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Original Research

Diversity and resource characteristics of tetraodontidae fishes from Andaman with special reference to *Arothron immaculatus* – a preliminary study

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ABSTRACT:

Puffer fish belonging to the family tetraodontidae are usually distributed in the shallow waters. During investigation in stations viz. Marina Park, Chidiyatapu and Burmanullah, around Andaman, five species from genus *Arothron* and two from *Canthigaster* have been recorded and were mostly found to prefer coral reefs and rock crevices, with the exception of *Arothron immaculatus,* which was found to be present in the open waters and it confined to sandy bottom substrate with patches of sea grasses around them. These fishes were found to be most diverse and abundant in Chidiyatapu with the Margelef's Richness Index of 2.49, Shannon-Wiener index of 1.05 and Pielou's evenness index of 0.96. Biometric analysis results demonstrate that they have shown an isometric growth. The individuals collected were mostly lying in the length group of 120-160 mm. Gut content analysis of *A. Immaculatus* reveals that the fish feed mainly on molluscs and sea urchin and the other food items were shrimps, crabs, sponges, micro algae, foraminiferans etc. gastro-somatic index, hepato-somatic index and gonado-somatic indices were also calculated to throw light upon the feeding behavior and reproductive maturity of the fishes. Most of the individuals were found to be in the developing stage of maturity.

Keywords:

Puffer fishes, *Arothron*, *Canthigaster*, Andaman, Reef fish

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INTRODUCTION

Puffer fish belong to the order Tetraodontiformes under the family Tetraodontidae and are variously known as the blowfish, toadfish, globefish, swellfish and balloon fish (Halstead, 1967). They are found in the tropical waters worldwide, but they rarely moves to the cooler waters too. (Grant, 1987). Usually fish from the order Tetradontiformes exhibit a typical swimming behavior which is relatively slow, with their pectoral and anal fins. They are morphologically well-defended from predation by large dorsal-ventral spines (trigger fishes, Balistidae), toxins, (puffers, Tetradontidae), and quill-like scales (Porcupine fishes, Diodontidae), the latter two families have fused dentition which is well adapted for

