

Preliminary Studies on the Acute Toxicity of Marine Sediments Collected Close to the Sewage Outfalls from Baixada Santista, SP, Brazil

Denis M. S. Abessa and Eduinetty C. P. M. Sousa

Abstract ? Sediments are the final destination for most of the compounds discharged in the aquatic ecosystems. In this study, sediments collected close to the diffusers of the sewage outfalls from Baixada Santista were evaluated by the whole sediment toxicity test using the amphipod *Tiburonella viscana*. Three samples from Santos, four from Guarujá and six from Praia Grande were considered significantly toxic. This indicated that the sediments are being affected by the sewage disposal, presenting thus a decreased quality for marine life. Further studies are recommended to determine the degree and extension of the effects caused by the sewage outfalls.

Key-words ? Baixada Santista, sediment, toxicity, sewage

I. INTRODUCTION

The Central coast of the State of São Paulo, named Baixada Santista, is a very urbanized area, and some of its cities are important touristic centers, specially during the summer [1]. The disorganized occupation of land in these cities since the 20th Century has produced several impacts to the environment. Among them, the discharge of sewage directly to the beaches has major importance, due to its implications not only to the natural environment but also to public health. Presence of sewage at the beaches causes marine contamination and water unsuitability for swimming, what can result in serious problems to the economies based on the tourism.

In the recent years, as part of a wide sanitation program developed by the govern, some sewage plants were built aiming to minimize or even eliminate the problem of beaches contamination by sewage [2]. Four plants were made up in Baixada Santista: two in Praia Grande, one in Santos and one in Guarujá. Since the beginning of operation of these plants, the domestic effluents are being disposed into the ocean by sewage outfalls. The average length of these outfalls is about 4 km and in none of them the sewage receives any kind of treatment.

Despite the advantages provided by the oceanic disposal of untreated sewage, environmental impacts may occur with more or less intensity, depending on the oceanographic conditions at the disposal sites [3]. Thus, the continuous monitoring of these discharges is necessary, aiming to identify the existence of possible environmental impacts. The effluents from the sewage outfalls from Baixada Santista were proved to be toxic [2], however, studies regarding their impacts to the marine ecosystem are still lacking.

In this study, the objective was to evaluate preliminarily the quality of sediments collected close to the diffusers of the sewage outfalls from Baixada Santista, by the acute sediment toxicity test with the amphipod *Tiburonella viscana* [4]. The sediment was selected to be tested because most of the contaminants accumulate into the sediments in concentrations many times higher than those observed to the water column [5], producing toxicity to the benthic organisms.

II. MATERIAL AND METHODS

A. Test-organism description and collection

The amphipod *T. viscana* is a common species from the coast of São Paulo, inhabiting the upper layers of clean sands or muddy sands from midwater level to 65m depth [6], and being considered as sensitive as other marine amphipods used in toxicity tests [4]. The organisms were collected at Engenho D'Água Beach, São Sebastião Island (23°48'S-45°22'W) and acclimated for 3 days in laboratory.

B. Sediment collection

The sediments were collected in January, 1998, at ten sites from Praia Grande, five sites from Santos and seven sites from Guarujá (Fig. 1), using a "Peterson" grab sampler. The stations were distributed around the diffusers of the four sewage outfalls. Sediment from Engenho D'Água Beach was used throughout the test as control. Only the sediments from the upper 2-cm layer were collected, cooled in the field to about 4°C and stored in the dark at 4 ± 2°C for 3 days.



Fig. 1. Scheme of Baixada Santista showing the sewage outfalls and the sampling sites.

C. Toxicity test procedure

The sediment toxicity test was conducted following the method described by Melo [7]. One day before the test, each sediment sample was thoroughly homogenized within its storage container by stirring, and aliquots were distributed into the test chambers (1-L polyethylene beakers). Sediments were not sieved. The test chambers were filled to 2 cm depth with the test sediments and filtered seawater up to 750 ml and then maintained overnight at 25 ± 2 °C with gentle aeration. On the next day, ten amphipods were added to each chamber and the test was started. Only adults, active and healthy organisms were used. Amphipods that did not bury within 1 hour were removed and replaced. Three replicates per test sediment were prepared. The test was conducted at 25 ± 2 °C, under constant aeration and lighting.

After ten days, the content of each chamber was gently sieved through a 0.5-mm screen and the surviving amphipods were counted. Missing organisms were considered dead. The mortalities were compared by the one-way analysis of variance (ANOVA), followed by Dunnett's test [8]. The dissolved oxygen concentration, salinity and pH of the overlying water in the test chambers were measured at the beginning and termination of the tests. The water temperature was monitored daily.

III. RESULTS

The conditions of the overlying water in the test chambers were considered appropriate. The salinities ranged from 34 to 35 ppt, the pH ranged from 8 to 8.5 and the DO ranged from 4.65 mg/L to 5.71 mg/L. Temperature was maintained constant at 25 ± 2 °C.

