# Horseshoe Crabs, Their Eco-biological Status Along the Northeast Coast of India and the Necessity for Ecological Conservation

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**Abstract** Horseshoe crabs *Tachypleus gigas* and *Carcinoscorpius rotundicauda* are distributed along the northeast coast of India extending from the extreme north of West Bengal through Orissa to the northern coast of Andhra Pradesh. High congregations of these animals are found along the breeding beaches of Orissa and West Bengal during full moon and new moon high tides. Both of these Indian species have significantly different breeding patterns particularly in relation to their habitat and laying of eggs. Although at times both the species inhabit the same body of water, *C. rotundicauda* selects mudflats of mangroves and *T. gigas* have the priority for sandy estuarine and creek zones for spawning.

Environmental conditions of horseshoe crabs along the Indian coast still remain free from any kind of pollution. Also there is no known commercial exploitation for the production of amebocyte lysate or bait. But the degradation and destruction of breeding beaches by excess human activities have been posing a serious threat. This is in turn affecting the breeding migration of adult pairs (in amplexus) to come ashore for breeding. Over time, it has been observed that the number of nests (identified by their concave shapes) following the high tide has been decreasing, indicating a decline in the number of breeding pairs on the beaches. By taking the example of the status of *T. tridentatus* in Japan, a concerted effort should be made both at the national and international levels to protect the breeding beaches of horseshoe crabs of the world and allow these precious guests to use the space as an incubator for their fertilized eggs as ever before to grow up to trilobites and swim freely to their nourishing grounds.

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## 1 Introduction

Horseshoe crabs in the world are now represented by four extant species (Sekiguchi and Nakamura 1979). Two species namely *Tachypleus gigas* and *Carcinoscorpius rotundicauda* inhabit coastal waters of northeast coast of India along the Bay of Bengal (Fig. 1). Sekiguchi et al. (1976, 1988) had earlier reported the availability of the species along the coast of West Bengal. The very presence of these animals in a coastal zone indicates the health of the environment (Chen et al. 2004), as it indicates that these conditions are suitable for their survival, reproduction and development. But it is now a major concern that the population of *Limulus polyphemus* along the east coast of United States is in a declining trend (Rudloe 1982, Widener and Barlow 1999, Carmichael et al. 2003) as is also the case for *Tachypleus tridentatus* along the coast of Japan (Botton 2001). But the reasons for the population depletion for these two species and the degree of their exploitation are different. In the case of *Limulus*, exploitation is economically driven by fisheries for bait and LAL (Berkson and Shuster 1999, Carmichael et al. 2003), whereas the Japanese species lost its

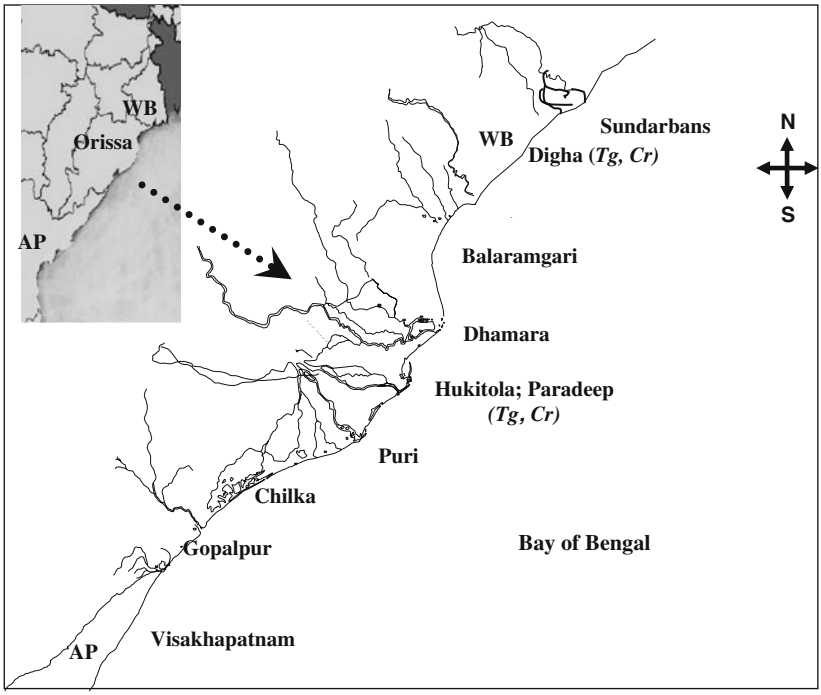


**Fig. 1** Location of study sites and distribution of *T. gigas* (*Tg*) and *C. rotundicauda* (*Cr*) along the northeast coast of India. Horseshoe crabs were observed at the three southernmost sites, and nesting was observed at the five northernmost sites. AP = Andhra Pradesh; WB = West Bengal