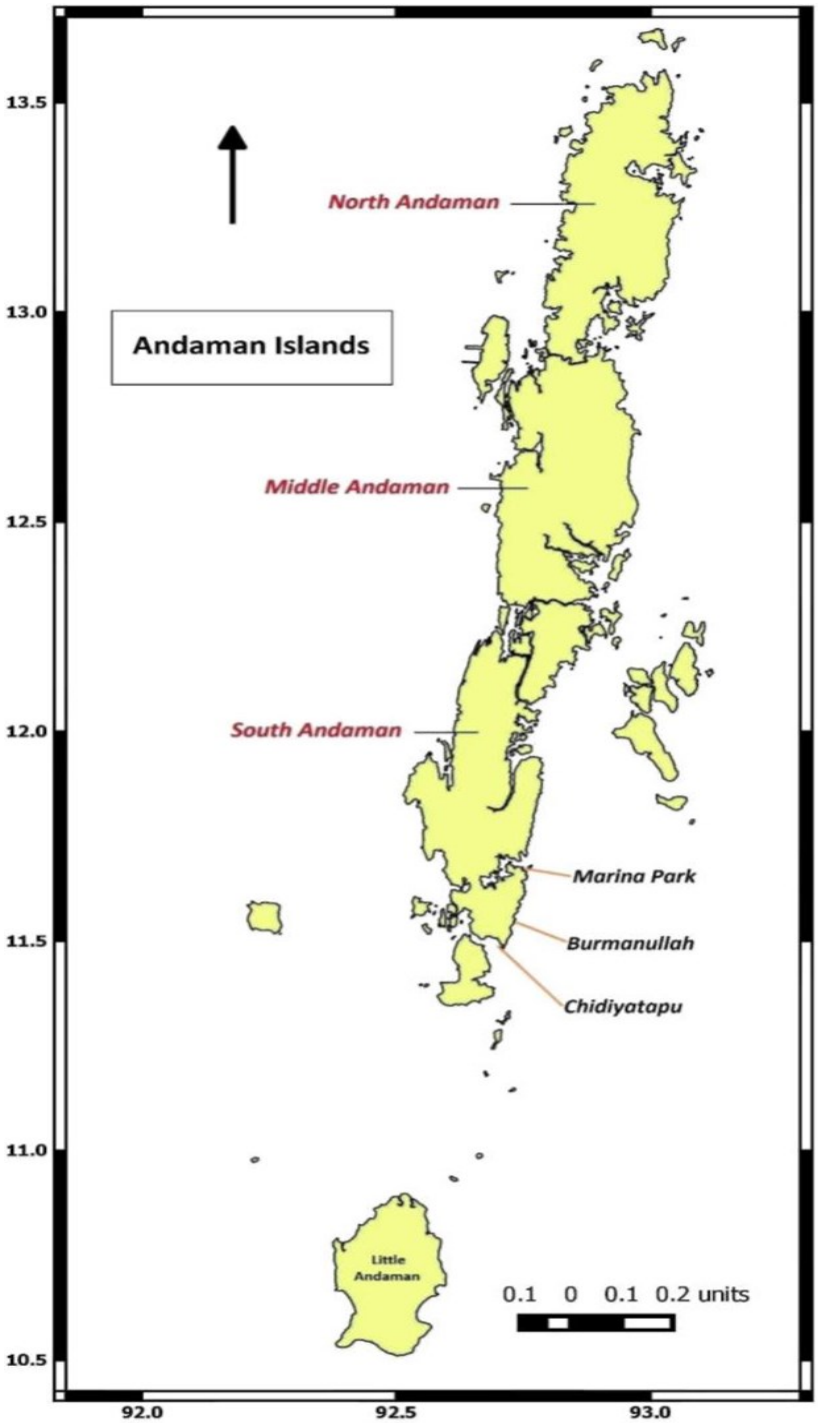


Figure 1. Location map showing all the study sites

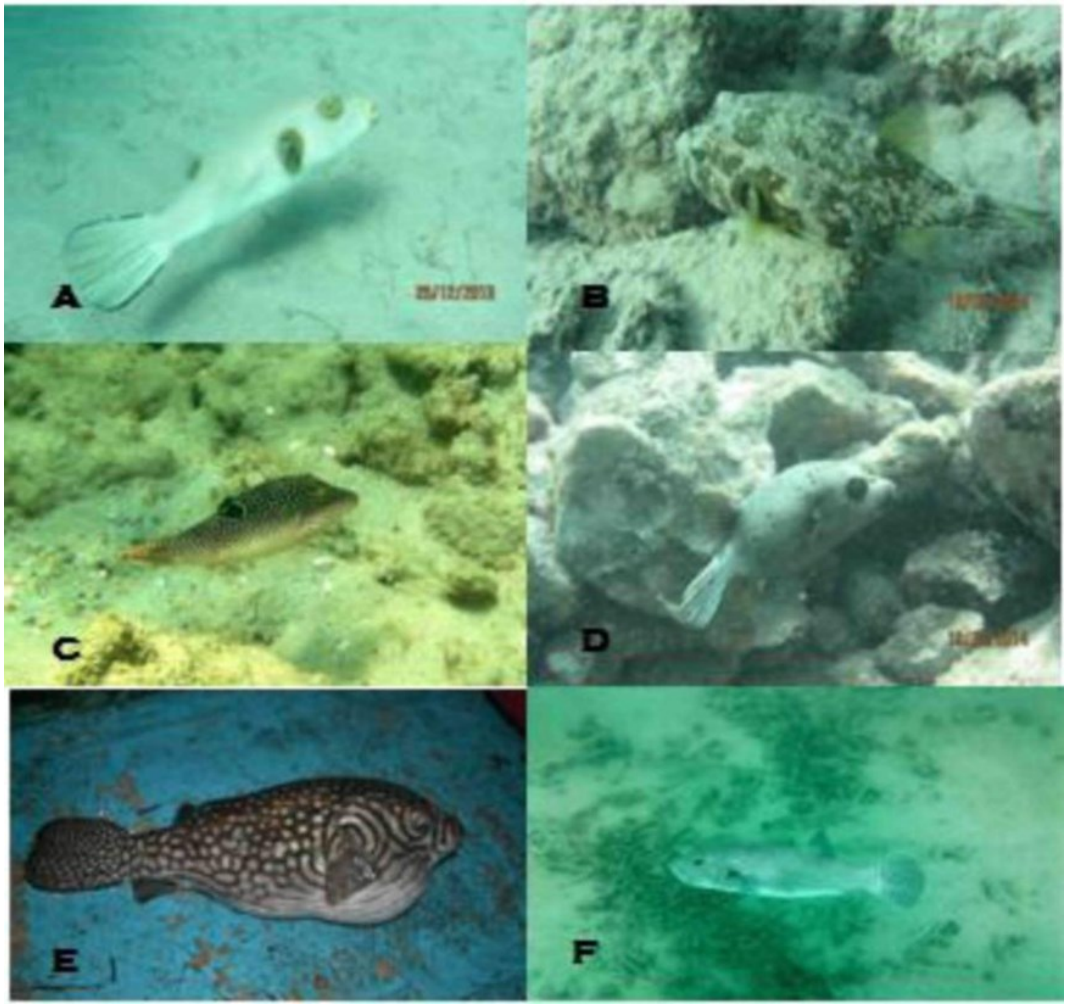


Figure 2. **(A)** ***Arothron immaculatus*** **(B)** ***Arothron hispidus*** ***(C) Canthigaster solandri*** ***(D) Arothron nigropunctatus*** ***(E) Arothron reticularis*** ***(F) Canthigaster bennetti***

