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RESEARCH ARTICLE

STUDIES ON RESOURCE POTENTIAL AND DIVERSITY OF PUFFER FISHES ALONG DIGHA COAST, WEST BENGAL, INDIA

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ABSTRACT

The present study describes the distribution of puffer fishes from the coastal belt of Digha (between 21°32´N to 21°45´N latitude and 87°32´E to 87°50´E longitude) in West Bengal along the east coast of India. The puffer fishes were collected by trawling from three different stations (Digha mohona, Sankarpur, Soula). During this survey, 7 different species from 5 genera under the order Tetraodontiformes belonging to the family Tetraodontidae was identified viz, *Arothron stellatus, Arothron immaculatus, Chelonodon patoca, Lagocephalus inermis, Lagocephalus lunaris, Takifugu oblongus, Tetraodon fluviatilis*. The present study revealed that three puffer fishes were distributed mostly viz, *Lagocephalus lunaris* (51.49%), *Takifugu oblongus* (27.02%), *Tetraodon fluviatilis* (13.55%) and rest of the puffers are very few viz, *Arothron stellatus* (2.09%), *Arothron immaculatus* (0.28%), *Chelonodon patoca* (1.50%), *Lagocephalus inermis* (4.07%). *Lagocephalus lunaris* was recorded maximum from this coastal region. This study also summarized the distribution as well as seasonal abundance and diversity indices of the available puffer fish species.

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INTRODUCTION

Puffer fishes are very notorious and recognized as second most poisonous vertebrate in the world after "Golden Poison Frog" (Keiichi *et al*., 1998). Puffer fishes belong to Family Tetraodontidae which owes its name to the word "Tetraodon", which in Greek means "four teeth" (Talwar and Jhingran, 1991). These are small to moderate sized fishes, with a heavy blunt body, rounded in cross section with large, broad and blunt head (Talwar and Jhingran, 1992). They are called puffer fish because of their ability to inflate themselves with water or air when they feel threatened. They use air to expand its body to look intimidating to predators (Shipp, 2003). Family Tetraodontidae contains 28 genera and 189 species (Oliveira *et al*., 2006; Froese and Pauly, 2007). Identification of a species is a primary step towards any research work and plays a key role for the behavioral study (Mandal *et al*., 2013). They are commonly distributed in the tropics, but are relatively uncommon in temperate regions and completely absent from cold water (Veeruraj *et al*., 2011; Shamsuzzaman *et al.,* 2015). This fish family Tetraodontidae is found mainly in marine, brackish, and freshwater environments from 58° N to 48° S and 115° W to 178° E (Padate *et al*., 2013; Venkataraman and Wafar, 2005)

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MATERIALS AND METHODS

Study area

Puffer fishes were collected from the coastal belt of Digha (between 21°32´N to 21°45´N latitude and 87°32´E to 87°50´E longitude), in Purba Medinipur District, West Bengal, east coast of India. This sea coast is situated at the northern end of Bay of Bengal (Manna and Goswami, 1985). It has low gradient with a shallow sand beach (Manna and Goswami, 1985). The puffer fishes were collected by trawling and local fishing. Local fishing has been carried out from this coastal region like Digha, Sankarpur, Mandarmoni, Soula, Junput, Rasulpur etc. Length of this coast line is almost 30 - 35 Kilometers. Trawling has been done from three different fish landing centers (Figure 1) of this coastal belt which were tabulated below (Table 1).

Sample collection and period of investigation

Samples had been collected for three years (January, 2013 - January, 2016). Throughout this period several commercial fishing cruises and fishermen interviews were conducted from three different trawling stations. The Primary data, regarding the specimen were collected by frequent survey of trawling stations and collecting live as well as dead fish species. Local fishing stations were also enclosed during this investigation.

