Hydrology and Phytoplankton Community Structure at Itamaracá-Pernambuco (Northeast Brazil)

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ABSTRACT

Quali-quantitative studies and hydrologic parameters were carried out in the profiles 6 (Orange) and 7 (Catuama) during the Victor Hensen cruise, in accordance with the bilateral scientific cooperation agreement Brazil/Germany. Hydrologically a zone of thermic and saline stability characterizes the superficial layer. The nutrient concentrations were generally low on the surface and higher at levels surpassing 100m in depth. 102 taxa were identified including diatoms (49), dinoflagellates (49), bluegreen algae (3), and euglenophyceae (1). The diversity and evenness were high, surpassing the environmental equilibrium. The clustering of samples showed evidence of 2 main groups, one encompassing the stations 32 and 38, characterized predominantly by Oscillatoria erythraeum, and another encompassing the remaining stations, characterized by dinoflagellates and diatoms. The clustering of species involved 4 groups, the biggest being oceanic marine species (49 species) and coastal and eurihaline marine species (31 species). The phytoplankton density varied from 50,000 cell.l⁻¹ to 590,000 cell.l⁻¹, characterizing an oligotrophic environment.

Key Words: Hydrology; nutrients; phytoplankton structure.

INTRODUCTION

The mangrove ecosystems are considered important functional components of the tropical coasts, as they constitute a primary source of organic material for the adjacent coastal systems. For this reason they are valued as being among the most productive vegetative communities in the world.

The phytoplankton organisms are composed of unicellular photosynthesizing microscopic algae, found in isolation or in colonies, that flow in the surface of the water. They are considered the most important primary producers of aquatic ecosystems (Boney, 1989). In tropical regions the primary phytoplankton production is low in the stratified oceanic waters and high in the coastal and upwelling waters, the availability of nutrient salts being one of the determinant factors for the development of phytoplankton, even when there is enough light (Gross & Gross, 1996).

Phytoplankton studies of the continental shelf of Pernambuco (Brazil) are limited to the neritic region, at approximately 15 miles from the coast. The first studies merely approached aspects of taxonomic character in phytoplankton, based on samples collected by net (Eskinazi-Leça, 1970, 1990; Eskinazi-Leça & Passavante, 1972; Passavante, 1979; Silva, 1982; Silva-Cunha & Eskinazi-Leça, 1990). Very few studies deal with the quantitative aspects of phytoplankton at the Continental Shelf of Pernambuco. Eskinazi-Leça et al. (1989a,b; 1991; 1993) studied the phytoplankton of the continental shelf of Pernambuco, in profiles in front of Piedade beach, the port of Recife and the island of Itamaracá; Passavante & Feitosa (1989) studied the primary biomass in terms of chlorophyll -a in the profile in front of Piedade beach; Gomes (1989; 1991) studied the composition, density and annual variance of phytoplankton in a profile at the north of the island of Itamaracá.

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and Ressurreição (1990) studied the phytoplankton biomass in a profile in front of the port of Recife.

Costa (1991) studied the hydrology and primary biomass of the Northeast region of Brazil, as a complementary study with stations distributed between Recife (PE) and Macau (Rio Grande do Norte), extending from the continental shelf to the oceanic area.

The cruise JOPS II (Joint Oceanographic Projects) was carried out through an agreement of bilateral cooperation in science and technology between Brazil (Ministério das Ciências e Tecnologia) and Germany / Zentrum für Marine Tropenökologie (ZMT).

This expedition was divided in 9 legs and its basic objective was to evaluate the contribution of the mangrove systems to the production and diversity of the coastal waters along the Brazilian continental shelf, between the latitudes of 3º and 9ºS.

The samples of leg 5, were collected in the continental shelf and oceanic waters between the states of Pernambuco and Ceará, along 14 profiles perpendicular to the coast, 50 miles in length and with 69 stations.

This study sought to estimate the degree of fertility of the water, based on the variation and distribution of the nutrient elements dissolved in the environment, and in relation with the structure and levels of production of the phytoplankton community.

**MATERIAL AND METHODS**

The samples for the analysis of the hydrologic and phytoplanktonic parameters were collected by the Research Vessel Victor Hensen, in 2 profiles perpendicular to the island of Itamaracá during 1 and 2 of March, 1995. These corresponded to profiles 6 (Orange) and 7 (Catuama) between the latitudes 07º49,0'S and 07º41,5'S, and longitudes 34º45,6'W and 33º03,3'W. In each profile 5 stations were demarcated, distanced 10 miles from each other being 2 at the neritic region and 3 at the oceanic one (Figure 1).

