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Occurrence and distribution of sulphate-reducing bacteria in a polluted lagoon

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Abstract

The presence and distribution of sulphate-reducing bacteria (SRB) in the sediment and water from four strategic points on the Lagos Lagoon were assessed using the most probable number technique. All the samples were positive for the dissimilatory sulphate reducers. The relative occurrence varied markedly with the site and pollution status. The least polluted end of the lagoon recorded the lowest number of SRB in both sediment (4.23×10^2 SRB/ml) and water (28 SRB/ml) while the most polluted site receiving sewage and domestic wastes harboured numbers as high as 5.71×10^3 and 7.6×10^4 SRB/ml for water and sediment samples, respectively. The occurrence of sulphate-reducing bacteria in such numbers indicated that this environment favoured biocorrosion of buried and immersed metals. The active involvement of these organisms in the syngenesis of sulphur, metallic sulphides and the general biodegradation of pollutants in this ecosystem is discussed.

Introduction

The current understanding that sulphate reducing bacteria can metabolize a vast range of substrates (Baker *et al.*, 1962; Hansen, 1988) implies that they may play an important role in the biodegradation of organic matter in reduced environments. Although they are ubiquitous, the abundance and distribution of these corrosion bacteria are influenced by pH, temperature and redox potential of a given environment (Postgate, 1965). The reasons for stimulated interest in the ecology of SRB in aquatic environments include their involvement in the biocorrosion of buried and immersed metals, the poor aesthetics associated with their dissimilatory sulphate reduction activity as well as their role in the biogeochemical cycling of molecules in the sediment.

This paper describes the first study on the prevalence of the sulphate-reducing bacteria in the Lagos Lagoon. The lagoon is an expanse of estuarine water (208 km^2 area) which is heavily polluted by industrial and domestic effluents and wastes, which extends from Lagos harbour to the Niger delta in South Western Nigeria.

Materials and methods

Sampling sites

Four points, namely the University of Lagos jetty (site 1), Ijora (site 2), Oko Baba (site 3) and Iddo (site 4) along the Lagos Lagoon, were studied. These sites represent the unpolluted, petroleum-polluted, sawdust and raw sewage/domestic waste-polluted points, respectively, on the Lagoon.

Sampling

Water and sediment samples were collected from each site for analysis. Pre-sterilized 500 ml capacity plastic kegs were used to collect water samples at 15 cm below the water surface. Sediment samples (0—10 cm top sediment) were collected with the aid of a ponar grab. Composite samples from at least three points in each site were taken to give a good sample representation of the site. The samples were stored in the refrigerator upon collection and analysed within 24 h. Sampling was conducted in June and August 1990.

Enumeration of SRB

Populations of sulphate-reducing bacteria in the samples were estimated using the three-tube regime most probable number technique. Baar's medium modified by Postgate (1966) and further modified by Obuekwe and Okoronkwo (1982) was employed as the culture medium. After 14 days of anaerobic incubation at ambient temperature (30—33°C) those screw cap tubes showing blackening of the 'iron' culture broth were recorded as positive.

Table 1 Populations of sulphate-reducing bacteria at polluted points in the Lagos lagoon

Site description	Sampling period	Sulphate-reducing bacteria*: Water (MPN/ml)	Sediment (MPN/g)
1 University of Lagos jetty (unpolluted)	June	2.77 x 10	4.23×10^2
	August	2.75 x 10	4.68×10^2
2 Ijora (industrial and hydrocarbon pollution)	June	4.67×10^3	2.24×10^4
	August	4.40×10^3	3.34×10^4
3 Oko-Baba (polluted by sawdust and wood industry wastes)	June	4.93×10^3	4.23×10^4
	August	4.02×10^3	4.75×10^4
4 Iddo (heavily polluted by raw sewage and domestic debris)	June	5.71×10^3	4.47×10^4
	August	5.00×10^3	7.60×10^4

Results

Sulphate-reducing bacteria were present in all sediment and water samples taken during the months of June and August. However, their relative occurrence varied markedly with the sampling sites. Table 1 displays the mean numbers of the SRB obtained in the Lagos Lagoon. Most probable numbers ranged from 28 to 5,710 SRB/ml in water samples, while sediment samples contained considerably more of the bacteria (423—76,000 SRB/g) than the surface water. All the polluted sites contained higher populations of the SRB than the relatively clean water of the University of Lagos jetty. Fewer SRB were recorded in the Lagoon water at the peak of the rains (August) than in June, whereas the reverse trend was observed for sediment samples.

Discussion

Quite a few studies have been carried out on the biotic processes in the Lagos Lagoon (Amund *et al.*, 1981; Amund and Igiri, 1990). This brief report is, however, the first to assess the presence of the sulphate-reducing bacteria in the ecosystem. Many industries in the fairly industrialized city of Lagos dump effluents and wastes indiscriminately into the Lagoon thereby overwhelming the self-purification capacity of the water body. Apart from government legislation on waste disposal, an understanding of the microbial communities involved in waste degradation in the Lagoon is of vital interest.

The significant differences in the population size of SRB in polluted *versus* unpolluted sites of the Lagoon is just one example of the impact of pollution of various kinds on the water body. The occurrence of the bacteria in all the sites studied was expected, given the prevailing temperature range (28—30°C), pH (6—7.4) and redox potentials (+100 mV) which were conductive for their growth. The numbers of SRB reported in the literature for polluted water was as high as 10^4—10^6/ml depending on a host of factors of which nutrient status, absence of toxic pollutants and redox potential are the most important (Postgate, 1965). On the other hand, clean water could contain 0 to 90 SRB/ml (Hardy, 1981); a report which tallied with the 28 SRB/ml of the University of Lagos jetty, described here (Table 1). The higher prevalence of SRB in sediment compared with surface water samples is explained by the fact that the high levels of organic debris which settle on the sediment enhance O_2 depletion thus favouring SRB proliferation.

Previous indications that SRB may play an important role in the degradation of wood and sawmill pollutants (Kimata *et al.*, 1955) such as that in Oko Baba (site 3), and petroleum/petrochemicals (Iverson and Olson, 1984) such as those in Ijora (site 2), are emphasized in this report. The fairly high numbers of SRB obtained in this brief survey indicate their active involvement in the biogeochemical cycling of molecules in the Lagos Lagoon. Further studies on the ecology of these microbes will be useful in evaluating their economic importance and in assessing their potential use as clean-up agents in reduced environments polluted with petrochemicals and other materials.

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