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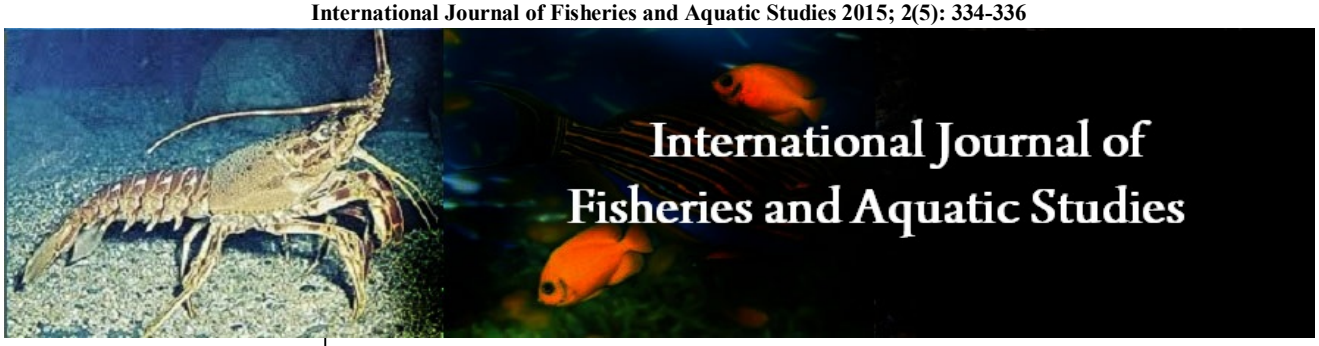

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Siddhartha Pati
Horseshoe Crab research Unit, Department of Bioscience & Biotechnology, Fakir Mohan University, Balasore-20, Odisha, India.

Gobinda Ch. Biswal
Department of Zoology, Sidheswar College, Amarda Road, Balasore.

Bisnu P. Dash
Horseshoe Crab research Unit, Department of Bioscience & Biotechnology, Fakir Mohan University, Balasore-20, Odisha, India.

Correspondence
Bisnu P. Dash
Horseshoe Crab research Unit, Department of Bioscience & Biotechnology, Fakir Mohan University, Balasore-20, Odisha, India.

Availability of *Tachypleus gigas* (Müller) along the river estuaries of Balasore district, Odisha, India

Siddhartha Pati, Gobinda Ch. Biswal, Bisnu P. Dash

Abstract
Populations of horseshoe crabs (*Tachypleus gigas*) along the northeast coast of India are under threat due to destruction of the breeding beaches. In this present study the availability and habitat of that species was surveyed. As per past report, Horseshoe Crabs were plenty available at Balaramgari beach along the northeast coast of India, and they 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 at Balaramgari beach. At present very less nesting and breeding pairs were observed so far in that said beach. Many 25 m^2 of areas of the 3 estuary beaches were surveyed between January to December 2014 along the Balasore coast, Odisha. Large numbers of nests and breeding pairs were encountered in Mahisali river mouth, Khandia river mouth, where as very negligible number of crab was found at the earlier reported beach i.e Balaramgari beach. Efforts should be made to protect their breeding beaches as well as to restore their population by application of advance scientific technique like sea ranching.

Keywords: *Tachypleus gigas*, Horseshoe Crab, spawning pattern, sea ranching

1. Introduction
The Asian horseshoe crab, *Tachypleus gigas* (Müller), also known as Asian king crabs, belongs to the family Limulidae. It is the only marine primitive invertebrate which is widely distributed on earth. There are only four species of horseshoe crabs in existence in the world today. These are *Limulus polyphemus, Tachypleus gigas, Tachypleus tridentatus, and Carcinoscorpius rotundicauda.* These creatures are sometimes called "living fossils" because they have changed little from their fossilized relatives; the earliest species identified is approximately 450 million years old. They evolved from trilobites about 550 million years ago, and keep similar shapes for more than 200 million years. They have been classified in Phylum Arthropoda; subclass Xiphosura and phylo-genetically more related to Arachnida than to Crustaceans [1-2].
In Asia, *T. gigas* are distributed from Bay of Bengal to South-West of Japan. The horseshoe crabs in the Bay of Bengal are the widely distribution in Asia and their species distribution, shapes and behaviors are very interesting. There are some reports about the distribution and spawning activities of horseshoe crabs of Odisha and West Bengal in India [3].
T. gigas is one of the most important invertebrate animals which are used in researches as a component of its blood to detect bacterial contamination in medical devices and drugs. This species can usually be found from Indian shore to Southeast Asian region and disperse to the South-western part of Lantau Island, Hongkong. It lives in sandy to muddy habitats [4-6]. In India, some *T. gigas* co-exist with *C. rotundicauda* [7-8]. Along with other three species, *T. gigas* is classified as either near threatened or data deficient [9]. Evidences from studies and fishermen suggest that this species once commonly found in different habitats throughout Asia is declining. Human disturbances have been attributed to the degradation and destruction of spawning beaches in India.
This species uses the intertidal zones of Odisha coast, associated with estuaries and creeks for breeding. This is due to the favorable conditions such as beach characteristics, estuaries, creek environment and suitable sand grain size at the breeding beaches. [10] Among the four species of king crabs, *T. gigas* is comparatively less studied. Very limited information is available on this species about its reproductive biology and population dynamics.
The Bay of Bengal, Odisha coast has a commercial fishery which uses king crabs for fertilizer and animal feed but it ceased in the recent years. However at present there is large fishery