For the hydrologic analysis the samples were collected at three depth levels in the stations situated in the continental shelf (surface, intermediate and deep layers) and at 5 depth levels in the oceanic region (0m, 50m, 100m, 150m and 200m). Salinity and the pH were determined through a CTD (conductivity, temperature and depth meter); the dissolved oxygen levels and those of nutrient salts (NO₂, NO₃, PO₄ and SiO₂), were determined through the methods described by Strickland & Parsons (1972) and Grasshoff et al. (1983).

Samples for the qualitative study of phytoplankton were collected by a Baby Bongo net with a mesh opening of 64 µm, being fixed with neutral formol to 4% and analyzed in optic microscopy. The identification of the species was based on the studies of Cupp (1943), Hustedt (1930; 1959; 1961/66), Desikachary (1959), Sournia (1967), Wood (1968), Pesantes (1978), Dodge (1982), Sournia (1986), Balech (1988) and Silva-Cunha & Eskinazi-Leça (1990). The diatom synonyms were based on Moreira Fiho et al. (1994/95).

For the calculation of the specific diversity the index of Shannon (1948) was utilized and in Cluster Analysis, for the samples as well as for the species, the Bray-Curtis similarity index was utilized, using the computer program NTSYS (Numerical Taxonomy and Multivariate Analysis System) of Metagraphics Corporation, California-U.S.A.

For the quantitative study (cellular density), the samples were collected from the surface with Van Dorn bottles, fixed with lugol solution and analyzed in inverted microscopy through the Utermöhrl method (Hasle, 1978).
RESULTS

Hydrology
The water masses displayed temperatures varying from 15.62°C (St.35) at 200m, to 28.97°C (St. 37) in the surface layer (Table I). The salinity ranged from 35.4 ppt (St.35 and 39) at 200m, and 37.1 ppt (St.34 and 40) at 100m. The concentrations of dissolved oxygen oscillated between 3.83 ml l\(^{-1}\) (St.35) and 5.01 ml l\(^{-1}\) (St.34), being the highest values recorded in the surface layer. The pH values oscillated between 7.95 (St.31) and 8.40 (St.34), both in the surface layer.

The concentrations of dissolved nutrient elements were relatively low, the minimum values being registered mostly in the surface layer, and the maximum at 200m.

The nitrite-N concentration ranged from 0.001 µmol.l\(^{-1}\) in stations on the surface layer to 0.100 µmol.l\(^{-1}\) (St.40) at a depth of 150m. The nitrate-N concentrations varied between 0.017 µmol.l\(^{-1}\) (St.34) at 50m and 3.610 µmol.l\(^{-1}\) (St.39) at 200m. The phosphate concentration showed a minimum value of 0.148 µmol.l\(^{-1}\) in the surface layer (St.34), and a maximum of 1.157 µmol.l\(^{-1}\) (St.35) at 200 m. In relation to the silicate-Si, the highest value (10,705 µmol.l\(^{-1}\)) was detected in station 32 (closest to shore), in the surface layer, being the minimum value, 1,418 µmol.l\(^{-1}\) (St.41) at 150m depth.
Table 1. Hydrological Parameters from the Orange and Catuama Profiles.