In order to facilitate the interpretation of the data, the results of the toxicity test for each city (Praia Grande, Santos and Guarujá) were separated in different graphics, being presented in the Figs. 2, 3 and 4, respectively. Six samples from Praia Grande, three from Santos and four from Guarujá were considered toxic to the amphipods.

IV. DISCUSSION

The oceanic disposal of untreated sewage by outfalls is a continuous and punctual source of contaminants to the marine environment. In shallow waters, where the dilution conditions are very restrict, this can result in an increasing contamination and occurrence of several effects to the biota [9].

Domestic sewage usually presents a wide range of chemicals in addition to the organic matter. Most of these contaminants are adsorbed to the particulate carbon and sink to the bottom, where they can accumulate in high concentrations. Once in the sediments, the contaminants interact with each other and the final result is an unknown toxicity to the benthic organisms [10]. In these cases toxicity tests can be much more cost-effective and reliable

in their estimations of the impacts than other methods as chemical analysis and ecological studies, for example.

The results obtained in this study showed that the sewage outfalls from Baixada Santista are causing a decreasing in the quality of the sediments located at their respective nearby areas, what is evidenced by the sediment toxicity of many samples.

In Praia Grande, where there are two outfalls, six samples were toxic to the amphipods (Fig. 2). Close to the outfall situated further East, the sediments tended to be more toxic (4 toxic samples), whereas the area close to the resting outfall seemed to be not as impacted, since only two samples were toxic.

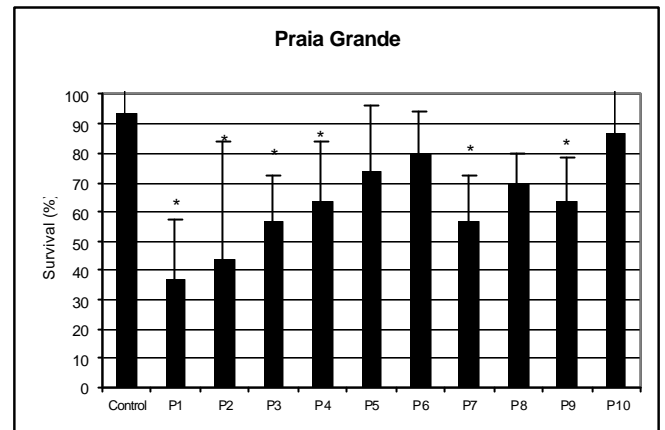


Fig. 2. Survival of amphipods exposed to sediments from Praia Grande (*= significant different from control, $p < 0.05$).

The sediments from Santos exhibited a similar pattern, three samples were considered toxic (Fig. 3). The sample collected close to the diffusers (station 1) was toxic, corroborating the results obtained previously [10] to the same site in a study on the conditions of the sediments from the Santos Estuary. For both outfalls from Santos and Praia Grande, samples collected close to the diffusers were toxic, evidencing that the effects were due to the discharges.

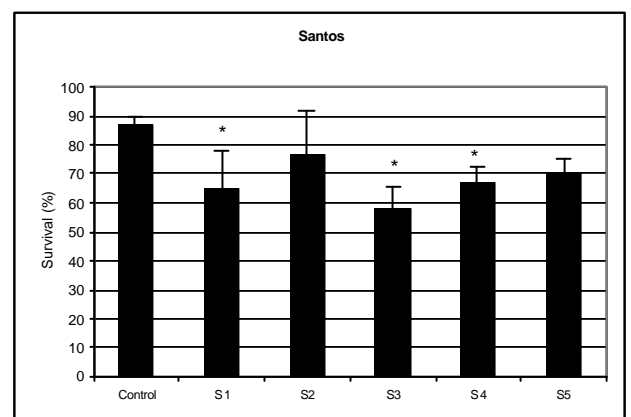


Fig. 3. Survival of amphipods exposed to sediments from Santos (*= significant different from control, $p < 0.05$).

For Guarujá, the situation is more complex. Two toxic samples were collected close to beach (stations G1 and G2) and the other two toxic ones were collected in the deeper stations (G5 and G6), with a set of non toxic samples between these two groups. This unexpected fact is understandable once the outfall from Guarujá was partially broken at about 1,5 km from the beach, where the stations G1 and G2 were situated, thus affecting the sediments of that area.

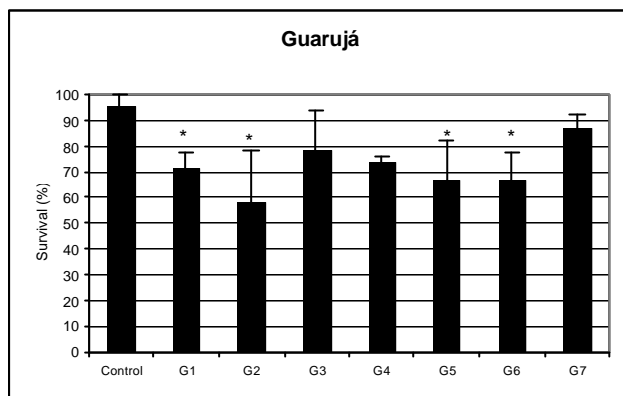


Fig. 4. Survival of amphipods exposed to sediments from Guarujá (*= significant different from control, $p < 0.05$).

