Taxocene of Crustacea at a Highly Impacted Bay: Guanabara Bay, Southeastern Brazil

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ABSTRACT


Guanabara bay is the most prominent Brazilian bay. Despite of its historical, economical, cultural and scientific relevance, it is one of the most degraded coastal Brazilian ecosystem. The great anthropogenic influxes to Guanabara bay have caused pollution to its water. This work aims to describe the abundance distribution of the major groups of soft-bottom crustaceans, relating to sediment features. The crustaceans were sampled in four season oceanographic surveys, between the years 2000 and 2001. In each survey 38 stations were sampled with a 0,1 m² van- Veen grab. The sediment was washed aboard with a 1,0 mm mesh sieve for sorting the macrobenthos and crustaceans were preserved with 70% alcohol. Sampling stations were grouped in three sectors in order to perform spatial analysis: inner (stations 1 - 14) medium (stations 15 - 26) and outer (stations 27 - 38) sectors. The percentage abundance of crustaceans major groups (Decapoda, Isopoda, Cumacea, Tanaidacea, Mysidacea, Ostracoda and Amphipoda) was calculated for each sector. The results points out a higher abundance of the crustaceans in the outer and intermediary sectors. Several stations located in the inner sector did not yield any crustacean at all. These stations with absence of crustaceans generally showed silt and fine sand prevalence, and characteristics of hypoxia, suggesting harmful effect to the local fauna. Amphipoda contributed with 64,16% of the total number of crustaceans, followed by Decapoda (23,44%) and Cumacea (4,91%). The other groups contributed with less than 4% each one.

ADDITIONAL INDEX WORDS: Abundance distribution, soft-bottom, macrobenthos.

INTRODUCTION

The Guanabara Bay (GB) is the most proeminent Brazilian Bay. Despite of its historical, economical, cultural and scientific relevance, it is one of the most degraded ecosystems in the Brazilian coast.

Estuaries are subject to wide seasonal and inter-annual fluctuations in water chemistry, circulation and sedimentation, particularly in response to weather-related variations in freshwater inflow (NICHOLS et al., 1986). Benthic faunal distribution varies considerably in time and space due in great part to the patchiness of species occurrences and overall heterogeneity of the benthic habitat. In GB studies addressing the relationship between the soft bottom fauna and the abiotic factors are very scarce and the description of its temporal variation have not been described accurately.

The importance of the sediment characteristics to understand the distribution patterns of the benthos has been largely discussed (GRAY, 1981; SNELGROVE and BUTMAN, 1994). Granulometry, organic matter and dissolved oxygen are limitant to many groups of the macrobenthos. Because of anthropogenic eutrophication hypoxia is spreading globally. Hypoxia can also lead to the decrease of diversity, affecting species abundance and composition, specially in estuarine benthic assemblages (SAGASTI et al., 2000; WU, 2002).

This work aims to describe the abundance distribution of the major groups of soft-bottom crustaceans, relating to sediment features (granulometry and organic matter).

Study Area

The actual total surface of GB (22°50’ S - 43°10’ W) is approximately 384 Km², 56Km² of which represented by islands (KIREFVE et al., 1997).

GB is bordered by several populated towns, which produce urban and industrial residues discharged into the bay. Approximately 6000 industries are installed at its surroundings areas, and others 6000 are located on its 4080 Km² drainage basin. Two oil refineries installed on the bay margin process 17% of the national petroleum. With many shipyards, the bay harbors a great number of passenger and fishing boats. This shipping activity requires a continuos dredging of the dock areas and navigation channels (KIREFVE et al., 1997).