| Station (No) | Depth (m) | Temp. (°C) | Salinity (ppt) | $O_2$ (ml/l) | pH | N-N\textsubscript{02} (µmol.l\textsuperscript{-1}) | N-N\textsubscript{03} (µmol.l\textsuperscript{-1}) | P-PO\textsubscript{4} (µmol.l\textsuperscript{-1}) | Si-Si\textsubscript{02} (µmol.l\textsuperscript{-1}) |
|--------------|-----------|------------|----------------|-------------|----|------------------|------------------|-----------------|------------------|
| **Orange Profile** | | | | | | | | | |
| St. 31 | 0 | 28.93 | 36.8 | 4.66 | 7.95 | 0.030 | 0.334 | 0.271 | 6.856 |
| St. 32 | 0 | 28.84 | 37.0 | 4.66 | 8.16 | 0.020 | 0.078 | 0.172 | 10.705 |
| | 0 | 28.89 | 37.0 | 4.58 | 8.04 | 0.001 | 0.044 | 0.172 | 7.016 |
| | 50 | 26.58 | 37.0 | 4.57 | 8.3 | 0.001 | 0.154 | 0.295 | 3.661 |
| St. 33 | 100 | 24.50 | 36.9 | 4.57 | 8.11 | 0.001 | 0.145 | 0.443 | 3.491 |
| | 150 | 20.22 | 36.2 | 4.52 | 8.09 | 0.060 | 1.897 | 0.566 | 1.762 |
| | 200 | 15.95 | 35.5 | 4.48 | 7.99 | 0.010 | 1.900 | 0.837 | 2.053 |
| | 0 | 28.49 | 36.6 | 4.68 | 8.40 | 0.020 | 0.029 | 0.148 | 4.395 |
| | 50 | 27.44 | 36.9 | 5.01 | 8.19 | 0.030 | 0.017 | 0.246 | 3.280 |
| St. 34 | 100 | 24.84 | 37.1 | 4.89 | 7.98 | 0.010 | 0.136 | 0.345 | 3.167 |
| | 150 | 20.07 | 36.2 | 4.46 | 8.23 | 0.010 | 1.041 | 0.615 | 3.047 |
| | 200 | 16.47 | 35.5 | 4.46 | 8.09 | 0.001 | 2.807 | 0.616 | 8.165 |
| | 0 | 28.32 | 36.6 | 4.68 | 8.08 | 0.010 | 0.034 | 0.246 | 4.173 |
| | 50 | 27.00 | 36.8 | 4.89 | 8.24 | 0.001 | 0.193 | 0.222 | 2.097 |
| St. 35 | 100 | 24.73 | 37.0 | 4.89 | 8.07 | 0.001 | 0.188 | 0.394 | 8.528 |
| | 150 | 20.10 | 36.8 | 4.57 | 8.29 | 0.080 | 0.878 | 0.468 | 7.406 |
| | 200 | 16.47 | 35.5 | 4.46 | 8.09 | 0.001 | 2.807 | 0.616 | 8.165 |
| **Catuama Profile** | | | | | | | | | |
| St. 37 | 0 | 28.97 | 36.9 | 4.69 | 8.12 | 0.001 | 0.097 | 0.246 | 3.326 |
| | 8 | 28.90 | 36.9 | 4.68 | 7.96 | 0.001 | 0.158 | 0.246 | 6.794 |
| | 12 | 28.90 | 36.9 | 4.68 | 8.08 | 0.001 | 0.093 | 0.222 | 8.851 |
| | 0 | 28.51 | 36.9 | 4.57 | 8.16 | 0.001 | 0.221 | 0.345 | 9.536 |
| St. 38 | 19 | 28.23 | 37.0 | 4.68 | 8.29 | 0.020 | 0.460 | 0.197 | 4.839 |
| | 37 | 28.17 | 37.0 | 4.78 | 8.22 | 0.001 | 0.318 | 0.246 | 4.740 |
| | 0 | 28.55 | 36.7 | 4.68 | 8.23 | 0.030 | 0.019 | 0.222 | 5.946 |
| | 50 | 26.92 | 36.9 | 4.78 | 8.12 | 0.001 | 0.048 | 0.222 | 6.754 |
| St. 39 | 100 | 24.81 | 36.8 | 4.57 | 8.16 | 0.09 | 0.033 | 0.295 | 5.608 |
| | 150 | 20.98 | 36.2 | 4.46 | 8.16 | 0.001 | 3.498 | 0.763 | 4.435 |
| | 200 | 16.30 | 35.4 | 4.41 | 8.06 | 0.050 | 3.610 | 0.739 | 4.359 |
| | 0 | 28.53 | 36.6 | 4.62 | 8.31 | 0.030 | 0.018 | 0.246 | 5.766 |
| St. 40 | 50 | 27.01 | 36.9 | 4.67 | 8.16 | 0.020 | 1.049 | 0.222 | 6.915 |
| | 100 | 24.84 | 37.1 | 4.67 | 8.24 | 0.100 | 0.534 | 0.295 | 5.322 |
| | 0 | 28.36 | 36.6 | 4.70 | 8.25 | 0.001 | 0.135 | 0.172 | 2.328 |
| | 50 | 27.26 | 36.8 | 4.57 | 8.09 | 0.001 | 0.102 | 0.271 | 2.762 |
| St. 41 | 100 | 24.75 | 37.0 | 4.46 | 8.32 | 0.001 | 0.129 | 0.222 | 3.957 |
| | 150 | 20.62 | 36.2 | 4.46 | 8.25 | 0.040 | 1.657 | 0.468 | 1.418 |
| | 200 | 16.23 | 35.5 | 4.29 | 8.30 | 0.001 | 2.710 | 0.689 | 7.893 |