consuming hard-shelled invertebrates. Puffer fish can generally grow to upto 60 cm in length but the exact length depends on the species, these fish can be found in a diversity of colors but can occasionally be hard to recognize when they are not inflated. It generally has the appearance of a big tadpole, with protruding eyes and an extended snout. They are omnivorous animals and eat an assortment of plants and animals. Puffer fish mostly forage on the algae that propagate on the rocks, corals and also the invertebrates that inhabitats these parts. Large species of puffer fish likewise feeds on shellfish such as shrimp and crabs and molluscs and the nutritional regime of milk spotted puffer Chelonodon patoca (Beumer, 1978) and of the puffer *S. spengleri* and *S. testudineus* (Targett, 1978) was largely dominated by hard-shelled crustaceans and molluscs and numerous examples of similar diet spectra have been observed for the Tetraodontidae family (Krumme *et al*., 2007). Mostly puffers possesses defense mechanisms to protect themselves against predators: being poisonous, inflation and aposematism (Krumme *et al*., 2007).

Immaculate puffer, *Arothron immaculatus* is a comparatively friendly puffer and has the characteristic form with a white greyish body without spots and has been initially found in the Indo-Pacific Ocean but can as well be found from the Red Sea and the East African coast to Indonesia and Japan. They are found in the sea-grass beds of shallow water or in mangrove forests and are most common in estuaries and sea-grass beds. These fishes are nocturnal in nature, carnivorous and feed on

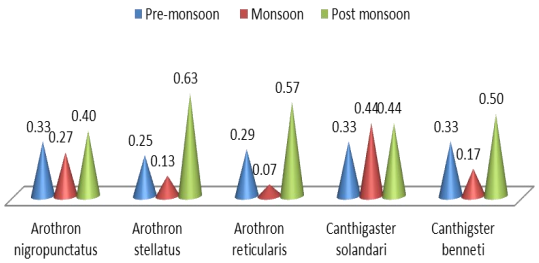


Figure 3. Fish composition during all the seasons at Burmanallah

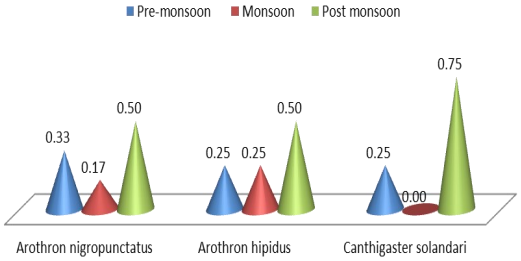


Figure 4. Fish composition during all the seasons at Chidiyatapu

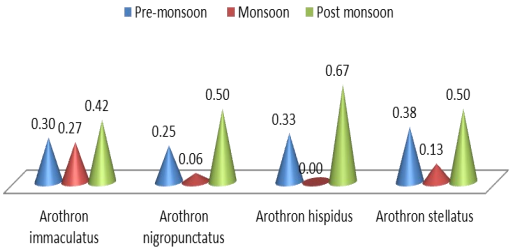


Figure 5. Fish composition during all the seasons at Marina park

shrimps, clams and mussels and benthic invertebrates (Krumme *et al*., 2007). Sex differentiation of immaculate puffer is hard but females are usually rounder than males.

Tetradontids are the most common fish species sampled from the tropical and sub-tropical mangroves (Bell *et al*., 1984; Hindell and Jenkins, 2004). In the Western Pacific, tetraodontids are commercially valuable and highly regarded as fish food, even though the presence of the family-specific tetradodoxin still causes the death of gastronomers each year and later the puffer fish were listed as 'grey species' in the reports by New South Wales Fisheries (NSW DPI, 2006), which means that this group requires further scientific or technical consideration and risk assessment.

There are 29 genera of tetraodontidae that has been documented by Froese and Pauly (2008) and species of puffer fish detailed from tropical sea are about 120 (Sabrah *et al*., 2006), but only 20 puffer fish species belonging to the family tetraodontidae has been described from the Andaman and Nicobar Islands (Rajan *et al*. 2013). The puffer fishes found in these islands are not commercially important. They are generally discarded by the fishermen since they are inedible because of their toxicity. Even though there are many works conducted on this group of fishes, but there is only a single work so far been conducted from Andaman water about the biology of puffer fishes (Kumar *et al*., 2013), So the present study will give an idea about the diversity and resource characters of these very important fishes in the habitats around the island ecosystems.

MATERIALS AND METHODS

The present study was conducted between the months of December 2013 to November 2014 in the waters around Port Blair, South Andaman and the stations investigated were Burmanallah, that mainly comprised of rocky substratum; Chidiyatapu with well-developed coral reef, mostly dominated by *Porites* spp. and Marina Park that mainly comprises of sandy substratum with patches of artificial reefs due to the presence of the marina. All these three habitats provided the fish with ample amount of food and shelter, thus a large fish aggregation was observed in these areas. This study investigated the diversity and abundance of the species belonging to the genera *Arothron* and *Canthigaster* along with the biology of *Arothron immaculatus*.

