ed.). *Estuaries and enclosed seas. Ecosystems of the world*, *26*: 103-149.

MILLER, C.B. (1995). The mesh size survey. *TASC Newsl.*, *4*: 5-7.

MMA (MINISTÉRIO DO MEIO AMBIENTE) - Brazilian Environmental Ministry. (1996). *Macrodiagnóstico da Zona Costeira do Brasil.* Brasília. 284 p.

MONTÚ, M.A. (1987). Síntese dos conhecimentos sobre zooplâncton estuarino. Estuário do sistema lagunar de Cananéia, complexo da Baía de Paranaguá e Lagoa dos Patos. *Publicações ACIESP*, *54(3)*: 176-193.

MONTÚ, M.A.; GLOEDEN, I.M.; DUARTE, A.K.; RESGALLA, C.Jr. (1997). Zooplankton. In: SEELIGER, U.; ODEBRECHT, C.; CASTELLO, J.P. (eds.). *Subtropical convergence environments. The coast and sea in the southwestern Atlantic*. Springer, Berlin Heidelberg New York. p. 110-114.

MOORE, E.; SANDER, F. (1976). Quantitative and qualitative aspects of the zooplankton and breeding patterns of copepods at two caribbean coral reef stations. *Est. and Coast. Mar. Sci.*, *4*: 589-607.

MORGAN, S.G. (1990). Impact of planktivorous fishes on dispersal. Hatching, and morphology of estuarine crab larvae. *Ecology 71*: 1639-1652.

MOURA, R.T. (1991). *Biomassa, produção primária do fitoplâncton e alguns fatores ambientais na Baía de Tamandaré, Rio Formoso, Pernambuco, Brasil.* Universidade Federal de Pernambuco (UFPE), Departamento de Oceanografia. Recife. Master's Thesis. 145 p.

MULLER, F. (1992). Hierarchial approaches to ecosystem theory. *Ecological Modelling*, *63*: 215-242.

MULTICONSULTORIA (1991). *Proposta Técnica do Projeto Costa Dourada*. DIPER-SPE. Recife. 54 p.

MULTICONSULTORIA (1992). *Avaliação de impactos ambientais do Projeto Costa Dourada*. DIPER-SPE. Recife. 76 p.

MUNRO, J.L.; WILLIAMS, D. MCB. (1985). Assessment and management of coral reef fisheries: biological, environmental and socioeconomic aspects. In: *Proc. 5th Intl. Coral Reef Cong.*, *4*: 545-572.

NASCIMENTO, D.A. (1980). *Composição e distribuição do zooplâncton no estuário do rio Botafogo, Itamaracá - Pernambuco - Brasil*. Universidade Federal do Paraná. Master's Thesis. 108 p.

NASCIMENTO, D.A.; PARANAGUÁ, M.N. (1981). Composição e distribuição do zooplâncton na estuário do rio Botafogo, Itamaracá - Pernambuco. *Encontro de Zoologia do Nordeste*, *3. Recife - PE, Abstract*, p. 2.

NASCIMENTO-VIEIRA, D.A. (2000). Macrozooplâncton recifal da baía de Tamandaré, Pernambuco - Brazil. Universidade Federal de Pernanbuco (UFPE). Doctor's Thesis. 134 p.

NASCIMENTO-VIEIRA, D.A.; SANT'ANA, E.E. (1987/1989). Composição do zooplâncton no estuário do rio Timbó (Pernambuco - Brasil). *Trab. Oceanogr., Univ. Fed. Pernambuco, Recife*, *20*: 77-97.

NASCIMENTO-VIEIRA, D.A.; FEITOSA, F.A.; PASSAVANTE, J.Z.O. (1988). Composição do zooplâncton na Bacia do Pina - Recife - Pernambuco. *Encontro de Brasileiro de Plâncton, 3, Pontal do Sul - Paraná, 1988. Abstract, p. 19.*

NEHER, D.A. (2000). Role of Nematodes in bottom Health and Their Use as Indicators. In*: Proceed. 39th Annual Meeting of The Society of Nematologists*. Quebec City, Canada. p. 1-16.

NEUMANN-LEITÃO, S. (1986). *Sistemática e ecologia dos rotíferos (Rotatoria) planctônicos da área estuarina-lagunar de Suape - Pernambuco (Brasil)*. Recife, Universidade Federal de Pernambuco, C.T.G., Departamento de Oceanografia. Master's Thesis. 261 p.

NEUMANN-LEITÃO, S. (1994). *Impactos antrópicos na comunidade zooplanctônica estuarina. Porto de Suape - Pernambuco - Brasil*. Escola de Engenharia de São Carlos, Universidade de São Paulo. Doctor's Thesis. 273 p.

NEUMANN-LEITÃO, S.; MATSUMURA-TUNDISI, T. (1988). Dynamics of a perturbed estuarine zooplanktonic community: Port of Suape, PE, Brazil. *Verh. Internat. Verein. Limnol.*, *26*: 1981-1988.

NEUMANN-LEITÃO, S.; GUSMÃO, L.M.O.; NASCIMENTO-VIEIRA, D.A. (1992). Zooplâncton dos estuários dos rios Massangana e Tatuoca, Suape (Pernambuco - Brasil). *Arq. Biol. Tecnol.*, *35(2)*: 341-360.

NEUMANN-LEITÃO, S.; GUSMÃO, L.M.O.; NASCIMENTO-VIEIRA, D.A. (1993). Zooplâncton da área estuarina do Rio Formoso - Pernambuco - Brasil. In: *REUNIÃO ANUAL DA SOCIEDADE BRASILEIRA PARA O PROGRESSO DA CIÊNCIA, 45, 1993*, São Paulo: SBPC, 1993. v. 7, p. 686.

NEUMANN-LEITÃO, S.; GUSMÃO, L.M.O.; NASCIMENTO-VIEIRA, D.A.; NOGUEIRA-PARANHOS, J.D. (1994/1995). Zooplâncton da área estuarina do rio Formoso - PE (BRASIL). *Trab. Oceanogr., Univ. Fed. Pernambuco, Recife*, *23*: 55-64.

NEUMANN-LEITÃO, S.; GUSMÃO, L.M.O.; NASCIMENTO-VIEIRA, D.A.; NOGUEIRA-PARANHOS, J.D. (1996). Variação diurna do zooplâncton no estuário do rio Ipojuca - Pernambuco - Brasil. *Trab. Oceanogr., Univ. Fed. Pernambuco, Recife*, *24*: 103-134.

NEUMANN-LEITÃO, S.; GUSMÃO, L.M.O.; NASCIMENTO-VIEIRA, D.A.; PORTO NETO, F. de F.; MOURA, M.C.O.; SILVA, A.P. (1998). Biodiversidade e Produtividade do Zooplâncton Estuarino de Pernambuco (Brasil). In: *4° Congresso de Ecologia do Brasil, 1998,* BELÉM. Abstract.

NEW, T.R. (1995). *An Introduction to Invertebrate Conservation Biology*. Oxford University Press. Oxford. 347 p.

NEWELL, G.E.; NEWELL, R.C. (1963). *Marine plankton: an pratical guide*. Hutchlson Educational. London. 221 p.

NILSSON, C.; GRELSSON, G. (1995). The fragility of ecosystems: a review. *Jour. Appl. Ecol.*, *32*: 677-692.

NOGUEIRA-PARANHOS, J.D. (1990). *Taxonomia e ecologia dos Tintinnina em um trecho da plataforma continental de Pernambuco - Brasil*. C.T.G., Universidade Federal de Pernamuco (UFPE). Recife. Master's Thesis. 149 p.

NORDI, M. (1982). *Ecologia do zooplâncton no estuário do rio Paraíba do Norte (Paraíba - Brasil).* São Carlos, Universidade Federal de São Carlos, 1982. Master' Thesis. 131 p.

NORSE, E.A. (1993). *Global marine biodiversity: a strategy for building conservation into decision making*. Island Press, Washington, DC. 415 p.

ODEBRECHT, C.; CASTELLO, J.P. (1994). The convergence ecosystem in the southwest Atlantic. In: SEELIGER, U.; KJERFVE, B. (eds.). *Coastal marine ecosystems of Latin America*. Springer, Berlin Heidelberg New York. p. 147-165.

ODUM, E.P. (1969). The strategy of ecosystem development. *Science*, *164*: 262-270.

ODUM, E.P., FINN, J.T.; FRANZ E. (1979). Pertubation theory and the subsidy-stress gradient. *BioScience*, *29*: 349-352.

ODUM, H.T.; ODUM, E.P. (1955). Thophic structure and productivity of a windward coral reef community of Eniwetok Atoll. *Ecol. Monogr.*, *25*: 291-320.

OGDEN, J.C.; ZIEMAN, J.C. (1977). Ecological aspects of coral reef seagrass bed contacts in the Caribbean. Miami. *Proc. Intl. Coral Reef Symp.*, *3*: 377-382.

OHLHORST, S.L. (1982). Diel migrations patterns of demersal reef zooplankton. *J. exp. mar. Biol. Ecol.*, *60*: 1-15.

ÖHMAN, M.C. (1993). Global Assessment of Coral Reefs, In: *Colloquium on global aspects of corals; health, hazard and history*. Univ. Miami. The State of the Marine Environment in the East Asian Seas Region; Regional Seas Reports and Studies, No. 126. 342 p.

OMORI, M.; IKEDA, T. (1984). *Methods in marine zooplankton ecology*. Wiley-Interscience Publication. New York. 331 p.

PAFFENHÖFER. G.A.; LEWIS, K.D. (1989). Feeding behavior of nauplii of the genus Eucalanus (Copepoda, Calanoida). *Mar. Ecol. Prog. Ser.*, *57*: 129-136.

PAINE, R.T. (1966). Food web complexity and species diversity. *American Naturalist*, *100*: 65-75.

PAINE, R.T. (1994). *Excellence in Ecology 4: Marine rocky shores and community ecology: an experimentalist's perspective.* Ecology Institute, Oldendorf/Luhe, Germany. 329 p.

PANE, L.; MARIOTTINI, G.L. (2002). Ecology of planktonic heterotrophic flagellates. A review. *Braz. J. Biol.*, *62(4B)*: 835-46.

PARANAGUÁ, M.N. (1985/1986). Zooplankton of the Suape area (Pernambuco - Brazil). *Trab. Oceanogr., Univ. Fed. Pernambuco, Recife*, *19*: 113-114.

PARANAGUÁ, M.N.; NASCIMENTO, D.A. (1973). Estudo do zooplâncton do estuário da região estuarina de Itamaracá. São Paulo. *Ciência e Cultura*, *25(6)*: 198, Abstract.

PARANAGUÁ, M.N.; NASCIMENTO-VIERA, D.A. (1984). Estudo ecológico da região de Itamaracá, Pernambuco, Brasil. XXV. Zooplâncton do rio Botafogo. *Trab. Oceanogr., Univ. Fed. Pernambuco, Recife*, *18*: 193-206.

PARANAGUÁ, M.N.; NOGUEIRA-PARANHOS, J.D. (1992). Estudos taxonômicos de Cladocera (Crustacea) do estuário do rio Capibaribe - Pernambuco. *Encontro de Zoologia do Nordeste, 9, Recife, 1992. Abstract*, p. 75*.*

PARANAGUÁ, M. N.; NASCIMENTO, D. A. DO; MACÊDO, S. J. (1979). Estudo ecológico da região de Itamaracá, Pernambuco, Brasil. II. Distribuição do zooplâncton no estuário do rio Igarassu. *Trab. Oceanogr., Univ. Fed. Pernambuco, Recife*, *14*: 65-92.

PARANAGUÁ, M.N.; SILVA, T.A.; NOGUEIRA-PARANHOS, J.D. (1990). Distribuição da comunidade zooplanctônica no estuário do rio Capibaribe - Pernambuco. *Encontro Brasileiro de Plâncton, 4, Recife. Abstract*, p. 87

PEREIRA, H.M. (1980). *Zooplâncton do estuário do rio Sergipe (composição e flutuação das populações)*. Curitiba, Universidade Federal do Paraná. Master's Thesis. 205 p.

PERNETTA, J.C.; MILLIMAN, J.D. (1995). Land-ocean interactions in the coastal zone: implementation plan. *Global Change Report No. 33*. International Geosphere-Biosphere Programme of ICSU. Stockholm. 251 p.

PERKINS, E. J. (1974). *The biology of estuaries and coastal waters*. *2 ed*. London: Academic Press. 678 p.

PETERSON, W.T. (1986). The effects of seasonal variations in stratification on plankton dynamics in Long Island Sound. Berlin, *Lecture Notes in Coastal and Estuarine Studies, 17*: 225-319.

PIELOU, E.C. (1984). *The interpretation of ecological data*. John Wiley & Sons, New York, USA. 574 p.

PIERROT-BULTS, A.C.; CHIDGEY, K.C. (1988). Chaetognatha. Keys and notes for the identification of the species. In: KERMACK, D.M.; BARNES, R.S.K. (eds.). *Synopses of the British fauna (new Species).*

PILSON, M.E.Q.; BETZER, S.B. (1973). Phosphorus flux across a coral reef. *Ecology*, *54*: 581-588.

PLATT, H.M .; SHAW, K.M.; LAMBSHEAD, P.J.D. (1984). Nematode species abundance patterns and their use in the detection of environmental perturbations. *Hydrobiologia*, *118*: 59-66.

PONTIN, R.M.; LANGLEY, J.M. (1993). The use of rotifer communities to provide a preliminary national classification of small water bodies in England. *Hydrob.*, *255/256*: 411-419.

POR, F.D.; ALMEIDA PRADO, M.S. (1982). The polyhaline mangal of Itamaracá (Pernambuco), characterized by a student workshop in september, 1891. In: *Simpósio Internacional sobre Utilização e Ecossistemas Costeiros: Planejamento, Poluição e Produtividade, Rio Grande, RS. Abstract. 5(2):* 99.

PORTO NETO, F.F. (1995). *Aspectos da Pesca em Tamandaré, Rio Formoso, Pernambuco.* Universidade Federal Rural de Pernambuco (UFRPE), Recife, PE. Graduation's Work. 96 p.

PORTO NETO, F.F. (1998). *Variação nictemeral e sazonal do zooplâncton no Canal de Santa Cruz, Itamaracá, Pernambuco - Brasil*. Universidade Federal de Pernambuco (UFPE). Recife. Master's Thesis. 134 p.

PORTO NETO, F.F. (1999). Estrutura da comunidade zooplanctônica dos recifes costeiros de Tamandaré, PE. *FACEPE Report.* Fundação de Amparo a Ciência de Pernambuco (FACEPE). Recife. 34 p.

PORTO NETO, F.F.; NEUMANN-LEITÃO, S.; NASCIMENTO-VIEIRA, D.A.; SILVA,. T.A.; SILVA, A.P.; MOURA, M.C. de O. (2000). Zooplâncton recifal de Tamandaré - PE (Brasil) e a influência dos manguezais na sua biodiversidade e biomassa. In: MANGROVE 2000. *Sustentabilidade de Estuários e Manguezais: Desafios e Perspectivas.* Recife: 2000. UFPE, ISME (CD-ROM).

PORTER, J.M.; PORTER, K.G. (1977). Quantitative sampling of demersal zooplankton migrating from different coral reef substrates. *Limnol. & Oceanogr.*, *22*: 553-556.

POURRIOT, R. (1965). *Recherches sur l'écologie des rotifères*. Vie et Milieu, Supp. 21, France. 124 p.

POURRIOT, R. (1976). Reflexions sur les rotiferes en tant qu'indicateurs biologiques. *Bulletin Français de Pisciculture*, *260:* 148-152

PROTIST INFORMATION SERVER (1995). *Digital Especimen Archives*. The Graduate University for Advanced Studies. (http :// 130. 158. 208. 53 / WWW / Protistmenu E. html - 10/2000).

PUTTEN, M. van. (2000). The NWF View: warning beneath the sea: the impact of global warming on coral reefs. *International Wildlife*, *23*: 45.

RAFFAELI, D.G.; MASON, C.F. (1981). Pollution monitoring with meiofauna, using the ratio of nematodes to copepods. *Marine Pollution Bulletin*, *12*: 158-163.

RAYMONT, J.E.G. (1983). *Plankton and productivity in the oceans. 2. Zooplankton*. *2nd ed*. Pergamont Press, Oxford.

REAKA-KUDLA, R.H. (1995). An estimate of known and unknown biodiversity and potential for extinction on coral reefs. *Reef Encounter (newsletter of the International Society for Reef Studies)*, *17*: 8-12.

RIEDL, R. (1983). *Fauna und Flora des Mittelmeeres. Ein systematischer Meeresführer für Biologen und Naturfruende*. Verlag Paul Parey. Hamburg und Berlin. 879 p.

RISK, M.J.; DUNN, J.J.; ALLISON; W.P.; HORRILL, C. (1994). Reef monitoring in Maldives and Zanzibar: Low-tech and high-tech science. In: GINSBURG, R.N. (compiler). *Proceedings of the colloquium on global aspects of coral reefs: health, hazards and history*, *1993*. Rosenstiel School of Marine and Atmospheric Science, University of Miami. p. 456-502.

ROBICHAUX, D.M.; COHEN, A.C.; REAKA, M.J.; ALLEN, D. (1981). Experiments with zooplankton on coral reef, or, will the real demersal plankton please come up?. *Mar. Ecol.*, *2*: 77-94.

RODRIGUES CAPÍTULO, A.; CÉSAR, I.; TASSARA, M., PAGGI, A.; REMES LENICOV, M. (1997). Zoobentos. In: CONSEJO PERMANENTE PARA EL MONITOREO DE LA CALIDAD DE AGUAS DE LA FRANJA COSTERA SUR DEL RÍO DE LA PLATA (ed.). *Calidad de aguas de la franja Costera Sur del Río de la Plata (San Fernando – Magdalena)*. Contartese Gráfica S. R. L., Buenos Aires. p. 131-142.

ROFF, J.C.; TURNER, J.T.; WEBBER, M.K.; HOPCROFT, R.R. (1995). Bacterivory by tropical copepod nauplii: extent and possible significance. *Aquat. Microb. Ecol.*, *9*: 165-175.

ROGERS, C.S. (1985). Degradation of caribbean and western Atlantic coral reefs and decline of associated fisheries. *Proceed. 5th Int. Coral Reefs Symp.*, *Tahiti*. 491-496.

ROHLF, F.J.; FISHER, D.L. (1968). Test for hierarchical structure in random data sets. *Systematic Zool.*, *17*: 407-421.

ROMAN, M.R.; FURNAS, M.J.; MULLIN, M.M. (1990). Zooplankton abundance and grazing at Davies Reef, Great Barrier Reef, Australia. *Mar. Biol.*, *105*: 75-82.

ROMAN, M.R.; DAM, H.G.; GAUZENS, A.L.; NAPP, J.M. (1993). Zooplankton biomass and grazing at the JGOFS Sargasso Sea time series station. *Deep-Sea Res.*, *40*: 883-901.

RUPPERT, E.E.; BARNES, R.D. (1994). *Invertebrate Zoology*. *6th Ed*. Saunders. 1256 p.

RUSS, G.R. (1984). Distribution and abundance of hervivorous grazing fishes in the central Great Barrier Reef. II. Patterns of zonation of mid-shelf and outer-shelf reefs. *Mar. Ecol. Prog. Ser.*, *20*: 35-44.

RUTTNER-KOLSKO, A. (1971). Rotatorien als Indikatoren für den Chemismus von Binnensalzgewäassern. *Sitz. Osterr. Akad. Wiss.*, *Mathem. Naturwiss. Kl.*, *1*, *179*, *8/10*: 283-298.

RUTTNER-KOLSKO, A. (1972). *Die Binnengewasser 26. Das Zooplankton der Binnengewasser* 1. Teil Schweizerbart'sch. Verlagsbuchhandlung, Stuttgart. 176 p.

SALE, P.F.; MCWILLIAMS, P.S.; ANDERSON, D.T. (1978). Faunal relationships amont near-reef zooplankton at three locations on Heron Reef, Great Barrier Reef, and seasonal changes. *Mar. Biol.*, *49*: 133-145.

SAMOILOFF, M.R. (1987). Nematodes as indicators of toxic environmental contaminants. In: VEECH, J.A.; DICKSON, D.W. (eds.). *Vistas on nematology: A commemoration of the 25th annual meting of The Society of Nematologists*. Hyattsville, Society of Nematologists. p. 433-439.

SAMMARCO, P.W.; CRENSHAW., H. (1984). Plankton community dynamics of the central Great Barrier Reef Lagoon: Analysis of data from Ikeda *et al*.. *Mar. Biol*., *82*: 167-189.

SANT'ANNA, E.M.E. (1993). Estrutura e biomassa da comunidade zooplanctônica da Bacia do Pina (Pernambuco - Brasil), relacionadas com fatores ambientais. São Paulo. Escola de Engenharia de São Carlos, Universidade de São Paulo. Master's Thesis. 135 p.

SANTANA-BARRETO, M.S.; (1986). Biomassa, densidade e composição do zooplâncton da Baía de Tamandaré. *Cad. Ômega da Universidade Federal Rural de Pernambuco, Recife*, *2(1)*: 55-65.

SANTANA-BARRETO, M.S.; MOURA, H.C. (1986). A seletividade na captação do zooplâncton na Baía de Tamandaré - PE. In: CONGRESSO BRASILEIRO DE ENGENHARIA DE PESCA, 4. Curitiba. p. 357-371.

SANTANA-BARRETO, M.S.; SANTOS, S.M. (1984). Zooplâncton na estuário do rio Timbó - Paulista - Pernambuco. *Encontro Brasileiro de Plâncton, 1, Arraial do Cabo, RJ, 1984. Abstract. p. 19.*

SANTANA-BARRETO, M.S.; BARROS-FRANCA, L.M.; RAPÔSO, L.A.B.; SILVA, C.J.P. (1981). Aspectos da variação diurna e sazonal do plâncton na Baía de Tamandaré - PE. In: ENCONTRO DE ZOOLOGIA DO NORDESTE, 6. Recife. p. 90-103.

SANTANA-BARRETO, M.S.; NÓBREGA, M.N.C.; MELO-FILHO, M.T.B. (1991). Revisão e atualização do zooplâncton no estuário do rio Ariquindá, Rio Formoso - Pernambuco. In: ECONTRO BRASILEIRO DE PLÂNCTON. 4. Departamento de Oceanografia, Universidade Federal de Pernambuco (UFPE), Recife: 415-430.

SASSI, R.; MELO, G.N. (1982). Contribuição ao conhecimento da fauna de protozoários do estuário do rio Paraíba do Norte : Tintinnóides do Rio Mandacaru. *Revista Nordestina de Biologia*, *v. 5(2)*: 141-155.

SAUTOUR, B.; ARTIGAS, F.; HERBLAND, A.; LABORDE, P. (1996). Zooplankton grazing impacts in the plume of dilution of the Gironde estuary (France) prior to the spring bloom. *Jour. Plankt. Res.*, *18(6)*: 835-853.

SCHWAMBORN, R. (1997). *Influence of mangroves on community structure and nutrition of macrozooplankton in northeast Brazil*. ZMT, Univ. Bremen. Doctor's Thesis. 77 p.