Phytoplankton Composition

The 102 identified taxa (Table II) are distributed as follows: dinoflagellates, 45 species and 4 varieties, predominated by *Ceratium macroceros*, *C. massiliense*, *C. pentagonum*, *C. tripos* var. *pulchellum* and *C. vultur* var. *vultur* in stations 35 and 40; diatoms, 48 species and 1 variety, represented primarily by *Rhizosolenia imbricata*, *Rhizosolenia styliformis* and
Rhizosolenia styliformis var latissima in station 41, and Asterionella notata and Streptotheca thamesis in stations 31 and 37; bluegreen algae, 3 species, composed prominently of Oscillatoria erythraeum in all stations, yet with percentages of 70% and 48% of the population in stations 32 and 38 respectively; and euglenophycae, represented by a single species, Euglena acus.

Specific diversity and Evenness

The specific diversity varied from 2.12 bits.cel\(^{-1}\) to 4.56 bits.cel\(^{-1}\). The values remained high (above 3 bits.cel\(^{-1}\)) in most stations of both profiles, with the exception of stations 32 and 38. The low phytoplankton diversity recorded at these stations was associated with the predominance of Oscillatoria erythraeum.

The evenness varied from 0.48 to 0.88, presenting overall high values, the lowest being stations 32 and 38 (Figure 2).

**Figure 2**: Specific diversity and evenness at Orange (Profile 6) and Catuama (profile 7)
The cellular density varied from 50,000 cells.l⁻¹ to 590,000 cells.l⁻¹, due to the reduced quantity of nutrient salts, that led to a low productivity in the water. Profile Orange presented densities from 85,000 cells.l⁻¹ in station 32, to 590,000 cells.l⁻¹ in station 33, and profile Catuama, with

### Table 2: Phytoplankton Composition from the Orange and Catuama Profiles

| Cyanophyceans                                      | 52-Pyrocallis robusta Kofoid            |
|----------------------------------------------------|----------------------------------------|
| 1-Oscillatoria erythraeum Ehrenberg                | 53-Pyrhophacus horologicum Stein       |
| 2-Oscillatoria sp                                  |                                        |
| 3-Oscillatoria princeps Vaucher ex Gomont          |                                        |
| Euglenophyceans                                    |                                        |
| 4-Euglena acus Ehrenberg                           |                                        |
| Dinoflagellates                                    |                                        |
| 5-Amphisolenia bidentata Schöder                   |                                        |
| 6-Ceratium candelabrum var candelabrum (Ehrenberg) Stein |                                        |
| 7-Ceratium cephalotum Lemmermann                   |                                        |
| 8-Ceratium dens Ostenfeld & Schmidt                |                                        |
| 9-Ceratium contortum var contortum Gourret         |                                        |
| 10-Ceratium furca (Ehrenberg) Claparède & Lachmann |                                        |
| 11-Ceratium fusus (Ehrenberg) Dujardin             |                                        |
| 12-Ceratium geniculatum (Lemmmermann) Cleve        |                                        |
| 13-Ceratium gibberum Gourret                       |                                        |
| 14-Ceratium gravidum Gourret                       |                                        |
| 15-Ceratium hexacamthum Gourret                    |                                        |
| 16-Ceratium horridum (Cleve) Gran                  |                                        |
| 17-Ceratium limus Gourret                          |                                        |
| 18-Ceratium lineatum (Ehrenberg) Cleve             |                                        |
| 19-Ceratium macrocros (Ehrenberg) Vânhoffen        |                                        |
| 20-Ceratium massiliense (Gourret) Jörgensen        |                                        |
| 21-Ceratium pentagonum Gourret                     |                                        |
| 22-Ceratium reflexum Cleve                         |                                        |
| 23-Ceratium tripos var pulchellum (Schröder) Lopez |                                        |
| 24-Ceratium vultur var vultur Cleve                |                                        |
| 25-Ceratocorys armata (Schütt) Kofoid              |                                        |
| 26-Ceratocorys gourelli Paulsen                    |                                        |
| 27-Ceratocorys horrida Stein                       |                                        |
| 28-Ceratocorys sp                                  |                                        |
| 29-Cladophyxc brachiolata Stein                    |                                        |
| 30-Cladophyxc hemibranchiata Bacleh                |                                        |
| 31-Corythodinium constrictum (Stein) Taylor        |                                        |
| 32-Dinophysis circumsutum (Kärsten) Bacleh         |                                        |
| 33-Dinophysis cuneus (Schüt) Abé                   |                                        |
| 34-Dinophysis hastata Stein                       |                                        |
| 35-Dinophysis rapa Stein                           |                                        |
| 36-Gonyaulax sp                                    |                                        |
| 37-Omnithococcus magnificus Stein                  |                                        |
| 38-Omnithococcus quadratus Schüt                   |                                        |
| 39-Omniococcus splendidus Schüt                    |                                        |
| 40-Omnithococcus steini Schüt                      |                                        |
| 41-Oxytoxum elegans Pavillard                      |                                        |
| 42-Phialocryxa sp                                  |                                        |
| 43-Podolampas elegans Schüt                        |                                        |
| 44-Procentrum micans Ehrenberg                     |                                        |
| 45-Proteroperidinium breve Paulsen                 |                                        |
| 46-Proteroperidinium grande (Kofoid) Bacleh        |                                        |
| 47-Proteroperidinium pedunculatum (Schüt) Bacleh    |                                        |
| 48-Proteroperidinium sp                            |                                        |
| 49-Pyrocallis fusiformis Wvylle-Thomson            |                                        |
| 50-Pyrocallis lunula (Schüt) Schüt                 |                                        |
| 51-Pyrocallis noctiluca Murray ex Schüt            |                                        |

