MINI REVIEW

Horseshoe Crab: A Keystone Species of Mangrove Forests of Coastal Belts of Sunderban

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Abstract

The mangroves within the biosphere reserve of Sundarban and Mahanadi Delta at Bhitarkanika and Kendrapara along the coastal belt of Bay of Bengal have been under considerable human impingement especially over the last few decades. Land reclamation for settlements along with agriculture and unplanned aquaculture practices, mechanized fishing in addition to non sustainable tourism activities proved deterrent to the ecosystem. It effect not to mention the additional burdens of pollution and changes in hydrological regimes that in turn causing adverse influence on subsistence dwellers in and around north-east coastal belt of Bay of Bengal. The horseshoe crabs are the creature on this earth surviving for the past 450 million years or so. Most of the biogenic activities of the horseshoe crab occur in the open ocean at a deeper zone. They specifically migrate regularly towards the shore for the purpose of breeding. Among the two Indian horseshoe crab species namely, *Tachypleus gigas* and *Carcinoscorpius rotundicauda*, the later species prefers mangrove habitat for breeding along the north-east coast of India. However, in spite of all previous studies on *T. gigas* such as spawning migration, feeding behaviour, breeding biology and several other aspects, no concerted efforts have been made for *C. rotundicauda* to develop effective strategies in protecting and conserving both the habitat and population of this valuable species along the coastal areas of India. The depleting population and losing important biodiversity has prompted us to undertake such a novel project. The degradation and destruction of the ground in the mangrove ecosystem of this species by natural and anthropogenic activities have also resulted in mass depletion of the population of this species along the north-east coast of West Bengal and Odisha. A mature female of this species carries hundreds of eggs under its prosoma but releases only a few eggs in one spawning act in a nest on suitable muddy breeding grounds in mangrove areas. The total number of eggs laid varied from 18 to 258 in each nest. The nest of the horseshoe crab is a depression in mud made by the female for laying their gametes. After fertilization, most of the pairs migrate to their natural habitat.

Keywords: Horseshoe Crab, Mangrove Forests, Sunderban.

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Introduction

The mangrove species diversity in the Indian sub-continent was recognised as high at both Andaman & Nicobar Islands and Sundarbans mangroves (Blasco, 1975; Dagar *et al*., 1991; Chadha and Kar, 1999; Anonymous, 2001). In 1998, the Government of India, Department of Ocean Development Directorate at Chennai (formerly Madras), as a part of its endeavour to develop a Critical Habitat Information System for select sites along east and west coasts of India, had initiated a large scale study on the Gulf of Kutch along northwest coast (Gujarat State) where some luxuriant coral formations and mangrove cover occur; the Islands of Gulf of Mannar, Southern India; mangroves of Pichavaram in Tamil Nadu; Bhitarkanika mangroves in Odisha halfway between Madras and Kolkata, the Sundarban in West Bengal and Coringa mangroves in the Godavari delta in Andhra Pradesh (Fig. 1).

However, these accounts are descriptive and susceptible to change with a number of multifactorial environmental settings and therefore require regular monitoring/assessments on the structure and distribution of mangroves. The complexity appears to be due to a combination of climatic, hydrographical and geo-morphological features. In addition, the mangroves within the biosphere reserve of Sundarban and Mahanadi Delta have been under considerable human impingement over the last few decades. Land reclamation for settlements along with agriculture and unplanned aquaculture practices, mechanized fishing, in addition to non sustainable tourism activities proved deterrent to the ecosystem. Such effects not to mention the additional burdens of pollution and changes in hydrological regimes that in turn causing adverse influence on subsistence dwellers in and around Mahanadi Delta.