ground primarily because of the loss of spawning habitat (Botton 2001). But, in both the cases, the threat to the horseshoe crab population is man made and needs attention.

In the case of two Indian species, *T. gigas* and *C. rotundicauda*, there is no known source of commercial exploitation for the production of amebocyte lysate or for bait as in the case of *Limulus* (Levin et al. 2003). But the animals are being used by traditional healers in the form of a liquified substance for curing joint pains (Fig. 2) and at times females are preyed upon by crows for their eggs but not to the extent that *Limulus* eggs are preyed upon by shorebirds along the east coast of United States (Botton and Shuster 2003). Though the above factors may not be the sole cause of population declines in Indian species, it has been observed during this study period that horseshoe crab populations along the Indian coast, particularly *T. gigas,* are declining very fast. Several studies have been carried out on Indian horseshoe crabs (Roonwall 1944, Sekiguchi et al. 1976, Chatterji et al. 1988, Debnath 1991, Mishra 1994) but they lack information on the population density. However, other studies suggest that there is a significant decline in the *L. polyphemus* population along east coast of United States (Widener and Barlow 1999, Berkson and Shuster 1999, Carmichael et al. 2003, 2004, Botton et al. 2006) and in *T. tridentatus* populations along the coast of Japan, Hong Kong, and Taiwan (Morton 1999, Botton 2001, Chen et al. 2004).

**Fig. 2** A Traditional healer selling medicine prepared out of *T. gigas* and *C. rotundicauda* on the streets of Kolkata (West Bengal), India

The objective of this chapter is to discuss the eco-biological status of *T. gigas* and *C. rotundicauda* including their distribution pattern, nature of coexistence, nesting behavior, and the necessity for their ecological restoration along the northeast coast of India.

## 2 Materials and Methods

This chapter is based on the studies carried out by the author extending over a period of 19 years from 1988 to 2007. During this period horseshoe crab habitats along the northeast coast of India including West

Bengal (WB), Orissa, and Andhra Pradesh (AP) were investigated (Fig. 1). An extensive survey was carried out in studying the natural habitat of *T. gigas* and *C. rotundicauda*. Simultaneously nesting behavior and ecological conditions of the breeding zone of both the species were also investigated. However, most of the studies were carried out with special reference to *T. gigas* due to easy accessibility to its natural habitat and the breeding beaches.

Spawning activity of the species was studied by egg laying behavior of the animal and the number of nests they make in each high tide to lay eggs. Egg densities were quantified by counting the number of eggs in each nest at Balaramgari (Lat. 21° 17' N; Long. 87° 00' E) in the vicinity of Budhabalanga estuary and at Kasafal in the vicinity of Haskura estuary (Lat. 21° 31' N; Long. 87° 09' E), where the congregation of breeding pairs of *T. gigas* were found to be highest (Mishra, 1991, 1994, Mishra et al. 1992).

## 3 Results

It was found that the horseshoe crabs are distributed along the northeast coast of India, extending from the Sunderbans (estuarine mangroves of Ganges) in the extreme north of West Bengal (WB) coast through the coasts of Orissa and northern Andhra Pradesh (AP) in the south of the Bay of Bengal (Table 1). Sekiguchi et al. (1976) reported that *T. gigas* are distributed along the coast of WB. During this study, it was observed that *C. rotundicauda* are available particularly along the coast of WB including the Sunderban mangroves of River Ganges up to Digha in concurrence with other reports (Chatterji et al. 1988, Itow et al. 2004). *T. gigas* are distributed along the coast of Orissa up to the coast of Visakhapatnam along northern AP in the south at a depth of up to 20–30 m. Sekiguchi (1988) reported that at Digha and Junput (coast of WB), both *T. gigas* and *C. rotundicauda* are available. Similarly along the coast of Orissa, coexistence of these two species were observed at Hukitola Bay (Lat. 20° 24' N; Long. 86° 48' E), which was found to be a unique habitat of sandy estuarine beaches and mudflats associated with mangrove forests suitable for nesting by both species. Although the distribution of horseshoe crabs stretches along a vast coast line of northeast Bay of Bengal with varying coastal geomorphology, the breeding migration and nesting behavior of the species were unique to the individual species and they navigate to particular breeding zones of their preference for egg laying.