**Cellular density**

The cellular density varied from 50,000 cells.l⁻¹ to 590,000 cells.l⁻¹, due to the reduced quantity of nutrient salts, that led to a low productivity in the water. Profile Orange presented densities from 85,000 cells.l⁻¹ in station 32, to 590,000 cells.l⁻¹ in station 33, and profile Catuama, with
a minimum of 50,000 cells.l\(^{-1}\) in station 38, and maximum of 365,000 cells.l\(^{-1}\) in station 41. Diatoms and phytoflagellates dominated the coastal regions and bluegreen algae the oceanic regions (Figure 3).

**Figure 3:** Phytoplankton density (Cells.l\(^{-1}\)) at the profiles Orange and Catuama (Profiles 6 and 7).

**Samples Clustering**

The results from the clustering of the samples (Figure 4) made evident 2 groups: one associating most of the stations, and characterized primarily by dinoflagellates and diatoms (group 1) and another, involving stations 32 and 38, where the species *Oscillatoria erythraeum* was dominant (group 2).
The clustering of species (Figure 5) made evident 4 groups: **Group 1**, with 6 species, (*Oscillatoria erythraeum, Protoperidinium grande, Chaetoceros tetrastichon, Ceratium pentagonum, Climacodium frauenfeldianum, Striatella unipunctata*) clustering primarily the oceanic diatoms. **Group 2**, was the biggest with 82 species, (*Oscillatoria princeps, Oscillatoria sp, Ceratium cephalotum, C. geniculatum, C. hexacanthum, Ceratocorys sp, Cladopyxix hemibranchiata, Dinophysis hastata, D. rapa, Protoperidinium pedunculatum, Chaetoceros lorenzianus, Corethron hystrix, Coscinodiscus sp, Hemidiscus hardmanianus, Euglena acus, Thallassiosira leptopus, Rhizosolenia styliformis, R. acuminata, Paralia sulcata, Nitzschia longissima, Mastogloia splendidia, Lithodesmium undulatum, Odontella mobiliensis, Gyrosigma balticum, Diploneis...*)
Bombus, Ceratium gravidum, Ceratium limulus, C. reflexum, Licmophora abbreviata,
Campylodiscus clypeus, Ceratocorys gouretti, Amphipora alata, Cladopyx brachiolata,
Dinophysis circumsutum, Corythodinium constrictum, Pyrophacus horologicum,
Nitzschia sp, Ornithocercus magnificus, Rhizosolenia bergoni, Ceratium candelabrum
var candelabrum, Ditylum brightwellii, Cylindrotheca closterium, Ethmodiscus gazelle,
Ceratocorys armata, Gonyaulax sp, Melchersiella hexagonalis Cocconeis scutellum,
Coscinodiscus oculusiridis, Hemiaulus sinensis, Isthmia enervis, Pyrocystis fusiformis,
Ceratium lineatum, Ornithocercus splendidus, Amphisolenia bidentata, Pseudo-solenia
calcaravis, Navicula sp, Leptocylindrus danicus Ceratocorys horrida, Guinardia stolterfothi,
Protoperidinium micans, Climacosphenia monilgera, Tropidoneis seriata, Lyrella lyra,
Amphora arenaria, Asterionellopsis glacialis, Achnanthes brevipes, Dinophysis cuneus,
Pyrocystis lunula, Ceratium contortum var. contortum, Oxytoum elegans, Ornithocercus
quadратus, Nitzschia sigma, Podolampas elegans, Ceratium gibbum, Asterionella
notata, Ceratium furca, Protoperidinium sp, Planktoniella sol, Ceratium horridum,
Ceratium fusus, C. macroceros, C. dens including 49 oceanic marine species and the rest
distributed among marine euryhaline and coastal species, therefore indicating that in the
sampling area, due to the short length of the continental shelf, exists an intrusion of oceanic
water that brings the species to the coastal region. Group 3, 10 species (Rhizosolenia
imbricata, Streptotheca thamensis, Protoperidinium breve, Ornithocercus steinii, Phalacroma
sp, Bacillaria paixillifer, Chaetoceros coarctatus, Rhizosolenia castracanei, Pyrocystis
robusta, Ceratium massiliense) were clustered including neritic, coastal and oceanic and
Group 4, represented by 3 species of oceanic dinoflagellates (Ceratium tripus var pulchellum,
Pyrocystis noctiluca, Ceratium vultur var. vultur).