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Status of Conservation of Horseshoe Crab

The horseshoe crab evolved in its present form about 350 million years ago and called trilobite which were reported in the Precambrian seas, nearly 600 million years ago. The horseshoe crab belongs to the benthic community and they prefer calm sea or an estuary with muddy sandy bottom. Though most of the biogenic activities occur in the open ocean, the horseshoe

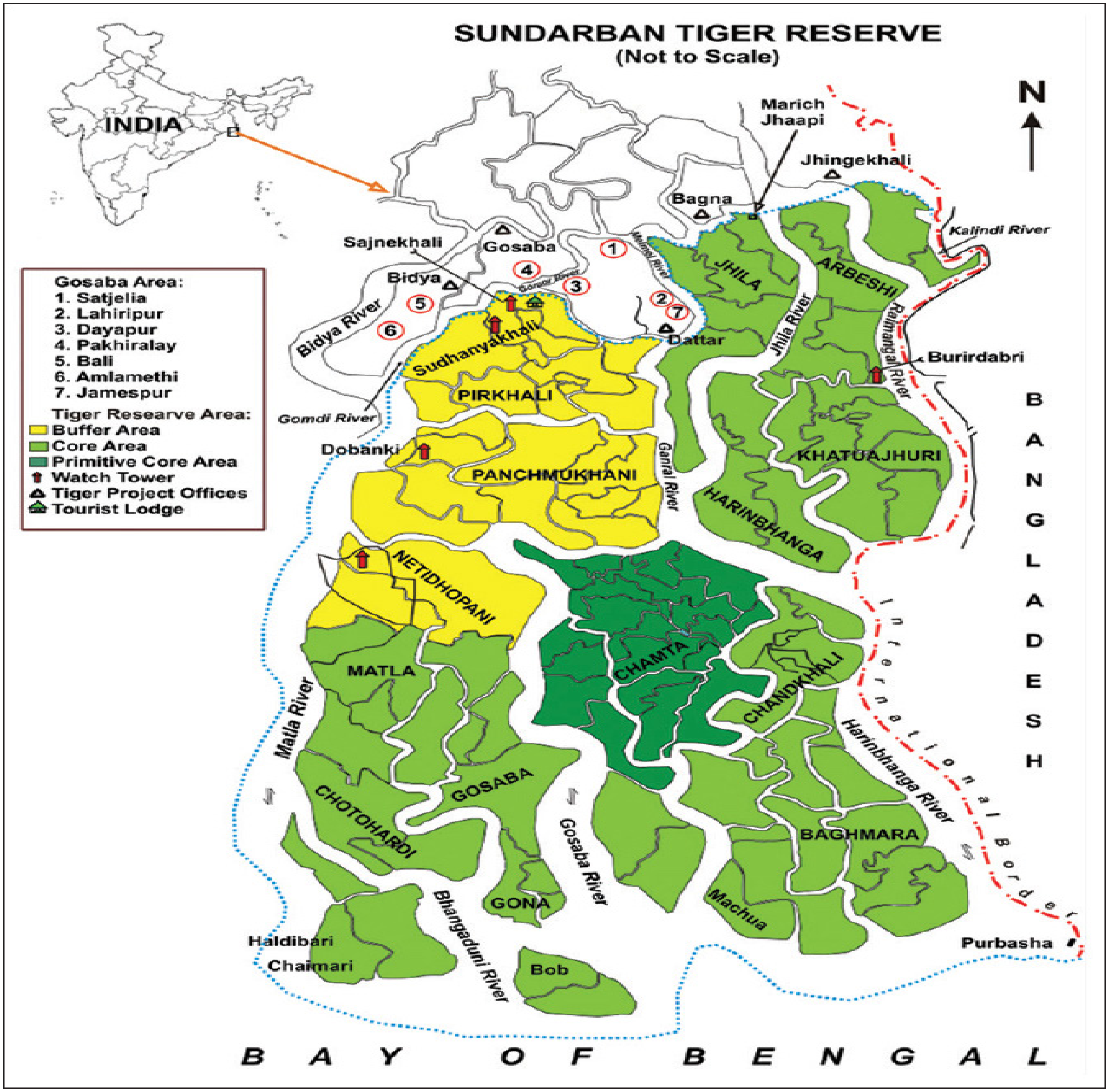

Fig. 1: Map showing delta of Suderban

crabs specifically migrate towards the shore for the purpose of breeding where they lay their gametes in nest on sandy and muddy beaches. There are some specific physical factors such as wave characteristic, seabed slope, beach gradient, near shore currents, geochemical and geophysical profiles play an important role, singly or collectively, in the spawning migration of the horseshoe crabs. The selection of the nesting site by the horseshoe crab has been related to the grain size and nature of the sediment. The Indian species of the horseshoe crab breeds for a prolonged period during the year on sandy beaches or mangrove forest (Satyanarayana *et al*., 2002, 2009, 2010, 2011a,b; Kovacs *et al*., 2004; Giri *et al*., 2007, 2008, 2011; Proisy *et al*., 2007; Neukermans *et al*., 2008; Massói Alemán *et al*., 2010).