The abundance of species were estimated by using Fish belt transect method (Brock, 1954; English *et al*., 1997). Shannon-Weiner index of diversity (Clarke and Warwick, 2001) Margalef's species richness index (Clifford and Stephenson, 1975), Simpson Index

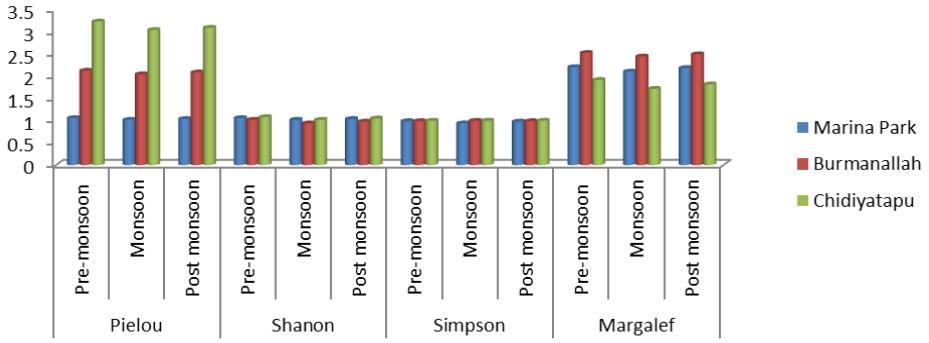


Figure 6. Various diversity indices for *A. immaculatus* in all the study sites

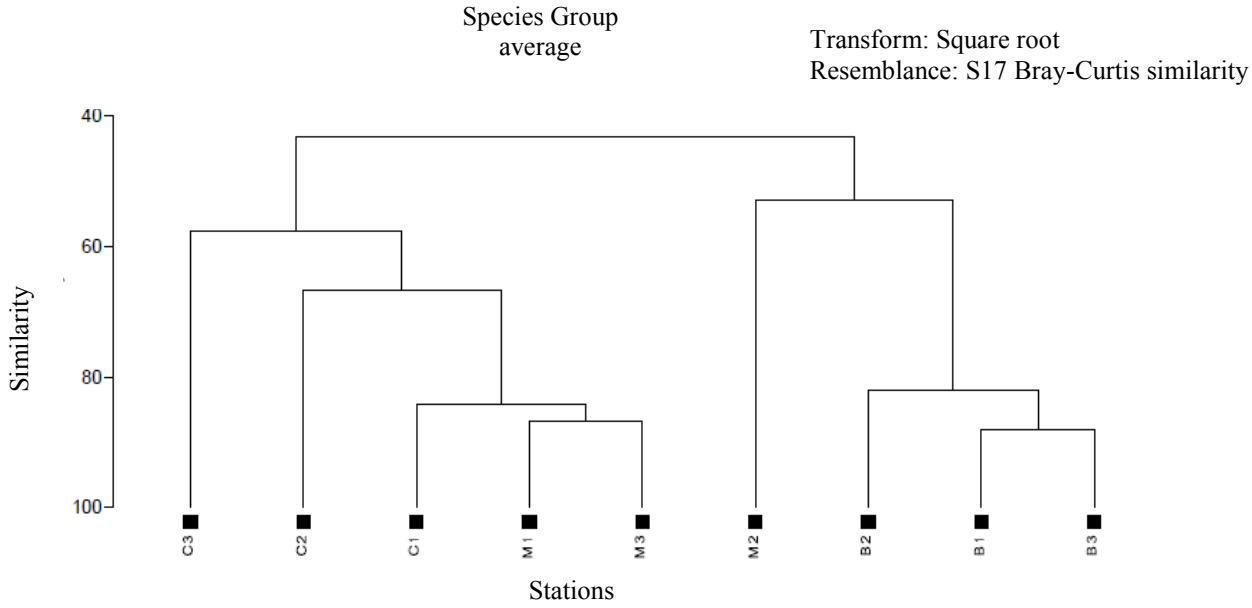
(Simpson, 1949) and Pielou's species evenness index (Hill, 1973) were used to estimate the evenness and diversity of fishes.

A total of 20 specimens ranging from 115-190 mm TL and 45.2-100.6 g weight were collected at the Marina Park and were analyzed for food and feeding habits, sex ratio and stages of maturity, length-weight relationships, hepatosomatic index, gastro-somatic index and gonado-somatic index. Length weight relationship is expressed by the formula $W= aL^b$ (Le Cren 1951; Ricker 1973). Occurrence of each item was expressed as the percentage of total number of stomach examined. In order to determine the maturity stages, general appearance of ovary like fullness in the ventral cavity, size, shape and colour were considered. The classification of maturity stages were made as per Qasim (1972).