DISCUSSION

On the continental shelf of Pernambuco the temperature did not vary much in the layers
closest to the surface, forming an ecological barrier in the thermoline region, and
consequently reducing the regeneration of nutrients between the superficial and deep
layers. The salinity was minimum in the deeper layers, reaching a maximum on the superficial
layer, near the top of the thermoline. Therefore, salinity and temperature present small variations
in the superficial layer of the area of study, and do not have great influence on the distribution
and variety of the phytoplankton community. Dissolved oxygen was high on the superficial
layer, with similar values to those of saturation, and the pH was alkaline in the whole area.
Nutrient salts showed lower concentrations on the surface, primarily in the oceanic stations,
except for silicate-Si that was higher in the stations closest to the coast. The poor nutrient
content on the surface layer can be attributed to thermoline. Therefore the nutrient elements can
be considered the primary factors that affect the development of phytoplankton and one of the
causes of low productivity in the lower latitudes. According to Costa (1991) the greatest source of
nutritional supplements for phytoplankton is the degradation and mineralization of organic
material in the superficial layer. In the oceanic region the stability and stratification of the
water column decreased considerably the nutrient concentrations, yet, according to Costa
(1991), it can not be affirmed that any of the nutrients are entirely exhausted, specially in the
levels of nitrate and silicate.

The composition of microphytoplankton was considerably diversified, having a higher
number of diatom species in the coastal stations and of dinoflagellates in the oceanic stations.
The presence of Oscillatoria erythraeum in the continental shelf of Pernambuco has already
been referred by Eskinazi-Leça et al. (1989b) and Gomes (1991), as being a very frequent
species with abundance of up to 70 %. The specific diversity and evenness were high, the
environmental and special stability being the cause of the high diversity. With consideration
to the ecology of the species, the predominance of oceanic planktonic species was observed,
followed by those of marine coastal species. The bluegreen algae group showed values of high
cellular density in the oceanic stations and the groups of diatoms and phytoflagellates in the
coastal stations.
In general, cellular density showed low values in the region as a whole, (minimum of 50,000 cells.l\(^{-1}\) and maximum of 590,000 cells.l\(^{-1}\)) characterizing an oligotrophic tropical environment. The results however, are comparable to the ones found by Gomes (1991) that mentioned to the Continental Shelf North of Pernambuco (Itamaracá) phytoplankton densities varying from 83,000 cells.l\(^{-1}\) to 1,383,300 cells.l\(^{-1}\), decreasing from the coast to offshore. Eskinazi-Leça et al. (1989b) found values oscillating from 50,000 cells.l\(^{-1}\) to 870,000 cells.l\(^{-1}\) in front of Piedade Beach (PE). The results are also comparable with works done at other states (Valentin et al., 1978; Teixeira et al., 1981).