activity on various marine organisms in the Odisha coast.
Human activities nevertheless threaten the crab's survival in various parts of the world. Beach development and shoreline modifications are some of the important reasons which prevent the crabs from reaching spawning areas. Oil spills from barges or tankers have been reported to pose threats to breeding and young ones. Although many efforts have been taken in various countries to increase the population of the species by implementing better management practices, the population is not showing immediate increase. The crabs do not breed until nine to ten years and this is another reason for the reduced population size of the species. There have been numerous studies concerning the general biology and life history of *T. gigas*, information concerning its status and population biology is not sufficiently known. As the demand of the species intensifies from different user groups, information about its status becomes increasing necessary. There are concerns that the population is declining and for any future management, an accurate data on the population biology of the species is very essential.

2. Material and method

2.1 Study sites

Balasore district is located in the northeast of the state of Odisha and lies between 21° 3' to 21° 59' north latitude and 86° 20' to 87° 29' east longitude. The average altitude of the district is 19.08 m and has a total area of 3634 km^2. The coastal belt is about 81 km wide and shaped like a strip. In this region, sand dunes are noticed along the coast with some ridges. This region is mostly flooded with brackish water of estuarine rivers which is unsuitable for cultivation. Shrimp culture and salt manufacturing units are also developing in this area recently. Two important rivers namely Budhabalanga and Subarnarekha and many sub rivers pass through this district from west to east before surging into the Bay of Bengal and make an estuary which is suitable for this horseshoe crab. Out of them Mahisali estuary, Balaramgarhi, Khandia estuary was selected for the survey under Balasore coast of Bay of Bengal.
Mahisali estuary sea beach is located at 21°24'35.97"N and 86°58'43.02"E in Balaore district near the mouth of Mahisali Estuary River and surrounding areas. It is about 5 km away from Chandipur. Balaramgarhi sea beach is located at 21°28'10.06"N and 87° 3'37.00"E in Balasore district near the mouth of Balaramgarhi Estuary River and surrounding areas. It is about 6 km away from Chandipur. Khandia estuary sea beach is located at 21°19'1.65"N and 86°53'32.99"E in Balasore district near the mouth of Khandia estuary river and surrounding areas. It is about 15 km away from Chandipur.

2.2 Survey on spawning density

To estimate the density of spawning population of *T. gigas*, surveys were made in the above mentioned three estuaries during Jan 2014-Dec-2014 using quadrate/transect sampling. To standardize the minimum area to be surveyed, we examined several protocols for the survey adopted by various workers. Initially the quadrate size was restricted to 1m x1m and the number of quadrat in each site was 25 (twenty five) and randomly laid to assess the spawning population. However, the data collected from these quadrates showed a lot of variations and we missed many a times to record the availability of *T. gigas* from the small size of the quadrate. Since the spawning density was observed to be relatively lower compared to many other studies reported, instead of using quadrates, we laid out four transects each measuring 25 m2 (1m width x 25m long) in each site to increase the area covered by the survey. A gap of 10 m was maintained between two transects.
Spawning survey was carried out regularly twice a month, coinciding with full and new moon phases from January to December 2014. The samples were collected one hour prior to and one hour following the predicted high tides except under extreme weather conditions. Since the breeding activity was more pronounced in the daylight high tide than the night tides for *T. gigas* [11], in our present study, we restricted all our observations during day light hours at the highest high tides of full or new moon. All animals within transects were counted and recorded the number of single males, single females, pairs (female and amplexed male), females with amplexed males and satellite males.