SCHWAMBORN, R.; NEUMANN-LEITÃO, S.; SILVA,. T.A.; SILVA, A.P.; EKAU, W.; SAINT-PAUL, U. (2001). Distribution and dispersal of decapod crustacean larvae and other zooplankton in the Itamaracá estuarine system, Brazil. *Tropical Oceanography*, *29(1)*: 1-17, Recife.

SHANNON, C.E. (1948). A mathematical theory of communication. *Bol. Syst. Tech. J.*, *27*: 379-423.

SILVA, T.A. (1994). *Variação nictemeral e sazonal do zooplâncton no estuário do rio Capibaribe - Recife - Pernambuco - Brasil*. Recife, C.T.G., Universidade Federal de Pernambuco, Departamento de Oceanografia. Master's Thesis. 89 p.

SILVA, A. P. (1997). *Diversidade, produtividade e dinâmica do microzooplâncton na desembocadura sul do canal de Santa Cruz, Itamaracá-Pernambuco (Brasil)*. Universidade Federal Rural de Pernambuco. Graduation Work. 57 p.

SINGARAJAH, K.V. (1978). Hydrographic conditions, composition and distribution of plankton in relation to potencial resourses of Paraíba river estuary. João Pessoa. *Rev. Nordest. Biol*., 1: 125-144.

SLADECEK, V. (1973). System of water quality from the biological point of view. *Arch. Hydrobiol.*, *Bieh. 7*, *Ergebn. Limnol.*, *7*: 218.

SMITH, S.V. (1978). Coral reef arca and contribution of reefs to processes and resources of the world's oceans. *Nature*, *273*: 225.

SOROKIN, Y.I. (1990). Plankton in the reef ecosystems. In: DUBINSKY, Z. *Ecosystems of the world*, *25*: 291-327.

SOUTO, S. (1981). Tintinnina. In: BOLTOVSKOY, D. (ed.). (1981). *Atlas del zooplancton del Atlantico Sudoocidental y métodos de trabajos com el zooplancton marino*. INIDEP. Mar del Plata.

SOUZA, W.P. (1979). Disturbance in marine intertidal boulder fields: the non-equilibrium maintenance of species diversity. *Ecology*, *60*: 1225-1239

STARKWEATHER, P.L. (1987). Rotifers energetics. In: PANDIAN, T.J.; VERNBERG, F.J. (eds.). *Animal Energetics*. *Vol. 1*. Academic Press, N. Y. p. 159-183.

STARKWEATHER, P.L. (1996). Sensory potential and feeding in rotifers: structural and behavioral aspects of diet selection in ciliated zooplankton. In: LENZ, P.H.; HARTLINE, J.E.; PURCELL, J.E.; MACMILLAN, D.L. (eds.). Zooplankton: sensory ecology and physiology. Gordon and Breach Publishers, Amsterdam. p. 255-266.

STEEDMAN, H. F. (1976). *Zooplankton Fixation and Preservation*. UNESCO Press, Paris. 189 p.

STOECKER, D.K.; EVANS, G.T. (1985). The effects of herbivory and carnivory in a microplankton food web. *Mar. Ecol. Prog. Ser.*, *25*: 159-167.

STRICKLAND, J.D.H.; PARSONS, T.R. (1965). A manual of seawater analysis*. Bull. Fish. Res. Board Can.*, *125*: 1-205.

SUAREZ-MORALES, E.; GASCA, R.A.F. (2000). The planktonic copepod community at Mahahual Reef, western Caribbean. *Bull. Mar. Sci.*, *1*: 255-267.

SZMANT, A.M.; FORRESTER, A. (1996). Water column and sediment nitrogen and phosphorus distribution patterns in the Florida Keys, USA. *Coral Reefs*, *15*: 21-41.

TAFE, D.J.; GRIFFITHS, F.B (1983). Seasonal abundance, geographical distribution and feeding types of the copepods species dominant in Port Hacking, New South Wales. Berlin. *Lectures notes on coastal and estuarine studies.*, *3*: 109-133.

TALBOT, F. (1995). What does management have to do with it? *Newsletter, International Marine Science, 75/76*: 67.

TELESH, I.; HEERKLOSS, R. (2002). *Atlas of Estuarine Zooplankton of the Southern and Eastern Baltic Sea. Part I: Rotifera*. Hamburg, Verlag Dr. Kovac. 90 p.

TELLES, M.D. (1998). Modelo trofodinâmico dos recifes em franja do Parque Marinho dos Abrolhos - Bahia. FURG, Rio Grande do Sul. Master's Thesis. 98 p.

TETT, P.; EDWARDS, A. (1984). Mixing and plankton: an interdisciplinary theme in oceanography. *Oceanogr. Mar. Biol. Ann. Rev.*, *22*: 99-123.

TINOCO, I.M. (1965/1966). Foraminíferos do Atol das Rocas. *Trab. Oceanogr., Univ. Fed. Pernambuco, Recife*, *7/8*: 91-114.

TINOCO, I.M. (1988). *Introdução ao estudo dos componentes bióticos dos sedimentos marinhos recentes*. Editora Universitária da Universidade Federal de Pernambuco (UFPE). Recife. 220 p.

TODD, C.D.; LAVERACK, M.S. (1991). *Coastal Marine Zooplankton: A pratical manual for students*. Cambridge University. London. 106 p.

TOMASCIK, T.; SANDER, F. (1985). Effects of eutrophication on reef-building corals. I - Growth rate of the building coral Montastrea annularis. *Mar. Biol.*, *87*: 143-155.

TOMASCIK, T.; SANDER, F. (1987a). Effects of eutrophication on reef-building corals. II - Structure of scleractinian coral communities on fringing reefs, Barbados, West Indies. *Mar. Biol.*, *94*: 53-75.

TOMASCIK, T.; SANDER, F. (1987b). Effects of eutrophication on reef-building corals. III - Reproduction of the reef-building coral Porites porites. *Mar. Biol.*, *94*: 77-94.

TOMASCIK, T.; SUHARSONO; MAH, A.J. (1993). Case histories: A historical perspective of the natural and anthropogenic impacts in the Indonesian Archipelago with a focus on the Kepulauan Seribu, Java Sea. In: GINSBURG R.N. (compiler). *Proceedings of colloquium on global aspects of coral reefs: Health, hazards and history, RSMAS, University of Miami, Florida*. p. 304-310.

TREGOUBOFF, G.; ROSE, M. (1957). *Manuel de planctologie Mediterraneéne*. Centre Nacion. Sci., Paris, 2v. 545 p.

TUNDISI, J.G. (1969). Produção primária, “standing-stock” e fracionamento do fitoplâncton na região lagunar de Cananéia, São Paulo. Instituto Oceanográfico, Universidade de São Paulo. Doctor's Thesis. 130 p.

TUNDISI, J.G. (1970). O plâncton estuarino. *Contr. Avulsas Inst. Oceanogr. São Paulo, sér. Oceanogr. Biol.*, *19*: 1-22.

TVA (Tennessee Valley Authority) (1994). *Tennessee Valley reservoir and stream quality - 1993: Summary of vital signs and use suitability monitoring. Vol. I. Water Management.* Water Resources Division, Chattanooga, TN. 134 pp.

TVA (Tennessee Valley Authority) (1995). *Aquatic ecological health determinations for TVA reservoirs - 1994: An informal summary of 1994 vital signs monitoring results and ecological health determination methods*. Water Management. Water Resources Division, Chattanooga, TN. 123 pp.

ULANOWICZ, R.E. (1986). *Growth and development: Ecosystems Phenomenology*. Springer-Verlag, New York. 234 p.

USEPA (United States Environmental Protection Agency). (1993). *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters.* U.S. Environmental Protection Agency, Washington, DC. 154 pp.

VALENTIN, J.L.; MACEDO-SAIDAH, F.E.; TENENBAUM, D.R.; SILVA, N.L.A. (1991). Diversidade específica para análise das sucessões fitoplanctônicas. Aplicação ao ecossistema da ressurgência de Cabo frio (Rio de Janeiro-Brasil). *Nerítica*, *6(1/2)*: 7-26.

VASCONCELOS, A.L.; GUEDES, D.S.; GALIZA, E.M.B.; AZEVEDO-ARAÚJO, D.S. (1984). Estudo Ecológico da região de Itamaracá. Pernambuco, Brasil. XXVII. Hábitos alimentares de alguns peixes estuarinos. *Trab. Oceanogr., Univ. Fed. Pernambuco, Recife*, *18*: 231-260.

VILES, H.; SPENCER, T. (1995). *Coastal problems - geomorphology, ecology and society at the coast*. Arnold Editors. London. 288 p.

VILLATE, F. (1991). Annual cycle of zooplâncton community in the Abra Harbour (Bay of Biscay): abundance, composition and size espectra. *Journal of Plankton Research*, *13(4)*: 691-706.

VITOUSEK, P.M. (1997). Human alteration of the global cycle: sources and consequences. *Ecological Applications (1997)*: 737-750.

VOURINEN, I.; RANTA, E. (1987). Dynamics of marine meso-zooplankton at Seili, northern Baltic Sea. *Ophelia*, *28*: 31-48.

XIAO, Y; GREENWOOD, J.G. (1979). Distribution of shallow-water epibentic macrofauna in Moreton Bay, Queensland, Australia. *Marine Biology*, *53*: 83-97.

ZULLINI, A. (1976). Nematodes of some activated sewage treatment plants. *Ateneo Parmense, Acta Nat.*, *12*: 271-283.

YAMAGUTI, S. (1963). *Parasitic Copepoda and Branchiura of fishes*. Interscience Publishers. New York. 89 p.

WALTER, T.C. (1989). Review of the new world species of *Pseudodiaptomus* (Copepoda: Calanoida), with a key to the species. *Bul. Of Mar. Scien.*, *45(3)*: 590-628.

WEBB, K.L.; DuPAUL, K.W.; WIEBE, W.J.; SOTTILLE, W.; JOHANNES, R.E. (1975). Enewetak (Eniwetok) Attoll: Aspects of the nitrogen cycle on a coral reef. *Limnol*. *Oceanogr*., *20*: 198-210.

WEISS, P.A. (1971). *Hierarchically organized systems in theory and pratice*. New York.

WILKEI, M.L. (1995). Mangrove conservation and management in the Sudan. *FAO Report*. Ministry of Environment and Tourism. Khartoum & FAO.

WILKINSON, C.R. (2002). *GCRMN Report: Status of coral reefs of the world: 2002*. Australian Institute of Marine Science, Townsville. 463 p.

WILKINSON, C.R.; CHOU, L.M.; GOMEZ, E.A.; RIDZWAN, R.; SOEKARNO, S.; SUDARA, S. (1993). Health, Hazards and History. In: GINSBURG, R.N. (ed.). (1994). *Proceedings of the Colloquium on Global Aspects of Coral Reefs*. Rosenstiel School of Marine and Atmospheric Science. University of Miami.

WILKINSON, C.R.; BUDDEMEIER, R.W. (1994). *Global climate change an coral reefs: implications for people and reefs*. IUCN, Gland. Switzerland. 328 p.

WRIGHT, S. (1936). A revision of the South America species of *Pseudodiaptomus* (Copepoda: Calanoida). *Annaes da Academia Brasileira de Sciencias*. Rio de Janeiro.

9 Appendix

Table A1: Mensal rainfall (mm) from 1991 to 2001.

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Jan	no data	141.3	20.1	140.5	19.8	94.2	19.9	42.8	33.6	185.9	74.6
Feb	7.4	212.1	25.9	96.2	18.1	38.8	88.2	20.3	27.3	93.2	168.8
Mar	153.3	277.5	119.9	132.4	237.6	209.5	175.5	113.9	110.7	138.4	200.7
Apr	224.3	242.1	179.4	199.8	169.4	394.2	446.9	83.3	5.6	331.0	212.9
May	479.4	87.8	157.0	523.2	435.7	160.3	397.7	56.2	135.8	212.6	37.6
Jun	211.0	401.8	203.4	509.8	500.2	262.7	161.9	136.1	121.3	770.9	490.6
Jul	296.1	226.7	169.6	321.3	323.3	318.4	168.6	162.2	173.6	929.6	319.4
Aug	199.0	147.9	94.3	143.5	71.2	199.7	113.2	212.2	91.4	321.9	215.0
Sep	35.2	149.2	24.0	200.2	18.3	153.9	16.7	32.7	28.0	367.6	72.9
Oct	113.3	35.6	37.2	31.6	9.8	49.1	35.5	31.9	91.4	21.8	87.2
Nov	10.9	45.6	45.0	17.3	107.9	59.9	85.3	9.9	26.8	21.8	24.0
Dez	2.3	11.5	46.8	22.8	0.7	26.2	94.4	16.2	71.7	55.0	80.6
TOTAL	1732.2	1979.1	1122.6	2335.0	1912.0	1966.9	1819.8	917.7	917.2	3449.7	1984.3
MEAN	157.4	164.9	93.5	194.5	159.3	163.9	151.6	76.5	76.4	287.5	165.3

Table A2: Tide levels (m) for the sampling days between February 1998 and January 1999 (DHN, 1998; 1999).

	11/02/98	13/03/98	11/04/98	11/05/98	10/06/98	09/07/98	07/08/98	06/09/98	09/10/98	04/11/98	03/12/98	03/01/99
Hour - HT	07:26	06:15	06:23	06:06	07:32	08:09	07:49	07:26	06:13	07:49	06:30	06:00
Tidal level HT	1.8	2.0	2.0	2.1	2.0	2.1	2.1	2.1	2.3	1.9	2.1	2.1
Hour - LT	13:21	12:17	12:34	12:21	13:54	14:30	14:04	13:39	12:26	13:51	12:34	12:00
Tidal level LT	0.7	0.5	0.5	0.4	0.5	0.5	0.4	0.4	0.3	0.7	0.5	0.4

Table A3: Tide table (m) for the sampling days between 2000 and 2001 (DHN, 2000; 2001).

Day (Winter)	Hour	Tide Level
10/07/00	6:11	0.7
	12:24	1.8
	18:47	0.7
11/07/00	0:56	1.8
	7:17	0.6
	13:30	1.8
	19:43	0.6
12/07/00	1:54	1.8
	8:11	0.6
	14:26	1.8
	20:30	0.6

Range: 1.2 m

Day (Summer)	Hour	Tide Level
17/01/01	4:32	0.7
	10:36	1.8
	17:02	0.8
	23:11	1.8
18/01/01	5:47	0.7
	11:47	1.7
	18:19	0.7
19/01/01	0:26	1.7
	6:49	0.7
	12:51	1.8
	19:17	0.7

Range: 1.1 m

Table A4: Hidrologic data for station M1 (Tamandaré Bay).

	Sampling Time (hour)		Water Depth (m)		Temperature (°C)		Salinity (PSU)		O_2 Conc. (ml $O_2.L^{-1}$)		Nitrite (µmol.L^{-1})		Nitrate (µmol.L^{-1})		Phosphate (µmol.L^{-1})		Silicate (µmol.L^{-1})	
	HT	LT	HT	LT	HT	LT	HT	LT	HT	LT	HT	LT	HT	LT	HT	LT	HT	LT
11/02/98	08:15	13:00	6.00	5.50	29.5	31.0	34.0	36.0	4.76	4.52	0.02	0.01	3.74	1.71	0.23	0.28	15.44	33.31
13/03/98	07:30	11:40	7.30	6.70	30.0	30.5	35.0	36.0	3.81	4.59	0.02	0.00	1.33	1.30	0.05	0.08	11.49	15.13
11/04/98	-	11:50	-	5.80	-	29.5	-	33.0	-	4.74	-	0.01	-	0.68	-	0.09	-	16.14
11/05/98	08:00	12:20	6.60	5.80	28.5	29.0	34.0	30.0	4.38	4.48	0.10	0.12	1.79	0.96	0.10	0.07	18.56	43.20
10/06/98	07:50	12:10	7.70	6.60	27.5	27.0	32.0	32.0	4.82	5.41	0.14	0.12	2.32	1.56	0.17	0.13	53.03	19.27
09/07/98	09:05	12:55	7.30	6.10	27.2	28.0	32.0	32.0	5.08	5.27	0.01	0.06	0.61	0.70	0.08	0.08	29.07	19.35
07/08/98	08:40	13:50	8.00	6.00	26.8	27.0	32.0	30.0	5.18	5.61	0.02	0.06	0.91	1.73	0.11	0.14	18.97	24.21
06/09/98	08:15	12:26	7.30	5.70	27.0	28.0	33.0	30.0	5.49	5.47	0.05	0.01	0.91	0.78	0.00	0.10	14.95	40.34
09/10/98	06:40	10:56	7.90	5.20	28.0	30.0	35.0	34.0	4.92	5.65	0.11	0.05	0.50	0.42	0.25	0.23	19.02	13.28
04/11/98	07:55	13:10	7.50	5.50	28.5	29.0	35.0	33.0	5.63	5.51	0.04	0.01	0.08	0.00	0.15	0.28	13.31	3.72
03/12/98	07:00	11:45	8.00	6.00	27.5	28.0	35.0	34.0	4.64	5.28	0.04	0.00	0.22	0.14	0.16	0.10	11.73	4.51
03/01/99	06:40	11:00	7.50	6.00	28.2	28.0	35.0	35.0	5.47	5.54	0.03	0.03	0.22	0.12	0.12	0.12	3.72	10.46
Mean	-	-	7.37	5.91	28.1	28.7	33.8	32.9	4.9	5.2	0.05	0.04	1.15	0.84	0.13	0.14	19.03	20.24

Table A5: Hidrologic data for station M2 (confluence of estuaries).

	Sampling Time (hour)		Water Depth (m)		Temperature (°C)		Salinity (PSU)		O_2 Conc. (ml $O_2.L^{-1}$)		Nitrite (µmol.L^{-1})		Nitrate (µmol.L^{-1})		Phosphate (µmol.L^{-1})		Silicate (µmol.L^{-1})	
	HT	LT	HT	LT	HT	LT	HT	LT	HT	LT	HT	LT	HT	LT	HT	LT	HT	LT
11/02/98	08:00	13:40	1.20	0.60	29.0	32.0	34.0	16.0	4.52	4.29	0.06	0.11	0.31	0.97	0.22	0.31	22.86	60.72
13/03/98	07:20	12:00	1.70	1.30	29.5	31.0	33.0	20.0	4.14	4.52	0.01	0.01	1.33	1.15	0.10	0.07	3.21	60.34
11/04/98	07:00	12:15	1.10	0.60	29.0	31.5	33.0	20.0	4.38	4.06	0.00	0.02	1.19	1.61	0.12	0.12	13.10	21.34
11/05/98	07:50	12:40	1.00	1.30	28.0	27.0	28.0	2.0	3.87	0.80	0.12	0.16	1.06	0.59	0.10	0.08	52.86	22.56
10/06/98	07:30	12:30	1.00	0.55	27.0	27.5	31.0	23.0	5.36	4.82	0.11	0.09	1.50	1.19	0.16	0.12	31.15	54.30
09/07/98	08:55	13:14	2.30	1.00	27.2	28.0	32.0	22.0	3.89	4.40	0.03	0.06	0.61	1.02	0.08	0.10	23.37	29.32
07/08/98	08:25	14:15	3.00	0.70	26.5	26.2	27.0	1.0	5.43	1.91	0.11	0.05	1.48	1.45	0.06	0.15	21.21	17.92
06/09/98	07:55	12:55	2.50	1.00	27.1	26.0	31.0	16.0	5.57	4.29	0.03	0.05	1.63	1.10	0.10	0.11	20.32	33.39
09/10/98	06:20	11:20	2.12	1.00	27.5	29.0	32.0	26.0	5.12	5.01	0.03	0.04	0.56	0.47	0.20	0.20	26.75	61.06
04/11/98	07:30	13:40	2.00	0.80	28.5	30.0	33.0	13.0	5.77	5.36	0.00	0.02	0.21	0.02	0.18	0.17	3.98	93.44
03/12/98	06:45	12:05	2.00	0.80	27.7	29.0	34.0	27.0	5.71	5.07	0.02	0.04	0.19	0.36	0.16	0.16	14.69	20.36
03/01/99	06:20	11:20	1.50	0.80	28.0	29.0	35.0	32.0	5.22	5.01	0.00	0.05	0.66	0.29	0.10	0.19	11.24	20.73
Mean	-	-	1.78	0.87	27.9	28.8	31.9	18.2	4.92	4.13	0.10	0.06	0.89	0.85	0.13	0.15	20.40	41.29

Table A6: Hidrologic data for station M3 (Ilhetas River estuary).

	Sampling Time (hour)		Water Depth (m)		Temperature (°C)		Salinity (PSU)		O_2 Conc. (ml $O_2.L^{-1}$)		Nitrite (µmol.L^{-1})		Nitrate (µmol.L^{-1})		Phosphate (µmol.L^{-1})		Silicate (µmol.L^{-1})	
	HT	LT	HT	LT	HT	LT	HT	LT	HT	LT	HT	LT	HT	LT	HT	LT	HT	LT
11/02/98	07:40	14:15	1.00	0.40	29.0	32.0	34.0	7.0	4.51	4.27	0.02	0.08	0.48	1.60	0.26	0.29	24.39	44.93
13/03/98	07:00	12:50	1.40	0.80	29.0	31.0	33.0	6.0	3.97	5.47	0.01	0.04	1.50	3.02	0.09	0.12	22.10	55.39
11/04/98	06:35	12:45	1.00	0.40	29.0	31.0	30.0	6.0	4.21	3.63	0.04	0.08	0.73	1.45	0.12	0.09	17.24	25.14
11/05/98	07:30	13:00	1.30	0.70	28.0	27.8	26.0	0.0	3.91	0.42	0.12	0.24	1.27	0.94	0.13	0.07	46.78	17.46
10/06/98	07:15	13:05	1.40	0.50	26.5	27.0	31.0	5.0	5.14	4.51	0.10	0.10	1.00	2.31	0.11	0.16	23.07	72.38
09/07/98	08:35	13:40	1.10	0.60	27.0	27.0	32.0	5.0	4.98	3.88	0.04	0.11	0.50	2.42	0.08	0.07	19.18	25.14
07/08/98	08:10	14:50	1.10	0.40	26.0	26.0	29.0	0.0	4.96	1.22	0.99	0.20	2.80	0.56	0.09	0.13	26.20	55.98
06/09/98	07:35	13:20	1.00	0.60	27.0	26.0	31.0	1.0	5.18	3.94	0.04	0.03	0.93	1.15	0.00	0.09	21.60	66.24
09/10/98	06:10	11:50	1.17	0.80	27.0	29.0	32.0	12.0	5.02	4.93	0.04	0.04	0.54	0.58	0.25	0.19	25.85	112.54
04/11/98	07:15	14:16	1.00	0.60	28.0	30.0	26.0	3.0	5.63	5.28	0.02	0.03	0.44	0.00	0.21	0.25	60.47	96.07
03/12/98	06:25	12:30	1.00	0.50	28.0	29.0	34.0	10.0	5.71	5.07	0.02	0.02	0.31	0.50	0.20	0.14	16.75	89.44
03/01/99	06:05	11:55	1.20	0.70	28.0	29.0	35.0	21.0	5.33	4.25	0.03	0.00	0.32	0.76	0.12	0.31	11.47	28.39
Mean	-	-	1.12	0.58	27.7	28.7	31.1	6.33	4.88	3.90	0.12	0.08	0.90	1.27	0.14	0.16	26.26	57.42

Table A7: Hidrologic data for station M4 (Mamucaba River estuary).

