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Environment International 32 (2006) 284 – 291
ENVIRONMENT INTERNATIONAL
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Ecotoxicological effect of grounded *MV River Princess* on the intertidal benthic organisms off Goa

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Available online 29 September 2005

Abstract

The ecotoxicological effects of oil spill from the grounded vessel *MV River Princess* on the intertidal benthic organisms of Sinquerim–Candolim beach at Goa were investigated. An intertidal expanse of 1 km on either side of the grounded vessel was selected to evaluate the concentration of total petroleum hydrocarbon (TPH) in the sediment and its effects on the composition, abundance and diversity of micro-, meio- and macrobenthos. TPH in the intertidal sediment ranged from 7.8 to 89 μg g^{-1} (mean 35.44 ± 26.35 SD). Microbenthos comprised of microalgae, protozoans and juvenile forms of meiobenthos. Apart from juvenile nematodes, which were abundant, *Coscinodiscus* spp., *Navicula* spp., and *Nitzschia* spp. representing microalgae were also observed in microbenthic samples. Meiobenthos was represented by 13 taxa and their total density ranged between 92 and 1057 nos. 10 cm^{-2}. Maximum meiobenthic abundance of 1057 nos. 10 cm^{-2} was observed at Sinquerim. Nematodes were the dominant meiobenthic taxa followed by turbellarians and harpacticoid copepods. The macrobenthos was numerically dominated by polychaetes, followed by crustaceans whereas bivalve molluscs were less represented. There was substantial increase in the petroleum concentration in the beach sediment compared to the previously reported values and highest TPH (89 μg g^{-1} sediment) values were in the vicinity of the grounded vessel. The polychaete/amphipod ratio and cumulative and partial dominance abundance–biomass curves showed significant negative impact of TPH on macrofauna. The benthic community structure also showed measurable changes, as there was significant decrease (60%) in the number of species. Given that the microalgal counts were low in sediment, it is assumed that the intertidal meiofauna was possibly using oil-degrading bacteria as alternate food source. In conclusion, the results reported here suggest that the grounded ore carrier is not only detrimental to the beach community, that may take longer time for recovery, but also affects the beach morphology which may have long-term impact on local fishery.

Keywords: Ecotoxicology; Grounding; Oil spills; *MV River Princess*; Petroleum hydrocarbon; Benthic fauna; Goa; India

1. Introduction

It is well known that oil spills represent one of the major threats to the marine environment. Petroleum hydrocarbon from oil spills and various other sources constitutes a potential threat to the coastal environment and to growing economic activities, such as ecotourism and fisheries (Commendatore et al., 2000). Oil spill can cause increase in abundance of benthic fauna via organic enrichment or mass mortality, as a result of direct toxicity as well as asphyxiation. In addition, the incorporation of sub-lethal amounts of oil and oil products into organisms can result in reduced resistance to infection and other diseases thereby affecting the survivability of marine species, which stand higher in the marine food web. However, the degree of impacts of oil on marine organisms varies depending on the concentration of oil, oil type, duration of contact with oil, sensitivity of organisms and geographical location of spill (Gin et al., 2001). Out of the one billion gallons of oil that enter the world oceans each year, 36% is from runoff, 12% is accidentally released from tankers, 22% is intentionally released from oil tankers as normal operating functions, and 8% is from natural seeps (Suchanek, 1993).

Benthic organisms are important components of the marine ecosystem and play a decisive role in maintaining ecological balance. They not only act as a major food source for many fish species but humans also consume some of the large-sized bivalves and crustaceans. Polychaetes, bivalves and crustaceans are dominant among the macrobenthic forms and are considered as environmental indicators. In the benthic ecosystem, hydro-

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doi:10.1016/j.envint.2005.08.025

Fig. 1. The ore-vessel *River Princess* grounded at Candolim.

carbon pollution may cause irreversible changes such as elimination of organisms in the lower trophic level, which could be useful in the breakdown processes of carbon, nitrogen and sulphur cycles and also altering the species composition in the food web (Gray and Ventilla, 1971). Cyanobacteria and microalgae (diatoms) are components of primary trophic level and contribute significantly to the primary productivity (MacIntyre and Cullen, 1996) as well as sediment stabilization (Sutherland, 1998) in the marine habitats. With meiobenthos being an important link between macro- and microbenthos, any adverse effects of petroleum on this integral component is enough to cause an imbalance in the food chain.