RESULTS AND DISCUSSION

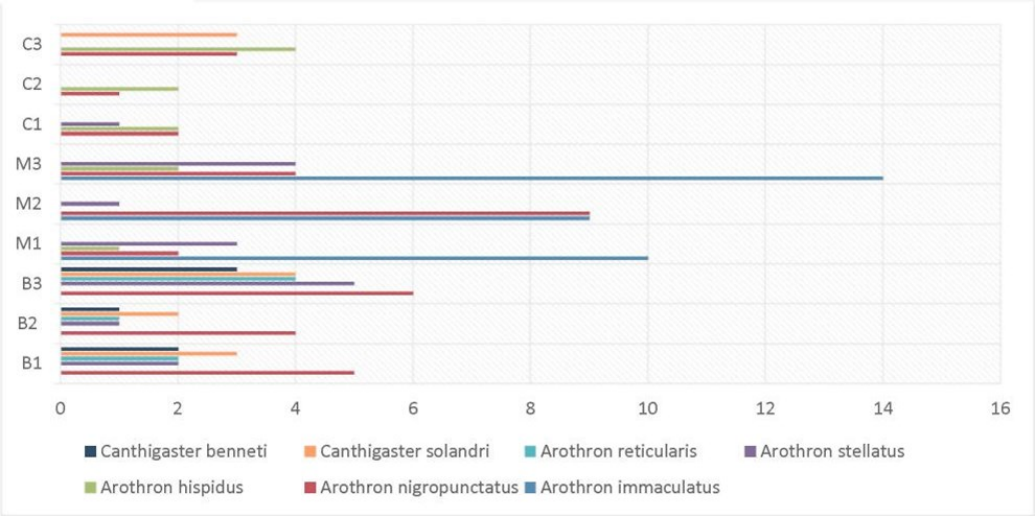
A total of 105 individuals, that represents seven species of puffer fishes (five from genus *Arothron* and two from the genus *Canthigaster*) were observed, where

Figure. 7 Cluster analyses of all the three seasons at all the study sites



C1- Chidiyatapu (pre-monsoon); C2- Chidiyatapu (monsoon) ; C3- Chidiyatapu (post-monsoon) ; M1- Marina Park (pre-monsoon); M2- Marina Park (monsoon) ; M3-Marina Park (post-monsoon) ; B1- Burmanullah (pre-monsoon); B2- Burmanullah (monsoon); B3- Burmanullah (post-monsoon)

Figure 8. Numerical data of puffer fish abundance at all the study sites depicting changes in different seasons



C1- Chidiyatapu (pre-monsoon); C2- Chidiyatapu (monsoon) ; C3- Chidiyatapu (post-monsoon) ; M1- Marina Park (pre-monsoon); M2- Marina Park (monsoon) ; M3-Marina Park (post-monsoon) ; B1- Burmanullah (pre-monsoon); B2- Burmanullah (monsoon); B3- Burmanullah (post-monsoon)

Arothron nigropunctatus was the most abundant species and was observed at all the study sites and it accounts for >25 % of the total number of total fish individuals observed, while *Arothron immaculatus,* accounts for > 28%, but its existence was witnessed only at Marina Park. The other species observed were *Arothron hispidus* (8.57%), *A. stellatus* (14.29%), *A. reticularis* (5.71%), *Canthigaster bennetti* (5.71%) and *C. solandri* (11.43%) from all the study sites. Seasonal observations display the higher abundance of all the puffer fishes during post-monsoon (Fig. 3-5).

The values of Shannon-Wiener and Pielou's evenness Index showed high fish diversity at Chidiyatapu along with a high abundance, these fishes