	Sampling Time (hour)		Water Depth (m)		Temperature (°C)		Salinity (PSU)		O_2 Conc. (ml $O_2.L^{-1}$)		Nitrite (µmol.L^{-1})		Nitrate (µmol.L^{-1})		Phosphate (µmol.L^{-1})		Silicate (µmol.L^{-1})	
	HT	LT	HT	LT	HT	LT	HT	LT	HT	LT	HT	LT	HT	LT	HT	LT	HT	LT
11/02/98	07:10	14:40	0.90	0.30	29.0	32.0	33.0	12.5	4.06	3.83	0.11	0.07	2.51	1.47	0.27	0.08	25.59	59.36
13/03/98	06:30	13:40	1.20	0.40	29.0	31.0	34.0	8.0	3.97	3.08	0.01	0.00	1.48	2.11	0.09	0.07	16.14	59.36
11/04/98	06:10	13:20	1.00	0.40	29.0	31.5	32.0	8.0	3.40	4.50	0.02	0.01	0.88	1.20	0.13	0.10	16.69	25.82
11/05/98	07:00	13:50	1.00	0.70	28.0	28.0	27.0	0.0	4.07	1.90	0.10	0.04	1.52	1.13	0.12	0.00	39.22	30.69
10/06/98	06:50	13:40	1.00	0.45	26.5	28.0	31.0	4.0	5.24	3.09	0.10	0.08	1.48	1.06	0.13	0.06	27.17	52.27
09/07/98	08:15	14:15	1.00	0.50	27.0	26.0	32.0	5.0	5.11	3.12	0.05	0.10	0.75	1.30	0.10	0.07	22.39	25.52
07/08/98	07:46	15:35	1.00	0.60	26.0	26.0	28.0	0.0	5.08	2.85	0.03	0.06	1.62	0.52	0.15	0.24	13.14	25.51
06/09/98	07:07	14:05	1.00	0.60	27.0	26.5	31.0	0.0	5.04	2.26	0.02	0.09	1.54	1.49	0.21	0.05	22.61	40.04
09/10/98	05:50	12:10	1.30	0.50	27.0	29.0	33.0	14.0	5.23	4.47	0.00	0.02	0.48	0.47	0.22	0.18	23.77	103.74
04/11/98	06:55	15:30	1.00	0.60	28.0	30.0	25.0	6.0	5.42	2.81	0.00	0.03	0.37	1.38	0.21	0.18	65.69	75.25
03/12/98	06:00	13:05	0.95	0.80	27.2	29.9	33.0	13.0	5.07	3.56	0.03	0.05	0.44	0.76	0.14	0.20	12.80	118.80
03/01/99	05:45	12:35	1.00	0.70	28.0	29.0	35.0	26.0	5.02	3.90	0.02	0.00	0.88	0.81	0.15	0.25	9.31	26.47
Mean	-	-	1.03	0.54	27.6	28.9	31.2	8.0	4.72	3.28	0.04	0.04	1.16	1.14	0.16	0.12	24.54	53.57

Table A8: Water depth and temperature at the reef area.

Station	Time / Tide	WINTER 10-12/07/00 Water Depth (m)	WINTER 10-12/07/00 Temperature (°C)	SUMMER 17-19/01/01 Water Depth (m)	SUMMER 17-19/01/01 Temperature (°C)
Station R1	18:00 LT	0.5	24.5	0.4	27.5
	00:00 HT	1.2	24.0	1.3	27.0
	06:00 LT	0.5	25.0	0.5	27.0
	12:00 HT	1.0	25.0	1.0	29.0
Mean	-	0.8	24.6	0.8	27.6
Station R2	18:00 LT	1.5	25.0	1.4	27.0
	00:00 HT	2.0	24.0	2.0	26.5
	06:00 LT	1.4	25.0	1.5	27.0
	12:00 HT	1.9	25.5	1.9	28.5
Mean	-	1.7	24.7	1.7	26.6
Station R3	18:00 LT	0.5	24.0	0.6	26.5
	00:00 HT	1.3	24.5	1.2	26.0
	06:00 LT	0.5	25.0	0.5	26.0
	12:00 HT	1.5	26.0	1.3	27.5
Mean	-	0.95	24.9	0.9	26.6
Station R4	18:00 LT	0.5	24.5	0.5	27.5
	00:00 HT	1.0	24.5	1.1	26.0
	06:00 LT	0.5	25.5	0.5	26.0
	12:00 HT	1.1	26.0	1.1	28.0
Mean	-	0.78	25.1	0.8	26.8
Channel C1	18:00 LT	4.0	24.5	3.8	26.0
	00:00 HT	6.5	24.5	6.4	26.0
	06:00 LT	4.5	25.0	3.7	26.5
	12:00 HT	6.7	25.0	6.0	27.5
Mean	-	5.43	24.7	4.9	26.5
Channel C2	18:00 LT	2.0	25.0	2.0	27.0
	00:00 HT	3.1	24.4	3.1	26.0
	06:00 LT	1.8	24.5	1.8	27.0
	12:00 HT	2.9	26.0	2.9	28.0
Mean	-	2.45	24.9	2.4	27.0

Table A9: Salinity, oxygen concentration, nitrite, nitrate, phosphate, and silicate at the reef area.

		WINTER 10-12/07/00					
Station	Time / Tide	Salinity (PSU)	O_2 Conc. (ml O_2.L^{-1})	Nitrite (μmol.L^{-1})	Nitrate (μmol.L^{-1})	Phosphate (μmol.L^{-1})	Silicate (μmol.L^{-1})
Stations R1 - R2	18:00 LT	28.53	5.20	0.0656	1.0511	0.1423	26.9799
	00:00 HT	29.07	5.09	0.1087	1.1378	0.1313	24.6430
	06:00 LT	30.95	5.31	0.0414	1.2534	0.2302	38.7294
	12:00 HT	34.45	5.52	0.0026	0.7531	0.1943	30.8874
Mean	-	30.75	5.28	0.0546	1.2238	0.1745	30.3099
Stations R3 - R4	18:00 LT	29.50	4.87	0.1998	1.9087	0.4876	67.7865
	00:00 HT	33.72	5.09	0.2967	1.9480	0.3089	75.9433
	06:00 LT	29.48	5.09	0.1832	1.9134	0.4944	74.7488
	12:00 HT	30.54	5.31	0.1406	1.8232	0.3100	53.0072
Mean	-	30.81	5.09	0.2051	1.8983	0.4002	67.8714
		SUMMER 17-19/01/01					
Station	Time / Tide	Salinity (PSU)	O_2 Conc. (ml O_2.L^{-1})	Nitrite (μmol.L^{-1})	Nitrate (μmol.L^{-1})	Phosphate (μmol.L^{-1})	Silicate (μmol.L^{-1})
Stations R1 - R2	18:00 LT	32.13	5.30	0.2091	0.9287	0.1145	33.1297
	00:00 HT	33.03	5.73	0.0975	1.3761	0.0824	31.3211
	06:00 LT	33.99	4.84	0.1955	1.2549	0.0001	28.7257
	12:00 HT	32.13	-	0.2198	0.6543	0.0646	39.8675
Mean	-	32.82	5.29	0.1805	1.0535	0.0654	33.2610
Stations R3 - R4	18:00 LT	32.13	5.01	0.2999	1.9912	0.3423	68.2597
	00:00 HT	33.72	5.61	0.2465	1.9186	0.4786	76.5196
	06:00 LT	33.19	5.04	0.2085	1.9478	1.4856	82.1435
	12:00 HT	33.79	-	0.2348	1.6454	0.3214	63.7139
Mean	-	33.20	5.22	0.2474	1.8757	0.6570	72.6591

Table A10: Zooplankton density (org.m^{-3}) at the station M1 (high tide).

	11/02/98	13/03/98	11/04/98	11/05/98	10/06/98	09/07/98	07/08/98	06/09/98	09/10/98	04/11/98	03/12/98	03/01/99	MEAN	TOTAL
Textulariidae (others)	2.88	5.75		1.44	3.70	2.27	2.47	1.23	1.44		1.39	7.19	2.71	29.77
Quinqueloculinidae (various)	20.86	15.82		1.44	2.47		2.47	1.23	1.44		1.39	14.38	5.59	61.49
Tretomphalus bulloides	22.65	4.31				2.27		1.23	1.44	1.44		10.79	4.01	44.14
Remaneica spp.											3.70		0.34	3.70
Trochamminidae (others)	21.57	4.31		1.44	8.63	3.41	4.93	1.85	2.52	1.44		19.78	6.35	69.88
Foraminiferida (others)	50.34	11.51		12.23	4.93	2.27	17.26	3.08	16.54	7.55	6.01	195.97	29.79	327.70
Tintinnopsis aperta	60.05			1.44		4.55	2.47		1.08	1.80	1.85	35.96	9.93	109.19
Tintinniopsis tocantinensis		12.94											1.18	12.94
Tintinnopsis nordqvivsti	20.50	80.55		2.16	40.68	48.91	11.10	17.26	17.98	24.81	11.10	86.30	32.85	361.33
Tintinnopsis beroidea		4.31					1.23	1.23					0.62	6.78
Codonellopsis morchella f. *typica*										4.31			0.39	4.31
Codonellopsis ostenfeldi										1.44			0.13	1.44
Favella ehrenbergii	93.13	57.53	**N**	6.47	106.03	31.85	38.22	16.64	51.06	47.46	21.73	75.51	49.60	545.64
Hidromedusae (various)			**O**	1.44									0.13	1.44
Nematoda (various)				1.44	1.23			1.23	1.08	1.44	1.39	8.99	1.53	16.80
Gastropoda (veliger)	31.64	23.01		1.44	4.93	15.92		1.85	4.67	24.09	2.31	84.50	17.67	194.38
Bivalvia (veliger)	59.33	71.92		7.91	98.63	21.61	1.23	5.55	33.08	7.19	24.97	77.31	37.16	408.73
Polychaeta (other larvae)	4.31	2.88	**D**	2.16	2.47		2.47	2.47	1.08	1.44	1.85	3.60	2.25	24.71
Polychaeta (eggs)			**A**	1.44									0.13	1.44
Parvocalanus crassirostris	270.77	94.93	**T**	39.55	13.56	40.95	22.19	17.26	17.98	38.48	41.15	332.61	84.49	929.42
Paracalanus nanus			**A**						1.08				0.10	1.08
Paracalanus indicus	11.51	4.31		1.44	4.93	11.37	3.70	1.23	3.60	3.24	2.31	53.94	9.23	101.58
Paracalanus parvus					2.47								0.22	2.47
Pseudodiaptomus acutus	12.94	5.75		1.44	2.47	4.55	6.16	1.85	1.44	4.31	5.55	7.19	4.88	53.66
Pseudodiaptomus richard		2.88			1.23		1.23				2.77		0.74	8.12
Temora turbinata	2.88	1.44					1.23	1.23	1.08	1.44	1.39		0.97	10.69
Temora stylifera		2.88					2.47		1.08	1.08			0.68	7.50
Calanopia americana									1.08				0.10	1.08
Acartia lilljeborgi	2.88	15.82		6.47	3.70	4.55	4.93	1.85	1.44		5.09	3.60	4.57	50.32
Oithona nana		7.19		38.83	7.40	7.96	6.16	3.70	3.24	5.39	6.93	8.99	8.71	95.80
Oithona hebes	257.46	156.78		140.24	69.04	97.82	176.30	173.22	190.58	57.17	60.56	307.44	153.33	1686.61
Oithona oswaldocruzi	44.23	71.92		20.86	41.92	48.91	6.16	50.55	15.46	27.69	38.37	133.05	45.37	499.11
Microsetella norvegica									1.08				0.10	1.08
Euterpina acutifrons	9.71	43.15		2.88	4.93	12.51	4.93	1.23	2.88	3.24	3.70	16.18	9.58	105.33
Tigriopus spp.	2.88	1.44				2.27	1.23		1.44	1.44	1.85		1.14	12.55
Metis spp.	1.08								1.08		1.85		0.36	4.01
Darcythompsonia radans				1.44		1.23			1.08	1.08			0.44	4.83
Haparcticoida (others)	4.67	7.19		2.88	6.16	6.82	3.70	2.47	1.44	2.88	9.25	12.59	5.46	60.04
Corycaeus speciosus	2.88						1.23	1.23		1.44	1.85		0.78	8.63
Corycaeus giebrechti		2.88											0.26	2.88
Farranula gracilis									1.08				0.10	1.08
Copepoda (nauplii)	714.49	468.90		122.26	208.35	323.03	526.43	450.61	537.58	635.38	880.26	275.08	467.49	5142.36
Lepas spp. (nauplii)									1.08	1.44			0.23	2.52
Balanus spp. (nauplii)	1.08	1.44		2.16		1.14	2.47	1.23	1.08	1.44	1.85	3.60	1.59	17.48
Lucifer faxoni											1.39		0.13	1.39
Brachyura (zoea)						1.14	1.23		1.08	1.08	1.85	12.59	1.72	18.97
Decapoda (megalopa - various)	1.08	2.88		1.44		2.27	1.23		1.08	1.08	1.85	3.60	1.50	16.51
Misidacea (various)									1.08				0.10	1.08
Epicaridae (Manca larvae)	1.08	1.44				1.14	2.47		1.08	1.08	1.85		0.92	10.13
Oikopleura dioica	4.67	1.44		1.44	3.70	2.27	2.47	1.23	1.44	1.08	1.85		1.96	21.59
Sagitta tenuis		2.88							1.08	1.08	1.85		0.63	6.89
Fish eggs		1.44					3.70		1.44	1.08	1.39	1.80	0.99	10.84
Fish larvae		2.88		1.44		1.14	2.47			1.08	1.85	1.80	1.15	12.65
TOTAL	**1733.56**	**1196.69**		**427.20**	**643.55**	**704.15**	**867.93**	**763.73**	**929.55**	**919.11**	**1156.29**	**1794.32**	**1012.37**	**11136.09**

Table A11: Zooplankton density (org.m^{-3}) at the station M1(low tide).

	11/02/98	13/03/98	11/04/98	11/05/98	10/06/98	09/07/98	07/08/98	06/09/98	09/10/98	04/11/98	03/12/98	03/01/99	MEAN	TOTAL
Textularia candeiana						2.16						2.88	0.42	5.03
Textulariidae (others)	4.11	5.55	1.64	2.88			5.75	14.69	21.57	7.40	3.70	7.19	6.21	74.49
Quinqueloculinidae (various)	10.27	5.55	2.47	71.92	7.40		5.75	12.43	32.36	15.62	6.16	28.77	16.56	198.70
Tretomphalus bulloides	2.05	2.77	2.47	1.44		11.51				1.64	2.47	20.14	3.71	44.49
Trochamminidae (others)	30.82	2.77	3.29	12.94	27.12		5.03	36.16	27.74		14.79	23.73	15.37	184.41
Foraminiferida (others)	34.93	16.64	36.99	149.59	37.60	10.79	76.23	55.38	161.81	59.18	45.62	18.70	58.62	703.45
Tintinnopsis aperta	10.27	8.32	8.22	20.14	5.55	3.60	1.44	15.82	151.02	3.29	9.86		19.79	237.53
Tintinniopsis tocantinensis				23.01		17.98		57.64			50.55	5.75	12.91	154.93
Tintinnopsis nordqvivsti	137.67	85.99	22.19	220.06	8.01	56.09	6.47	187.60	86.30	46.03	138.08	62.57	88.09	1057.07
Tintinniopsis beroidea		11.10				9.35					4.93		2.11	25.38
Favella ehrenbergii	65.75	24.97	6.58	96.37	33.29	41.71	23.01	105.10	208.04	113.42	138.08	37.40	74.48	893.72
Hidromedusae (various)			2.47							1.64			0.34	4.11
Nematoda (various)	4.11		1.64	4.31		2.88				1.64			1.22	14.58
Gastropoda (veliger)	8.22	27.74	38.63	84.86	7.40	28.05	8.63	37.29	44.69	13.15	98.63	25.89	35.26	423.18
Bivalvia (veliger)	30.82	66.57	18.08	43.15	28.97	33.80	14.38	72.33	83.22	53.42	53.01	43.15	45.08	540.91
Polychaeta (other larvae)	2.05	24.97		7.19	3.08	1.44	1.44	1.13	4.62		56.71		8.55	102.64
Parvocalanus crassirostris	205.48	477.12	50.96	84.86	246.57	30.20	158.22	202.29	69.35	92.05	70.27	97.81	148.76	1785.17
Paracalanus indicus	22.60	72.12	3.29	10.07	30.82	10.79	1.44	48.60	6.16	17.26	38.22	16.54	23.16	277.90
Paracalanus parvus		138.70	17.26	4.31	6.78	12.94	3.60	122.05	23.12			37.40	30.51	366.16
Pseudodiaptomus acutus	8.22	19.42	50.14	53.22	18.49	23.73	7.19	28.25	23.12	76.44	16.03	19.42	28.64	343.66
Pseudodiaptomus richard		44.38					5.03	1.13					4.21	50.55
Temora turbinata		2.77	1.64		4.93	1.44		2.26		2.47	6.16	2.16	1.99	23.83
Temora stylifera		5.55			3.70	3.60		2.26		4.93	6.16	3.60	2.48	29.79
Calanopia americana						2.16							0.18	2.16
Labidocera fluviatilis			1.64		1.23	1.44	1.44			1.64			0.62	7.40
Pontellidae (nauplii)			1.64										0.14	1.64
Acartia lilljeborgi	4.11	66.57	5.75	14.38	29.59	7.19	45.31	13.56	16.95	12.33	3.70	2.88	18.53	222.32
Oithona nana	34.93	19.42	26.30	43.15	75.82	25.17	24.45	16.95	18.49	62.46	91.23	60.41	41.57	498.79
Oithona hebes	659.58	565.88	407.66	710.54	273.69	363.18	289.82	73.46	95.55	294.24	425.34	450.92	384.15	4609.85
Oithona oswaldocruzi	285.61	282.94	71.51	234.45	136.23	179.79	176.20	50.86	32.36	209.59	245.34	242.36	178.94	2147.22
Microsetella norvegica						1.44							0.12	1.44
Euterpina acutifrons	30.82	16.64	12.33	27.33	14.18	9.35	5.75	58.77	9.25	14.79	41.92	72.64	26.15	313.76
Tigriopus spp.	4.11		4.93			1.44					11.10		1.80	21.57
Darcythompsonia radans							4.31						0.36	4.31
Haparcticoida (others)	12.33	24.97	13.97	17.26	5.55	6.47	3.60	11.30	33.90	9.86	4.93	19.42	13.63	163.56
Corycaeus speciosus	4.11		1.64	2.88	4.31	2.16							1.26	15.10
Corycaeus giebrechti					9.25	2.88		5.65	15.41		7.40	2.16	3.56	42.74
Farranula gracilis						1.44							0.12	1.44
Copepoda (nauplii)	1267.79	1092.93	1011.76	1398.06	675.60	934.92	741.46	1080.39	1502.54	859.71	1156.42	1025.53	1062.26	12747.1
Lepas spp. (nauplii)								2.26			2.47	4.31	0.75	9.04
Balanus spp. (nauplii)	6.16	5.55	1.64	1.44	2.47		1.44	5.65	3.08	2.47	7.40	2.16	3.29	39.45
Lucifer faxoni			1.64	1.44	1.23	1.44		2.26	1.54	2.47		1.44	1.12	13.45
Porcellanidae (zoea)			1.64									1.44	0.26	3.08
Brachyura (zoea)			1.64	2.88	1.23	1.44		5.65		3.29	9.86	1.44	2.29	27.43
Misidacea (various)	4.11	8.32	1.64	4.31	2.47	2.16	1.44	2.26	3.08	2.47	6.16	2.16	3.38	40.59
Epicaridae (Manca larvae)	4.11		2.47	2.88	3.70	1.44	1.44	38.42	3.08	6.58	4.93	2.88	5.99	71.92
Crustacea (protozoea - various)			1.64					1.13				1.44	0.35	4.21
Oikopleura dioica	2.05	22.19		5.75	1.23	1.44	1.44	6.78	12.33	7.40	4.93	3.60	5.76	69.14
Sagitta tenuis	2.05	11.10	1.64		2.47			3.39			3.70	2.16	2.21	26.50
Pluteus larvae	2.05		1.64					1.13				1.44	0.52	6.26
Fish eggs					1.23								0.10	1.23
Fish larvae						1.44	1.44						0.24	2.88
TOTAL	**2901.31**	**3159.50**	**1842.67**	**3357.07**	**1711.20**	**1850.42**	**1623.16**	**2382.29**	**2690.71**	**1998.87**	**2786.25**	**2353.83**	**2388.11**	**28657.29**

Table A12: Zooplankton density (org.m^{-3}) at the station M2 (high tide).