RESUMO
Estudos hidrológicos e fitoplanctônicos foram realizados em dois perfis perpendiculares à costa, em frente à Ilha de Itamaracá-PE (perfis Orange e Catuama), durante a Expedição do Navio de Pesquisas Victor Hensen, dentro do acordo de cooperação bilateral celebrado entre o Departamento de Oceanografia da UFPE e o Centro de Ecologia Marinha Tropical (ZMT-Bremen-Alemanha). A camada superficial está caracterizada por uma zona de estabilidade térmica e salina. As concentrações de nutrientes foram geralmente mais baixas na superfície e mais elevadas em profundidades acima de 100m. Foram identificados 102 táxons, incluindo 49 diatomáceas, 49 dinoflagelados, 3 cianofíceas e 1 euglenofícea. A diversidade específica e equitabilidade foram elevadas, indicando um equilíbrio ambiental. A associação das amostras evidenciou 2 grupos, um caracterizado por dinoflagelados e diatomáceas, englobando a maioria das estações e outro, compreendendo as estações 32 e 38, caracterizadas pelo predominio de *Oscillatoria erythraeum*. A associação de espécies evidenciou 4 grupos, sendo o maior caracterizado por 49 espécies marinhas oceânicas e 31 espécies costeiras e euríalinas. A densidade fitoplanctônica variou de 50.000 cels.l\(^{-1}\) a 590.000 cels.l\(^{-1}\) denotando um ambiente oligotrófico.

REFERENCES
Balech, E. (1988), *Los Dinoflagelados del Atlantico Sudoccidental*. Madrid : Instituto Español de Oceanografía (Publicaciones especiales, n. 1) 310 pp.
Boney, A. D. (1989), *Phytoplankton*. 2. ed. London : E. Arnold, 118 pp.
Costa, K. M. P. (1991), Hidrologia e biomassa primária da região Nordeste do Brasil entre as latitudes de 8°00'00" e 2°44'30"S e as longitudes de 35°56'30" e 31°48'00"W. Recife, 217pp Dissertação (Mestrado em Oceanografia Biológica) Universidade Federal de Pernambuco.
Cupp, E. E. (1943), *Marine plankton diatoms of the West Coast of North America*. Bull. Scripps Institution of Oceanography of the University of California, La Jolla, v. 5, 1-237.
Desikachary, T. V. (1959), *Cyanophyta*. New Delhi : Indian Council of Agricultural Research, 686pp.
Dodge, J. D. (1982), *Marine dinoflagellates of the British Isles*. London : Hobbs the Printers of Southhampton, 303pp.
Eskinazi-Leça, E. (1970), Estudo da Plataforma Continental na área do Recife (Brasil). III. Diatomáceas do fitoplâncton. *Trab. Oceanog. Univ. Fed. PE*, 9/11, 159-172.
Eskinazi-Leça, E. (1990), Estudos ecológicos do fitoplâncton na Plataforma Continental de Pernambuco. In: *IV Encontro Brasileiro de Plâncton*, Recife, p. 54.
Eskinazi-Leça, E. & Passavante, J. Z. O. (1972), Estudo da Plataforma Continental na área do Recife (Brasil). IV. Aspectos quantitativos do fitoplâncton. *Trab. Oceanog. Univ. Fed. PE*, 13, 83-106.
Eskinazi-Leça, E.; Koeing, M. L.; Silva, M. G. G. & Sant'anna, E. E. (1989a), Hidrologia e plâncton da Plataforma Continental de Pernambuco. 3. Fitoplâncton. IN: *III Encontro Brasileiro de Gerenciamento Costeiro*, Fortaleza, p. 373-402.
Eskinazi-Leça, E.; Silva-Cunha, M. G. G. & Koeing, M. L. (1989b), Variação quantitativa do fitoplâncton na Plataforma Continental de Pernambuco (Brasil). *Insula*, Florianópolis, 19, 37-46.
Eskinazi-Leça, E.; Silva-Cunha, M. G. G. & Koening, M. L. (1991), Condições ecológicas da área do Porto do Recife. 2. Comportamento anual do fitoplâncton. In: IV Congresso Nordestino de Ecologia, Recife, p. 22.

Eskinazi-Leça, E.; Silva-Cunha, M. G. G. & Koening, M. L. (1993), Variação espaço-temporal do fitoplâncton na Plataforma Continental de Pernambuco. In: III Congresso Latino Americano de Ficologia, México, p. 121.

Gomes, N. A. (1989), Composição e variação anual do fitoplâncton na Plataforma Continental Norte de Pernambuco. Recife, 198pp. Dissertação (Mestrado em Criptógamos) Universidade Federal de Pernambuco.

Gomes, N. A. (1990), Estrutura e composição florística do fitoplâncton na plataforma continental norte de Pernambuco (Brasil). In: IV Encontro Brasileiro de Plâncton, Recife, p. 35-53.

Grasshof, K.; Ehrhardt, M. & Kremling, K. (1983), Methods of seawater analysis. 2 ed. New York : Verlag Chemie, 419 pp.

Gross, M. G. & Gross, E. (1996), Oceanography a view of earth. 7th ed. New Jersey : Prentice Hall, cap. 11, p. 277-299 : Oceanic Life and Ecosystems.