An ore-carrier *MV River Princess* ran aground hardly 500 m off Goa's internationally famous Sinquerim–Candolim–Calangute beach on 6th June 2000. This 240-m-long ship (Fig. 1) drifted away with rough heavy winds on 6th June 2000 after being anchored for one year and a half at Marmugao harbour. Almost 40 tonnes of oil were removed from the ship while the Coast Guard still suspects about 15 tonnes of leftover. Urgent removal of *MV River Princess* was anticipated as it was expected that the ship over the time would affect the ecology of Sinquerim—a tourist spot in Goa. However, due to some unavoidable circumstances, removal of the ship was hindered and it remained grounded for a period of 3 years. It was assumed that grounding of the vessel for such a long period would affect the benthic biota. Thus, sampling in intertidal area was conducted with a view to study the impact of oil spill on the benthic organisms.

2. Materials and methods

2.1. Study area

The study area is located between lat. 15°30′–15°33′ N and long. 73°40′–73°46′ E along the Sinquerim–Calangute beach (Fig. 2). The ship was grounded at Candolim, which is flanked by Sinquerim beach on one side and Calangute on the other. Benthic samples were collected during low tide at mid tide level along the intertidal stretch of 2 km starting from Sinquerim to Calangute, covering an area of 1 km each on either side of the ship.

2.2. Field sampling

A total of 11 stations were fixed at ≈200 m distance (Fig. 2). The beach area from Sinquerim to Candolim (the place where the ship was grounded) was ≈1 km. Thus, for comparison purposes, sampling

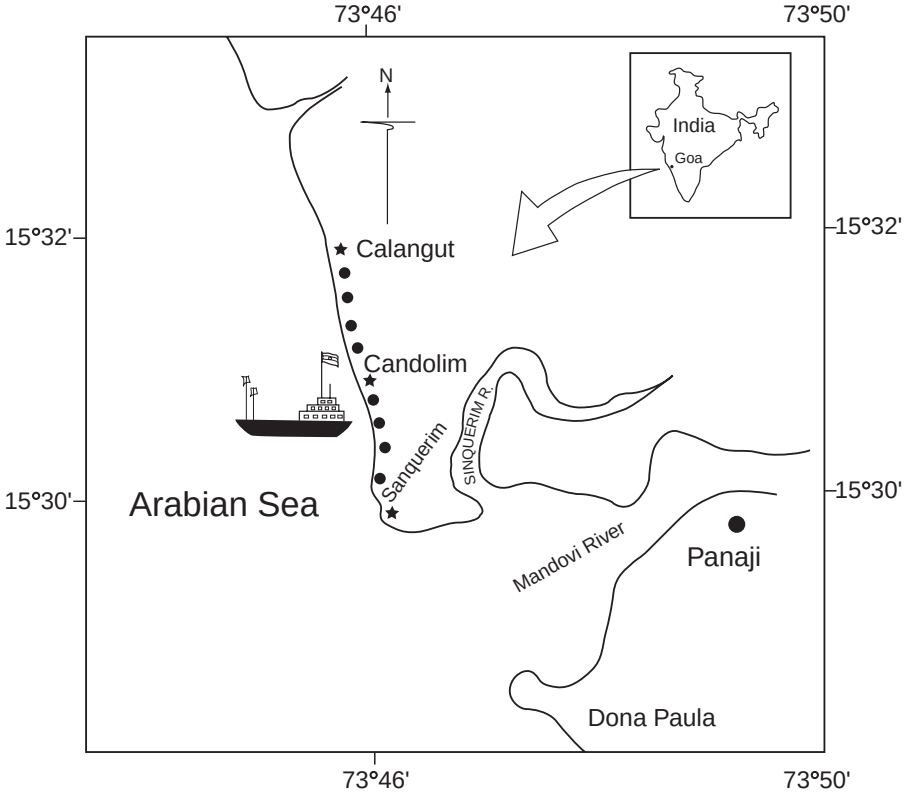

Fig. 2. Location of sampling stations.