It was found that *T. gigas* prefers the sandy estuarine zones for laying eggs, whereas *C. rotundicauda* lays eggs in the mangrove mud flats (Sekiguchi et al. 1976, 1978, Chatterji and Parulekar 1992, Mishra 1994, Itow et al. 2004). Also the nesting pattern and number of eggs in each nest varies in these two species

**Table 1** Distribution and nesting sites of *T. gigas* and *C. rotundicauda* along the northeast coast of India. '**O**' stands for availability and '–' for non-availability of eggs and juveniles

| Name of the place surveyed | Species | Location of availability | Nest site with fertilized eggs | Juveniles |
|---|---|---|---|---|
| Canning (WB) | *C. rotundicauda* | Mangrove mud flats | O | – |
| Bakhali (WB) | *C. rotundicauda* | Mangrove mud flats | O | O |
| Digha (WB) | *C. rotundicauda* | Coastal waters | – | |
| Talachua (Orissa) | *T. gigas* | Estuarine sandy beaches | O | – |
| Haskura Estuary (Orissa) | *T. gigas* | Estuarine sandy beaches | O | – |
| Panchkura Estuary (Orissa) | *T. gigas* | Estuarine sandy beaches | O | – |
| Balaramgari (Orissa) | *T. gigas* | Estuarine beaches | O | Trilobites of *T. gigas* with ebbing tide |
| Dhamara (Orissa) | *T. gigas* | Creeks | – | – |
| Puri (Orissa) | *T. gigas* | Devi estuarine beaches | O | O |
| Hukitola (Paradeep, Orissa) | *T. gigas*, *C. rotundicauda* | Sandy beaches and mangrove mud flats | O<br>O | Juveniles of *C. rotundicauda* of different sizes |
| Chilika (Orissa) | *T. gigas* | 20–30 m | – | – |
| Gopalpur (Orissa) | *T. gigas* | 20–30 m | – | – |
| Visakhapatnam (AP) | *T. gigas* | 20–30 m | – | – |

(Table 2). In case of *T. gigas*, breeding is found to be perennial with maximum during the months of July to February. The intensity of nesting was closely related with the textural properties (mean grain size) of the sediments of the estuarine breeding beach at Balaramgari. The species preferred a range of 63–125 μm mean grain size for nesting and any deviation from this affected their nesting behavior (Mishra, 1991). This phenomenon was in confirmation with the shifting of the nesting site from one place to another accompanied by the changes in sand grain size driven by the monsoon pattern at this breeding beach. Similarly eggs and juveniles were found in the mangrove mud flats at Hukitola. Though the breeding time of *C. rotundicauda* in Indian waters is not

**Table 2** Nesting behavior of *T. gigas* and *C. rotundicauda*

| Species | Natural habitat | Nest size (cm) | | Number of eggs | Egg size (mm) | Larva |
|---|---|---|---|---|---|---|
| | | Diameter (cm) | Depth of egg laying (cm) | | | |
| *T. gigas* | Off shore water 20–30 m depth | 12–30 | 10–13 | 60–720 | 3.7 | Trilobites found swimming to the sea with the ebbing tide |
| *C. rotundicauda* | Mangrove mud flats | – | 3–7 | 80–200 | 2.3 | Juveniles found in the mangrove mud flats |

yet studied, in the waters of Thailand they breed throughout the year (Sekiguchi and Nakamura 1979).

