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Unusual Spawning Behaviour of the Horseshoe Crab (*Tachypleus gigas,* Müller) after the Tsunami along Orissa Coast, India

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ABSTRACT

The central coast of Tamil Nadu, Andaman and Nicobar Islands, along with other regions, was severely hit by the tsunami on 26 December 2004. A strange spawning behaviour of the Indian horseshoe crabs (*Tachypleus gigas,* Müller) was observed after the tsunami disturbance. Along the northeast coast of India, the horseshoe crabs normally migrate towards the shore in large numbers coinciding with the tidal height and grain size of the sediment and spawn in nests made in sand. The spawning behaviour was normal until November 2004 and throughout that period about 35 to 45 nests in 200 m^2 of area of the breeding beach were examined. However, no nesting was observed from December 2004 to March 2005, i.e. after the occurrence of tsunami. The number of nests per 200 m^2 of area (~82) and the number of eggs per nest (750-1000 eggs) were increased considerably when the normal conditions were restored in April 2005. The absence of spawning migration, from December 2004 to March 2005, is totally an unusual behaviour and this happened for the first time during the past several years of the study period.

Keywords: Indian horseshoe crab, unusual spawning behaviour, tsunami

INTRODUCTION

Many of the Asian and Pacific developing countries are situated in the world's hazardous belts and they are vulnerable to natural disasters which occur periodically as a result of climatic and seismic activities (ESCAP, 1995). In the recent years, more and different kinds of natural disasters such as earthquakes, super cyclones, cloud bursts, floods and tsunami have occurred. These disasters kill thousands of people and destroy habitat as well as properties worth million of dollars each year. The rapid growth of the world's population and its increasing concentration along the coastal belt accelerate the problems of hazard, leading to both frequency and severity of natural disasters (ESCAP, 1995).

On 26 December 2004, the central coast of Tamil Nadu, Andaman and Nicobar Islands in India, along with several other countries in South-East Asia, were severely hit by the tsunami (*Fig. 1*). The massive tsunami was triggered by an underwater earthquake with a magnitude of about 9.3 Richter scale, off the coast of the northern Sumatra Island, Indonesia (Lay *et al.*, 2005). The impact of its tidal waves, measuring up to 7 m to 10 m high, caused seawater surges and severe flooding which led to widespread environmental and infrastructure damages along Nagapattinam and Cuddalore districts of India. Although several studies have been carried out to study on the impact of this particular disaster, no study has been carried out to investigate the behavioural changes of the inter-tidal and sub-tidal marine animals due to tsunami disturbance (Lay *et al.*, 2005). Therefore

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Fig. 1: A map of India (dots show tsunami affected areas)

an attempt was made to study the impact of tsunami on the spawning behaviour of the horseshoe crabs in the present study.

MATERIALS AND METHODS

In India, horseshoe crabs (*Tachypleus gigas*, Müller) are found in abundance along the Balramgari coast (Lat 21° 27'N, Long 87° 04' E) (Chatterji, 1994). They regularly migrate towards the shore in large numbers to spawn in nests made in sand, depending upon the tidal height (Chatterji *et al*., 1992). A 200 m^2 area at the Balramgari beach was regularly monitored by the researchers for the past several years to study the nesting behaviour of the horseshoe crabs. The nest of the horseshoe crab was a depression in the sand made by female brooders for laying their gametes. The number of depressions, along with number of eggs in each depression, was counted every time during the full moon tides at monthly intervals, and this was done regularly to study the nesting frequency of the horseshoe crabs. Replicate sediment samples were also collected from the nesting area during the low tide, while grain size analysis was done following the method as described by Chauhan and Chaubey (1989). The same area was monitored immediately after the tsunami disturbance, following the same protocol as described above.

