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Mass mortality of macrobenthos in a biodiverse rocky beach- Impact of a minor oil spill

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A field survey was carried immediately post an accidental oil spill at rocky intertidal zone of Uran. Mass mortality of macrobenthos was observed at spillage site whereas reference site harboured diverse and live macrobenthic population. This study aims to highlight the importance of early monitoring of impacted and reference locations for determining the magnitude of damage caused to the environment due to any kind of spill and in turn acquire baseline information for tracing future path of recovery.

[**Keywords:** Oil spill, Rocky intertidal zone, Macrobenthos, Mass mortality]

Introduction

The presence of a multipurpose harbour, major oil and gas port and multiple oil refineries along its coastline has rendered Mumbai vulnerable to periodic oil spills. In the last few years, at least three accidental oil spills have occurred in the coastal waters around Mumbai which were extensively reported in major newspapers and have raised concerns among citizens and ecologists alike. In the background of the aforementioned spills, an urgent need was felt to evaluate the immediate consequences of oil spills of different dimensions on the fauna and flora of the impacted area. One such study was undertaken in the rocky beach of Uran which was severely affected by an oil spill.

Materials and Methods

A pipeline of a major oil and gas company situated at Uran developed a leak on the night of 6th October 2013, spilling about 5000 litres of crude oil into the Arabian Sea sparking widespread concern on its impact on the coastal ecology. A field study was conducted a day after the occurrence of oil spill, at the rocky intertidal zone of Uran. Replicate macrobenthic as well as sediment samples for petroleum hydrocarbon analysis[1] were collected during the ebb tide from high, mid and low water zones of a severely oil impacted region and a nearby non-impacted intertidal area which served as a reference station (Figure 1).

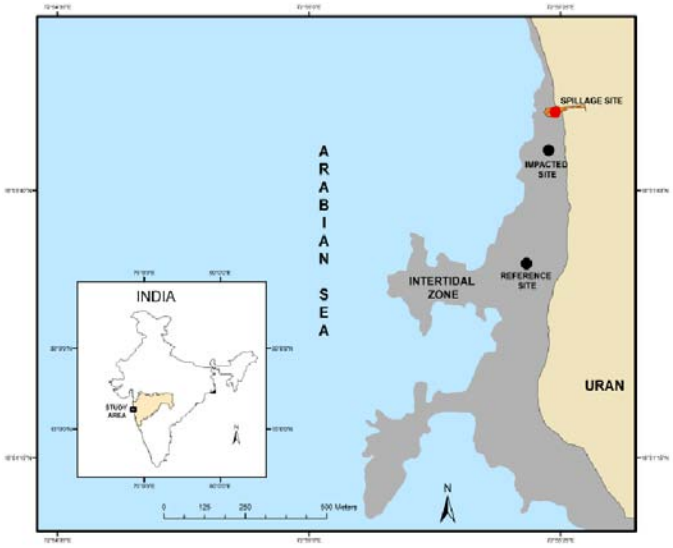

Fig. 1- Study area with the impacted and

Results

The intertidal rocks of the spillage site (Figure 2a) were covered with a thick layer of oil and devoid of algae (Fig 2b). The disparity between the affected and non-affected beaches was stark both in terms of the extent of oil coating as well the presence of live macrobenthic fauna. Dead organisms like brachyurans, decapods, large polychaetes belonging to families like Eunicidae, Terebellidae and small sized fishes were found

scattered in the tidal pools (Figures 2c-i) smeared with oil. While the high and mid water line were strewn with dead or partially lifeless organisms, macrobenthic groups like tanaidaceans, isopods, gastropods, amphipods, anomurans, brachyurans and polychaetes were observed in a live condition in the low water area. The most interesting observation was the mass mortality of large polychaetes, many of which otherwise are rarely found in macrobenthic samples collected from rocky areas. Polychaetes were found in tidal pools in convoluted aggregations (Figures 2d-e). Gentle prodding of these animals indicated that many were dead and the remaining were sluggish and appeared to have been narcotized by the oil. Analyses of petroleum hydrocarbon in sediments collected from mid water zone indicated higher content (477 µg g^{-1}) as compared to the high (106.9 µg g^{-1}) and low water zones (33.7 µg g^{-1}). Values from high, mid and low zones of the reference station were 14.7 µg g^{-1}, 5.1µg g^{-1} and 5.7 µg g^{-1} respectively.