Figure 9. Food and Feeding Habit of *A. immaculatus*

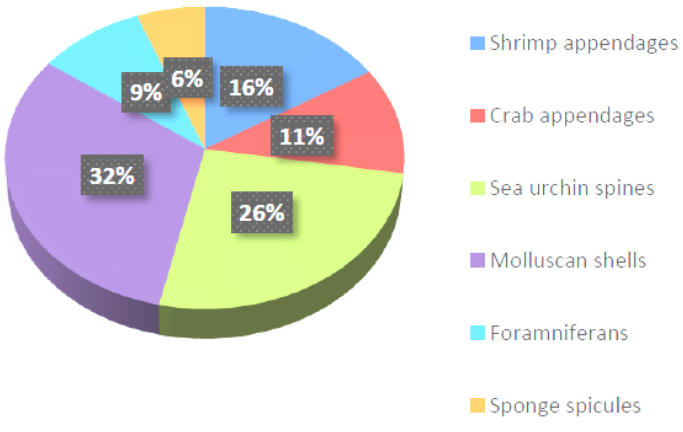


Figure 10. Length-Weight Relationship in *A. immaculatus*

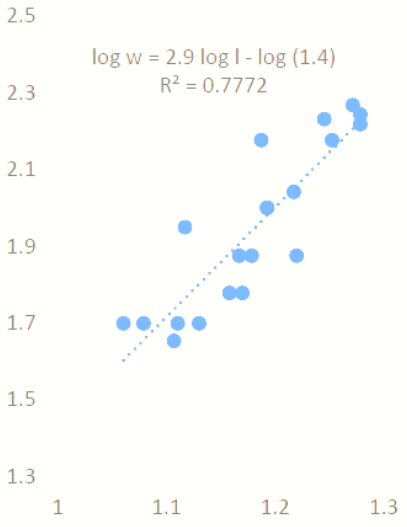


Figure 11. **Length frequency distribution of *A. immaculatus***

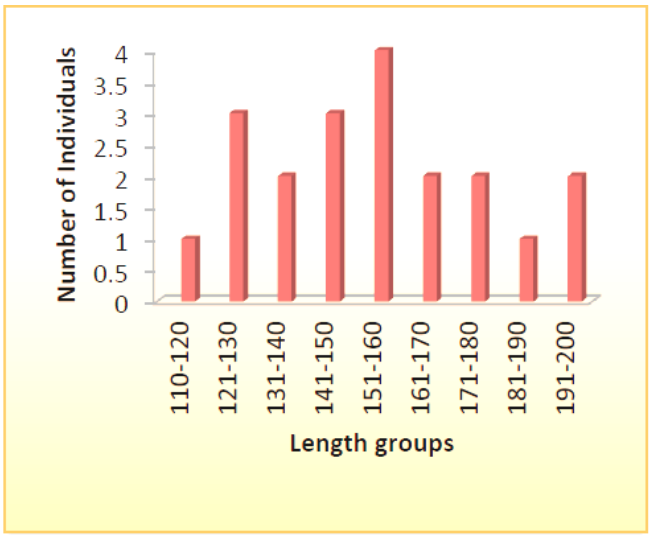
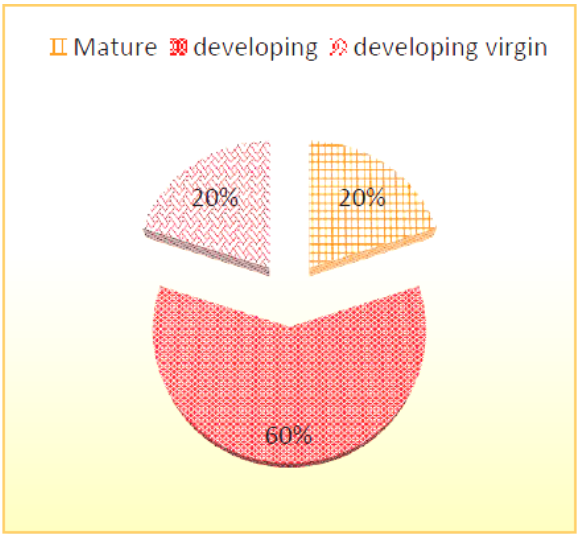


Figure 12. Maturity stages of *A. immaculatus*

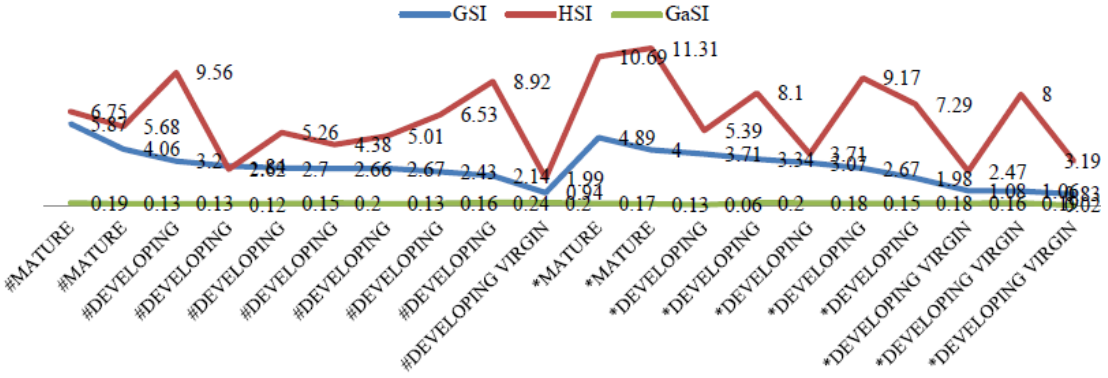


were found to be evenly distributed and it could be due to the vast area of bottom substratum covered with corals and associated organisms which serve as feed for these fishes.

While same values were found to be low in Burmanullah and it showed very least diversity and the number of individuals observed among different species also varied to a wide margin indicating very low species evenness. The reason could be the presence of rocky shore that gets exposed to strong wave actions which makes it less supportable for the fishes, particularly for the slow moving puffer fishes. Although Marina Park showed virtuous diversity and evenness of puffer fish species its diverse substratum of rocks, reefs and sand accommodating the puffer fish species was high .The value for the Margalef species richness index was found to be very high in Barmanullah indicating the presence of a wide variety of reef fishes but in some or very few numbers and Chidiyatapu showing a low richness but the species present was more in numbers and evenly distributed as well.

It can be clearly observed from Fig 7., that the there were two revealing cluster formed when the abundance data of all the three study sites clustered

Figure 13. Sex wise Hepato-Somatic index, Gastro somatic Index and Gonado-Somatic Indices indicating the reproductive maturity level of *Arothron immaculatus*.