Reproduction Cycle

A mature female of horseshoe crab carries many eggs under its prosoma but releases only a few eggs in one spawning act on a suitable breeding beach (Fig. 2a,b). The total number of eggs laid varied from 18 to 258 in each nest. After fertilization, most of the pairs migrate to their natural habitat with the ebb tides. The nest of the horseshoe crab is a depression in the sand or mud made by the female brooders for laying their gametes.

However, in spite of all previous studies, no concerted effort has been made to study in detail the spawning habitat of *C. rotundicauda* that known as mangrove horseshoe crab. Nevertheless, mangrove sediment samples will be collected from the respective locations on a seasonal basis to understand

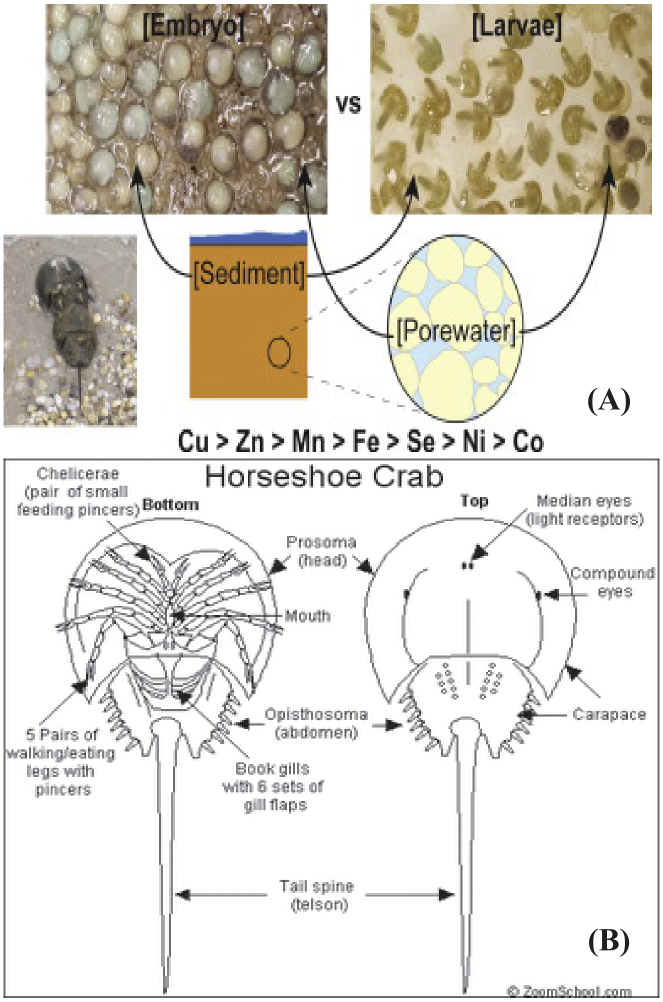

Fig. 2: A. Life cycle of Horseshoe Crab; b. Reproduction stages of Horseshoe crab

the ecosystem level health by elucidating the benthic faunal communities (macrofauna and meiofauna). These organs were used as proxy to identify the changes in both temporal and spatial patterns in relation to continuous anthropogenic pressures in these regions and resulting consequences for mangrove horseshoe crabs.

International Status of Mangroove

Mangroves distributed in the (sub)tropical coastlines play a significant role in the local livelihoods as well as coastal protection (Adeel and Pomeroy, 2001; Mumby *et al.*, 2004; Primavera *et al.*, 2004; Dahdouh-Guebas *et al.*, 2005a; FAO, 2007; Walters *et al.*, 2008). However, they gained renewed attention only after the incident of Indian Ocean tsunami (26 December, 2004) that caused vast devastation across the southeast and south-central Asia (Baird, 2006; Barbier, 2006, 2008; Dahdouh-Guebas, 2006; Dahdouh-Guebas and Koedam, 2006; Alongi, 2008; Ellison, 2008, 2012; Osti *et al.*, 2008). In this context, several researchers found that the areas with no ecological mangrove degradation have experienced less destruction to both public and property (Dahdouh-Guebas *et al.*, 2005b,c; Roy and Krishnan, 2005; Williams, 2005; Chang *et al.*, 2006; Stone, 2006; Quartel *et al.*, 2007; Tanaka *et al.*, 2007; Cochard *et al.*, 2008; The