	11/02/98	**13/03/98**	**11/04/98**	**11/05/98**	**10/06/98**	**09/07/98**	**07/08/98**	**06/09/98**	**09/10/98**	**04/11/98**	**03/12/98**	**03/01/99**	**MEAN**	**TOTAL**
Textulariidae (others)	1.44	1.16	1.44		1.13	1.70			8.48		1.20	1.20	1.48	17.74
Quinqueloculinidae (various)	1.80	1.39	3.24		3.96	2.26			3.96		1.20	3.00	1.73	20.79
Tetomphalus buloides	1.80	1.39			1.13	1.13			1.13		1.80	1.20	0.80	9.58
Trochamminidae (others)	1.44	1.39	1.08	3.70	3.96	3.96			3.39		1.80	3.00	1.98	23.70
Foraminiferida (others)	1.80	3.93	1.44	17.26	15.82	7.91	19.42		53.68	5.39	8.99	27.57	13.60	163.21
Tintinnopsis aperta	1.44	23.58		55.48	5.65	19.78	5.03		12.43	1.80	26.97	119.86	22.67	272.02
Tintinniopsis tocantinensis				1.23			40.99	5.03				6.59	4.49	53.85
Tintinnopsis nordqvivsti	1.80	16.87	23.37	59.79	30.51	79.67	29.49	7.19	31.08	1.80	230.13	20.98	44.39	532.69
Tintinnopsis beroidea				28.97	5.09	16.39			1.13	2.70			4.52	54.27
Codonellopsis morchella f.typica			1.08			11.30							1.03	12.38
Codonellopsis ostenfeldi											3.60		0.30	3.60
Undella hyalina						1.13					26.97		2.34	28.10
Favella ehrenbergii	2.88	18.03	17.08	4.93	20.34	18.08	22.29	1.44	109.06	11.69	672.42	47.35	78.80	945.58
Acanthostomella norvegica			1.08										0.09	1.08
Hidromedusae (various)		1.39											0.12	1.39
Nematoda (various)	1.44	1.16	1.08			1.13		1.44					0.52	6.25
Gastropoda (veliger)	4.32	1.16	7.55			15.26			5.65	45.85	3.60	4.20	7.30	87.57
Bivalvia (veliger)	1.44	7.40	14.92	30.82	3.96	25.99	1.44	6.11	25.99	57.53	8.39	11.39	16.28	195.38
Polychaeta (others larvae)	1.80	1.39	1.08	1.23		1.13	4.31	4.31	1.13	3.60	5.39	1.20	2.22	26.58
Parvocalanus crassirostris	52.50	6.24	31.10	3.70	11.87	15.82	10.79	40.27	26.56	65.62	23.97	68.92	29.78	357.37
Paracalanus indicus	1.08	1.16	1.08			15.26	13.66		4.52	1.80		7.79	3.86	46.35
Paracalanus parvus	1.44		1.98				27.33		1.13				2.66	31.87
Pseudodiaptomus acutus	12.23	1.16	7.01	2.47		28.82	11.51	1.08	4.52	5.39	10.19	1.20	7.13	85.57
Pseudodiaptomus richard			1.62						1.13	5.39			0.68	8.14
Temora turbinata	2.52	1.39	1.98						1.13	2.70		1.20	0.91	10.91
Temora stylifera	1.44	1.16	1.80						1.13	1.80			0.61	7.33
Calanopia americana										3.60			0.30	3.60
Labidocera fluviatilis								1.08	1.13		1.20		0.28	3.41
Pontellidae (nauplii)												1.80	0.15	1.80
Acartia lilljeborgi	1.44	1.39			2.83				5.65	1.80	1.20		1.19	14.30
Oithona simplex										1.80			0.15	1.80
Oithona nana	11.51	1.39	2.70	1.85	1.13		4.31	1.44	1.70	5.39	8.39	1.80	3.47	41.60
Oithona hebes	101.76	45.66	79.29	38.22	91.54	75.15	175.48	375.40	159.91	259.80	471.05	443.49	193.06	2316.75
Oithona oswaldocruzi	44.59	6.24	12.59	5.55	1.13	6.22	46.75	87.74	42.38	90.80	91.69	61.13	41.40	496.79
Microsetella norvegica					1.70				1.13				0.24	2.83
Euterpina acutifrons	1.80	1.39	7.91	2.47	1.13	10.74	17.26	375.40	35.60	2.70	1.80	41.35	41.63	499.54
Tigriopus spp.	1.44	1.16	1.80		1.13				1.70	1.80		2.40	0.95	11.43
Metis spp.									1.70				0.14	1.70
Haparcticoida (others)	6.11	2.77	1.80	3.70	1.70	1.70	1.08	8.27	6.22	10.79	10.19	1.20	4.63	55.52
Oncaea venustra										1.80			0.15	1.80
Corycaeus speciosus	4.68				1.70	55.38			1.13		4.20		5.59	67.07
Corycaeus giebrechti										3.60			0.30	3.60
Copepoda (nauplii)	722.76	184.30	344.12	219.45	208.51	332.25	652.28	110.03	373.50	592.41	743.74	581.92	422.11	5065.29
Lepas spp. (nauplii)									1.13	1.80			0.24	2.93
Balanus spp. (nauplii)		1.39		1.23	1.13	1.13			3.39	1.80	1.80	1.20	1.09	13.07
Lucifer faxoni	1.44												0.12	1.44
Porcellanidae (zoea)										1.80			0.15	1.80
Brachyura (zoea)	1.44		1.08						1.13	2.70		1.20	0.63	7.54
Misidacea (various)	1.80	1.39	1.26	1.23	1.13				1.13			1.80	0.81	9.74
Epicaridae (Manca larvae)		1.16			1.13				1.13	1.80			0.44	5.22
Oikopleura dioica		1.39	1.10			2.26	2.16			2.70	1.80		0.95	11.40
Pluteus larvae	1.80												0.15	1.80
Sagitta tenuis	1.44									1.80			0.27	3.24
Fish eggs												1.20	0.10	1.20
Fish larvae										1.80		1.20	0.25	3.00
TOTAL	**998.59**	**340.98**	**574.65**	**483.27**	**419.28**	**751.53**	**1085.58**	**1026.25**	**936.88**	**1205.52**	**2363.67**	**1468.31**	**971.21**	**11654.51**

Table A13: Zooplankton density (org.m^{-3}) at the station M2 (low tide).

	11/02/98	**13/03/98**	**11/04/98**	**11/05/98**	**10/06/98**	**09/07/98**	**07/08/98**	**06/09/98**	**09/10/98**	**04/11/98**	**03/12/98**	**03/01/99**	**MEAN**	**TOTAL**
Textulariidae (others)	2.70			1.08	1.44	3.70			1.23	2.16		1.44	1.15	13.74
Quinqueloculinidae (various)	1.35		1.44	1.44	2.88	2.47		2.31	8.63			2.88	1.95	23.39
Tretomphalus buloides	1.35	1.20			1.44	1.85			1.23	1.44			0.71	8.51
Remaneica spp.	1.80		1.44	11.51		3.70		3.34		1.08		3.96	2.23	26.82
Foraminiferida (others)	14.83	3.60	3.96	24.09	24.09	13.25	1.08	82.70	6.78	2.16		6.83	15.28	183.38
Tintinnopsis aperta	21.13		48.90	38.12	1.44	4.93	1.08	22.09		1.80	9.71	42.43	15.97	191.62
Tintinniopsis tocantinensis			1.44	17.62		49.62			19.73				7.37	88.41
Tintinnopsis nordqvivsti	5.84		74.79	186.26	2.88	32.98	1.08	83.99		99.24	79.47	717.73	107.02	1284.26
Codonellopsis morchella f. *typica*								1.28			11.51	139.52	12.69	152.31
Codonellopsis morchella f. *schabi*								1.28				70.48	5.98	71.76
Codonellopsis pusilla												7.91	0.66	7.91
Undella hyalina									1.85				0.15	1.85
Favella ehrenbergii	25.62	8.39	16.54	2.16	4.31	20.03	17.62	46.75	33.29	50.34	107.87	16.18	29.09	349.11
Hidromedusae (various)		2.40			1.44					1.06			0.41	4.90
Nematoda (various)							1.08						0.09	1.08
Gastropoda (veliger)	46.75	4.20		2.16	8.63		1.08	14.38	2.47	23.01			8.56	102.67
Bivalvia (veliger)	9.44	2.40	14.02	19.06	6.11	2.77	1.08	3.08		15.46	2.88	2.16	6.54	78.46
Polychaeta (other larvae)			1.44	3.24		1.85	1.08	5.39			1.06	1.44	1.29	15.50
Polychaeta (eggs)								1.28					0.11	1.28
Parvocalanus crassirostris	51.69	21.57	13.30	1.08	15.46	20.34	111.65	25.68	49.93	28.77	36.32	25.89	33.47	401.69
Paracalanus indicus	7.19	7.19	1.80	5.03		7.09	1.08	2.05	7.40	1.44		1.08	3.45	41.35
Paracalanus parvus		3.00						1.28					0.36	4.28
Pseudodiaptomus acutus	4.05	13.18	1.44	1.44	8.27	3.70	1.08	8.73	8.63	11.87	12.94	6.11	6.79	81.44
Pseudodiaptomus richard								1.28					0.11	1.28
Temora turbinata			1.44	1.08				3.85	1.23	1.44	1.44	1.08	0.96	11.57
Temora stylifera		3.60						3.08					0.56	6.68
Calanopia americana									1.23	1.44			0.22	2.67
Labidocera fluviatilis		1.80						1.28	1.85	2.16			0.59	7.08
Pontellidae (nauplii)							1.08						0.09	1.08
Acartia lilljeborgi		3.60			4.31			1.54		1.44			0.91	10.89
Oithona nana	24.72	28.17	1.80	1.44	3.24	7.09	25.89			4.67	10.79	16.90	10.39	124.71
Oithona hebes	288.57	127.65	142.39	41.71	28.05	68.12	219.71	146.40	106.64	193.46	751.17	441.57	212.95	2555.43
Oithona oswaldocruzi	63.38	53.34	12.23	16.18	2.88	4.31	24.45	33.90	24.04	24.81	37.76	134.12	35.95	431.40
Microsetella norvegica										1.44			0.12	1.44
Euterpina acutifrons	10.79	117.46	1.44	1.44	3.24	41.61	1.08	4.88	4.31	21.22	6.83	1.44	17.98	215.74
Tigriopus spp.		4.20		5.03	2.16			1.28		1.08			1.15	13.75
Metis spp.										1.06			0.09	1.06
Haparcticoida (various)	5.39	7.19	1.08	1.80	2.88	1.85	1.44	1.03	3.08	24.45	1.44	1.44	4.42	53.07
Corycaeus speciosus		5.39								5.03			0.87	10.43
Corycaeus giebrechti		4.79			1.80				1.85				0.70	8.44
Copepoda (nauplii)	1056.72	982.86	285.15	69.40	148.15	503.93	378.64	362.41	710.12	829.20	1025.17	321.47	556.10	6673.22
Lepas spp. (nauplii)							1.44			1.08			0.21	2.52
Balanus spp. (nauplii)	1.35	2.40	1.08	1.44	1.44	1.85		1.03	1.23	1.44			1.11	13.26
Lucifer faxoni		3.60								1.08			0.39	4.68
Caridea (various)	1.35	1.20			1.44				1.23	2.88	1.08		0.76	9.17
Porcellanidae (zoea)										1.08			0.09	1.08
Brachyura (zoea)		2.40								1.08			0.29	3.48
Misidacea (various)										1.44			0.12	1.44
Cumacea (various)										1.08			0.09	1.08
Epicaridae (Manca larvae)	1.35	1.20			2.88					1.08	1.08		0.63	7.58
Isopoda (adults)												1.08	0.09	1.08
Oikopleura dioica	1.35	1.80						1.54	1.85	4.67	2.88	1.44	1.29	15.53
Sagitta tenuis		1.20							1.23	1.44		1.80	0.47	5.67
Fish eggs							1.44	1.03	1.23	1.44			0.43	5.14
Fish larvae	1.35							1.03	1.85	1.44			0.47	5.67
TOTAL	**1650.04**	**1420.95**	**627.12**	**453.81**	**280.84**	**797.04**	**794.16**	**871.21**	**1004.15**	**1373.94**	**2101.39**	**1968.37**	**1111.92**	**13343.02**

Table A14: Zooplankton density (org.m^{-3}) at the station M3 (high tide).

	11/02/98	13/03/98	11/04/98	11/05/98	10/06/98	09/07/98	07/08/98	06/09/98	09/10/98	04/11/98	03/12/98	03/01/99	MEAN	TOTAL
Textulariidae (others)	3.01			12.33	5.75	1.10	1.44	1.92		1.37	1.23	1.64	2.48	29.79
Quinqueloculinidae (various)	4.52	1.88	1.51	2.74	3.29	3.29	2.88	1.44		2.05	2.47	2.47	2.38	28.53
Tretomphalus bulloides	1.51			1.37	1.64		2.40	1.44					0.70	8.36
Trochamminidae (others)	6.78	1.88	6.78	12.33	34.52	3.84	1.92	4.79		6.16	3.29	1.64	6.99	83.93
Foraminiferida (others)	6.03	1.88	33.15	69.86	115.07	13.70	53.70	20.14	1.20	26.71	19.73	42.74	33.66	403.90
Tintinnopsis aperta				160.27	14.79	3.84	4.31			10.27	1.23	110.96	25.47	305.68
Tintinniopsis tocantinensis							7.67			25.34			2.75	33.01
Tintinnopsis nordqvivsti	4.52	1.88	4.52	67.12	35.34	2.74	296.78	40.27	1.20	1.37	3.70	1.64	38.42	461.09
Favella ehrenbergii	4.52	1.88	3.01	34.25	5.75	30.14	139.04	13.90	1.20		1.23	1.64	19.71	236.57
Hidromedusae (various)											1.23		0.10	1.23
Nematoda (various)						1.10			1.20		1.23	3.29	0.57	6.81
Gastropoda (veliger)	85.14		20.34	1.37	36.16	3.29	7.19	9.59	1.20	5.48	1.23	14.79	15.48	185.79
Bivalvia (veliger)	27.88		4.52	4.11	32.88	5.48	5.75	2.88	2.40	8.22	2.88	4.93	8.49	101.92
Polychaeta (other larvae)		3.77	2.26		1.64	2.19			1.20	6.16	2.88	12.33	2.70	32.43
Polychaeta (eggs)									1.20	1.37			0.21	2.57
Parvocalanus crassirostris	46.71	44.26	46.71	86.30	20.55	13.15	23.49	21.10	32.36	12.33	54.25	325.47	60.56	726.68
Paracalanus indicus		75.34				7.12	1.44	8.15	1.20		6.99	6.58	8.90	106.82
Paracalanus parvus	4.52	78.17				3.29	2.88	3.84				30.41	10.26	123.10
Pseudodiaptomus acutus	4.52		7.53		1.64	8.77		3.36	5.99	19.18		4.93	4.66	55.92
Pseudodiaptomus richard			3.77										0.31	3.77
Temora turbinata		132.79	1.51										11.19	134.30
Temora stylifera			1.51										0.13	1.51
Acartia lilljeborgi		13.18	4.52		1.64	7.12		2.40	4.31		20.14	2.47	4.65	55.78
Oithona nana	144.66	92.29	7.53	9.59	8.22	9.31	1.44	2.40	3.36	13.70	11.10	3.29	25.57	306.88
Oithona hebes	323.97	696.91	66.30	130.13	62.46	96.98	2.88	35.48	55.14	50.68	81.37	12.33	134.55	1614.63
Oithona oswaldocruzi	116.78	355.99	31.64	54.79	32.05	42.74	2.40	28.29	28.29	23.97	27.12	4.11	62.35	748.17
Euterpina acutifrons	3.01	3.77	39.18	4.11		11.51	19.66	9.59	1.20	115.07	4.11	105.20	26.37	316.40
Tigriopus spp.		1.88		1.37		1.10		1.44	1.20	2.05		3.29	1.03	12.33
Metis spp.		1.88		1.37		1.10			1.20	1.37	1.23		0.68	8.15
Darcythompsonia radans										1.37			0.11	1.37
Harparcticoida (others)	3.01	4.71	3.01	4.11	2.47	2.19	1.44	1.44	1.44	4.79	8.63	116.71	12.83	153.96
Corycaeus speciosus												7.40	0.62	7.40
Copepoda (nauplii)	351.09	1067.02	417.39	172.60	630.40	160.00	153.42	321.23	72.16	342.46	173.42	633.69	374.57	4494.87
Lepas spp. (nauplii)					1.64		1.44					4.93	0.67	8.01
Balanus spp. (nauplii)			1.51	6.85	2.47	1.10	1.44	1.44	1.20	6.85		23.01	3.82	45.87
Caridea (various)	1.51			2.74	1.64	1.10		1.44		1.37			0.82	9.80
Porcellanidae (zoea)											1.23		0.10	1.23
Brachyura (zoea)											2.88	1.64	0.38	4.52
Epicaridae (Manca larvae)	1.51		1.51	2.74	1.64	1.10	1.44	1.44	1.20	1.37			1.16	13.94
Membranipora spp. (Cyphonaute larvae)					3.29								0.27	3.29
Oikopleura dioica		1.88		1.37	1.64	1.10			1.20				0.60	7.19
Fish eggs		2.83			1.64	2.74					1.64	1.64	0.87	10.49
Fish larvae		1.88		1.37	1.64	1.64		1.44	1.20		1.23		0.87	10.40
TOTAL	**1145.19**	**2587.96**	**709.72**	**845.19**	**1061.88**	**443.84**	**736.43**	**540.82**	**223.44**	**691.09**	**437.64**	**1485.18**	**909.03**	**10908.38**

Table A15: Zooplankton density (org.m^{-3}) at the station M3 (low tide).

	11/02/98	13/03/98	11/04/98	11/05/98	10/06/98	09/07/98	07/08/98	06/09/98	09/10/98	04/11/98	03/12/98	03/01/99	MEAN	TOTAL
Textulariidae (others)	8.63		1.85		1.64	1.51	1.61				2.96		1.52	18.20
Quinqueloculinidae (various)	3.84	1.23	1.23		2.47	1.51	2.15						1.04	12.43
Tretomphalus buloides						1.51							0.13	1.51
Trochamminidae (others)	5.75	1.23	2.47		3.29	2.26	1.61	5.02	2.74		1.48		2.15	25.86
Foraminiferida (others)	7.67	2.05	11.10	2.05	7.40	9.04	2.15	6.28				9.04	4.73	56.79
Tintinnopsis aperta	14.38					1.51	1.08	3.77			10.36	3.29	2.86	34.38
Tintinniopsis tocantinensis									28.49				2.37	28.49
Tintinnopsis nordqvivsti	3.84	2.88	1.23	1.03	4.93	1.51	36.06	51.48		23.84	5.92	9.04	11.81	141.74
Favella ehrenbergii	12.47		2.47	1.03	42.74	1.51	17.76	18.84	24.11	53.42	7.40	16.44	16.51	198.17
Nematoda (various)	1.92	1.64					2.15	2.51	1.10	1.64	1.48	3.29	1.31	15.74
Gastropoda (veliger)	1.92	2.05	4.31	1.03	4.93	2.26	1.08	1.26	2.19	31.23	104.30	29.59	15.51	186.15
Bivalvia (veliger)	18.22	4.93	9.25	3.08	7.40	6.78	2.69	6.28	7.67	23.84	40.68	39.45	14.19	170.27
Polychaeta (other larvae)		1.64			3.29	2.26	1.08	2.51	2.74	4.11		2.47	1.67	20.09
Parvocalanus crassirostris	39.31	30.82	103.56	14.59	41.92	26.37	32.83	35.16	13.15	13.15	25.89	43.56	35.03	420.31
Paracalanus indicus	4.79	1.23	1.23	4.31		1.51			2.74				1.32	15.82
Paracalanus parvus									9.31				0.78	9.31
Pseudodiaptomus acutus	1.92			2.88		1.51	3.77	2.51	1.10	11.51			2.10	25.19
Acartia lilljeborgi		1.23			1.64								0.24	2.87
Oithona nana	48.90	7.81	1.23	13.56	4.11	6.78	4.31	2.51	2.74	6.58	1.48	4.11	8.68	104.12
Oithona hebes	167.81	42.33	5.55	46.03	60.82	17.33	50.59	104.22	67.94	81.37	34.77	88.77	63.96	767.51
Oithona oswaldocruzi	74.79	20.55	3.70	24.86	36.16	6.03	17.76	6.28	24.11	8.22	1.48	25.48	20.78	249.42
Euterpina acutifrons	18.22	1.64	6.78	5.55	4.93	1.51	1.61	5.02	2.74		35.51	2.47	7.17	85.98
Tigriopus spp.	1.92				1.64	1.51			6.58		2.22		1.15	13.86
Metis spp.	1.92		1.23		1.64		1.08				1.48		0.61	7.34
Darcithompsonia radans					1.64			1.26				1.64	0.38	4.54
Harparcticoida (others)	2.88	1.23	5.55	3.90	4.93		2.15	1.26	3.29	5.75	5.18	3.29	3.28	39.41
Corycaeus giesbrechti												1.64	0.14	1.64
Copepoda (nauplii)	247.39	305.34	244.11	55.27	184.93	86.64	80.72	85.39	73.42	180.00	184.19	120.00	153.95	1847.40
Lepas spp. (nauplii)										1.64			0.14	1.64
Balanus spp. (nauplii)	1.92			1.03	1.64	2.26	1.08		1.10	2.47	1.48	1.64	1.22	14.61
Caridea (various)		1.64											0.14	1.64
Brachyura (zoea)									3.84			1.64	0.46	5.48
Epicaridae (Manca larvae)	1.92			1.03					1.10	1.64	1.48	1.64	0.73	8.81
Oikopleura dioica								2.51	2.74	1.64	2.22	1.64	0.90	10.75
Fish eggs					1.64				1.10				0.23	2.74
Fish larvae		1.64	1.85			1.51		1.26	1.10	1.64	1.48	1.64	1.01	12.12
TOTAL	**692.32**	**433.13**	**408.68**	**181.24**	**425.73**	**184.60**	**265.31**	**345.31**	**287.13**	**453.68**	**473.42**	**411.76**	**380.19**	**4562.32**

Table A16: Zooplankton density (org.m^{-3}) at the station M4 (high tide).

	11/02/98	13/03/98	11/04/98	11/05/98	10/06/98	09/07/98	07/08/98	06/09/98	09/10/98	04/11/98	03/12/98	03/01/99	MEAN	TOTAL
Textulariidae (others)			1.41		5.14	7.71				5.14			1.62	19.39
Quinqueloculinidae (various)			1.41	1.16	5.14	4.62				4.11		1.67	1.51	18.11
Tretomphalus bulloides						43.15				3.08			3.85	46.23
Trochamminidae (others)	2.70		70.63	4.62	7.19	9.25		16.95	13.87	9.25		6.68	11.76	141.14
Foraminiferida (others)	6.29	73.97	217.55	18.49	44.18	41.61	70.63	22.60	64.72	19.52	41.95	31.72	54.44	653.24
Tintinnopsis aperta	125.85	122.52	66.39	35.83	14.38	3.08	16.48						32.04	384.54
Tintinniopsis tocantinensis					15.41				26.20				3.47	41.61
Tintinnopsis nordqvivsti	2.70	41.61	7.06	153.72	16.44	53.94	343.74	90.41	6.16	4.11	11.99	11.69	61.96	743.57
Undella hyalina					12.33								1.03	12.33
Favella ehrenbergii	19.78	117.89	9.89	11.56	22.60	7.71	89.47	93.23	6.16	10.27	20.98	6.68	34.68	416.22
Nematoda (various)		4.62		3.47	2.05				6.16	2.05	8.99		2.28	27.35
Gastropoda (veliger)	6.29	36.99		4.62	8.22			8.48		16.44	50.94	58.43	15.87	190.41
Bivalvia (veliger)	14.38	30.05	12.71	8.09	21.57	13.87	223.67	2.83	13.87	13.36	5.99	21.70	31.84	382.10
Polychaeta (other larvae)		2.31	38.14		5.14			1.41	3.08	7.19	11.99	16.69	7.16	85.96
Polychaeta (eggs)											26.97		2.25	26.97
Parvocalanus crassirostris	85.4	198.80	91.82	180.31	124.31	89.38	44.73	57.92	255.82	124.31	254.70	70.12	131.47	1577.63
Paracalanus indicus	5.39	18.49	50.86	8.09	14.38	66.27	4.71	14.13	10.79	7.19	35.96	10.02	20.52	246.27
Paracalanus parvus	129.45			4.62	41.10			49.44	6.16	32.88	116.86	56.76	36.44	437.28
Pseudodiaptomus acutus			4.24	23.12	15.41		30.61		100.17	7.19	11.99	1.67	16.20	194.39
Pseudodiaptomus richard					4.11				4.62				0.73	8.73
Labidocera fluviatilis		87.84	12.71							7.19	3.00	13.36	10.34	124.10
Pontellidae (nauplii)						9.25							0.77	9.25
Acartia lilljeborgi	1.80	34.67		10.40	10.27			50.86	174.14	14.38	23.97	6.68	27.26	327.18
Oithona nana	37.76	34.67	8.48	99.40	50.34	21.57	44.73	40.97	10.79	59.59	5.99	18.36	36.05	432.66
Oithona hebes	515.10	446.14	79.11	294.73	183.90	57.02	230.73	103.12	53.94	26.71	98.89	60.10	179.12	2149.49
Oithona oswaldocruzi	80.01	203.42	31.08	201.11	78.08	32.36	94.18	55.09	13.87	111.98	11.99	35.06	79.02	948.23
Euterpina acutifrons	96.19	20.80	49.44	4.62	31.85	24.66	94.18	9.89	13.87	14.38	11.99	51.75	35.30	423.62
Tigriopus spp.	1.80				1.03					6.16			0.75	8.99
Metis spp.										2.05			0.17	2.05
Harparcticoida (others)	5.39	30.05	12.71	3.47	16.44	27.74	14.13	5.65	7.71	7.19	8.99	65.11	17.05	204.58
Corycaeus giebrechti							18.84						1.57	18.84
Copepoda (nauplii)	584.32	406.84	1340.60	440.36	247.60	870.70	235.44	963.43	744.34	378.08	991.85	681.15	657.06	7884.71
Balanus spp. (nauplii)		2.31	1.41	1.16	3.08					1.03	20.98	10.02	3.33	39.98
Brachyura (zoea)			4.24									6.68	0.91	10.92
Epicaridae (Manca larvae)										5.14			0.43	5.14
Oikopleura dioica			7.06		6.16		9.42			2.05			2.06	24.70
Fish eggs		4.62	4.24		2.05								0.91	10.92
Fish larvae											3.00		0.25	3.00
TOTAL	**1720.61**	**1918.63**	**2123.21**	**1512.94**	**1009.91**	**1383.88**	**1565.68**	**1586.40**	**1536.45**	**902.04**	**1779.94**	**1242.10**	**1523.48**	**18281.80**

Table A17: Zooplankton density (org.m^{-3}) at the station M4 (low tide).