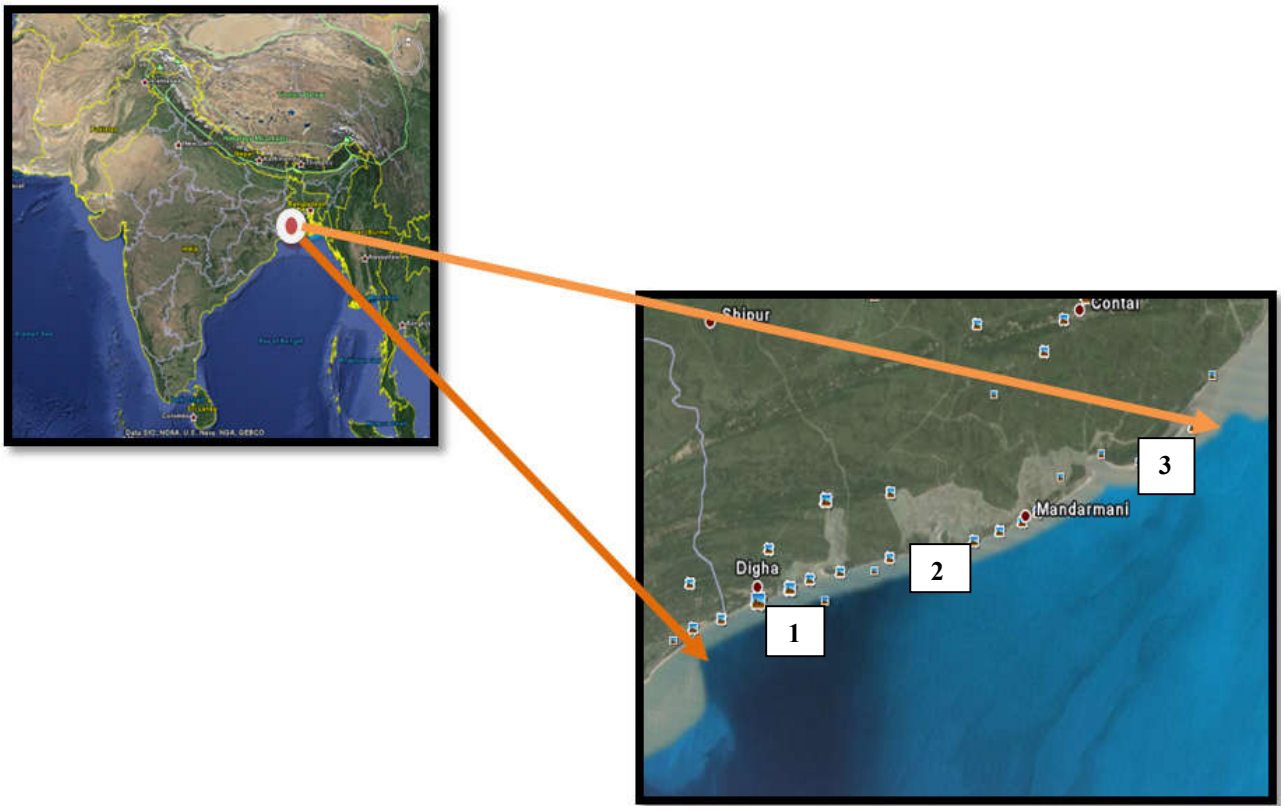

Figure 1. Satellite image of study region and three fish landing centers (Station 1- Digha mohona, Station 2 - Sankarpur, Station 3 - Soula) along Digha coastal region, West Bengal, east coast of India

All the quantitative and qualitative measures were recorded for each fishing cruise, like- the trip duration, fishing grounds (depth and type of bottom), gear used, fishing time and landing quantity. Puffer fishes were collected from the deeper waters of Digha coast. It is beyond shelf zone and around 55 nautical miles away from the shore. Only adult specimens are represented in hook and line catches. Immediately after the collection the fishes were photographed for their original colour and shape of different body parts. For the purpose of photograph "Nikon Coolpix L 24" was used, made by Nikon Corporation, Japan (14.0 Megapixel, 3.6 X optical zoom). After that, the samples were stored in different ice boxes according to their length and weight. Then the samples were brought to the laboratory and immediately washed, kept in sterile saline water and stored at -20°C (Veeruraj *et al*., 2011; Padate *et al*., 2013).