#: Male; *: Female; GSI: Gonado-somatic Index; HSI : Hepato-somatic Index; GaSI: Gastro somatic Index

together and it revealed that Burmanullah site have similar number of fish abundance at all the season while the other stations showed proximity with each other in the second cluster. In the Fig 8. Number wise data of puffer fish has been displayed that is clearly indicating the highest number of fishes in Marina Park during the post-monsoon season.

The general feeding habit of puffers consists mainly of hard-shelled crustaceans and molluscs and small estuarine puffer fishes feed on resident benthic fauna found often burrowed in the sediment. Very few species have preference for algae and other invertebrates as the teeth are modified into beak-like structures for crushing the hard-shelled organisms. Present study has also shown the same patterns in feeding habit, where the fish mainly feeds on benthic organisms (Figure. 9), where the maximum available content was found to be of molluscan shells (32%) followed by sea urchin spines (26%) and shrimp appendages (16%). In addition, crab appendages (11%), foramaniferans (9%) and sponge spicules (6%) were also in considerable proportions, and it indicates the carnivorous nature of the fish. It has been confirmed in other studies as well where the gut content of the puffer fish mainly comprising of rock oysters (71.66%), sea weed pieces (15.38%) and broken crab shells (6.41%) (Kumar *et al*., 2013), while the puffer fish *Torquigener pleurogramma* from Western Australia feeds on polychaetes and amphipods for fish less that 130mm, and bivalve molluscs for larger fish (Potter *et al*., 1988). *Colomesus psittacus* from North Brazilian mangrove were specified predators of Cirripedia (Balanus spp.) and crabs (Uca spp., Pachygrapsus gracilis) (Krumme, *et al*., 2007). *Tetractenos glaber* in Sydney estuaries feeds mainly on prawns, Semaphore crabs *Heloecius cordiformis*, mussels and brown algae (Alquezar *et al*., 2006), and the food of *Lagocephalus sceleratus* from the Gulf of Suez, Egypt was composed mainly of cephalopods (squids and cuttle fishes), crustaceans (particularly crabs) and fishes (Sabrah *et al*., 2006).

In the present study the analysis of length-weight relationship of *Arothron immaculatus* was done to assess its pattern of growth in pre-monsoon season. The b value was found to be 2.9 which is a negative allometry (Fig. 10). Even though it shows almost an isometric growth since it is very proximal to three. According to Bagenal and Tesch (1978) b parameters generally do not vary significantly throughout the year unlike parameter a that may vary seasonally, daily and in different habitats (Can *et al*., 2002). The length frequency observed in the previous work done by Taskavak and Bilecenoglu, 2001 showed that the species of puffer fish (*Lagocephalus spadiceus*) was found to be in the size range between 159 -199 mm. Similar works were done by Sabrah *et al*. (2006), Michailidis (2010) and Aydin (2011) on *Lagocephalus scleratus* which showed lengths within the size ranges 185-785 mm, 60-770 mm and 125-630 mm respectively. In this study the maximum numbers of individuals were found to be in the size group between 150-160 mm (Fig. 11). The least number of individuals were found among two size groups of 110-120 mm and 180-190 mm. The size range was between 115-190 mm in the specimens analyzed and 50% of the individuals were found to be male and another 50% as female (Fig. 12). Recent studies have revealed a proportional relationship between toxicity and gonado-somatic index suggesting that with the increase in GSI, the toxicity increases (Ghosh *et al*., 2004). Tani, 1945, clearly showed that the concentration of toxin per gram ovary increased with the increase in the weight of the ovaries. The maximum GSI was found to be 5.87 and the least was 0.83 and it is shown in Figure 5. GSI values depicts that most of the fishes have a more or less high GSI indicating that they are approaching their spawning season and hence the intensity of toxicity is also high. GaSI (Gastro somatic Index) values for all the specimens ranges in between 0.02 to 0.24 and HSI value was in between 2.47 to 9.99 (Figure.13).

CONCLUSION

The biology study indicates that *A. immaculatus* fish species are going to approach their spawning season and length-weight relationship study specifies that the maximum numbers of fishes are in150-160 mm length group, which reveals that they are about to reach their maturity stage and the same result was portrayed by GSI values.

REFERENCES

Alquezar R, Markich SJ and Booth DJ. (2006). Metal accumulation in the smooth toadfish, *Tetractenos glaber*, in estuaries around Sydney, Australia. *Environmental Pollution,* 142(1): 116-122.

Aydin M. (2011). Growth, reproduction and diet of pufferfish (*Lagocephalus sceleratus* Gmelin, 1789) from Turkey's Mediterranean Sea Coast. *Turkish Journal of Fisheries and Aquatic Sciences,* 11(4): 589-596.

Bagenal TB and Tesch FW. (1978). Age and growth. In: Methods for assessment of fish production in fresh waters, 3rd edn. T. Bagenal (Ed.). IBP Handbook. Blackwell Science Publications, Oxford, (3): 101–136.