	11/02/98	**13/03/98**	**11/04/98**	**11/05/98**	**10/06/98**	**09/07/98**	**07/08/98**	**06/09/98**	**09/10/98**	**04/11/98**	**03/12/98**	**03/01/99**	**MEAN**	**TOTAL**
Textulariidae (others)		1.80			3.60		2.83			2.70	1.28		1.02	12.20
Quinqueloculinidae (various)		1.80	8.67		5.39			5.39		1.80	1.28	1.54	2.16	25.88
Tretomphalus bulloides										16.18	1.61		1.48	17.79
Trochamminidae (others)	7.19		17.34	1.54	10.79	6.16	7.06	3.60		3.60	2.89	1.54	5.14	61.71
Foraminiferida (others)	19.52	2.70	26.01	13.87	26.97	20.03	16.95	11.69	55.48	30.56	4.49	3.08	19.28	231.35
Tintinniopsis tocantinensis			1.73										0.14	1.73
Tintinnopsis nordqvivsti	2.05		5.20	5.39	12.59	9.25	2.83	1.80	11.56	1.80	1.28	2.31	4.67	56.06
Favella ehrenbergii	2.05		5.20	1.54	21.57	15.41	2.83	17.98	6.93	5.39		6.16	7.09	85.08
Nematoda (various)		1.80	1.73	1.54				2.70			2.25	1.54	0.96	11.56
Gastropoda (veliger)	21.57	42.25	62.41	30.82	7.19			2.70	36.99	4.49	8.67	9.25	18.86	226.34
Bivalvia (veliger)	11.30	18.88	10.40	12.33	21.57	55.48	28.25	1.80	54.32	10.79	2.89	10.02	19.84	238.03
Polychaeta (other larvae)	2.05	12.59	13.87	1.54	7.19	6.16	2.83	1.80			3.85	7.71	4.97	59.59
Polychaeta (eggs)	1.03	2.70							2.31				0.50	6.04
Parvocalanus crassirostris	31.85	26.97	98.82	30.05	84.50	57.02	14.13	2.70	40.45	26.07	31.78	92.46	44.73	536.81
Paracalanus indicus		4.49	19.07		12.59	9.25			13.87	2.70	2.57	9.25	6.15	73.78
Paracalanus parvus				3.08		7.71				3.60		28.51	3.57	42.89
Pseudodiaptomus acutus			3.47					1.80	6.93			6.16	1.53	18.37
Acartia lilljeborgi					1.80					1.80		1.54	0.43	5.14
Oithona nana	9.25			3.08	3.60	1.54	2.83	1.80		2.70	15.73	3.85	3.70	44.37
Oithona hebes	62.67	35.06	39.88	61.64	106.08	81.68	56.51	53.94	112.11	136.64	81.23	126.37	79.48	953.79
Oithona oswaldocruzi	20.55	8.99	3.47	3.85	10.79	23.12	7.06	3.60	31.21	69.22	28.57	44.69	21.26	255.11
Euterpina acutifrons	6.16	2.70	12.14	3.08	7.19			4.49			1.28		3.09	37.05
Tigriopus spp.		1.80											0.15	1.80
Metis spp.		1.80											0.15	1.80
Darcythompsonia radans		6.29		3.08	1.80								0.93	11.17
Harparcticoida (others)	5.14	4.49	15.60	2.31	7.19	6.16		4.49		2.70	2.25	6.16	4.71	56.51
Copepoda (nauplii)	316.43	200.47	390.08	141.01	269.69	286.64	187.88	145.63	149.10	175.30	264.23	174.14	225.05	2700.60
Balanus spp. (nauplii)		1.80	3.47	1.54		3.08		1.80		2.70	1.61	3.85	1.65	19.84
Brachyura (zoea)			5.20									2.31	0.63	7.51
Misidacea (various)		1.80				1.54				1.80	1.61		0.56	6.75
Epicaridae (Manca larvae)	1.03		3.47			1.54		1.80		1.80	1.28		0.91	10.91
Oikopleura dioica	2.05		3.47	2.31	3.60			1.80		2.70	1.28	3.85	1.76	21.06
Sagitta tenuis			5.20										0.43	5.20
Fish eggs				1.54							1.28		0.24	2.82
Fish larvae		1.80		2.31				1.80		1.80			0.64	7.71
TOTAL	**521.91**	**382.97**	**755.89**	**327.48**	**625.67**	**591.77**	**331.97**	**275.09**	**521.27**	**508.81**	**465.21**	**546.31**	**487.86**	**5854.35**

Table A18: Zooplankton density (org.m^{-3}) at the station R1 (Winter: 10-12/07/00; LT = low tide; HT = high tide; N = nocturnal; D = diurnal).

	LT-N	HT-N	LT-D	HT-D	MEAN	TOTAL
Textulariidae (others)	3.69	1.23		28.86	8.45	33.79
Quinqueloculinidae (various)		1.22		63.45	16.17	64.68
Tretomphalus bulloides	6.10	1.23	2.75	11.31	5.35	21.39
Trochamminidae (others)	4.98	11.05	17.66	133.01	41.67	166.69
Spirillinidae (various)		1.22	3.68		1.23	4.91
Foraminiferida (others)	8.67	14.73	21.47	135.58	45.11	180.45
Tintinnopsis aperta	17.21	6.13	3.68	40.34	16.84	67.36
Tintinnopsis tocantinensis	39.33	9.82	26.15	59.86	33.79	135.15
Tintinnopsis nordqvisti	106.53	52.75	55.45	112.52	81.81	327.25
Tintinnopsis baltica	2.40		1.81	1.80	1.50	6.01
Tintinnopsis parvula		1.23	1.81		0.76	3.05
Tintinnopsis beroidea	16.26		1.81	7.02	6.27	25.09
Codonellopsis morchella f. *typica*		222.09	26.50	48.13	74.18	296.71
Codonellopsis morchella f. *schabi*	7.22			14.73	5.49	21.95
Codonellopsis pusilla	12.56	15.94		15.67	11.04	44.18
Codonellopsis ostenfeldi	4.99		17.95	29.63	13.14	52.58
Eutintinnus medius		2.45	1.81	2.65	1.73	6.91
Undella hyalina			1.81		0.45	1.81
Favella ehrenbergii	324.53	952.80	214.22	316.36	451.98	1807.92
Favella ehrenbergii f. *coxliella*	16.08				4.02	16.08
Acanthostomella norvegica	4.99	2.45	1.81	2.57	2.95	11.82
Hidromedusae (various)	6.10	4.91		3.51	3.63	14.52
Cubomedusae (various)				1.71	0.43	1.71
Scyphomedusae (Ephyra - larvae)		1.22			0.31	1.22
Nematoda (various)	42.29	2.45	1.81		11.64	46.55
Brachionus plicatilis		2.46		32.20	8.67	34.66
Brachionus palutus		1.22			0.31	1.22
Platyias quadricornis		2.46			0.61	2.46
Lecane bulla		3.67			0.92	3.67
Synchaeta spp.		4.92			1.23	4.92
Trichocerca spp.		6.14		41.02	11.79	47.16
Kinorhynca (various)		2.45			0.61	2.45
Gastropoda (veliger)	6.10	47.89	3.74	17.39	18.78	75.12
Bivalvia (veliger)	14.96	55.25	2.81	40.17	28.30	113.18
Nereis spp. (adults)		1.22	1.81	1.71	1.19	4.75
Nereis spp. (Nectochaeta larvae)		1.23	1.81		0.76	3.05
Spionid (various)		2.46		3.51	1.49	5.97
Polychaeta (others)	10.17	4.91	3.74	2.65	5.37	21.47
Polychaeta (other larvae)	6.28	11.03	5.73	11.31	8.59	34.35
Asterope spp.	2.40	2.46	1.00		1.46	5.85
Parvocalanus crassirostris	28.27	44.18	34.86	81.44	47.19	188.75
Paracalanus nanus	13.49	1.23		1.80	4.13	16.52
Paracalanus indicus	14.60	11.03	7.43	25.26	14.58	58.33
Paracalanus parvus	4.99	3.68	1.00	3.43	3.27	13.09
Pareucalanus sewelli		1.22		1.80	0.76	3.02
Pseudodiaptomus acutus	62.45	8.59	25.03	42.05	34.53	138.12
Pseudodiaptomus richardi	25.67	3.68	7.31	13.02	12.42	49.68
Temora turbinata	4.98	4.92		6.00	3.97	15.89
Temora stylifera	10.91	2.45	1.93	1.80	4.27	17.09
Calanopia americana	29.54	1.23	1.00	7.79	9.89	39.57
Labidocera fluviatilis	4.99	1.22	1.81	4.37	3.10	12.39
Pontellidae (nauplii)	4.98	1.22	1.00		1.80	7.20
Acartia lilljeborgi		7.36	2.81		2.54	10.17
Oithona simplex		7.36	1.00		2.09	8.36
Oithona nana	21.98	52.78	51.82	6.00	33.14	132.58
Oithona hebes	69.77	138.65	130.82	348.31	171.89	687.55
Oithona oswaldocruzi	38.77	63.81	66.08	147.65	79.08	316.31
Oithona plumifera		1.23	1.81		0.76	3.05
Microsetella norvegica		2.45	2.75		1.30	5.19
Microsetella rosea	1.11	1.22	1.87	2.57	1.69	6.78
Macrosetella gracilis	2.40	1.23			0.91	3.63
Euterpina acutifrons	48.05	27.02	15.09	40.94	32.77	131.09
Longipedia spp.	2.40			2.65	1.26	5.05
Tigriopus spp.	2.40	2.46		11.31	4.04	16.16
Laophonte spp.	3.87	2.46			1.58	6.32
Metis spp.	4.99	3.68			2.17	8.67
Harparcticoida (others)	26.98	19.64	33.74	92.75	43.28	173.12
Oncaea venustra		2.45	1.93	1.80	1.54	6.18
Corycaeus speciosus	23.47	19.62	4.68	3.43	12.80	51.20
Corycaeus giesbrechti		4.91	5.67	41.02	12.90	51.60
Corycaeus spp.	18.65		2.75		5.35	21.40
Farranula gracilis	4.99	2.46	1.81	6.08	3.84	15.34
Caligus spp.	4.81	4.91	3.74		3.36	13.45
Caligus spp. (metanauplii)	6.28	1.23		3.51	2.76	11.02
Asterocheres spp.	2.40		1.00		0.85	3.40
Parasite Copepods (others)	7.03	4.91	1.81	2.65	4.10	16.40
Monstrilla spp.	4.99			2.65	1.91	7.65
Monstrillidae (others)	2.40	1.23		3.51	1.79	7.14
Copepoda (nauplii)	125.27	604.94	432.91	926.98	522.53	2090.10
Lepas spp. (nauplii)	4.98	4.91		5.22	3.78	15.11
Balanus spp. (nauplii)	7.22	22.09	4.62	9.59	10.88	43.52
Cypris (various)	4.99	1.22	1.00	3.51	2.68	10.73
Stomatopoda (pseudozoea)	2.40				0.60	2.40
Lucifer faxoni		4.91		1.71	1.65	6.62
Caridea (various)			1.81		0.45	1.81
Porcellanidae (zoea)		3.68			0.92	3.68
Brachyura (zoea)		4.91	1.81	50.87	14.40	57.59
Decapoda (megalopa - various)	6.10	2.46		6.08	3.66	14.64
Misidacea (various)		2.46	6.61	19.10	7.04	28.17
Cumacea (various)	16.07	7.36	1.93	10.53	8.97	35.90
Amphipoda (various)	29.37	1.22	3.80	27.06	15.36	61.46
Epicaridae (Manca larvae)	21.98	11.06	3.80	15.67	13.13	52.51
Isopoda (adults)	22.35	1.23	1.00	18.33	10.73	42.90

	LT-N	HT-N	LT-D	HT-D	MEAN	TOTAL
Membranipora spp. (Cyphonaute larvae)	4.81				1.20	4.81
Ascidiidae (larvae)	3.69	1.22		3.51	2.11	8.43
Oikopleura dioica	16.08	46.67	8.48	15.76	21.75	87.00
Pluteus larvae	3.69	2.46			1.54	6.15
Sagitta tenuis	4.99	4.91	1.81	13.19	6.22	24.90
Fish eggs		4.91	3.80		2.18	8.71
Fish larvae	3.88		2.75		1.66	6.63
TOTAL	**1444.32**	**2645.07**	**1311.52**	**3211.38**	**2153.07**	**8612.29**

Table A19: Zooplankton density (org.m^{-3}) at the station R1 (Summer: 17-19/01/01; LT = low tide; HT = high tide; N = nocturnal; D = diurnal).

	LT-N	HT-N	LT-D	HT-D	MEAN	TOTAL
Textulariidae (others)	5.68	32.99	3.63	12.62	13.73	54.92
Quinqueloculinidae (various)		11.40	4.61	6.56	5.64	22.57
Tretomphalus bulloides		3.00	1.90	12.62	4.38	17.52
Remaneica spp.		5.40	3.63	2.78	2.95	11.80
Trochamminidae (others)	14.09	58.18	16.93	43.42	33.16	132.62
Foraminiferida (others)	126.08	75.55	35.05	58.83	73.88	295.51
Tintinnopsis aperta	2.40			3.28	1.42	5.68
Tintinnopsis tocantinensis	20.37	29.98	12.15	8.84	17.84	71.34
Tintinnopsis nordqvisti	34.14	121.20	18.99	36.86	52.80	211.19
Tintinnopsis baltica			3.34	3.28	1.65	6.62
Tintinnopsis parvula	3.28	3.00	3.17	2.78	3.06	12.23
Tintinnopsis beroidea	2.40	5.40		3.28	2.77	11.08
Codonellopsis morchella f. *typica*	27.85	28.20	11.74	18.18	21.49	85.97
Codonellopsis morchella f. *schabi*	11.97	8.40	5.52	12.12	9.50	38.01
Codonellopsis pusilla		2.39		3.28	1.42	5.67
Codonellopsis ostenfeldi	5.40	11.40	6.51	8.84	8.04	32.15
Undella hyalina		3.00	1.90	3.28	2.05	8.18
Favella ehrenbergii	23.05	126.55	30.23	75.23	63.77	255.06
Favella ehrenbergii f. *coxliella*	2.40	2.39		2.78	1.89	7.57
Acanthostomella norvegica		2.39		3.28	1.42	5.67
Hidromedusae (various)		3.00			0.75	3.00
Cubomedusae (various)			3.17		0.79	3.17
Nematoda (various)	46.43	24.59	15.37		21.60	86.38
Trichocerca spp.		6.01		3.28	2.32	9.29
Gastropoda (veliger)	11.69	17.41	8.40	12.62	12.53	50.12
Bivalvia (veliger)	17.65	40.21	32.12	18.18	27.04	108.16
Nereis spp. (adults)		3.00	3.63		1.66	6.63
Nereis spp. (Nectochaeta larvae)		3.00			0.75	3.00
Spionid (various)	5.40	11.40	6.51	3.28	6.65	26.59
Polychaeta (others)		7.79	1.44	3.28	3.13	12.51
Polychaeta (other larvae)	11.97	17.41	9.84	15.40	13.65	54.62
Asterope spp.		5.40		3.28	2.17	8.68
Parvocalanus crassirostris	52.07	380.31	154.04	198.44	196.21	784.86
Paracalanus nanus		3.00	3.63		1.66	6.63
Paracalanus indicus	17.65	10.79	13.76	15.40	14.40	57.60
Paracalanus parvus		3.00	1.44	3.28	1.93	7.73
Pareucalanus sewelli	5.40	8.40	5.35	3.28	5.61	22.44
Pseudodiaptomus acutus	20.65	45.00	10.30	12.62	22.14	88.57
Pseudodiaptomus richardi	5.68	13.80	3.34	6.06	7.22	28.87
Temora turbinata	3.00		3.34	2.78	2.28	9.12
Temora stylifera		6.01	1.90	6.56	3.62	14.47
Calanopia americana	6.28	3.00	5.23	9.34	5.97	23.86
Labidocera fluviatilis	2.40	8.40	6.79	12.62	7.55	30.22
Pontellidae (nauplii)			1.44		0.36	1.44
Acartia lilljeborgi	8.41	16.19	3.63		7.06	28.22
Oithona simplex	11.97		6.51		4.62	18.47
Oithona nana	120.91	60.62	24.01	15.90	55.36	221.45
Oithona hebes	276.73	195.53	114.21	199.45	196.48	785.92
Oithona oswaldocruzi	151.65	11.40	73.15	87.86	81.02	324.07
Oithona plumifera	5.68	5.40	6.51		4.40	17.58
Microsetella norvegica	2.40	5.40	5.07	12.62	6.37	25.49
Microsetella rosea	7.80	5.40	8.40	9.85	7.86	31.45
Macrosetella gracilis		3.00	8.23	6.06	4.32	17.30
Euterpina acutifrons	14.37		17.21	18.68	12.57	50.26
Tigriopus spp.		13.80			3.45	13.80
Laophonte spp.		6.01			1.50	6.01
Harparcticoida (others)	8.41		23.77	47.21	19.85	79.39
Oncaea venustra		11.40			2.85	11.40
Corycaeus speciosus		19.80	6.51	8.84	8.79	35.14
Corycaeus giesbrechti	5.68	6.01	9.96	5.56	6.80	27.21
Corycaeus spp.		3.00	6.96	9.85	4.95	19.81
Caligus spp.	11.97	13.80	8.23	12.12	11.53	46.12
Caligus spp. (metanauplii)	3.28	5.40		18.18	6.71	26.86
Parasite Copepods (others)		13.80	6.96	14.90	8.91	35.65
Monstrilla spp.				3.28	0.82	3.28
Copepoda (nauplii)	923.87	1369.44	496.23	1568.85	1089.60	4358.39
Balanus spp. (nauplii)	14.37	19.80	8.52	15.40	14.52	58.09
Lepas spp. (nauplii)	5.68	11.40	5.52	9.34	7.99	31.95
Cypris (various)		3.00		6.56	2.39	9.57
Stomatopoda (pseudozoea)				3.28	0.82	3.28
Paguridae (larvae - Glaucothoe stage)		5.40			1.35	5.40
Alpheidae (various)			3.63		0.91	3.63
Brachyura (zoea)		3.00			0.75	3.00

	LT-N	HT-N	LT-D	HT-D	MEAN	TOTAL
Misidacea (various)		17.41		18.18	8.90	35.59
Cumacea (various)		25.81	10.59	41.15	19.39	77.55
Amphipoda (various)	9.29	16.19	6.51	15.40	11.85	47.38
Epicaridae (Manca larvae)	2.40	5.40	6.96	6.06	5.20	20.82
Isopoda (adults)	3.00	7.79	5.35	6.06	5.55	22.21
Crustacea (protozoea - various)	5.40	3.00			2.10	8.41
Mambranipora spp. (Cyphonaute larvae)	3.00				0.75	3.00
Ascidiidae (larvae)		3.00			0.75	3.00
Oikopleura dioica	2.40	31.81	16.64	30.80	20.41	81.65
Pluteus larvae		6.01	3.17	2.78	2.99	11.95
Sagitta tenuis		3.00			0.75	3.00
Fish eggs	11.97	14.41	9.84	18.18	13.60	54.39
Fish larvae		11.91		9.18	5.27	21.09
TOTAL	**2096.06**	**3105.48**	**1352.58**	**2873.44**	**2356.89**	**9427.56**

Table A20: Zooplankton density (org.m^{-3}) at the station R2 (Winter: 10-12/07/00; LT = low tide; HT = high tide; N = nocturnal; D = diurnal).