FERREIRA (1995) estimates that 18 tons of petroleum hydrocarbons, of which 85% of urban origin, are carried to the bay every day. Great numbers of solids in suspension, organic matter, heavy metals and hydrocarbons are poured into the bay and accumulated in the sediment (KIREFVE et al., 1997). The high influx of nutrients to the bay resulted in the eutrophication of its waters (e.g., REBELLO et al., 1988; LAVRADO et al., 1991; QUIROGA, 1999). A high level of heavy metals have been detected associated to the sediment of the inner beaches of the bay, wich, depending on the circumstances, could be incorporated to the food web (CAÇONIA, 1984; LACERDA et al., 1988). CARVALHO and LACERDA (1992) showed that in GB the large input of sewage results in partially reducing sedimentation rates; this maintains heavy metals buried in anoxic sediments unavailable for biological uptake.

The plankton characteristics were discussed by many authors (e.g., OLIVEIRA et al., 1971; MACHADO, 1986; MACHADO et al., 1998; SCHUTZE, 1987; JICA, 1993; SEVIRNERREYSSAC et al., 1989; MAYR et al., 1998; QUIROGA, 1999). FERNANDES (1998) concluded that planktonic crustaceans show different dynamics between summer and winter seasons, probably due to salinity and temperature variations. GB has some characteristics of eutrophic environment, with chlorophyll a mean 57 G L-1, and maximum reaching 100 G L-1.

Studies about macrobenthos of GB have been centered on marginal habitats, such as beaches, mangroves and around some islands (e.g., OLIVEIRA, 1939, 1946, 1947, 1950, 1958; OLIVEIRA and KRAU, 1953, 1976; ARAÚJO and MACHIEL, 1979; SILVA et al., 1980; MACIEL, 1984; ZALMON, 1988; VERGARA FILHO, 1991, 1992a, 1992b; VERGARA FILHO et al., 1997).

BATALHA et al. (1998) studied the mollusks in GB and showed that the taxocene of this group is important in water quality evaluation. The studies on the soft bottom crustaceans of GB are scarce and mainly qualitative (OLIVEIRA, 1940; REBELLO and SILVA, 1985; LAVRADO et al., 2000).

MATERIAL AND METHODS

Four oceanographic surveys were carried out in GB at 38
stations (Figure 1) between 2000 (winter and spring) and 2001 (summer and autumn). At each station a 0.1 m3 van-Veen grab sample was taken in triplicate for analysis of macrobenthos and sediment abiotic features (granulometry, organic matter and carbonate content, and redox potential). The grain size fractions were determined by the mechanical dry sieving and decantation method described by Suguro (1973). Organic matter content was obtained by loss of mass on ignition after sediment was oven-dried at 105°C for 12 h and ashed at Lavosier oven at 500°C for 2 h. Biodetritic carbonate (CaCO₃) was obtained by HCl 10% attack. Dissolved oxygen was determined by Winkler method and superficial and bottom water temperatures were measured using a temperature probe.

Sediment samples were sieved out through a 1,0 mm mesh size and the benthos was sorted under stereomicroscope. The crustaceans groups were characterized by their abundance and frequency of occurrence.

An exploratory data analysis (Principle Component Analysis - PCA) was performed to test differences of mean abundance between sectors. Spearman correlation by rank was used to test the relationship between abundance of crustaceans and sediment features (granulometry and organic matter).

The organic matter content was higher on the inner sector and outer sector at stations 1 to 14; an medium sector (stations 15 to 26); and an outer sector (stations 27 to 38).

Because the abundance data did not fit Gaussian distribution and homocedasticity, even after transformation, it was employed non-parametrical methods. Kruskall-Wallis ANOVA by rank was performed to test differences of mean abundance between sectors.

The higher values of abundance were found mainly in the inner sector and outer sector at stations 15 located at the inner sector at station 30 located at the outer sector, at station 9 only (821 individuals).

In the spring the inner sector yielded, atypically, 587 individuals, being 46 on station nine. The abundance was higher towards the outer sector where 458 individuals were encountered.

The higher values of abundance were found mainly in the autumn due to tanaidaceans that were found in high abundance (16,69%).