Hasle, G. R. (1978), The inverted-microscope methods. In: SOURNIA, A. (Ed.). Phytoplankton manual. Paris: UNESCO, pp. 88-96.

Hustedt, F. (1930), Die Kieselalgen : Deutschlands, Österreichs und der Schweiz unter Berücksichtigung der übrigen Länder Europas sowie der angrenzenden Meeresgebiete. Leipzig : Akademische Verlagsgesellschaft Geest & Portig K.-G, 920 pp; 7, pt. 1.

Hustedt, F. (1959), Die Kieselalgen : Deutschlands, Österreichs und der Schweiz unter Berücksichtigung der übrigen Länder Europas sowie der angrenzenden Meeresgebiete. Leipzig : Akademische Verlagsgesellschaft Geest & Portig K.-G, 920pp. 7, pt. 2, n.1-6.

Hustedt, F. (1961-1966), Die Kieselalgen : Deutschlands, Österreichs und der Schweiz unter Berücksichtigung der übrigen Länder Europas sowie der angrenzenden Meeresgebiete. Leipzig : Akademische Verlagsgesellschaft Geest & Portig K.-G, 920pp. 7, pt. 3, n.1-4.

Moore-Neto, H.; Eskinazi-Leça, E. & Valente-Moreira, T. M. (1994/95), Avaliação taxonômica e ecológica das diatomáceas (Chrysophyta, Bacillariophyceae) marinhas e estuarinas nos estados do Espírito Santo, Bahia, Sergipe e Alagoas, Brasil. Biol. Bras. Recife, 6, n. 1/2, 87-110.

Passavante, J. Z. O. (1979), Contribuição ao estudo dos dinoflagelados da Plataforma Continental de Pernambuco-Brasil. Trab. Oceanog. Univ. Fed. PE.,14, 31-54.

Passavante, J. Z. O. & Feitosa, F. A. (1989), Hidrologia e plâncton da Plataforma Continental de Pernambuco.2. Biomassa primária do fitoplâncton. IN: II Encontro Brasileiro de Gerenciamento Costeiro, Fortaleza, Fortaleza, p. 363-37.

Pesantes, F. (1978), Dinoflagelados del fitoplancton del gulf de Guayaquil. Guayaquil: Instituto oceanográfico Armada del Ecuador, 98 pp.

Ressurreição, M. G. (1990), Variação anual da biomassa fitoplanctônica na Plataforma Continental de Pernambuco: Perfil em frente ao Porto do Recife, Recife, 306pp. Dissertação (Mestrado em Oceanografia Biológica) Universidade Federal de Pernambuco.

Shannon, C. E. (1948), A mathematical theory of communication. Bull. Syst. Tec. J., 27, 379-423.

Silva, M. G. G. (1982), Diatomáceas (Bacillariophyceae) da Plataforma Continental de Pernambuco-Brasil, Recife, 345pp. Dissertação (Mestrado em Botânica) - Universidade Federal Rural de Pernambuco.

Silva-Cunha, M. G. G. & Eskinazi-Leça, E. (1990), Catálogo das diatomáceas (Bacillariophyceae) da Plataforma Continental de Pernambuco, Recife SUDENE, 308pp.

Sournia, A. (1967), Le genre Ceratium (Peridinien Planctonique) dans le Canal Mozambique : contribution a une révision mondiale. Vie et Milieu, Paris, 2/3, 375-499.

Sournia, A. (1986), Introduction, Cyanophycées, Dictyochophycées, Dinophycées et
Rhaphidophycées. In: Atlas du phytoplancton marin. Paris.

Strickland, J. D. H. & Parsons, T. R. (1972), A manual of seawater analysis. Bull. Fish. Res. Board Canada, Ottawa, 125, 1-205.

Teixeira, C.; Kutner, M. B. & Aidar-Aragão, E. Estudo preliminar sobre a produção primária e o fitoplâncton de águas do Atlântico Equatorial (Lat. 00°00'S, Long.35°00'W. Academia Brasileira de Ciências, Rio de Janeiro, p. 173-179.

Valentin, J. et al. (1978), Hidrologia e plâncton da região costeira entre o Cabo Frio e o estuário do rio Paráiba (Brasil). Inst. Pesq. da Marinha, Rio de Janeiro, 127, 1-23.

Wood, E. J. F. (1968), Dinoflagellates of the Caribbean Sea and adjacents areas. Miami : University of Miami Press, 143pp.

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