	LT-N	HT-N	LT-D	HT-D	MEAN	TOTAL
Textulariidae (others)	15.89	62.21		9.29	21.85	87.39
Quinqueloculinidae (various)	31.14	54.53		25.30	27.74	110.97
Tretomphalus bulloides	6.99		5.04	5.95	4.49	17.98
Remaneica spp.	8.87	1.44	5.37	2.44	4.53	18.13
Trochamminidae (others)	34.45	102.07	24.10	11.82	43.11	172.44
Foraminiferida (others)	54.64	116.04	44.15	23.94	59.69	238.77
Tintinnopsis aperta	5.92	27.91	3.81	35.06	18.18	72.71
Tintinnopsis tocantinensis	8.86	61.28	37.20	9.12	29.11	116.46
Tintinnopsis nordqvisti	55.42	116.51	68.01	32.75	68.17	272.70
Tintinnopsis baltica	4.92				1.23	4.92
Tintinnopsis parvula	3.13			1.54	1.17	4.68
Tintinnopsis beroidea		17.85	5.04	2.61	6.37	25.50
Codonellopsis morchella f. *typica*	54.92	52.65	107.16	65.90	70.16	280.63
Codonellopsis morchella f. *schabi*	18.71	10.36	42.50	14.43	21.50	86.00
Codonellopsis pusilla	5.92		8.16		3.52	14.08
Codonellopsis ostenfeldi		8.93		6.77	3.92	15.69
Eutintinnus medius	5.92	2.57	1.03		2.38	9.51
Undella hyalina	4.92	6.05	1.56	3.25	3.95	15.79
Favella ehrenbergii	83.12	246.61	68.25	226.16	156.04	624.14
Favella ehrenbergii f. *coxliella*	7.92	7.49	1.22	3.25	4.97	19.89
Acanthostomella norvegica	6.91			2.44	2.34	9.35
Hidromedusae (various)	5.06	5.44	2.79	5.69	4.75	18.98
Cubomedusae (various)	1.07				0.27	1.07
Scyphomedusae (Ephyra - larvae)	1.07				0.27	1.07
Nematoda (various)	36.97	5.44	28.25	14.90	21.39	85.56
Brachionus plicatilis	9.85	22.59	2.25		8.67	34.69
Brachionus palutus	1.07		2.59		0.91	3.66
Platyias quadricornis			3.28		0.82	3.28
Trichocerca spp.		36.35	13.53		12.47	49.89
Lecane bulla	1.07		1.56		0.66	2.63
Synchaeta spp.	4.92		2.79		1.93	7.71
Kinorhynca (various)			1.22		0.31	1.22
Gastropoda (veliger)	40.26	12.32	7.09	36.86	24.13	96.53
Bivalvia (veliger)	15.79	11.71	9.19	15.97	13.16	52.65
Nereis spp. (adults)	3.13		1.22		1.09	4.36
Nereis spp. (Nectochaeta larvae)		4.00			1.00	4.00
Spionid (various)	2.06	4.00	2.05	3.25	2.84	11.38
Polychaeta (others)		8.01	9.19	7.49	6.17	24.69
Polychaeta (other larvae)	2.94	5.44	7.43	17.94	8.44	33.75
Asterope spp.			2.25		0.56	2.25
Parvocalanus crassirostris	69.80	186.18	16.29	93.56	91.46	365.82
Paracalanus nanus	2.06		2.25		1.08	4.32
Paracalanus indicus	4.92	13.66	5.37	19.87	10.96	43.82
Paracalanus parvus	3.93	17.85	1.22	9.12	8.03	32.13
Pareucalanus sewelli	2.06	1.13	5.37	3.25	2.96	11.82
Pseudodiaptomus acutus	62.85	14.68	23.41	17.60	29.63	118.54
Pseudodiaptomus richardi	43.39	20.73	25.52	29.33	29.74	118.97
Temora turbinata	13.80	4.00		9.29	6.77	27.09
Temora stylifera		5.13	55.88	13.62	18.66	74.63
Calanopia americana	6.93	5.44	8.12	21.41	10.47	41.90
Labidocera fluviatilis	14.91	5.13	5.04	10.92	9.00	36.00
Pontellidae (nauplii)	2.06				0.52	2.06
Acartia lilljeborgi	21.16	14.68	15.74	10.02	15.40	61.60
Oithona simplex		14.27		16.96	7.81	31.23
Oithona nana	38.71	80.27	20.73	103.36	60.77	243.07
Oithona hebes	144.57	343.50	71.54	129.26	172.22	688.88
Oithona oswaldocruzi	40.85	144.73	48.13	83.88	79.40	317.59
Oithona plumifera		5.44			1.36	5.44
Microsetella norvegica		5.44	2.25	2.44	2.53	10.13
Microsetella rosea	1.87		2.59	5.69	2.54	10.15
Macrosetella gracilis	2.06	5.13			1.80	7.20
Euterpina acutifrons	33.30	17.55	7.29	45.60	25.94	103.74
Longipedia spp.			1.56		0.39	1.56
Tigriopus spp.	3.06	2.57	2.25		1.97	7.88
Metis spp.			1.03		0.26	1.03
Harparcticoida (others)	7.80	29.78	19.91	25.56	20.76	83.05
Oncaea venustra			3.81	2.44	1.56	6.25
Corycaeus speciosus	3.93	1.44	3.47	7.41	4.06	16.25
Corycaeus giesbrechti	4.07	10.36	4.84	45.43	16.17	64.70
Corycaeus spp.		12.84	2.25		3.77	15.09
Farranula gracilis	4.01	5.13	2.25		2.85	11.39
Caligus spp.	5.86	6.57	5.04	11.90	7.34	29.37
Caligus spp. (metanauplii)	4.07	2.57	2.25	2.61	2.87	11.50
Asterocheres spp.	2.06		1.03		0.77	3.09
Parasite Copepods (others)	5.00	5.44		2.61	3.26	13.06
Monstrilla spp.		4.00	1.22		1.31	5.23
Monstrillidae (others)	1.07	1.44			0.63	2.51
Copepoda (nauplii)	363.61	1176.42	185.12	1317.21	760.59	3042.36
Lepas spp. (nauplii)		2.57		5.69	2.07	8.26

	LT-N	HT-N	LT-D	HT-D	MEAN	TOTAL
Balanus spp. (nauplii)	8.86	10.36	5.04	5.05	7.33	29.31
Cypris (various)		4.31		5.69	2.50	10.01
Stomatopoda (pseudozoea)	1.07			1.54	0.65	2.61
Lucifer faxoni	3.93		2.25	10.10	4.07	16.29
Brachyura (zoea)	4.07	17.46		11.65	8.29	33.17
Decapoda (megalopa - various)	3.93	6.88		4.15	3.74	14.96
Misidacea (various)	11.91	12.01	1.03	5.69	7.66	30.65
Cumacea (various)	5.00	32.04	6.40	5.69	12.28	49.14
Amphipoda (various)	6.85	62.13	7.43	25.18	25.40	101.59
Epicaridae (Manca larvae)	3.93	18.59	8.65	10.02	10.30	41.19
Isopoda (adults)	4.07	60.90	1.22	9.85	19.01	76.03
Crustacea (protozoea - various)	1.93	2.57		1.54	1.51	6.04
Membranipora spp. (Cyphonaute larvae)	1.07	2.57		1.54	1.29	5.18
Ascidiidaee (larvae)	2.94	1.44	1.22		1.40	5.60
Oikopleura dioica	46.68	14.68	6.40	24.10	22.97	91.86
Pluteus larvae	9.99		2.25	5.69	4.48	17.93
Sagitta tenuis	11.00	4.00	5.87	19.95	10.21	40.82
Fish eggs				2.61	0.65	2.61
Fish larvae	3.99		6.06	7.66	4.43	17.72
TOTAL	**1588.86**	**3425.85**	**1125.92**	**2787.91**	**2232.13**	**8928.54**

Table A21: Zooplankton density (org.m^{-3}) at the station R2 (Summer: 17-19/01/01; LT = low tide; HT = high tide; N = nocturnal; D = diurnal).

	LT-N	HT-N	LT-D	HT-D	MEAN	TOTAL
Textularia candeiana		5.58			1.39	5.58
Textulariidae (others)	8.12	11.58	9.68	7.38	9.19	36.75
Quinqueloculinidae (various)	10.58	3.00	9.68	28.40	12.91	51.66
Tretomphalus bulloides		2.57	2.81		1.35	5.39
Trochomminidae (others)	41.72	22.31	21.28	33.49	29.70	118.80
Foraminiferida (others)	98.04	74.65	29.72	41.99	61.10	244.40
Tintinnopsis aperta	6.73	11.58	2.15	7.55	7.00	28.01
Tintinnopsis tocantinensis	14.07	105.96	16.78	60.31	49.28	197.12
Tintinnopsis nordqvisti	67.14	196.05	106.23	68.03	109.36	437.46
Tintinnopsis baltica		2.57			0.64	2.57
Tintinnopsis parvula		9.01			2.25	9.01
Tintinnopsis beroidea		2.57			0.64	2.57
Codonellopsis morchella f. *typica*	73.52	34.32	112.26	67.21	71.83	287.31
Codonellopsis morchella f.*schabi*	8.84	8.15	26.91	13.17	14.27	57.08
Codonellopsis pusilla	2.89		4.96	4.97	3.20	12.82
Codonellopsis ostenfeldi	24.65	20.16	35.92	28.75	27.37	109.48
Undella hyalina	1.50			2.81	1.08	4.31
Favella ehrenbergii	41.77	137.28	97.08	110.91	96.76	387.04
Favella ehrenbergii f. *coxliella*	2.89		16.78	4.97	6.16	24.64
Acanthostomella norvegica	4.27	2.57			1.71	6.84
Hidromedusae (various)	4.39		4.96		2.34	9.34
Cubomedusae (various)				5.39	1.35	5.39
Scyphomedusae (Ephyra - larvae)	1.38				0.35	1.38
Nematoda (various)	4.27	17.16	24.31	15.16	15.23	60.90
Brachionus plicatilis	47.18	177.18	69.12	67.69	90.29	361.17
Lecane bulla		76.36			19.09	76.36
Trichocerca spp.	54.76	78.94	34.23	92.04	64.99	259.97
Kinorhynca (various)			2.36		0.59	2.36
Gastropoda (veliger)	16.11	96.95	28.60	20.79	40.61	162.46
Bivalvia (veliger)	52.71	54.05	69.48	86.76	65.75	263.01
Nereis spp. (Nectochaeta larvae)			2.15		0.54	2.15
Spionid (various)	1.50	2.57	5.17		2.31	9.25
Polychaeta (others)		9.01			2.25	9.01
Polychaeta (other larvae)	15.27	8.58	10.13	15.16	12.29	49.14
Parvocalanus crassirostris	95.99	293.44	115.87	187.06	173.09	692.36
Paracalanus nanus		2.57			0.64	2.57
Paracalanus indicus	8.23	9.01	19.59	49.13	21.49	85.96
Paracalanus parvus			4.96	5.39	2.59	10.34
Pareucalanus sewelli			2.81	2.57	1.35	5.39
Pseudodiaptomus acutus	36.19	63.06	55.97	62.54	54.44	217.76
Pseudodiaptomus richardi	8.23	26.17	16.99	30.91	20.58	82.31
Temora turbinata	4.39	5.15	14.85	4.97	7.34	29.36
Temora stylifera	8.23	3.00	10.13	7.61	7.24	28.98
Calanopia americana	2.89	5.58	12.04	5.21	6.43	25.71
Labidocera fluviatilis	5.23		22.17	10.19	9.40	37.58
Pontellidae (nauplii)	1.50		4.96		1.61	6.46
Acartia lilljeborgi	1.50	21.88		2.40	6.45	25.78
Oithona simplex	2.89	2.57	2.81		2.07	8.27
Oithona nana	33.84	88.80	38.52	13.17	43.58	174.34
Oithona hebes	162.53	272.84	153.83	338.49	231.92	927.70
Oithona oswaldocruzi	107.49	170.31	52.34	224.46	138.65	554.60
Oithona plumifera		5.58	2.36	4.97	3.23	12.91
Microsetella norvegica	1.50	5.58		10.19	4.32	17.27
Microsetella rosea		9.01		7.55	4.14	16.56
Macrosetella gracilis				5.21	1.30	5.21
Euterpina acutifrons	17.73	48.48	7.32	17.98	22.88	91.50
Longipedia spp.			2.15		0.54	2.15
Tigriopus spp.	6.73	14.59			5.33	21.32
Metis spp.	1.50				0.38	1.50
Harparcticoida (others)	26.39	92.66	9.68	54.69	45.85	183.41
Oncaea venustra			2.15		0.54	2.15
Corycaeus speciosus			18.92		4.73	18.92
Corycaeus giesbrechti		2.57	12.04		3.65	14.61
Corycaeus spp.	2.89	9.01	16.33	15.16	10.85	43.38
Caligus spp.	3.85	11.58		5.39	5.20	20.82

	LT-N	HT-N	LT-D	HT-D	MEAN	TOTAL
Caligus spp. (metanauplii)			2.81	7.61	2.61	10.43
Parasite Copepods (others)				2.57	0.64	2.57
Monstrillidae (others)		5.58			1.39	5.58
Copepoda (others nauplii)	736.32	936.94	490.48	1640.62	951.09	3804.35
Lepas spp. (nauplii)				2.40	0.60	2.40
Balanus spp. (nauplii)	4.39	5.58		5.21	3.79	15.18
Lucifer faxoni	1.50			2.40	0.98	3.90
Decapoda (megalopa - various)	6.73				1.68	6.73
Misidacea (various)	6.73	20.16		4.97	7.97	31.87
Cumacea (various)	12.50	34.75	15.30	17.80	20.09	80.36
Amphipoda (various)	8.23	11.58	7.32		6.78	27.13
Epicaridae (Manca larvae)	1.50	17.59		10.19	7.32	29.28
Isopoda (adults)	6.73	11.58	14.18		8.12	32.50
Crustacea (protozoea - various)	2.89	2.57		2.40	1.96	7.86
Membranipora spp. (Cyphonaute larvae)	1.50				0.38	1.50
Ascidiidae (larvae)	1.50	2.57		2.40	1.62	6.48
Oikopleura dioica	13.58	28.74	6.86	14.40	15.90	63.59
Pluteus larvae	2.89		2.36	2.40	1.91	7.65
Sagitta tenuis	1.50				0.38	1.50
Fish eggs	5.23	11.15		4.97	5.34	21.36
Fish larvae	1.50			4.97	1.62	6.48
TOTAL	**1959.22**	**3422.99**	**1880.84**	**3573.52**	**2709.14**	**10836.58**

Table A22: Zooplankton density (org.m^{-3}) at the station R3 (Winter: 10-12/07/00; LT = low tide; HT = high tide; N = nocturnal; D = diurnal).

	LT-N	HT-N	LT-D	HT-D	MEAN	TOTAL
Textularia candeiana	20.89	25.83	20.30	24.74	22.94	91.77
Quinqueloculinidae (various)	18.83	46.24	15.36	42.74	30.79	123.17
Tretomphalus bulloides	7.53	6.34	10.68	5.74	7.57	30.28
Remaneica spp.	19.53		4.77	1.47	6.44	25.76
Trochamminidae (others)	55.66	20.72	79.73	19.00	43.78	175.12
Foraminiferida (others)	29.46	108.06	31.48	100.03	67.26	269.04
Tintinnopsis aperta	14.90	45.90	17.05	42.08	29.98	119.93
Tintinnopsis tocantinensis	38.72	27.23	50.80	24.84	35.40	141.58
Tintinnopsis nordqvisti	79.84	105.49	102.88	97.52	96.43	385.73
Tintinnopsis baltica	2.05	1.54	3.34		1.73	6.93
Tintinnopsis parvula	2.05	1.54	1.43		1.25	5.02
Tintinnopsis beroidea	2.05	3.08	3.34	2.70	2.79	11.18
Codonellopsis morchella f. *typica*	129.57	77.59	153.06	75.07	108.82	435.28
Codonellopsis morchella f. *schabi*	12.84	8.05	25.27	7.53	13.42	53.70
Codonellopsis pusilla	3.25	4.62	6.48		3.59	14.36
Codonellopsis ostenfeldi	9.93	14.39	18.90	17.33	15.14	60.55
Eutintinnus medius	7.02		15.93		5.74	22.95
Undella hyalina		1.54	3.25		1.20	4.79
Favella ehrenbergii	169.96	173.83	140.39	142.99	156.79	627.17
Favella ehrenbergii f. *coxliella*		6.34			1.58	6.34
Acanthostomella norvegica	4.62	1.54	7.62		3.45	13.79
Hidromedusae (various)		1.54		1.47	0.75	3.01
Cubomedusae (various)		4.62			1.16	4.62
Scyphomedusae (Ephyra - larvae)			1.43		0.36	1.43
Nematoda (various)	107.87	91.80	253.88	76.54	132.52	530.09
Rotaria spp.	2.05		3.14		1.30	5.20
Brachionus plicatilis	88.23	39.56	126.80	36.58	72.79	291.18
Brachionus palutus	2.05	11.13	1.43	8.44	5.76	23.05
Platyias quadricornis		3.08			0.77	3.08
Trichocerca spp.	6.17	6.34	9.73	8.44	7.67	30.67
Lecane bulla	2.05	3.25	1.63	1.80	2.18	8.73
Synchaeta spp.	3.77	3.08	4.57	1.47	3.22	12.89
Kinorhynca (various)		1.54		1.47	0.75	3.01
Gastropoda (veliger)	9.08	14.21	28.41	6.30	14.50	58.00
Bivalvia (veliger)	24.66	6.34	32.98	3.27	16.81	67.24
Nereis spp. (adults)	2.05		4.77		1.70	6.82
Nereis spp. (Nectochaeta larvae)	2.05	3.25	4.57	1.47	2.84	11.35
Spionid (various)	3.77		19.33		5.77	23.10
Polychaeta (others)	11.13	6.34	21.93	5.74	11.28	45.13
Polychaeta (other larvae)	16.10		26.41	6.30	12.20	48.81
Polychaeta (eggs)		1.54	1.63		0.79	3.17
Asterope spp.	1.20	1.54	3.05		1.45	5.80
Parvocalanus crassirostris	**52.64**	**62.86**	**97.75**	**95.16**	**77.10**	**308.41**
Paracalanus nanus		3.08	1.63	1.23	1.49	5.94
Paracalanus indicus	7.02	11.13	9.25	10.00	9.35	37.41
Paracalanus parvus	7.02	6.34	7.54	5.74	6.66	26.63
Pareucalanus sewelli		6.34	1.63		1.99	7.96
Pseudodiaptomus acutus	18.16	33.74	19.35	12.94	21.05	84.20
Pseudodiaptomus richardi	8.40	4.62	6.59	3.94	5.89	23.55
Temora turbinata	2.40	6.34		3.94	3.17	12.67
Temora stylifera		3.25	3.34	1.47	2.02	8.06
Calanopia americana	11.48			3.27	3.69	14.74
Labidocera fluviatilis	14.84	9.59	17.05	1.23	10.68	42.72
Pontellidae (nauplii)	1.20				0.30	1.20
Acartia lilljeborgi	26.56	16.10	30.98		18.41	73.63
Oithona simplex		6.34		3.94	2.57	10.27
Oithona nana	133.73	69.19	143.82	20.46	91.80	367.20
Oithona hebes	145.74	195.07	181.44	182.37	176.15	704.61
Oithona oswaldocruzi	83.22	65.25	69.74	15.64	58.46	233.85
Oithona plumifera	1.20	1.54	1.43	2.70	1.72	6.87
Microsetella norvegica	3.26		3.05	3.94	2.56	10.25
Microsetella rosea	3.60				0.90	3.60
Macrosetella gracilis			3.05	1.80	1.21	4.85
Euterpina acutifrons	8.05	19.53	8.11	18.66	13.59	54.35
Longipedia spp.	2.40	1.54	1.63		1.39	5.57
Tigriopus spp.		1.54	1.43		0.74	2.97
Laophonte spp.		1.54			0.39	1.54
Harparcticoida (others)	19.69	64.90	25.72	45.31	38.91	155.63
Oncaea venustra		1.54	4.48		1.51	6.02
Corycaeus speciosus	14.73		18.67	2.70	9.03	36.11

	LT-N	HT-N	LT-D	HT-D	MEAN	TOTAL
Corycaeus giesbrechti	2.40	7.88	1.63	7.20	4.78	19.11
Corycaeus spp.		3.08	6.20		2.32	9.28
Farranula gracilis	2.05	3.25	3.14		2.11	8.45
Caligus spp.	2.91		6.20	2.70	2.95	11.81
Caligus spp. (metanauplii)	2.05	1.54	3.14	5.97	3.18	12.71
Asterocheres spp.				3.03	0.76	3.03
Parasite Copepods (others)			12.39	6.30	5.87	23.49
Monstrilla spp.				2.70	0.68	2.70
Monstrillidae (others)	2.05	1.71	3.14		1.73	6.91
Copepoda (nauplii)	449.68	1420.95	268.44	883.18	755.56	3022.25
Lepas spp. (nauplii)	2.91				0.73	2.91
Balanus spp. (nauplii)	2.05	4.80	3.14	9.57	4.89	19.56
Cypris (various)				3.27	0.82	3.27
Stomatopoda (pseudozoea)		1.54			0.39	1.54
Lucifer faxoni				1.47	0.37	1.47
Caridea (various)	6.51		6.39		3.23	12.90
Porcellanidae (zoea)	1.20	3.25			1.11	4.45
Brachyura (zoea)	7.71	19.01	6.48	13.27	11.62	46.47
Decapoda (megalopa – various)	1.20	1.54		2.70	1.36	5.44
Misidacea (various)		3.25		1.80	1.26	5.05
Cumacea (various)	3.25	11.13	4.77		4.79	19.15
Amphipoda (various)	11.99	16.10	18.78	1.47	12.09	48.34
Epicaridae (Manca larvae)	10.62	8.05	12.87	6.30	9.46	37.84
Isopoda (adults)	4.96	9.42	7.62		5.50	22.01
Membranipora spp. (Cyphonaute larvae)	1.20				0.30	1.20
Ascidiidae (larvae)		1.54	1.43	1.47	1.11	4.44
Oikopleura dioica	5.31	17.64	6.39	12.94	10.57	42.28
Pluteus larvae	1.20	4.80	1.63	4.50	3.03	12.12
Sagitta tenuis		4.80	1.43	1.23	1.86	7.46
Fish eggs			1.63		0.41	1.63
Fish larvae	4.11		3.14	1.23	2.12	8.48
TOTAL	**2001.69**	**3020.49**	**2295.38**	**2171.81**	**2372.34**	**9489.37**

Table A23: Zooplankton density (org-m^{-3}) at the station R3 (Summer: 17-19/01/01; LT = low tide; HT = high tide; N = nocturnal; D = diurnal).