Table 1. Three Trawling stations with GPS Location where samples were collected periodically from Digha coast during this survey

Sl. No.	Station Name	GPS Location
Station 1	Digha mohona	21°37′N latitude and 87°32′E longitude
Station 2	Sankarpur	21°38′N latitude and 87°34′E longitude
Station 3	Soula	21°44′N latitude and 87°50′E longitude

RESULTS AND DISCUSSION

The distribution of puffer fishes were studied from station 1, station 2 and station 3 of coastal belt of Digha (between 21°32′N to 21°45′N latitude and 87°32′E to 87°50′E longitude), West Bengal, east coast of India. During this survey, 7 different species from 5 genera under the order Tetraodontiformes belonging to the family Tetraodontidae was identified. Totally 3542 puffer fishes (Table 2) were collected during this survey period from the above mentioned three stations and they were identified viz, *Arothron stellatus, Arothron immaculatus, Chelonodon patoca, Lagocephalus inermis, Lagocephalus lunaris, Takifugu oblongus, Tetraodon fluviatilis* (Table 4). The present study revealed that three puffer fishes were distributed mostly viz, *Lagocephalus lunaris* (51.49%), *Takifugu oblongus* (27.02%), *Tetraodon fluviatilis* (13.55%) and rest of the puffers are very few viz, *Arothron stellatus* (2.09%), *Arothron immaculatus* (0.28%), *Chelonodon patoca* (1.50%), *Lagocephalus inermis* (4.07%). *Lagocephalus lunaris* was recorded maximum from this coastal region. All the three trawling stations show almost equal percentage of captured puffer fishes. Catch percentage of puffer fishes during this survey period from Digha mohona, Sankarpur, Soula is 35.18%, 27.84%, 36.98% respectively (Figure 2).

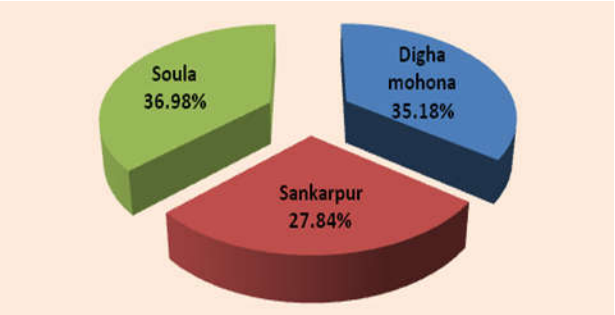

Figure 2. Percentage (%) of captured puffer fishes in three different trawling stations along coastal belt of West Bengal, East Coast of India

Abundance of different captured puffer fishes in three different trawling stations during this survey period is calculated (Table 2, Figure 3, Figure 4) and total catch of individual puffer fish species is represented (Figure 4).

Table 2. Sampling data of captured puffer fishes from three trawling stations along coastal belt of West Bengal, east Coast of India

S.No.	Species	FISH LANDING CENTRES			Total	Percentage (%) of Puffer fishes
		Station 1	Station 2	Station 3		
		Digha mohona	Sankarpur	Soula		
1	*Arothron stellatus*	17	36	21	74	2.09%
2	*Arothron immaculatus*	3	5	2	10	0.28%
3	*Chelonodon patoca*	13	29	11	53	1.50%
4	*Lagocephalus inermis*	57	58	29	144	4.07%
5	*Lagocephalus lunaris*	611	458	755	1824	51.49%
6	*Takifugu oblongus*	389	255	313	957	27.02%
7	*Tetraodon fluviatilis*	156	145	179	480	13.55%
	Total	1246	986	1310	3542	

Table 3. Data showing Seasonal survey of different puffer fish species during survey period along coastal belt of Digha, West Bengal, east Coast of India

No.	Species	SEASONAL SURVEY			
		Pre Monsoon (Apr – Jun)	Monsoon (Jul – Sep)	Post Monsoon (Oct – Dec)	Total
1	*Arothron stellatus*	3	54	17	74
2	*Arothron immaculatus*	0	9	1	10
3	*Chelonodon patoca*	4	42	7	53
4	*Lagocephalus inermis*	13	110	21	144
5	*Lagocephalus lunaris*	76	1415	333	1824
6	*Takifugu oblongus*	37	801	119	957
7	*Tetraodon fluviatilis*	29	397	54	480
	Total	162	2828	552	3542