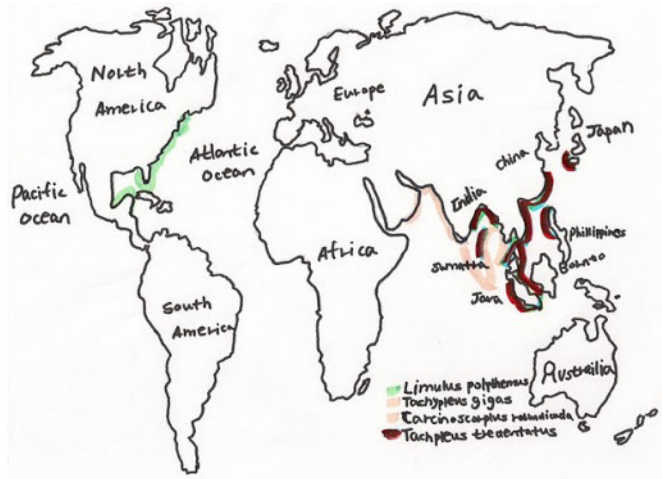

Fig. 3: International map showing the habitat of Horseshoe crab

et al., 2009; Yanagisawa *et al.*, 2009).

On the other hand, loss of mangroves is still evident in many parts of the world due to lack of awareness or perseverance in the conservation and management strategies already implemented and/or proposed (Farnsworth and Ellison, 1997; Foell *et al.*, 1999; Kovacs, 2000; Primavera, 2000; Armitage, 2002; Dahdouh-Guebas *et al.*, 2002, 2005b,c). It is not exceptional for mangroves since they are located close to densely populated urban or rural settlements that ensue a constant pressure on these ecosystems (Dahdouh-Guebas *et al.*, 2002; Mohamed *et al.*, 2009). At the same time, viewing the interaction between humans and ecological components (Crona *et al.*, 2010), the function of mangrove ecosystems in the local livelihoods should not be underestimated (Farnsworth and Ellison, 1997; Armitage, 2002; Duke *et al.*, 2007; Walters *et al.*, 2008) (Fig. 3).

The data on ecological and socio-economic aspects were indeed essential for appropriate planning and conservation of the coastal and marine habitats (Bart, 2006; Ban *et al.*, 2009; Bhadury and Austen, 2010; Weeks *et al.*, 2010; Bhadury et al., 2015; Semprucci *et al.*, 2015). Moreover, the scientific input in mangrove afforestation, particularly in terms of vegetation growth and habitat recovery, is of great concern to many mangrove researchers (*e.g.*, Tomlinson, 1986; Kairo *et al.*, 2002; Bosire *et al.*, 2006; Koedam and Dahdouh-Guebas, 2008).

The fluctuating habitats during different developmental stages encountered by the amazing horseshoe crab showed their ability to tolerate and adapt to different environmental conditions. However, the study on the distribution of mangrove horseshoe crab along a particular site is difficult because migration of the animal is totally dependent on two important physical stimuli-the tide and –the lunar periodicities.

History of Horseshoe Crab

The horseshoe crabs evolved in its present form about 350 million years ago and considered to be descended from mud dwelling primitive arthropods called trilobite which were reported in the Precambrian seas, nearly 600 million years ago. The horseshoe crab belongs to the benthic community and they prefer calm sea or an estuary with muddy sandy bottom (Fig. 4).