	LT-N	HT-N	LT-D	HT-D	MEAN	TOTAL
Textulariidae (others)	4.29	9.47	9.74	10.57	8.52	34.07
Quinqueloculinidae (various)	6.86	9.47	8.64	2.77	6.93	27.74
Tretomphalus bulloides	2.23	2.40	1.71	5.77	3.03	12.12
Trochamminidae (others)	10.97	4.91	4.12	18.74	9.68	38.74
Spirillinidae (various)	4.46				1.11	4.46
Foraminiferida (others)	58.98	47.82	41.98	121.85	67.66	270.64
Tintinnopsis aperta		9.47	9.74	12.97	8.05	32.18
Tintinnopsis tocantinensis	9.09	157.32	30.80	46.73	60.98	243.94
Tintinnopsis nordqvisti	13.55	158.66	55.01	124.61	87.96	351.84
Tintinnopsis baltica	2.23	5.14			1.84	7.37
Tintinnopsis parvula		6.96			1.74	6.96
Tintinnopsis beroidea		2.74		2.77	1.38	5.51
Codonellopsis morchella f. *typica*	19.72	83.49	49.11	39.06	47.85	191.38
Codonellopsis morchella f. *schabi*	6.52	7.31	8.64	5.77	7.06	28.24
Codonellopsis pusilla		5.14			1.29	5.14
Codonellopsis ostenfeldi	9.09	15.19	8.64	10.94	10.97	43.86
Favella ehrenbergii	8.74	129.18	67.02	136.38	85.33	341.32
Favella ehrenbergii f. *coxliella*		5.14	1.71		1.71	6.86
Acanthostomella norvegica		5.14			1.29	5.14
Hidromedusae (various)		2.40		5.17	1.89	7.57
Nematoda (various)	174.73	68.40	125.05	89.05	114.31	457.23
Rotaria spp.	84.88			38.32	30.80	123.20
Brachionus plicatilis	143.18	66.00	149.81	126.28	121.32	485.26
Trichocerca spp.	33.26	66.92	120.46	145.79	91.61	366.43
Lecane bulla		46.00			11.50	46.00
Synchaeta spp.			93.56		23.39	93.56
Kinorhynca (various)	4.46	2.40			1.71	6.86
Gastropoda (veliger)	28.46	21.58	23.60	19.35	23.25	92.98
Bivalvia (veliger)	42.52	49.46	55.01	57.44	51.11	204.43
Nereis spp. (Nectochaeta larvae)	2.23			2.77	1.25	5.00
Spionid (various)	6.34		9.74		4.02	16.09
Polychaeta (other larvae)	13.72	14.27	6.93	11.17	11.52	46.09
Polychaeta (eggs)	2.23	2.40			1.16	4.63
Parvocalanus crassirostris	17.83	194.17	30.45	82.88	81.33	325.33
Paracalanus nanus	6.52			2.77	2.32	9.28
Paracalanus indicus	33.78	32.08	28.74	30.15	31.19	124.75
Paracalanus parvus	2.23	2.40			1.16	4.63
Pareucalanus sewelli	2.23	2.40	4.12		2.19	8.74
Pseudodiaptomus acutus	33.78	37.77	27.92	46.39	36.47	145.86
Pseudodiaptomus richardi	15.60	14.27	14.27	21.64	16.45	65.79
Temora turbinata	4.29	9.71	4.53	2.77	5.32	21.29
Temora stylifera	6.86	2.40	5.83	10.34	6.36	25.43
Calanopia americana	10.97	4.56	6.93	7.57	7.51	30.03
Labidocera fluviatilis		6.73	8.64	13.71	7.27	29.08
Pontellidae (nauplii)	2.23		4.53	2.40	2.29	9.16
Acartia lilljeborgi		2.40	1.71	2.77	1.72	6.88
Oithona simplex				7.57	1.89	7.57
Oithona nana	77.16	163.57	101.59	101.79	111.03	444.11
Oithona hebes	255.14	241.44	309.23	284.79	272.65	1090.60
Oithona oswaldocruzi	131.69	92.14	171.90	208.34	151.02	604.07
Oithona plumifera	4.29	4.56	1.71	8.17	4.68	18.74
Microsetella norvegica			6.24		1.56	6.24
Macrosetella gracilis	2.40	11.87			3.57	14.27
Euterpina acutifrons	18.00	35.85	27.03	52.27	33.29	133.15
Longipedia spp.			1.71		0.43	1.71
Tigriopus spp.	4.63	2.40	4.12		2.79	11.15

	LT-N	HT-N	LT-D	HT-D	MEAN	TOTAL
Laophonte spp.		2.16			0.54	2.16
Harparcticoida (others)	30.69	31.18	27.03	12.74	25.41	101.64
Oncaea venustra	4.29	2.16	5.21		2.92	11.66
Corycaeus speciosus	24.69	6.73	8.64		10.02	40.06
Corycaeus giesbrechti	13.20	9.71	6.24		7.29	29.15
Corycaeus spp.		2.40	4.12	7.94	3.61	14.45
Farranula gracilis		4.56	6.93		2.87	11.49
Caligus spp.	4.46		14.27	7.94	6.67	26.66
Caligus spp. (metanauplii)				5.17	1.29	5.17
Asterocheres spp.				2.77	0.69	2.77
Parasite Copepods (others)				15.74	3.94	15.74
Copepoda (nauplii)	975.14	1539.77	1064.05	1497.04	1269.00	5076.00
Lepas spp. (nauplii)	4.63	2.16	4.12	2.77	3.42	13.68
Balanus spp. (nauplii)	4.29	4.56	9.33	11.17	7.34	29.35
Cypris (various)		2.40			0.60	2.40
Lucifer faxoni				5.77	1.44	5.77
Brachyura (zoea)		4.56	1.71		1.57	6.28
Decapoda (megalopa - various)	4.29				1.07	4.29
Misidacea (various)	15.78	9.47	10.36	15.74	12.84	51.34
Cumacea (various)	19.72	30.70	14.47	29.45	23.59	94.34
Amphipoda (various)	13.72	33.34	26.34	13.34	21.69	86.74
Epicaridae (Manca larvae)	4.46	4.56	10.36	10.57	7.49	29.95
Isopoda (adults)	11.32	18.83	12.76		10.73	42.91
Crustacea (protozoea - various)				5.17	1.29	5.17
Mambranipora spp. (Cyphonaute larvae)	2.23				0.56	2.23
Ascidiidae (larvae)	2.06	2.40	1.71	5.17	2.84	11.34
Oikopleura dioica	32.58	28.65	23.94	30.29	28.86	115.45
Pluteus larvae	4.29	5.14	4.12		3.39	13.55
Sagitta tenuis		2.40	1.71		1.03	4.12
Fish eggs	8.92	9.71	8.64	8.17	8.86	35.44
Fish larvae	4.63	7.31	1.71	7.94	5.40	21.59
TOTAL	**2507.72**	**3630.41**	**2910.02**	**3615.45**	**3165.90**	**12663.59**

Table A24: Zooplankton density (org.m^{-3}) at the station R4 (Winter: 10-12/07/00; LT = low tide; HT = high tide; N = nocturnal; D = diurnal).

	LT-N	HT-N	LT-D	HT-D	MEAN	TOTAL
Textulariidae (others)	34.24	31.93	33.26	28.01	31.86	127.43
Quinqueloculinidae (various)	32.18	39.40	39.09	42.88	38.39	153.54
Tretomphalus bulloides	11.84	6.48	122.82	9.26	37.60	150.40
Remaneica spp.	4.59	12.88	33.06	8.97	14.88	59.50
Trochamminidae (others)	19.03	17.12	30.86	21.06	22.02	88.08
Foraminiferida (others)	186.04	386.93	193.70	428.17	298.71	1194.84
Tintinnopsis aperta	12.77	3.47	11.95	4.80	8.25	32.99
Tintinnopsis tocantinensis	105.35	26.22	74.41	39.18	61.29	245.16
Tintinnopsis nordqvisti	146.48	58.08	184.39	91.95	120.22	480.90
Tintinnopsis baltica	4.59				1.15	4.59
Tintinnopsis parvula	2.67		1.42		1.02	4.09
Tintinnopsis beroidea	4.59	5.01	16.83	7.18	8.40	33.61
Codonellopsis morchella f. *typica*	52.54	115.15	96.02	92.18	88.97	355.89
Codonellopsis morchella f. *schabi*	9.65	57.77	21.64	11.69	25.19	100.74
Codonellopsis pusilla	3.13		7.10	4.80	3.76	15.03
Codonellopsis ostenfeldi	16.18	17.19	16.01	23.44	18.21	72.82
Eutintinnus medius	18.33		16.23		8.64	34.57
Undella hyalina			3.14		0.78	3.14
Favella ehrenbergii	178.47	236.89	200.01	309.42	231.20	924.79
Favella ehrenbergii f.*coxliella*	2.67			2.43	1.27	5.10
Acanthostomella norvegica	4.59		18.84		5.86	23.43
Hidromedusae (various)	1.20	1.54	1.71	2.37	1.71	6.83
Nematoda (various)	40.77	145.51	114.42	213.25	128.49	513.95
Rotaria spp.	27.08	3.47	22.66	4.80	14.50	58.01
Brachionus plicatilis	122.35	95.33	114.24	131.07	115.75	463.00
Brachionus palutus	2.67	33.93		46.53	20.78	83.12
Platyias quadricornis	42.27	15.19	38.45	20.72	29.16	116.64
Trichocerca spp.		13.65	29.04	18.34	15.26	61.04
Lecane bulla	23.67	5.32	22.51	6.94	14.61	58.44
Synchaeta spp.	17.92	9.49	18.01	13.71	14.78	59.13
Kinorhynca (various)			5.83	2.43	2.07	8.26
Gastropoda (veliger)	19.10	77.51	17.57	45.14	39.83	159.32
Bivalvia (veliger)	24.48	17.96	21.64	25.69	22.44	89.78
Nereis spp. (adults)	6.52		5.83	2.43	3.70	14.78
Nereis spp. (Nectochaeta larvae)	5.79	3.47	6.20	4.80	5.06	20.26
Spionid (various)			8.68	6.94	3.91	15.62
Polychaeta (others)	31.70	13.34	31.46	16.20	23.18	92.71
Polychaeta (other larvae)	36.00	7.95	31.92	11.34	21.80	87.20
Polychaeta (eggs)		1.93			0.48	1.93
Asterope spp.			1.35		0.34	1.35
Parvocalanus crassirostris	12.31	15.27	22.51	9.26	14.84	59.35
Paracalanus nanus			2.85		0.71	2.85
Paracalanus indicus	5.06	6.48	6.56	9.26	6.84	27.36
Paracalanus parvus			17.37	6.89	6.06	24.26
Pareucalanus sewelli			1.71		0.43	1.71
Pseudodiaptomus acutus	9.93	7.87	10.76	11.05	9.90	39.61
Pseudodiaptomus richardi	22.47	4.94	20.80	6.89	13.77	55.09
Temora turbinata		1.47		2.08	0.89	3.55
Temora stylifera	1.20		1.71	2.37	1.32	5.28
Calanopia americana	1.20		1.71		0.73	2.91
Labidocera fluviatilis			6.12		1.53	6.12
Pontellidae (nauplii)			1.35		0.34	1.35

	LT-N	HT-N	LT-D	HT-D	MEAN	TOTAL
Acartia lilljeborgi	12.58		11.74	6.54	7.71	30.86
Oithona simplex			5.83		1.46	5.83
Oithona nana	30.47	6.40	25.07	8.97	17.73	70.91
Oithona hebes	144.58	112.93	147.36	78.93	120.95	483.81
Oithona oswaldocruzi	44.88	9.49	39.60	13.71	26.92	107.69
Microsetella norvegica			1.42		0.36	1.42
Microsetella rosea			1.71	4.51	1.56	6.23
Macrosetella gracilis		1.54	1.71	2.37	1.41	5.63
Euterpina acutifrons	24.15		21.97		11.53	46.13
Longipedia spp.		1.54	2.69	2.37	1.65	6.61
Harparcticoida (others)	10.66	51.51	15.94	62.90	35.25	141.01
Oncaea venustra			1.42		0.36	1.42
Corycaeus speciosus		4.55	1.71	6.83	3.27	13.09
Corycaeus giesbrechti	18.60	6.86	15.94	4.46	11.47	45.87
Corycaeus spp.			1.71	4.80	1.63	6.52
Farranula gracilis			8.60	2.08	2.67	10.68
Caligus spp.	1.47		1.42	4.51	1.85	7.41
Caligus spp. (metanauplii)	2.67		1.71	2.37	1.69	6.75
Asterocheres spp.		1.54			0.39	1.54
Parasite Copepods (others)		3.47	1.71	2.37	1.89	7.55
Monstrilla spp.				2.43	0.61	2.43
Copepoda (others nauplii)	205.62	518.24	288.64	998.29	502.70	2010.79
Lepas spp. (nauplii)			1.71		0.43	1.71
Balanus spp. (nauplii)	5.79	8.40	18.70	2.08	8.75	34.98
Cypris (various)	2.67		3.14		1.45	5.80
Lucifer faxoni		4.94		2.08	1.75	7.02
Porcellanidae (zoea)	1.20				0.30	1.20
Brachyura (zoea)			3.14		0.78	3.14
Misidacea (various)	4.59	18.28		4.80	6.92	27.67
Cumacea (various)	3.87	46.74			12.65	50.60
Amphipoda (various)		34.17	15.09	2.08	12.83	51.34
Epicaridae (Manca larvae)	2.67		3.14		1.45	5.80
Isopoda (adults)	1.20		1.71		0.73	2.91
Crustacea (protozoea - various)	1.47				0.37	1.47
Membranipora spp. (Cyphonaute larvae)	1.47		1.42		0.72	2.89
Ascidiidae (larvae)		1.54		2.37	0.98	3.91
Oikopleura dioica	4.59	29.23	14.43	4.51	13.19	52.77
Pluteus larvae	1.20	3.47		4.80	2.37	9.47
Sagitta tenuis	1.20	7.95		4.80	3.49	13.95
Fish eggs		6.48		7.18	3.41	13.65
Fish larvae		19.36		2.37	5.43	21.73
TOTAL	**1831.20**	**2394.76**	**2366.18**	**2991.52**	**2395.91**	**9583.65**

Table A25: Zooplankton density (org.m^{-3}) at the station R4 (Summer: 17-19/01/01; LT = low tide; HT = high tide; N = nocturnal; D = diurnal).

	LT-N	HT-N	LT-D	HT-D	MEAN	TOTAL
Textulariidae (others)	16.83	22.29	5.38	5.83	12.58	50.33
Quinqueloculinidae (various)	24.23	13.03	19.19	19.97	19.11	76.42
Tretomphalus bulloides	3.75	4.63		5.17	3.39	13.55
Trochamminidae (others)	46.21	95.16	46.38	30.67	54.61	218.42
Spirillinidae (various)			11.00	12.03	5.76	23.03
Foraminiferida (others)	38.06	97.57	21.75	148.28	76.41	305.66
Tintinnopsis aperta	3.75		5.38	8.97	4.52	18.09
Tintinnopsis tocantinensis	21.23	50.07	5.82	24.77	25.47	101.88
Tintinnopsis nordqvisti	68.73	130.49	146.47	132.07	119.44	477.75
Tintinnopsis baltica			3.00	3.43	1.61	6.44
Tintinnopsis beroidea			2.37	5.17	1.89	7.54
Codonellopsis morchella f. *typica*	34.74	93.28	60.95	39.57	57.13	228.54
Codonellopsis morchella f. *schabi*	14.90		3.00	18.23	9.03	36.14
Codonellopsis pusilla	9.76	8.74		9.26	6.94	27.77
Codonellopsis ostenfeldi	45.89	105.62	11.00	64.67	56.80	227.18
Undella hyalina			5.38		1.34	5.38
Favella ehrenbergii	164.48	143.00	132.99	197.99	159.62	638.46
Favella ehrenbergii f. *coxliella*	11.90	11.32	11.00	13.77	12.00	47.99
Acanthostomella norvegica	5.58	4.63		5.83	4.01	16.04
Hidromedusae (various)		2.23		2.77	1.25	5.00
Nematoda (various)	142.17	289.78	140.73	250.78	205.87	823.46
Rotaria spp.	11.90	8.74	11.00	8.60	10.06	40.25
Brachionus plicatilis	136.38	15.43	100.34	32.00	71.04	284.16
Brachionus palutus	53.39	13.20	18.75	14.43	24.94	99.78
Platyias quadricornis	49.21	8.92	24.12	11.37	23.41	93.62
Trichocerca spp.	154.27	33.26	37.06	26.83	62.86	251.42
Lecane bulla	39.88	8.92	5.38	7.94	15.53	62.11
Synchaeta spp.	19.83	15.26	27.76	11.37	18.55	74.22
Kinorhynca (various)	5.58	2.06			1.91	7.63
Gastropoda (veliger)	22.41	28.81	27.38	26.47	26.26	105.06
Bivalvia (veliger)	69.69	64.13	43.56	44.03	55.36	221.42
Nereis spp. (adults)		8.74			2.19	8.74
Nereis spp. (Nectochaeta larvae)		6.52			1.63	6.52
Spionid (various)	11.90	8.74	2.81	26.83	12.57	50.29
Polychaeta (others)	18.23		11.00	11.37	10.15	40.60
Polychaeta (other larvae)	20.48	15.43	13.56	8.60	14.52	58.08
Parvocalanus crassirostris	5.58	28.64	22.19	11.00	16.85	67.41
Paracalanus indicus		49.38	11.19	5.17	16.44	65.74
Paracalanus parvus		8.74			2.19	8.74
Pareucalanus sewelli	5.58				1.39	5.58
Pseudodiaptomus acutus	5.58	63.27	11.00	14.43	23.57	94.28
Pseudodiaptomus richardi		26.41		2.40	7.20	28.81

	LT-N	HT-N	LT-D	HT-D	MEAN	TOTAL
Temora turbinata		19.72		3.43	5.79	23.15
Temora stylifera	2.57	44.58		2.77	12.48	49.92
Calanopia americana	8.15		2.37		2.63	10.52
Labidocera fluviatilis	5.58		13.56		4.79	19.14
Pontellidae (nauplii)	3.00				0.75	3.00
Acartia lilljeborgi	2.57	2.23	11.00		3.95	15.80
Oithona nana	16.08	151.06	130.91	62.98	90.26	361.04
Oithona hebes	158.58	320.64	357.15	440.84	319.30	1277.21
Oithona oswaldocruzi	47.40	160.67	256.05	161.19	156.33	625.31
Microsetella norvegica	6.32		2.37		2.17	8.70
Microsetella rosea			2.81		0.70	2.81
Macrosetella gracilis			2.81		0.70	2.81
Euterpina acutifrons	36.56	6.69			10.81	43.25
Longipedia spp.	3.75		2.37		1.53	6.12
Harparcticoida (others)		6.69	20.01	35.04	15.43	61.73
Oncaea venustra	3.75				0.94	3.75
Corycaeus speciosus	8.58	4.63	2.37		3.90	15.58
Corycaeus giesbrechti	8.15	4.29			3.11	12.44
Corycaeus spp.	9.33	2.23	5.38		4.23	16.93
Farranula gracilis	10.50	4.29			3.70	14.79
Caligus spp.	8.90	6.69	11.00	5.17	7.94	31.76
Caligus spp. (metanauplii)	2.57	6.86	2.81	5.83	4.52	18.08
Asterocheres spp.		4.63			1.16	4.63
Parasite Copepods (others)	53.71	9.09			15.70	62.80
Copepoda (others nauplii)	581.51	1250.69	805.02	1435.16	1018.09	4072.38
Lepas spp. (nauplii)			2.37		0.59	2.37
Balanus spp. (nauplii)		8.74	2.81	2.40	3.49	13.96
Cypris (various)			3.00		0.75	3.00
Lucifer faxoni		2.23			0.56	2.23
Paguridae (larvae - Glaucothoe stage)		13.03			3.26	13.03
Misidacea (various)			2.81	2.77	1.40	5.58
Cumacea (various)	21.23	22.29			10.88	43.52
Amphipoda (various)	13.08	15.60	11.00		9.92	39.68
Epicaridae (Manca larvae)	8.15		5.38		3.38	13.53
Isopoda (adults)	9.33		8.63		4.49	17.96
Membranipora spp. (Cyphonaute larvae)			2.37		0.59	2.37
Ascidiidae (larvae)		2.23			0.56	2.23
Oikopleura dioica	20.05	24.52		5.83	12.60	50.41
Pluteus larvae	6.75	8.74		5.17	5.17	20.67
Fish eggs	2.57	2.40	24.38		7.34	29.35
Fish larvae	5.58	2.23	2.37	2.77	3.24	12.95
TOTAL	**2346.41**	**3594.14**	**2692.05**	**3433.44**	**3016.51**	**12066.04**

Table A26: Zooplankton density (org.m^{-3}) at the station C1 (Winter: 10-12/07/00; LT = low tide; HT = high tide; N = nocturnal; D = diurnal).

	LT-N	HT-N	LT-D	HT-D	MEAN	TOTAL
Textulariidae (others)	41.61	17.62	8.99	12.71	20.23	80.94
Quinqueloculinidae (various)	21.57	13.22	26.98	8.48	17.56	70.25
Tretomphalus bulloides	15.41	4.41	8.99	8.48	9.32	37.29
Trochamminidae (others)	15.41	4.41	8.99	4.24	8.26	33.05
Spirillinidae (various)	43.15	92.51	14.68	63.57	53.48	213.91
Foraminiferida (others)	52.40	83.70	58.74	38.14	58.24	232.98
Tintinnopsis tocantinensis	43.15	26.43	26.43	38.14	33.54	134.15
Tintinnopsis nordqvisti	64.72	101.32	202.64	80.52	112.30	449.21
Tintinnopsis baltica	6.16		35.98		10.54	42.14
Tintinnopsis beroidea	3.08	4.41	17.99	8.48	8.49	33.95
Codonellopsis morchella f. *typica*	52.40	105.73	55.80	144.09	89.50	358.01
Codonellopsis morchella f. *schabi*	43.15	96.92	5.87	50.86	49.20	196.80
Codonellopsis pusilla	3.08	8.81	2.94	16.95	7.95	31.78
Codonellopsis ostenfeldi	24.66	70.48	41.12	25.43	40.42	161.69
Eutintinnus medius		4.41			1.10	4.41
Undella hyalina	3.08	4.41	8.99	4.24	5.18	20.72
Favella ehrenbergii	64.72	343.61	372.98	245.80	256.78	1027.12
Acanthostomella norvegica	3.08		17.99		5.27	21.07
Hidromedusae (various)	3.08	8.81	5.87	4.24	5.50	22.00
Cubomedusae (various)			8.99		2.25	8.99
Nematoda (various)	70.89	101.32	143.17	114.42	107.45	429.80
Brachionus plicatilis	33.90	57.27	55.80	46.62	48.40	193.59
Brachionus palutus	6.16		2.94		2.28	9.10
Trichocerca spp.	40.07	17.62	5.87	8.48	18.01	72.04
Lecane bulla	24.66		2.94		6.90	27.59
Synchaeta spp.	18.49	4.41			5.72	22.90
Gastropoda (veliger)	36.99	17.62	17.99	8.48	20.27	81.07
Bivalvia (veliger)	12.33	8.81	11.75	4.24	9.28	37.12
Nereis spp. (adults)	3.08	4.41	8.99		4.12	16.48
Nereis spp. (Nectochaeta larvae)				8.48	2.12	8.48
Spionid (various)		4.41			1.10	4.41
Polychaeta (others)	6.16	4.41	8.99	4.24	5.95	23.80
Polychaeta (other larvae)	12.33	8.81	11.75	8.48	10.34	41.36
Polychaeta (eggs)	3.08		2.94		1.50	6.02
Asterope spp.		4.41			1.10	4.41

	LT-N	HT-N	LT-D	HT-D	MEAN	TOTAL
Parvocalanus crassirostris	27.74	39.65	35.97	25.43	32.20	128.79
Paracalanus nanus	3.08		8.99	4.24	4.08	16.31
Paracalanus indicus	15.41	17.62	38.18	4.24	18.86	75.45
Paracalanus parvus	3.08	4.41	26.98		8.62	34.47
Pareucalanus sewelli	18.49				4.62	18.49
Pseudodiaptomus acutus	24.66	22.03	20.56	63.57	32.70	130.81
Pseudodiaptomus richardi	15.41	17.62	8.99	38.14	20.04	80.17
Temora turbinata	24.66				6.16	24.66
Temora stylifera	27.74				6.93	27.74
Acartia lilljeborgi	15.41	26.43	2.94	21.19	16.49	65.97
Oithona simplex	9.25		8.99		4.56	18.24
Oithona nana	43.15	74.89	49.93	38.14	51.53	206.11
Oithona hebes	104.79	334.80	99.85	233.09	193.13	772.53
Oithona oswaldocruzi	80.14	163.00	85.17	122.90	112.80	451.20
Microsetella rosea		4.41		4.24	2.16	8.64
Macrosetella gracilis	3.08	4.41	8.99		4.12	16.48
Euterpina acutifrons	27.74	22.03	5.87	21.19	19.21	76.83
Tigriopus spp.	3.08	4.41	8.99	4.24	5.18	20.72
Harparcticoida (others)	43.15	35.24	38.18	29.67	36.56	146.24
Oncaea venustra	6.16		8.99		3.79	15.16
Corycaeus speciosus	24.66	8.81	2.94	8.48	11.22	44.88
Corycaeus giesbrechti	27.74	8.81	5.87	12.71	13.78	55.14
Corycaeus spp.	36.99	4.41	5.87	8.48	13.94	55.74
Farranula gracilis		4.41			1.10	4.41
Caligus spp.	3.08	4.41	2.94		2.61	10.42
Caligus spp. (metanauplii)	9.25				2.31	9.25
Parasite Copepods (others)	6.16	8.81	5.87	4.24	6.27	25.09
Monstrilla spp.	9.25				2.31	9.25
Copepoda (nauplii)	403.76	1414.10	848.75	1262.91	982.38	3929.52
Lepas spp. (nauplii)	3.08		5.87		2.24	8.96
Balanus spp. (nauplii)	6.16	4.41	17.62	4.24	8.11	32.43
Lucifer faxoni	6.16	4.41			2.64	10.57
Caridea (various)	3.08	4.41	5.87	4.24	4.40	17.60
Alpheidae (various)		4.41	2.94	4.24	2.90	11.59
Brachyura (zoea)		8.81	5.87		3.67	14.68
Cumacea (various)	15.41	8.81	2.94		6.79	27.16
Amphipoda (various)	12.33	4.41	14.68	4.24	8.91	35.66
Epicaridae (Manca larvae)	3.08	4.41	2.94	4.24	3.67	
Isopoda (adults)	9.25	4.41	5.87	4.24	5.94	23.76
Oikopleura dioica	3.08	8.81	20.56	8.48	10.23	40.93
Fish eggs	3.08	13.22	5.87	4.24	6.60	26.41
Fish larvae		4.41	8.99	16.95	7.59	30.35
TOTAL	**1853.91**	**3524.24**	**2633.99**	**2919.95**	**2733.02**	**10932.08**

Table A27: Zooplankton density (org.m^{-3}) at the station C1 (Summer: 17-19/01/01; LT = low tide; HT = high tide; N = nocturnal; D = diurnal).