The decapods were the dominant group in the autumn. The amphipods were largely dominants, followed by decapods and cumaceans. The decapods were the dominant group in the autumn. The minor groups showed a higher abundance also in the autumn due to tanaidaceans that were found in high abundance (16,69%).

The higher values of abundance were found mainly in the other sector at stations 38 (124 individuals), 37 (139 individuals) and 34 (489 individuals), but also in the inner sector, at station 9 only (821 individuals).

On the third survey the inner sector comprised 206 individuals, being 52 individuals on station nine. The abundance increased towards the outer sector where 458 individuals were encountered.

In the spring the inner sector yielded, atypically, 587 individuals, being 566 on station nine. The abundance decreased towards the outer sector which had 295 individuals.

The third survey the inner sector comprised 206 individuals, being 52 individuals on station nine. The abundance increased towards the outer sector where 458 individuals were encountered.

Table 2. Results of Kruskal-Wallis ANOVA by rank (K) on sediment variables between the inner (IN), intermediary (INT) and outer (OUT) sectors. K= Kruskall Wallis value; p= probability; MGS= mean grain size (phi); SC= sorting coefficient; PB= pebble (%); VCS= very coarse sand (%); CS= coarse sand (%); MS= median sand (%); FS= fine sand (%); VFS= very fine sand (%); OM= organic matter (%); CaCO₃= carbonate content (%). Lines indicate significant differences between the GB's sectors.

<table>
<thead>
<tr>
<th></th>
<th>IN</th>
<th>MED</th>
<th>OUT</th>
<th>K</th>
<th>p</th>
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</thead>
<tbody>
<tr>
<td>MGS</td>
<td></td>
<td></td>
<td>26.396</td>
<td>&lt;0.01</td>
<td></td>
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<tr>
<td>SC</td>
<td></td>
<td></td>
<td>9.815</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>PB</td>
<td></td>
<td></td>
<td>10.609</td>
<td>&lt;0.05</td>
<td></td>
</tr>
<tr>
<td>VCS</td>
<td></td>
<td></td>
<td>20.669</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>CS</td>
<td></td>
<td></td>
<td>26.679</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>MS</td>
<td></td>
<td></td>
<td>32.812</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>FS</td>
<td></td>
<td></td>
<td>33.558</td>
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<td></td>
</tr>
<tr>
<td>VFS</td>
<td></td>
<td></td>
<td>31.216</td>
<td>&lt;0.001</td>
<td></td>
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<tr>
<td>Silt</td>
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<td></td>
<td>37.718</td>
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<tr>
<td>Clay</td>
<td></td>
<td></td>
<td>25.747</td>
<td>&lt;0.001</td>
<td></td>
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<tr>
<td>OM</td>
<td></td>
<td></td>
<td>27.098</td>
<td>&lt;0.001</td>
<td></td>
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<tr>
<td>CaCO₃</td>
<td></td>
<td></td>
<td>19.040</td>
<td>&lt;0.001</td>
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Table 3. Abundance of the main groups during the four surveys.

<table>
<thead>
<tr>
<th></th>
<th>1st Survey</th>
<th>2nd Survey</th>
<th>3rd Survey</th>
<th>4th Survey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amphipoda</td>
<td>59.75%</td>
<td>80.30%</td>
<td>60.55%</td>
<td>28.86%</td>
</tr>
<tr>
<td>Decapoda</td>
<td>16.91%</td>
<td>13.31%</td>
<td>32.25%</td>
<td>40.72%</td>
</tr>
<tr>
<td>Cumaceae</td>
<td>7.90%</td>
<td>4.03%</td>
<td>3.49%</td>
<td>4.84%</td>
</tr>
<tr>
<td>Minor</td>
<td>15.44%</td>
<td>2.36%</td>
<td>3.71%</td>
<td>25.58%</td>
</tr>
</tbody>
</table>
DISCUSSIONS

GB is a estuarine area subjected to a continuous input of domestic sewage and influence of freshwater from its drainage basin. This environment is characterized by two well definedwet (December-April) and dry (June-August) seasons.