The most important observation was on the destruction of breeding beaches, which is very important for the egg-laying activity of both the species. Along the coast of Orissa at Balaramgari, there is a tremendous change in the intertidal sands due to the shrinkage of nesting area caused by human activities such as maintenance work by fishing trawlers on the beach itself (Fig. 3) and shifting of beach sands for construction purposes at times. These may be the major cause of damage to the main nesting sites (about 200 $m^2$) of *T. gigas* at Balaramgari and there is a sharp decline in the number of nests (identified by their concave shape) (Fig. 4).

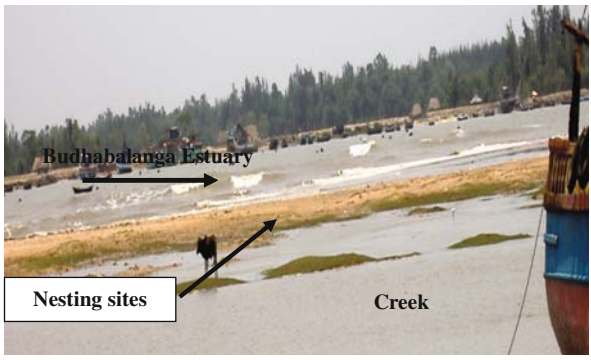


**Fig. 3** Breeding beaches at Balaramgari in the vicinity of Budhabalanga Estuary, showing the sand bar adjacent to creek where nesting by *Tachypleus gigas* occurs

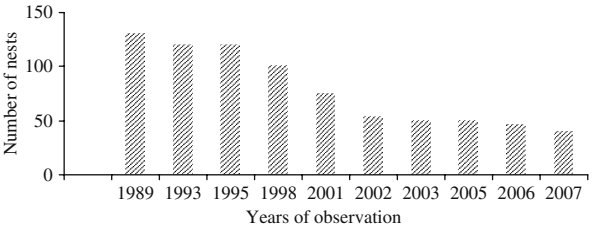


**Fig. 4** Number of fresh horseshoe crab nests found at Balaramgari, northeast coast of India

## 4 Discussion and Conclusions

Breeding migrations of horseshoe crabs are found throughout the year, which is dependent upon the preparedness of the breeding beaches with a maximum percentage of sand with grain size between 63 and 125 μm as in case of *T. gigas*. This phenomena was observed in one of the much studied site at Balaramgari, where breeding pairs navigate to either site of the estuary sensing the availability of the preferable sands in that area (Mishra 1991) at different times of the year. However, the mechanism behind these environmental phenomena needs a detailed study.

Several anthropogenic activities, mainly related to fisheries and construction works along the coastline, are posing serious threats by destroying the natural breeding beaches. This restricts the migrating pairs from finding a suitable nesting site for spawning. Unlike their American counterpart (Rudloe 1982, Berkson and Shuster 1999, Widener and Barlow 1999, Carmichael et al. 2003, Levin et al. 2003) horseshoe crabs in India are not subjected to commercial exploitation for biomedical, fertilizer, and bait purposes. The real threat comes from the human population, which plays an important role in the coastal ecology (Botton et al. 2006). In addition, natural calamities such as super cyclones and tsunamis cause serious damage by shifting the sands from the beaches.

A constructive approach is needed to protect the intact, undisturbed breeding zones in India to help honeymooning horseshoe crab couples to come ashore and lay eggs. As it is evident from the present status of breeding beaches at Balarmgari, it is a matter of concern that the day is not far away when we will not be able to encounter breeding pairs. Efforts should be made by creating public awareness, educating fisher folks, providing alternative sites for boat building and repairing, and if required, enacting laws to protect these precious guests from the brink of extinction from our coast.

## References

Berkson J, Shuster C (1999) The horseshoe crab: the battle for a true multiple-use resource. Fisheries 24:6–10

Botton ML (2001) The conservation of horseshoe crabs: what can we learn from the Japanese experience? In: Tanacredi JT (ed) *Limulus* in the Limelight. Kluwer Academic/Plenum, New York, pp 47–51

Botton ML, Shuster CN (2003) Horseshoe crabs in a food web: who eats whom? In: Shuster CN Jr, Barlow RB, Brockmann HJ (eds) The American Horseshoe Crab. Harvard University Press, Cambridge, pp 133–153