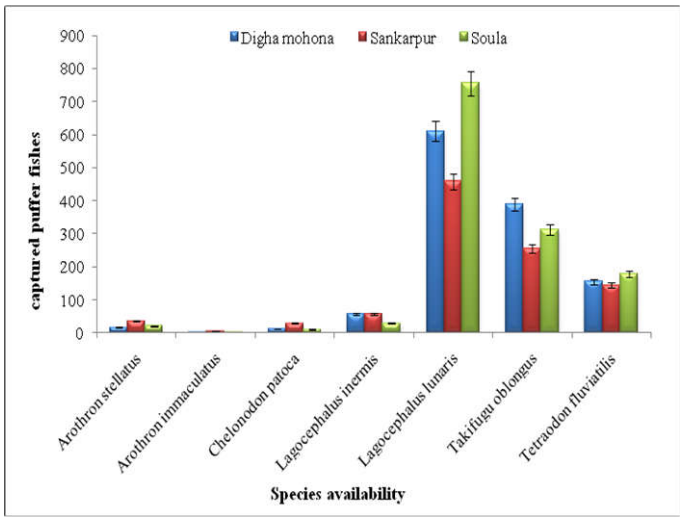

Figure 3. Abundance of captured different puffer fish species in three different fish landing centers during study period along coastal belt of west Bengal, east coast of India

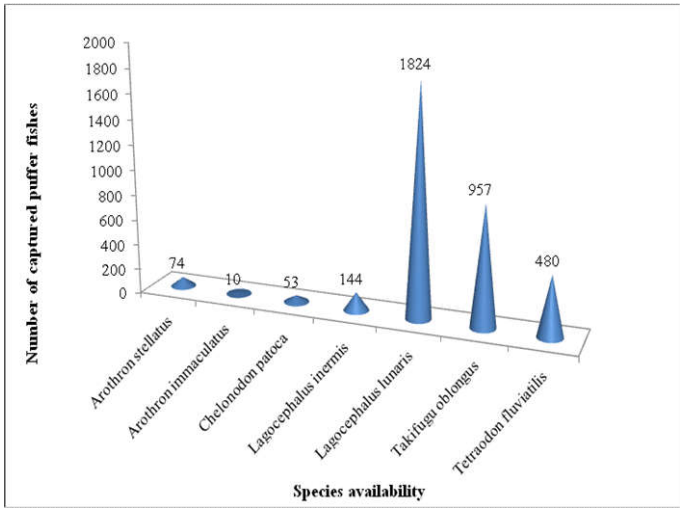

Figure 4. The total number of captured puffer fishes along coastal belt of West Bengal, east coast of India

Abundance of different captured puffer fishes in three different seasons i.e. pre-monsoon, monsoon, post-monsoon season during this survey period is tabulated (Table 3, figure 5) and total catch of individual puffer fish species in each season is represented (Figure 6).

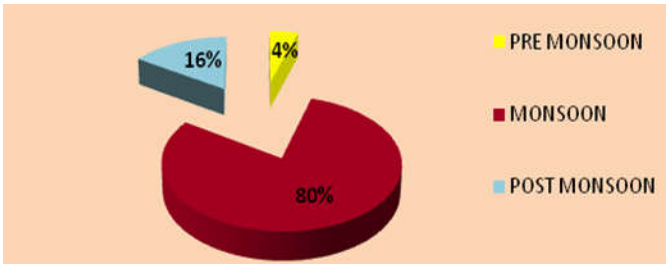

Figure 5. Pie diagram showing percentage of puffers collected in 3 seasons pre monsoon, monsoon, and post monsoon during study period along coastal belt of Digha, West Bengal, east Coast of India