Table 4. Frequency of the mains groups during the four surveys.

<table>
<thead>
<tr>
<th></th>
<th>1st Survey</th>
<th>2nd Survey</th>
<th>3rd Survey</th>
<th>4th Survey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crustacea</td>
<td>73.68%</td>
<td>60.53%</td>
<td>55.26%</td>
<td>57.89%</td>
</tr>
<tr>
<td>Amphipoda</td>
<td>63.16%</td>
<td>44.73%</td>
<td>44.73%</td>
<td>50.00%</td>
</tr>
<tr>
<td>Decapoda</td>
<td>57.89%</td>
<td>44.73%</td>
<td>47.37%</td>
<td>42.11%</td>
</tr>
<tr>
<td>Cumacea</td>
<td>52.63%</td>
<td>26.31%</td>
<td>18.42%</td>
<td>15.79%</td>
</tr>
</tbody>
</table>

(KJERV VE et al., 1997).

The abundance data of crustaceans of the present work agreed with previous studies conducted at GB and other estuarine systems. Semi-quantitative data obtained by LAVRADO et al. (2000) showed a higher abundance and diversity of crustaceans in the outer sector, followed closely by the medium sector. Even with a different sampling gear (dredge) they were not able to collect an expressive amount of crustaceans in the inner sector. Yet, REBELO and SILVA (1985) reported five azoic stations in the inner sector and only one in the medium sector. Even though the outer sector did not present azoic stations, they mentioned low diversity in one station. They also emphasized that many of the species recorded by OLIVEIRA (1940) were missing in their samples.

SANCHEZ-MATA et al. (1993) using similar methodology at Ria de Ares-Betanzos (NW Spain) also showed an amphipod dominance, followed by decapods and cumaceans. Similarly, in their study, the remaining crustaceans groups were also poorly represented and were also treated as minor groups. In their study area SANCHEZ-MATA et al. (1993) found that the abundance of crustaceans increased from the inner sector to the outer sector of the bay. A similar gradient of abundance along an estuarine system was also reported by BACHELET et al. (1996) working in Arcachon Bay, SW coast of France.

Changes in the sediment characteristics have been reported to exert a strong influence on the macrobenthic communities (BOESCH, 1973; CHESTER et al., 1983; DESROY et al., 2002; FLINT and KALKE, 1985; METTAM et al., 1994; Teske and WOOLDRIDGE, 2003). The correlation found in this work between sediment features (granulometry and organic matter) and the abundance of crustaceans at GB support these animal-sediment relationship. Such texture-related faunal trend has also been found by other authors (SANCHEZ-MATA et al., 1993). The greater faunal diversity found in the outer sector of GB, related to a coarse sand prevalence supports what BOESCH (1972) observed.

SANCHEZ-MATA et al. (1993) also found a higher abundances correlated with low organic matter contents. BACHELET et al. (1996) also reports the existance of a strong relationship between the macrobenthos abundance and organic matter.

CONCLUSIONS

The taxocene of soft bottom crustaceans in GB is dominated by the amphipods. The crustacean abundance vary along the
The crustacean distribution patterns is correlated with sediment grain size and sediment organic matter contents. The greatest crustacean abundances occur in the areas with prevalence of coarse sand where the organic matter contents are lower. Conversely, the soft bottom crustaceans proved to be less abundant in the areas rich in silt and fine sand and higher organic matter contents.

**ACKNOWLEDGEMENTS**

The authors would like to thank FAPERJ for the financial support (process number E-26/150.148/2001), and CNPq for the Mastership's grant for the first author. We are also very grateful to Prof. MSc. Ricardo Pollery (USU) for all chemical and sedimentologic analysis and to Santa Ursula University (USU) for the logistic support which made possible the execution of this project.

**LITERATURE CITED**


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