Fig. 4: Some Horseshoe crab in nature

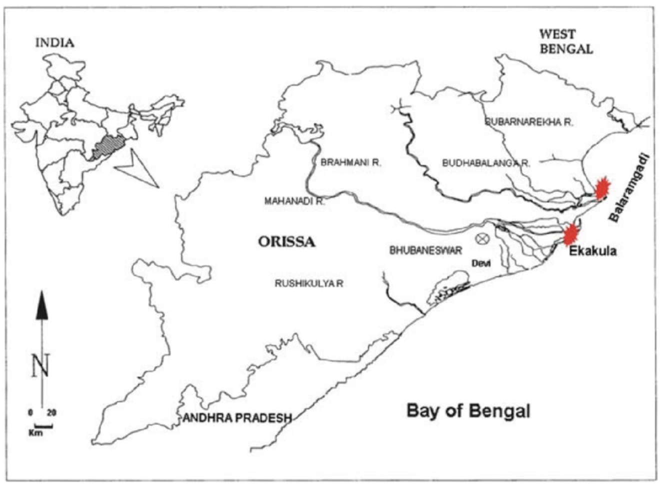

Fig. 5: Map showing the adaptation of Horsecrab in Bay of Bengal

National Status

The mangrove species diversity in the Indian sub-continent was recognised as high at both Andaman & Nicobar Islands and Bhitarkanika regions each with about 29 true (exclusive) mangroves (Dagar *et al.*, 1991; Chadha and Kar, 1999; Anonymous, 2001). In 1998, the Government of India, Department of Ocean Development Directorate at Chennai (formerly Madras), as a part of its endeavour to develop a Critical Habitat Information System for select sites along east and west coasts of India, had initiated a large scale study on the Gulf of Kutch along northwest coast (Gujarat State) where some luxuriant coral formations and mangrove cover occur; the Islands of Gulf of Mannar, Southern India; mangroves of Pichavaram in Tamil Nadu; Bhitarkanika mangroves in Odisha halfway (Fig. 5) between Madras and Kolkata, the Sundarbans in West Bengal and Coringa mangroves in the Godavari delta in Andhra Pradesh.

A combination of *Avicennia alba*, *A. officinalis* and *Excoecaria agallocha* in outer as well as inner zones of Bhitarkanika was described. However, these accounts are descriptive and not based on statistical evaluation. A number of many-sided environmental settings are found to influence the structure and distribution of mangroves in Mahanadi Delta. The complexity appears to be due to a combination of climatic, hydrographical and geo-morphological features reflected as it were through a stratified estuary, extensive mangrove swamps and a shallow low energy system under tropical conditions separated from the sea by a moderate sand spit, especially at Kendrapara region.

In the case of mangrove horseshoe crabs in India, these animals in large numbers migrate towards the shore depending upon the tidal height where they spawn in nests made in sand. There are some specific physical factors such as wave characteristic, seabed slope, beach gradient, near shore currents, geochemical and geophysical profiles that play an important role, singly or collectively, in the spawning migration of the horseshoe crab. The Indian species of horseshoe crab (*T. gigas*) appears to be selective and prefers a range of 0.182 to 0.203 mm of grain size for nesting. Any increase in this range, does not seem to favour nesting. The Indian species of the horseshoe crab breeds for a prolonged period during the year on sandy beaches or mangrove areas. The spawning migration was observed to be directly related with the tidal amplitude and occurred around the highest high water mark of the high tides of the new moon and full moon.

The other important contributions are regeneration of gill tissues, cardiogenesis, angiogenesis, wound healing, growth factors by the perivitelline fluid of the fertilized eggs of the horseshoe crab. Extensive work on spawning migration, feeding behaviour, breeding biology and several other aspects. Limited number of studies have been undertaken to investigate the benthic faunal communities in mangroves of India (*e.g.*, Satheesh Kumar and Khan, 2013; Ansari et al., 2017) and more so along the north-east coast of Bay (*e.g.*, Austen, 2004; Bhattacharjee *et al.,* 2013a,b; Fonseca *et al.*, 2014; Ansari and Bhadury, 2017). However, to date no study has looked into the applicability of benthic fauna as proxy for monitoring ecosystem level health of mangroves located in north east Bay of Bengal.

Conclusion

The above study concludes that Horseshoe crabs, within Sundarban, have conservation protection based on limited and fragmented habitat and geographic isolation from other regions, but elevated risk applies to the horseshoe crabs, in this region, until sufficient data can confirm population stability. In future species status throughout its range will depend on the effectiveness of conservation to mitigate habitat loss and management for sustainable harvest among and within regions. Thus the overall study shows the outcome of this assessment is that the horseshoe crab species is vulnerable to local extinction and that the degree and extent of the risk vary among and within the genetically-defined regions.

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