Botton ML, Loveland RE, Tanacredi JT, Itow T (2006) Horseshoe crabs (*Limulus polyphemus*) in an urban estuary (Jamaica Bay, New York) and the potential for ecological restoration. Estuar Coasts 29: 820–830

Carmichael RH, Rutecki D, Valiela I (2003) Abundance and population structure of the Atlantic horseshoe crab *Limulus polyphemus* in Pleasant Bay, Cape Cod. Mar Ecol Prog Ser 246:225–239

Carmichael RH, Rutecki D, Annett B, Gaines E, Valiela I (2004) Position of horseshoe crabs in estuarine food webs: N and C stable isotopic study of foraging ranges and diet composition. J Exp Mar Biol Ecol 299:231–253

Chatterji A, Vijaykumar R, Parulekar AH (1988) Growth and morphometric characteristic in the horseshoe crab, *Carcinoscorpius rotundicauda* (Latreiile) from Canning (West Bengal), India. Pakistan J Sci Ind Res 33:352–355

Chatterji A, Parulekar AH (1992) Fecundity of the Indian horseshoe crab, *Carcinoscorpius Rotundicauda* (Latreiile). Trop Ecol 33:97–102

Chen CP, Yeh HY, Lin PF (2004) Conservation of the horseshoe crab at Kinmen, Taiwan: strategies and practices. Biodivers Conserv 13:1889–1904

Debnath R (1991) Studies on species morphology and sexual dimorphism of Indian horseshoe crabs. Gobios new Reports 10:128–131

Itow T, Mishra JK, Ahmed ATA (2004) Horseshoe crabs (King crabs) in the Bay of Bengal, South Asia. Bull Fac Edu Shizuoka Univ Nat Sci 54:13–30

Levin J, Hochstein D, Novotsky TJ (2003) Clotting cells and Limulus amoebocyte lysate: An amazing analytical tool. In: Shuster CN Jr, Barlow RB, Brockmann HJ (eds) The American Horseshoe Crab. Harvard University Press, Cambridge, pp 310–340

Mishra JK (1991) Embryonic development and variations in the haemolymph of Indian horseshoe crab, *Tachypleus gigas* (Muller). PhD Thesis. Berhampur University, Orissa, India

Mishra JK, Chatterji A, Parulekar AH (1992) A freak twin trilobite lava of the Indian horseshoe crab, *Tachypleus gigas* (Muller). J Bombay Nat Hist Soc 90:115–117

Mishra JK (1994) Horseshoe crab, an amazing creature of Orissa coast. Project Swarajya Publ, Orissa, India pp 35

Morton B (1999) On turtles, dolphins and, now Asia's horseshoe crabs. Mar Poll Bull 38:845–846

Roonwall ML (1944) Some observations on the breeding biology, and on the swelling, weight, water-content and embryonic movements in the developing, eggs, of the Moluccan king-crab, *Tachypleus gigas* (Muller) [Arthropoda, Xiphosura]. Proc Indian Acad Sci 20:115–129

Rudloe A (1982) Man's influence as an environmental threat to *Limulus*. In: Bonaventura J, Bonaventura C, Tesh S (eds) Physiology and Biology of Horseshoe Crabs. Alan R. Liss, New York, pp 297–300

Sekiguchi K, Nakamura K, Sen TK, Sugita H (1976) Morphological variation and distribution of a horseshoe crab, *Tachypleus gigas*, from the Bay of Bengal and the Gulf of Siam. Proc Jap Soc Syst Zool 15: 13–20

Sekiguchi K, Nakamura K, Seshimo H (1978) Morphological variation of a horseshoe crab, *Carcinoscorpius rotundicauda*, from the Bay of Bengal and the Gulf of Siam. Proc Jap Soc Syst Zool 15: 24–30

Sekiguchi K, Nakamura K (1979) Ecology of the extant horseshoe crabs. In: Cohen E (ed) Biomedical Applications of the Horseshoe Crab (Limulidae), Alan R Liss, New York, pp 37–45

Sekiguchi K (1988) Biology of horseshoe crabs. In: Koichi Sekiguchi (ed) Biology of Horseshoe crabs. Science House Co., Ltd., Tokyo, pp 50–68

Widener JW, Barlow RB (1999) Decline of a horseshoe crab population on Cape Cod. Biol Bull 197: 300–302