Bell JD, Pollard DA, Burchmore JJ, Pease BC and Middleton MJ. (1984). Structure of a fish community in a temperate tidal mangrove creek in Botany Bay, New South Wales. *Australian Journal of Marine and Freshwater Research,* 35(1): 33-46.

Beumer JP. (1978). Feeding ecology of four fishes from a mangrove creek in north Queensland, Australia. *Journal of Fish Biology*, 12(5): 475-490.

Brock VE. (1954). A preliminary report on a method of estimating reef fish populations. *Journal of Wildlife Management,* 18(3): 297-308.

Can MF, Basuta N and Cekic M. (2002). Weight length relationships for selected fish species of the small-scale fisheries off the south coast of Iskenderun Bay. *Turkish Journal of Veterinary and Animal Sciences*, 26(5): 1181-1183.

Clarke KR and Warwick RM. (2001). Changes in marine communities: an approach to statistical analysis and interpretation, 2nd edition, PRIMERE: Plymouth. 172.

Clifford HT and Stephenson W. (1975). An introduction to numerical classification. Academic Press, London.

English S, Wilkinson C and V Baker. (1997). Survey Manual for Tropical Marine Resources. Townsville, Australia, *Australian Institute of Marine Science, Townsville Australia*. 378.

Froese R and Pauly. (2008). Family Tetraodontidae-Puffers [Electronic Version]. Retrieved 29 December 2009.

Ghosh S, Hazra AK, Banerjee S and Biswapati Mukherjee (2004). The seasonal toxicological profile of four puffer fish species collected along Bengal coast, India. *Indian Journal of Marine Sciences*, 33(3): 276-280.

Grant E. (1987). Fishes of Australia. E.M. Grant PTY Limited. Redcliffe, Australia.

Hindell JS and Jenkins GP. (2004). Spatial and temporal variability in the assemblage structure of fishes associated with mangroves (*Avicennia marina*) and intertidal mudflats in temperate Australian embayments. *Marine Biology*, 144(2): 385-395.

Hill MO (1973). Diversity and evenness: a unifying notation and its consequences. *Ecology*, 54(2)427-473.

Halstead B (1967). Poisonous and venomous marine animals of the world, US Government Printing Office, Washington DC.

Krumme U, Keuthen H, Saint-Paul U and Villwock

W. (2007). Contribution to the feeding ecology of the banded pufferfish *Colomesus psittacus* (Tetraodontidae) in north Brazilian mangrove creeks. *Brazilian Journal of Biology*, 67(3): 383-392.

Kumar P, Mishra JK, Ysamin and Kumar SC. (2013). Studies on Biology of Puffer Fish Species from South Andaman Sea. *Journal of Coastal Environment,* 4(1): 81-89.

Le Cren ED. (1951). The length-weight relationship and seasonal cycle in gonad weight and condition in the perch (Perca fluviatilis). *Journal of Animal Ecology*, 20(2): 201-219.

Michailidis N. (2010). Study on the lessepsian migrant *Lagocephalus sceleratus* in Cyprus. East med subregional technical meeting on the lessepsian migration and its Impact on Eastern Mediterranean Fishery. 74-87.

NSW Goverment of Natural Resources. (2006). Estuaries in NSW; Sandon River [Electronic Version].

Potter IC, Cheal AJ and Loneragan NR. (1988). Protracted estuarine phase in the life cycle of the marine pufferfish. *Torquigener pleurogramma*. *Marine Biology*, 98(3): 317-329.

Qasim SZ. (1972). The dynamics of food and feeding habits of some marine fishes. *Indian Journal of Fisheries*, 19(1 and 2): 11-28.

Rajan PT, Sreeraj CR and Titus Immanuel. (2013). Fishes of Andaman and Nicobar Islands: a checklist. *Journal of the Andaman Science Association,* 18(1): 47-87.

Ricker WE. (1973). Linear regressions in fishery research. *Journal of the Fisheries Research Board of Canada,* 30(3): 409-434.

Sabrah MM, El-Gannainy AA and Zaky MM. (2006). Biology and toxicity of the puffer fish *Lagocephalus sceleratus* (Gmelin, 1789) from the Gulf of Suez. *Egyptian Journal of aquatic Research*, 32(1): 283-297.

Simpson EH. (1949). Measurement of diversity. Nature, 163:688.

Tani I. (1945). A study of the toxicity of Japanese fugu (Teikoku Tosho Co., Tokyo, Japan), 103 p.

Targett TE. (1978). Food resource partitioning by the pufferfishes *Spoeroides spengleri* and *S. testudineus* from Biscayne Bay, Florida. *Marine Biology*, 49(1): 83-91.

Taskavak E and Bilecenoglu M. (2001). Length weight relationships for 18 Lessepsian (Red Sea) immigrant fish species from the eastern Mediterranean coast of Turkey. *Journal of the Marine Biological Association of the UK,* 81: 895-896.