The reference transect situated barely a kilometre away, was visually free from oil coating and had an extensive algal cover (Figure 2j) with thriving macrobenthic assemblages (av 1496 ind.m^{-2}). Macrobenthic groups found abundant at the reference site were pelecypods, gastropods, amphipods, isopods, sipunculids, nemertines, decapods and polychaete families like Nereidae, Aphroditidae, Phyllodocidae, Spionidae, Capitellidae, Lumbrineridae and Eunicidae. However, large polychaetes, that were seen strewn in the impacted zone, were absent here. These large sized polychaetes live in the rocky crevices of unpolluted intertidal zones and toxic pollutants like the crude oil in this case, created stressful conditions forcing them to huddle together in tidal pools.

Discussion

The large scale macrobenthic mortality had happened not only due to the smothering and coating effect of the oil but also due to the resultant high toxicity as well as asphyxiation[2]. Past studies have indicated that the short-term adverse effects of oil pollution may include smothering, hypothermia and mortality[3].

Amphipods are known to be particularly sensitive to oil pollution[4] and their relative abundances are used in many oil spill related environmental impact assessment studies to evaluate the health of the ecosystem subsequent to a spill[5]. In this case, amphipods were completely absent from the highly impacted high and mid water zones and only few individuals (av 38 ind.m^{-2}) were present in the relatively unaffected low water zone.

Fig. 2- (a) Spillage site at Uran (b) Impacted site at Uran (c) Dead organisms at impacted site (d) Dead large sized polychaetes at oil smeared high water line of impacted site (e) Convoluted aggregations of large polychaetes in oiled tidal pools at mid water (f) A large dead terebellid polychaete (g) Dead berried crab (h) Dead prawn on oil smeared rocky substratum (i) Dead fish in oil impacted site (j) Reference site at Uran

Conversely, significantly high numbers of amphipods (av 448 ind.m^{-2}) were present in the reference station. Algal cover of the reference area was also found to harbour rich populations of isopods, gastropods, pelecypods, and polychaetes. High macrobenthic abundance and diverse faunal groups of the reference site indicated that the rocky shoreline of Uran was healthy supporting diverse benthic communities.

A subsequent visit to the oil impacted transect on the very next day (9.10.2013) revealed that while the oil coating still persisted in the area, all traces of dead animals had disappeared. However there were no signs of any kind of animal movement in the area. While past studies have reported that substantial mortality happens when oil in appreciable quantities impact benthic habitats[6], it is often not apparent as the dead remains of soft-bodied organisms are often either swept away by subsequent tides or scavenged by birds flocking on the intertidal areas. The latter was noticed during our first field study. This observation emphasises the importance of early surveys in estimating the damage caused to the environment by any kind of spill.

In general, impacts of oil spill include large scale faunal mortalities especially that of large-sized sensitive species which then get replaced by tiny bodied opportunistic species[7]. Other impacts may also include a reduction of diversity and density[8]. Similar post spill impacts were seen in this study. Oil impacted areas can be considered as recovered only if the area regains its pre spill condition including having its pre spill fauna and flora[6]. A systematic follow-up study is being planned to trace the path of recovery of study area. This is essential to discern whether the environmental damage caused to a rocky beach such as Uran is of a short term or long term nature.

Conclusion

The study documented macrobenthic mass mortality due to minor oil spill at rocky intertidal zone of Uran. Observations emphasized the importance of early monitoring of impacted and reference locations for determining the extent of damage. Present spill, despite its fatality in the affected region provides an opportunity to study the recovery of an area denuded of its inhabitants.

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