	LT-N	HT-N	LT-D	HT-D	MEAN	TOTAL
Textularia candeiana	3.97	10.27			3.56	14.25
Textulariidae (others)	7.95	41.10	3.60	6.85	14.87	59.49
Quinqueloculinidae (various)	11.92	51.37	32.36	13.70	27.34	109.35
Trochamminidae (others)	7.95	61.64	17.98	41.10	32.17	128.67
Peneroplis spp.	3.97				0.99	3.97
Foraminiferida (others)	71.54	123.29	46.75	82.19	80.94	323.76
Tintinnopsis tocantinensis	7.95	20.55	75.51	13.70	29.43	117.71
Tintinnopsis nordqvisti	47.69	10.27	28.77	82.19	42.23	168.92
Tintinnopsis baltica		10.27	3.60		3.47	13.87
Tintinnopsis beroidea		10.27	3.60	6.85	5.18	20.72
Codonellopsis morchella f. *typica*	47.69	10.27	43.15	27.40	32.13	128.51
Codonellopsis morchella f. *schabi*	23.85		14.38	13.70	12.98	51.93
Codonellopsis pusilla	11.92		21.57		8.37	33.50
Codonellopsis ostenfeldi	7.95		3.60	6.85	4.60	18.39
Undella hyalina		10.27	3.60		3.47	13.87
Favella ehrenbergii	3.97	30.82	53.94	82.19	42.73	170.92
Favella ehrenbergii f. *coxliella*		41.10			10.27	41.10
Acanthostomella norvegica	55.64				13.91	55.64
Hidromedusae (various)	3.97			13.70	4.42	17.67
Nematoda (various)	91.40	92.47	222.94	184.92	147.93	591.73
Brachionus plicatilis	27.82	10.27	14.38		13.12	52.48
Brachionus palutus			3.60		0.90	3.60
Platyias quadricornis		10.27			2.57	10.27
Trichocerca spp.	47.69			13.70	15.35	61.39
Gastropoda (veliger)	11.92	20.55	68.32	20.55	30.33	121.34
Bivalvia (veliger)	7.95	20.55	75.51	13.70	29.43	117.71
Nereis spp. (adults)		10.27			2.57	10.27
Nereis sp (Nectochaeta larvae)		10.27			2.57	10.27
Spionid (variuos)		10.27	3.60		3.47	13.87
Polychaeta (other larvae)	7.95	10.27	3.60	13.70	8.88	35.52

	LT-N	HT-N	LT-D	HT-D	MEAN	TOTAL
Polychaeta (eggs)	3.97				0.99	3.97
Parvocalanus crassirostris	47.69	20.55	35.96	47.95	38.04	152.15
Paracalanus nanus			3.60		0.90	3.60
Paracalanus indicus	11.92	20.55	17.98	27.40	19.46	77.85
Paracalanus parvus		10.27	3.60		3.47	13.87
Pareucalanus sewelli	43.72	10.27			13.50	53.99
Pseudodiaptomus acutus	7.95	30.82	57.53	6.85	25.79	103.15
Pseudodiaptomus richardi	11.92	41.10	17.98	13.70	21.17	84.70
Temora turbinata	3.97	10.27			3.56	14.25
Temora stylifera	7.95	10.27			4.56	18.22
Calanopia americana		10.27			2.57	10.27
Labidocera fluviatilis		10.27			2.57	10.27
Acartia lilljeborgi	3.97	20.55	7.19	13.70	11.35	45.41
Oithona nana	47.69	164.38	115.07	232.87	140.00	560.01
Oithona hebes	302.04	452.05	302.05	458.90	378.76	1515.03
Oithona oswaldocruzi	135.12	297.94	197.77	308.21	234.76	939.05
Microsetella norvegica		10.27			2.57	10.27
Euterpina acutifrons	23.85	71.92	28.77	20.55	36.27	145.08
Tigriopus spp.	7.95	10.27		13.70	7.98	31.92
Harparcticoida (others)	19.87	51.37	43.15	34.25	37.16	148.64
Oncaea venustra	3.97				0.99	3.97
Corycaeus speciosus	23.85	30.82	25.17	13.70	23.38	93.54
Corycaeus giesbrechti	7.95	20.55	10.79	20.55	14.96	59.83
Corycaeus spp.	3.97	20.55	14.38	6.85	11.44	45.75
Farranula gracilis		10.27			2.57	10.27
Caligus spp.	3.97	10.27			3.56	14.25
Parasite Copepods (others)			3.60	6.85	2.61	10.45
Monstrilla spp.	3.97				0.99	3.97
Copepoda (nauplii)	1029.96	1808.2	1427.54	1260.3	1381.48	5525.94
Lepas spp. (nauplii)		10.27	3.60		3.47	13.87
Balanus spp. (nauplii)	3.97	20.55	3.60		7.03	28.12
Stomatopoda (pseudozoea)		10.27			2.57	10.27
Lucifer faxoni		10.27			2.57	10.27
Brachyura (zoea)		20.55	3.60		6.04	24.14
Misidacea (various)		10.27			2.57	10.27
Cumacea (various)	7.95	20.55	7.19	13.70	12.35	49.39
Amphipoda (various)	7.95	20.55	7.19		8.92	35.69
Epicaridae (Manca larvae)	3.97	20.55	3.60	6.85	8.74	34.97
Isopoda (adults)	3.97	20.55	3.60	20.55	12.17	48.67
Crustacea (protozoea - various)		20.55			5.14	20.55
Ascidiidae (larvae)		10.27			2.57	10.27
Oikopleura dioica	135.12	102.74	86.30	308.21	158.09	632.37
Fish eggs	7.95	20.55	3.60		8.02	32.09
Fish larvae		10.27			2.57	10.27
TOTA	**2440.79**	**4109.52**	**3178.71**	**3472.54**	**3300.39**	**13201.56**

Table A28: Zooplankton density (org.m^{-3}) at the station C2 (Winter: 10-12/07/00; LT = low tide; HT = high tide; N = nocturnal; D = diurnal).

	LT-N	HT-N	LT-D	HT-D	MEAN	TOTAL
Textulariidae (others)	56.34	30.82	7.12	61.13	38.85	155.40
Quinqueloculinidae (various)	44.27	36.98	3.56	82.70	41.88	167.51
Tretumphalus bulloides	24.14	26.71	3.56	21.57	19.00	75.99
Remaneica spp.	12.07	24.65	1.78	39.55	19.51	78.06
Trochamminidae (others)	108.65	47.25	8.90	46.75	52.89	211.55
Foraminiferida (others)	144.87	76.01	23.13	75.51	79.88	319.53
Tintinnopsis tocantinensis	60.36	47.25	21.35	43.15	43.03	172.12
Tintinnopsis nordqvisti	156.94	69.85	40.93	68.32	84.01	336.04
Tintinnopsis baltica		4.11		3.60	1.93	7.70
Tintinnopsis parvula		6.16		7.19	3.34	13.35
Tintinnopsis beroidea	2.01	12.33	3.56	7.19	6.27	25.09
Codonellopsis morchella f. *typica*	48.29	123.27	346.98	129.45	162.00	647.98
Codonellopsis morchella f. *schabi*	36.22	86.29	170.82	57.53	87.71	350.86
Codonellopsis pusilla	24.14	65.74	26.69	57.53	43.53	174.11
Codonellopsis ostenfeldi	84.51	117.10	42.70	25.17	67.37	269.49
Eutintinnus medius	12.07	8.22		3.60	5.97	23.89
Undella hyalina	12.07	4.11	1.78	3.60	5.39	21.56
Favella ehrenbergii	60.36	211.61	779.36	201.37	313.17	1252.70
Favella ehrenbergii f. *coxliella*		24.65		17.98	10.66	42.63
Hidromedusae (various)	12.07	8.22	1.78	3.60	6.42	25.67
Cubomedusae (various)		2.05			0.51	2.05
Nematoda (various)	46.28	80.12	40.93	97.09	66.10	264.41
Brachionus plicatilis	26.16	45.20	24.91	39.55	33.95	135.82
Brachionus palutus		10.27		7.19	4.37	17.46
Trichocerca spp.	24.14	41.09	26.69	43.15	33.77	135.07
Lecane bulla		14.38	16.01	10.79	10.30	41.18
Synchaeta spp.	10.06	32.87	14.23	3.60	15.19	60.76
Kinorhycha (various)		4.11		3.60	1.93	7.70
Gastropoda (veliger)	8.05	47.25	3.56	53.94	28.20	112.80
Bivalvia (veliger)	12.07	24.65	10.68	46.75	23.54	94.15

	LT-N	HT-N	LT-D	HT-D	MEAN	TOTAL
Nereis spp. (adults)	2.01	2.05	1.78		1.46	5.85
Nereis spp. (Nectochaeta larvae)		8.22			2.05	8.22
Spionid (various)	2.01	2.05		3.60	1.92	7.66
Polychaeta (others)	4.02	4.11	3.56	3.60	3.82	15.29
Polychaeta (other larvae)	6.04	16.44	5.34	14.38	10.55	42.19
Polychaeta (eggs)	2.01				0.50	2.01
Asterope spp.	2.01	2.05	1.78	3.60	2.36	9.44
Parvocalanus crassirostris	46.28	30.82	23.13	53.94	38.54	154.16
Paracalanus nanus		4.11		10.79	3.72	14.90
Paracalanus indicus	4.02	18.49	3.56	10.79	9.22	36.86
Paracalanus parvus		2.05	1.78	14.38	4.55	18.22
Pseudodiaptomus acutus	18.11	18.49	14.23	28.77	19.90	79.60
Pseudodiaptomus richardi	14.08	8.22	3.56	14.38	10.06	40.24
Temora turbinata	6.04				1.51	6.04
Temora stylifera	4.02				1.01	4.02
Acartia lilljeborgi	8.05	10.27	8.90	7.19	8.60	34.41
Oithona nana	20.12	24.65	16.01	28.77	22.39	89.55
Oithona hebes	40.24	100.67	35.59	35.96	53.11	212.45
Oithona oswaldocruzi	22.13	43.14	23.13	17.98	26.60	106.39
Oithona plumifera	2.01	4.11	3.56	3.60	3.32	13.28
Microsetella rosea	2.01	4.11		3.60	2.43	9.72
Macrosetella gracilis	2.01	2.05	1.78	3.60	2.36	9.44
Euterpina acutifrons	12.07	2.05	5.34	17.98	9.36	37.44
Tigriopus spp.	4.02	2.05	1.78	3.60	2.86	11.45
Metis spp.	2.01			3.60	1.40	5.61
Harparcticoida (others)	16.10	34.93	10.68	21.57	20.82	83.27
Corycaeus speciosus	4.02	6.16	3.56	21.57	8.83	35.32
Corycaeus giesbrechti	2.01	4.11	1.78	25.17	8.27	33.07
Corycaeus spp.	2.01	6.16	1.78	28.77	9.68	38.72
Farranula gracilis	2.01	4.11	3.56	7.19	4.22	16.87
Caligus spp.	2.01	2.05	3.56		1.91	7.63
Caligus spp. (metanauplii)	4.02	4.11		3.60	2.93	11.73
Parasite Copepods (others)	2.01	4.11	1.78	7.19	3.77	15.09
Copepoda (nauplii)	515.09	361.58	245.55	1021.22	535.86	2143.44
Lepas spp. (nauplii)		4.11		7.19	2.83	11.30
Balanus spp. (nauplii)	2.01	2.05	3.56	10.79	4.60	18.41
Lucifer faxoni	2.01	4.11	1.78	7.19	3.77	15.09
Paguridae (larvae - Glaucothoe stage)		2.05			0.51	2.05
Porcellanidae (zoea)		8.22			2.05	8.22
Brachyura (zoea)	2.01	2.05			1.02	4.07
Misidacea (various)	4.02	16.44	1.78	3.60	6.46	25.83
Cumacea (various)	12.07	10.27	1.78	7.19	7.83	31.32
Amphipoda (various)	4.02	6.16	1.78	7.19	4.79	19.16
Epicaridae (Manca larvae)	2.01	8.22	3.56	3.60	4.35	17.38
Isopoda (adults)	2.01	4.11		10.79	4.23	16.91
Crustacea (protozoea - various)		4.11		3.60	1.93	7.70
Membranipora spp. (Cyphonaute larvae)		2.05		3.60	1.41	5.65
Oikopleura dioica	2.01	8.22	10.68	10.79	7.92	31.69
Pluteus larvae		10.27		3.60	3.47	13.87
Sagitta tenuis	2.01	2.05		3.60	1.92	7.66
Fish eggs	4.02	8.22		7.19	4.86	19.43
Fish larvae	2.01	6.16	1.78	3.60	3.39	13.55
TOTAL	**1841.05**	**2179.76**	**2074.73**	**2775.98**	**2217.88**	**8871.52**

Table A29: Zooplankton density (org.m^{-3}) at the station C2 (Summer: 17-19/01/01; LT = low tide; HT = high tide; N = nocturnal; D = diurnal).

	LT-N	HT-N	LT-D	HT-D	MEAN	TOTAL
Textulariidae (others)	3.08	24.66	30.82	11.30	17.47	69.86
Quinqueloculinidae (various)	9.25	18.49	15.41	22.60	16.44	65.75
Tretumphalus bulloides	18.49	30.82	46.23	39.55	33.78	135.10
Trochamminidae (others)	3.08	6.16	10.27	11.30	7.71	30.82
Spirillinidae (various)	6.16	6.16	5.14	5.65	5.78	23.12
Foraminiferida (others)	70.89	104.79	118.15	90.41	96.06	384.24
Tintinnopsis tocantinensis	6.16	18.49	35.96	16.95	19.39	77.57
Tintinnopsis nordqvisti	24.66	24.66	66.78	22.60	34.67	138.70
Tintinnopsis baltica				16.95	4.24	16.95
Tintinnopsis parvula				5.65	1.41	5.65
Tintinnopsis beroidea	3.08	12.33			3.85	15.41
Codonellopsis morchella f. *typica*	6.16	49.31	15.41	16.95	21.96	87.84
Codonellopsis morchella f. *schabi*		6.16			1.54	6.16
Codonellopsis pusilla		18.49	10.27		7.19	28.77
Codonellopsis ostenfeldi	3.08	6.16		22.60	7.96	31.85
Eutintinnus medius		6.16		5.65	2.95	11.81
Undella hyalina		6.16	5.14		2.83	11.30
Favella ehrenbergii	70.89	141.78	118.15	84.76	103.89	415.58
Favella ehrenbergii f. *coxliella*		12.33		11.30	5.91	23.63
Hidromedusae (various)		6.16			1.54	6.16
Nematoda (various)	12.33	18.49	10.27	22.60	15.92	63.70
Brachionus plicatilis	12.33	18.49	15.41	11.30	14.38	57.53
Brachionus palutus		6.16			1.54	6.16
Trichocerca spp.	6.16	12.33	25.68	16.95	15.28	61.13

	LT-N	HT-N	LT-D	HT-D	MEAN	TOTAL
Lecane bulla			10.27		2.57	10.27
Synchaeta spp.		6.16	10.27	11.30	6.93	27.74
Kinorhyncha (various)		6.16			1.54	6.16
Gastropoda (veliger)	27.74	55.48	35.96	45.20	41.10	164.38
Bivalvia (veliger)	24.66	43.15	15.41	28.25	27.87	111.47
Nereis spp. (adults)			5.14		1.28	5.14
Spionid (various)	6.16	6.16	10.27	5.65	7.06	28.25
Polychaeta (others)	3.08	12.33	10.27		6.42	25.68
Polychaeta (other larvae)	9.25	18.49	20.55	16.95	16.31	65.24
Asterope spp.		12.33			3.08	12.33
Parvocalanus crassirostris	46.23	209.59	164.38	67.81	122.00	488.01
Paracalanus nanus		6.16			1.54	6.16
Paracalanus indicus	6.16	36.99	35.96	28.25	26.84	107.36
Paracalanus parvus		12.33		11.30	5.91	23.63
Pseudodiaptomus acutus	15.41	30.82	46.23	16.95	27.35	109.42
Pseudodiaptomus richardi	12.33	36.99	10.27	22.60	20.55	82.19
Temora stylifera	3.08				0.77	3.08
Acartia lilljeborgi	6.16	6.16	5.14	11.30	7.19	28.77
Oithona nana	73.97	86.30	71.92	22.60	63.70	254.79
Oithona hebes	240.41	345.20	349.31	485.95	355.22	1420.87
Oithona oswaldocruzi	200.34	277.39	133.56	192.12	200.85	803.41
Oithona plumifera		6.16			1.54	6.16
Microsetella rosea	3.08	6.16	5.14		3.60	14.38
Macrosetella gracilis	3.08				0.77	3.08
Euterpina acutifrons	24.66	55.48	61.64	50.86	48.16	192.63
Tigriopus spp.	3.08	6.16	5.14	5.65	5.01	20.03
Harparcticoida (others)	40.07	55.48	25.68	67.81	47.26	189.04
Oncea Venustra		6.16			1.54	6.16
Corycaeus speciosus	6.16	18.49	10.27	11.30	11.56	46.23
Corycaeus giesbrechti	6.16	6.16	5.14	16.95	8.60	34.42
Corycaeus spp.	9.25	12.33	10.27		7.96	31.85
Farranula gracilis				22.60	5.65	22.60
Caligus spp.	3.08	6.16			2.31	9.25
Parasite Copepods (others)		6.16	10.27		4.11	16.44
Copepoda (nauplii)	1198.95	1843.12	996.56	2231.98	1567.65	6270.61
Lepas spp. (nauplii)	3.08	6.16	5.14		3.60	14.38
Balanus spp. (nauplii)	3.08	12.33	10.27	5.65	7.83	31.34
Stomatopoda (pseudozoea)		6.16			1.54	6.16
Lucifer faxoni	3.08	6.16	5.14		3.60	14.38
Caridea (various)	3.08	12.33	10.27	5.65	7.83	31.34
Brachyura (zoea)		6.16	5.14		2.83	11.30
Cumacea (various)	9.25	36.99	5.14	11.30	15.67	62.67
Amphipoda (various)		12.33			3.08	12.33
Epicaridae (Manca larvae)	3.08	6.16	10.27	5.65	6.29	25.17
Isopoda (adults)	6.16		5.14		2.83	11.30
Membranipora spp. (Cyphonaute larvae)		6.16			1.54	6.16
Oikopleura dioica	27.74	55.48	30.82	11.30	31.34	125.34
Sagitta tenuis		6.16			1.54	6.16
Fish eggs		6.16			1.54	6.16
Fish larvae				5.65	1.41	5.65
TOTAL	**2286.95**	**3969.80**	**2681.46**	**3853.70**	**3197.98**	**12791.90**

Table A30: Density (org.m^{-3}) at the Maceió River mouth (19/01/2001).

Taxa	Density
Rotaria spp.	23.8
Brachionus plicatilis	281.32
Brachionus palutus	38.91
Platyas quadicornis	101.9
Tricocerca spp.	157.43
Lecane bulla	40.61
Synchaeta spp.	31.43
Nematoda (various)	135.71
Polychaeta (various)	4.76
Oithona hebes	33.33
Copepoda (nauplius)	78.57
TOTAL	**927.78**

Table A31: Diversity (*bits*.ind^{-1}) and eveness at the mangrove area.

	M1	**M2**	**M3**	**M4**	Mean
Diversity – Summer	2.634	2.421	2.838	2.625	2.629
Diversity – Winter	2.734	2.399	2.596	2.777	2.627
Eveness – Summer	0.531	0.489	0.629	0.610	0.565
Eveness – Winter	0.553	0.529	0.583	0.647	0.578
Total Diversity	2.684	2.410	2.717	2.701	2.628
Total Eveness	0.542	0.509	0.606	0.629	0.571

Table A32: Diversity (*bits*.ind^{-1}) and eveness at the reef area.

	R1	**R2**	**R3**	**R4**	**C1**	**C2**	Mean
Diversity – Summer	3.525	3.995	3.763	3.988	3.470	3.232	3.662
Diversity – Winter	4.066	4.330	4.150	4.418	3.788	4.239	4.165
Eveness – Summer	0.592	0.681	0.630	0.683	0.622	0.569	0.629
Eveness – Winter	0.662	0.698	0.666	0.734	0.681	0.696	0.689
Total Diversity	3.796	4.162	3.956	4.203	3.629	3.736	3.914
Total Eveness	0.627	0.689	0.648	0.708	0.651	0.632	0.659