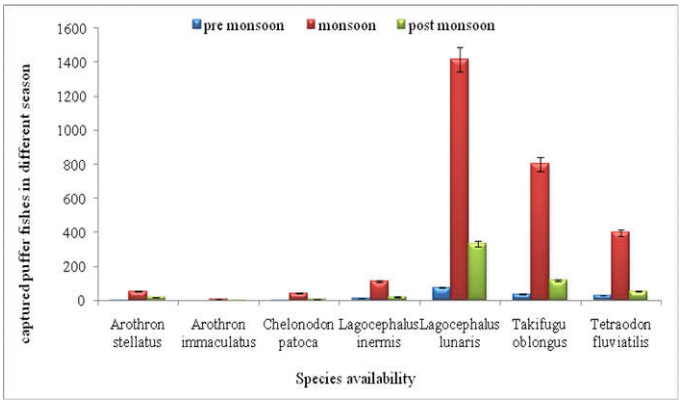

Figure 6. Diagram showing different catch of puffer fishes in 3 seasons i.e. pre monsoon, monsoon, and post monsoon during study period along coastal belt of Digha, West Bengal, east Coast of India

Table 4. Photographs of captured puffer fishes from three trawling stations during study period along coastal belt of West Bengal, east Coast of India

SL. NO.	SCIENTIFIC NAME	PHOTO
1	*Arothron stellatus* (Anonymous, 1798)	
2	*Arothron immaculatus* (Bloch and Schneider, 1801)	
3	*Chelonodon patoca* (Hamilton, 1822)	
4	*Lagocephalus inermis* (Temminck & Schlegel, 1850)	
5	*Lagocephalus lunaris* (Bloch and Schneider, 1801)	
6	*Takifugu oblongus* (Bloch, 1786)	
7	*Tetraodon fluviatilis* (Hamilton, 1822)	

Diversity study

A biodiversity index is an arithmetical calculation of species diversity in a given community in a particular area based on the species richness (the number of species present) and species abundance (the number of individuals per species). In present study we use the following indices.

Shannon Index

The Shannon index is an information statistic index, which means it assumes all species are represented in a sample and that they are randomly sampled.

$$\text{Shannon Index (H)} = -\sum_{i=1}^{s} p_i \ln p_i$$

Where, p is the proportion (n/N) of individuals of one particular Species found (n) divided by the total number of individuals found (N), in is the natural log, Σ is the sum of the calculations, and s is the number of species.

Simpson index

The Simpson index is a dominance index because it gives more weight to common or dominant species. In this case, a few rare species with only a few representatives will not affect the diversity.

$$\text{Simpson Index (D)} = \frac{1}{\sum_{i=1}^{s} p_i^{\,2}}$$

In the Simpson index, p is the proportion (n/N) of individuals of one particular species found (n) divided by the total number of individuals found (N), Σ is still the sum of the calculations, and s is the number of species. A biodiversity index is an arithmetical calculation of species diversity in a given community in a particular area based on the species richness (the number of species present) and species abundance (the number of individuals per species). In present study, the Shannon and Simpson index (Table 5) has been done on the basis of data shown in Table 2 and Table 3.

Table 5. Shannon and Simpson index in three sampling stations

Sl. No.	Sampling Station	Shannon index	Simpson index
1.	Digha mohona	0.634	2.813
2.	Sankarpur	0.722	3.233
3.	Soula	0.581	2.449
4.	Total sampling	0.645	2.7879

Conclusion

The present study recommended that the near shore waters provide as prospective spawning grounds of the marine puffer fishes. The catch of juveniles from the opaque waters of the Digha suggests their significance as nursery areas. The importance of mangrove fringed turbid estuarine waters as protected shelter for juveniles of different marine fishes. This area has also accessibility of adequate food and condensed probability of predation. We found 7 different species of puffer fishes in Digha coast. Thus it can be concluded that the Digha coast situated along the east coast of India has provided sufficient taxonomical information and distribution of Tetraodontidae family with special reference to puffer fishes. Particularly the *Lagocephalus lunaris, Takifugu oblongus* and *Tetraodon fluviatilis* are common in this coastal region as compared to other species. From the result of Shannon and Simpson index we can conclude that, the species richness (the number of species present) and species abundance (the number of individuals per species) of puffer fishes are low. So, it is the proper time to take measure for the conservation strategy for the puffer fishes in the Digha coast, West Bengal, east coast of India.

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