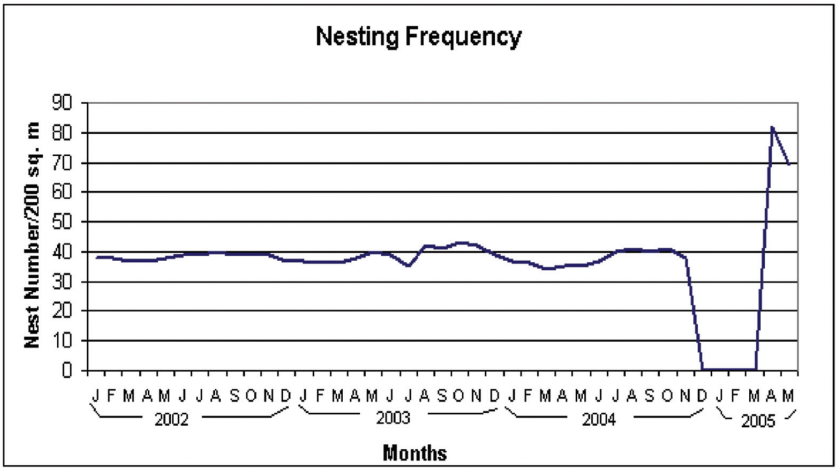

Fig. 2: The number of nests per 200 m² area, from January 2002 to May 2005

RESULTS

The breeding behaviour of the horseshoe crabs was found to be normal during January 2001 to November 2004 (*Fig. 2*). During these months, the tidal heights ranged from 2.53 to 2.99 mm, with the grain size of sand from 0.182 to 0.221 mm. Meanwhile, the average number of nests ranged from 35 to 45 in 200 m^2 of the area with the number of eggs varied from 18 to 258 in each nest. After the occurrence and disturbance of tsunami, not a single nest was found from December 2004 till March 2005 on the breeding beach of Balramgari (*Fig. 2*). Nevertheless, the re-appearance of nests on this beach was started only in April 2005, when surprisingly about 82 nests in 200 m^2 of the area were encountered. In each nest, about 750-1000 eggs were released by a single brooder, as compared to our previous observations whereby only 18-258 eggs $nest^{-1}$ were encountered. In May 2005, the same trend was repeated when 69 nests in 200 m^2 of the area, with a range of 550-990 eggs $nest^{-1}$ were observed. The tidal amplitude during these months was found to be between 2.60 and 2.85 m, whereas the sand grain size was between 0.182 and 0.221 mm. Although the condition of the beach was ideal for normal spawning during December 2004 to March 2005, surprisingly no spawning migration of the horseshoe crabs was observed after the tsunami. The absence of their nests from December 2004 to March 2005 was entirely an unusual behaviour which was observed for the first time during the past several years of the study period.

DISCUSSION

In India, though the impact of tsunami was not very bad along the coastal villages off Balramgari in Orissa, a strange spawning behaviour of the horseshoe crabs was observed after the occurrence of tsunami. In particular, the Balramgari coast has always experienced semidiurnal tides ranging between 215 and 325 cm. The intertidal exposure at Balramgari is large, and this can extend up to several kilometres, depending upon the changing tidal range. Thus the area has the characteristics of a tidal flat and provides a suitable ground for nest building of the horseshoe crabs. The dominant rains, associated with the southwest monsoon, subside after September and therefore, the beach provides a more suitable environment for sand deposition and this makes the beach ideal for spawning (Chatterji, 1994).

Plate 1: Breeding beach showing settlement of thick clay just after the tsunami

Plate 2: Breeding beach after the recovery of the breeding beach

In India, the horseshoe crabs breed for a prolonged period during the year on sandy beaches. In our previous study, spawning migration was observed to be directly related with the tidal amplitude and this occurred around the highest high water mark of the high tides of the new and full moon (Chatterji *et al*., 1992). The researchers also observed that the selection of the nesting sites by the horseshoe crabs was also related to the grain size of the sediment. For instance, *Tachypleus gigas* (Müller) appears to be selective and prefers a grain size ranging from 0.182 to 0.203 mm for nesting. Any increase in this range does not seem to favour nesting (Rudloe and Herrnkind, 1976). However, there were some unusual changes observed in the beach characteristics of Balramgari, and these were due to the seismic activities caused by tsunami making the beach unfavourable for nest building by the horseshoe crabs (Plate 1). This might have prevented the horseshoe crabs to migrate to the shore for breeding purposes. There could be another reason related to an increase in salinity due to a sudden penetration of giant sea waves into the coastal waters. This might have also

been one the reasons terminating the spawning. There was also a possibility that during December 2004 to April 2005 the horseshoe crabs might have shifted their breeding ground to an unknown place on the account of unfavourable condition along the Balramgari beach and once the beach became suitable they started migrating to the place again for breeding (Plate 2).

It has been a well known fact that there are some specific physical factors such as wave characteristic, seabed slope, beach gradient, near shore currents, geochemical and geophysical profiles which play an important role, singly or collectively, in the spawning migration of marine animals (Botton *et al*., 1988; Chatterji *et al*., 1996). Any major change in these factors, which are due to sudden disturbances of the sea, may affect the normal behavioural activity of these animals. Moreover, the relationship between the breeding activities and the characteristics of the beach sediment has been discussed in detail in several other marine species (Henning *et al*., 1982; Fleming and Fricke, 1983).

There have been only a few observations made along the affected areas in Sri Lanka to study on the impacts of tsunami on the behaviour of marine animals (Bambaradeniya, 2005; Sandun *et al*., 2005). A heavy mortality was encountered in the estuarine fishes due to the sudden increase in salinity in Rekawa lagoon in Sri Lanka after the tsunami (Bambaradeniya, 2005). It was also found that many species of the marine fishes, which were not previously inhabitants of this lagoon, are now occurring in the water (Sandun *et al*., 2005). A large number of turtle nests in the Rekawa beach were also been destroyed by the tsunami waves. The nesting of the Green Turtle (*Chelonia mydas*) and the Olive Ridley (*Lepidochelys olivaceae*) was also severely affected. Now, these turtles have started migrating towards the beaches to lay eggs, and this probably indicates a gradual recovery of the normal nesting behaviour. However, the number of migrating turtles for breeding was reported to have reduced considerably as compared to the pre-tsunami situation (Sandun *et al*., 2005).

CONCLUSIONS

There have been several attempts made by some scientists to study the behaviour of the animals before or after the occurrence of earthquakes and tsunamis. In a country like Japan, which is considered to be one of the world's most earthquake-prone countries, researchers have been continuing for the past several decades, to understand the behaviour of animals in relation to sudden disturbances caused by this natural disaster. Japanese scientists are primarily interested in knowing and discovering specific factors which responsible for the changes in the normal behaviour of the animals, before or after the earthquakes. Some American seismologists are still sceptical about these studies, although there have been documented cases of strange animal behaviour prior to the earthquakes. The United States Geological Survey, which provides scientific information about the earth, states that a reproducible connection between a specific behaviour of the animal and the occurrence of an earthquake or tsunami has never been properly documented. Thus, more researches are needed to determine and understand the strange behaviour of the animals on the account of earthquakes and tsunami. These researches in the near future may be useful as a prediction tool to forecast earthquakes and tsunami.

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