3. Result

In our study, the population of *T. gigas* has been found throughout the year, though the breeding season of this species is found to be restricted. The spawning density of *T. gigas* varied between high tide of full moon and low tide of new moon.
At Balaramgadi estuary beach, during 2014, a total of 12 males/transect (=25 m^2) and 10 females was observed in new moon while a total of 06 males and 07 females were observed during full moon. The total number of crabs arrived during the year 2014 were 22 during new moon and 13 respectively during full moon (Fig-1). At Mahisali estuary beach, during 2014, a total of 16 males/transect (=25 m^2) and 18 females were observed in new moon while a total of 14 males and 18 females were observed during full moon. The total number of crabs arrived during the year 2014 were 34 during new moon and 32 respectively during full moon (Fig-2). At Khandia estuary beach, during 2014, a total of 33 males/transect (=25 m2) and 34 females were observed in new moon while a total of 30 males and 35 females were observed during full moon. The total number of crabs arrived during the year 2014 were 67 during new moon and 64 respectively during full moon (Fig-3). The population of *T. gigas* has been found throughout the year, though the breeding season of this species is found to be restricted from March to September. The spawning density of *T. gigas* varied between high tide of full moon and low tide of new moon.

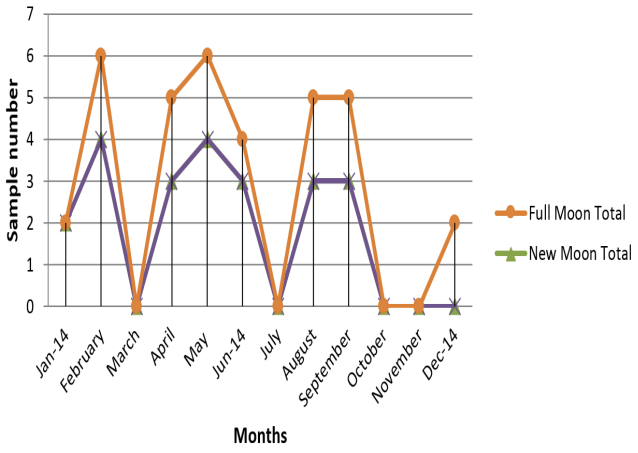

Fig 1: Month wise variations and Population density (mean number/25m2) of *T. gigas* population during new moon and full moon at Balaramgadi estuary.

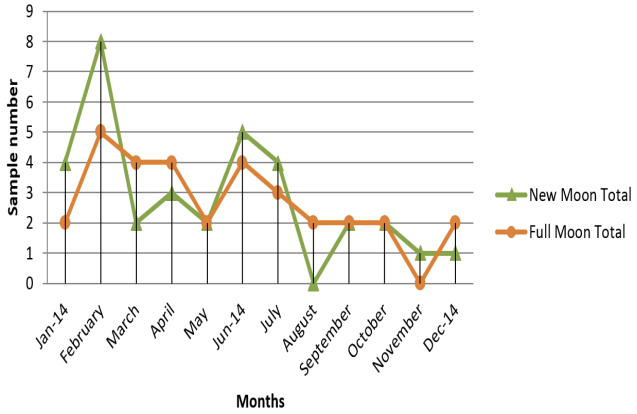

Fig 2: Month wise variations and Population density (mean number/25m2) of *T. gigas* population during new moon and full moon at Mahisali estuary

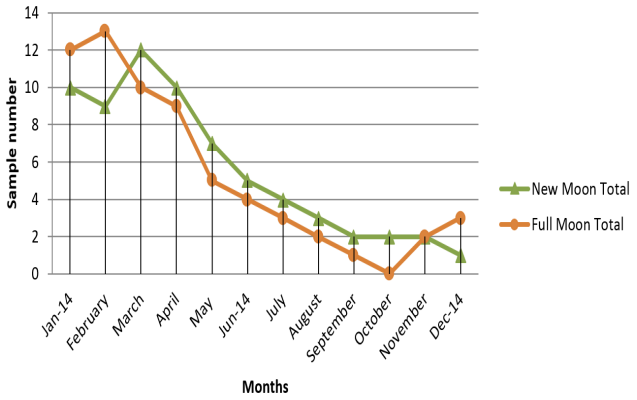

Fig 3: Month wise variations and Population density (mean number/25m2) of *T. gigas* population during new moon and full moon at Khandia estuary

4. Dicsussion

Horseshoe crab were plenty available at Balaramgari beach Along the northeast coast of India, and they 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 at Balaramgari beach [13] but this survey shows that the habitat has almost shifted to Balaramgari estuary to near estuary where less human activity are there in same district Balasore. Horseshoe crabs were incidentally caught largely by trammel net used for prawn fishing, mechanized trawler nets, monofilament gill netting on the mudflats and beach shore seine [12]. Currently, the availability of horseshoe crabs (*T. gigas*) are restricted to smaller areas of coast of Balasore. In this connection, it is suggested to declare those remaining breeding part of horseshoe crabs as a conservation reserve. Efforts should be made to protect their breeding beaches from destruction and environmental degradation. Environmentalists should ensure regular planting of trees to control beach erosion, ban the removal of sand gravel for construction purposes, Restriction of trawler and local fisher community in that breeding beaches. Further attempt can be made to increase the horseshoe crab population by the application of advance scientific technique and conserve the valuable creature from the verge of extinction.

5. Acknowledgements

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