Observing the results of each set of samples, it is possible to compare the effects of each outfall. By this point of view, there were few differences in the sediment toxicity for all of them. The amphipod survival means for all the toxic samples were not very low, evidencing that the toxicity tends to be moderate around the sewage outfalls. Moreover, for none of the outfalls all the samples were toxic, suggesting that the area affected by the discharges possibly is not so broad.

However, based on the results obtained in this study, the sediments collected close to the Eastern outfall from Praia Grande seemed to present the worst situation, followed by the sediments from Guarujá and Santos, respectively. The sediments collected close to the Western outfall from Praia Grande seemed to be in best conditions, compared to the others, once only two samples were toxic and their toxicity was not very high.

Anyway, the results showed that all the sewage outfalls are affecting the marine environment, which can be observed by presence of acutely toxic sediments close to them.

In addition, the diffusers of all the studied outfalls are located in shallow waters (12m deep), being subject to the resuspension due to the action of waves and tides [10]. Thus, by one hand, this means that waves can remove the contaminants and transport them to other areas, but on the other hand it also means that the compounds retained in the sediments can return to water column, i.e., the sediments can be not only repositories but also sources of chemicals to the water. This also suggests that the toxicity may change according to the presence of wave swells in these areas, evidencing the need of a continuous monitoring of such discharges.

For a complete comprehension of the effects induced by the sewage outfalls from Baixada Santista, the additional studies should comprise water and sediment toxicity evaluations, chemical analysis, ecological studies and determination of biochemical indicators in vertebrates and invertebrates. These studies must be continuous in order to provide sets of data that can be interpreted with more reliability.

V. CONCLUSIONS

The results showed that the sewage disposal by the outfalls from Baixada Santista is producing negative effects to the sediments situated at their respective nearby areas. Further studies are necessary in order to investigate more precisely the extension and the degree of the impacts caused by each one of them.

VI. REFERENCES

- [1] L. R. Tommasi. "Considerações ecológicas sobre o sistema estuarino de Santos (SP)". Honorary Professor Thesis. Universidade de São Paulo, São Paulo, Brazil, 2 vols. 1979.
- [2] B. R. F. Rachid. "Ecotoxicidade de efluentes sanitários urbanos lançados ao mar através de emissários submarinos, no Estado de São Paulo". Master of Science Dissertation. Universidade de São Paulo, Instituto Oceanográfico. 95p. 1996.
- [3] R. C. Swartz, F. A. Cole, D. W. Schults and W. A. DeBen. "Ecological changes in the Southern California Bight near a large sewage outfall: benthic conditions in 1980 and 1983". *Mar. Ecol. Prog. Ser.*, n? 31, pp. 1-13. 1981.
- [4] D. M. S. Abessa, S.L.R. Melo and E.C.P.M. Sousa. "Note on the biology and feeding behaviour of the amphipod *Tiburonella viscana* and its use in toxicity tests". *Proceedings: 4º Simpósio de Ecossistemas Brasileiros*. Vol 2. Águas de Lindóia, SP, Brazil. pp. 270-276. April, 1998.
- [5] M. G. Nipper, D. J. Greenstein and S. M. Bay. "Short- and long-term sediment toxicity test methods with the amphipod *Grandidierella japonica*". *Environ. Toxicol. Chem.* n? 8, pp. 1191-1200. 1989.
- [6] Y. Wakabara. "Sobre alguns *Gammaridea (CRUSTACEA-AMPHIPODA)* da região de Ubatuba". Master of Science Dissertation. Universidade de São Paulo, São Paulo, 52p. 1969.
- [7] S. L. R. Melo. "Testes de Toxicidade com sedimentos marinhos: adequação de metodologia para o anfípodo escavador *Tiburonella viscana*". Master of Science Dissertation. Universidade de São Paulo, Escola de Engenharia de São Carlos, São Carlos, SP, 172p. 1993.
- [8] J. H. Zar. "Biostatistical Analysis". Prentice-Hall, Englewood Cliffs, NJ. 383p. 1984.
- [9] R. C. Weber. "Sistemas costeiros e oceânicos". *Química Nova*, n?15, vol. 2, pp. 137-143. 1982.
- [10] D. M. S. Abessa. "Testes de toxicidade de sedimentos da região de Santos-SP-Brasil, utilizando o anfípodo escavador *Tiburonella viscana (Crustacea-Platyischnopidae)* Thomas & Barnard (1983)". Master of Science Dissertation. Universidade de São Paulo, Instituto Oceanográfico, São Paulo, 97p. 1996.