

Ichthyofaunal diversity and ecology of intertidal rock pools of Goa, west coast of India

Lobsang Tsering, Pawar H.B., Sreepada R.A.,*Sanaye S.V., Suryavanshi U. and Tanu

Aquaculture Laboratory, National Institute of Oceanography (NIO)
Council of Scientific & Industrial Research (CSIR), Dona Paula, Goa - 403004 (India).

Abstract

A diversity of the fish communities inhabiting rock pools of Goa, west coast of India was studied in the present study. A total of 386 fish, representing 9 species, were collected from two rocky shores of Goa viz. Vainguinim and Anjuna beaches. Blenniidae family constitutes 80% of all the total fishes which includes 3 species of genus *Istiblennius* namely *Istiblennius dussumieri*, *Istiblennius omobranchus* and *Istiblennius banditus*, followed by Gobiidae 12%, 3 species, *Pseudogobius sp.*, *Istigobius sp.* and *Istigobius ornatus*, Pomacentridae 5.24% with a single species, *Abudefduf sordidus*, Mugilidae 0.52% *Mugil cephalus* and Terapontidae 0.26% *Terapon jarbua*. The most abundant species found from both the sites was *Istiblennius dussumieri*.

Introduction

There are four basic types of shore distinguished along the Indian coast, (8129 km coast line) viz., 1) sandy shores, 2) rocky shores, 3) muddy shore (estuarine region), and 4) coral formations. Though the west coast of India is with predominantly rocky shores, there are also stray of sandy region (Krishnamurthy & Subbaramaiah, 1972). Rocky shores confined narrow gullies and small tide pools on the intertidal zone called as Intertidal rock pools or tide pools. Although, these intertidal rock pools represent an extremely harsh environmental condition but they serve diverse marine communities, especially fishes (Castellanos- Galindo *et al.*, 2005) Therefore, ichthyofaunal diversity in the intertidal rock pool has attracted researchers from across the world focusing on different dimensions, including sediment pool fishes, Australia (Chargulaf *et al.*, 2011), tropical tide pool fish assemblage structure, Colombia (Castellanos-Galindo, 2005), microhabitat segregation of intertidal fishes, Portugal (Faria & Almada, 2000), and vertical distribution of intertidal fishes from Atlantic coast of France (Gibson,1972) etc. All these studies contribute to great deal of ecological importance to the rocky shore ecosystem and for the conservation of marine biodiversity. However, there is limited information on intertidal ichthyofaunal diversity of rock pools and its ecology from India. In

addition, resident intertidal rock pool fishes along the west coast of India during India's pre-monsoon and the monsoon seasons are poorly studied.

The unique feature of these intertidal rock pool's fishes is that as the tide ebbs and flows they experience continuous and rapid change in temperature, salinity, pH and dissolved oxygen content, and these fishes have adaptive nature for such a dynamic environment (Griffith, 2003) including the strong turbulence by the wave action. The fishes in the intertidal rock pools are mainly composed of Blennidae and Gobiidae families (Griffiths *et al.*, 2003). Interestingly some of the species of Blennidae, for instance, *Entomacrodus* and *Alticus* show amphibian characters such as air breathing and active life outside the water (Graham, 1997). Many species of blennies and gobies share same rocky coastal habitat, feeding behavior and use small hollows to hide and spawn (Nieder, 1997; Velasco *et al.*, 2010). Even though they share many common features including habitat, spawning, feeding behavior and also from the same order it is easy to distinguish between them. Goby has a fused pelvic fin located on ventral side of the body which helps to cling on the rocks and on the corals during strong turbulence. They are usually found at the bottom of the rock pool. Whereas blennies are commonly called as rock skippers, they jump from one pool to another and their pelvic fins are used to upright the head on the rocks and for the crawling on the rocky area. In addition to that, macro algae are the major primary producers for the temperate rocky shores in west coast of India, herbivorous intertidal rock pool fishes, particularly blennies spend most of their time on grazing algae that are grown on the substratum.

According to Griffiths (2003) intertidal fishes are categorized into three different groups based on their habitat, namely 1) permanent resident, where fishes spend their entire life (juvenile to adult) in the pool, 2) Opportunists or secondary resident, where only part of the life is in the intertidal rock pool, usually juveniles and feeding during high tide, and 3) Transient, these fishes are present in the rock pool occasionally and they don't have any specialized adaptations for intertidal life.

The main objective of this study was to understand the fish composition on the rocky shores of West Coast of India, Goa, as well as to evaluate the physical characteristics of the rock pool area (depth, area, temperature, salinity and DO).

Methods and material

The study was carried out from 1st May 2011 to 30th June 2011, at two rocky shores in west coast of India, Goa *viz.* Vainguinim beach (15°27'15"N; 73°44'12"E) and Anjuna beach (15°35'05"N; 73°44'12.40"E). Vainguinim and Anjuna beach were visited weekly, during pre-monsoon (May, 2011) and monsoon season (June, 2011). Total of 10 rock pools were monitored,

five from each site. From each pool prior to fish collection temperature, salinity, pH was measured and water sample collected for dissolved oxygen (DO) measurement. Temperature was measured by regular thermometer (0 to 50°C), salinity by digital refractometer PAL-06S from the surface water in both the sea and rock pool water. pH was measured by digital pH meter ecoTester pH1 whereas DO measured by Winkler's method. Moreover, physical features of the pools were measured using a meter tape. Pool length was measured as the maximum distance across the top of the pool. Pool width was considered to the distance perpendicular to the mid point of the length axis and average depth was considered by mean depth of 10 pools (Zanata, 1990). Volume of the water was taken as the product of surface area and the depth of the pool.

During low tide sample collection was done, initially excess amount of water was siphoned out from the rock pool and removed with the bucket until fishes were visible from the top. Rock pool was then treated with clove oil anesthesia (1:9 ratio of clove oil and ethanol) (Griffiths, 2003). Anesthesia was added according to the volume of water content in the pool and mixed thoroughly. Anesthetized fishes were collected by hand and dip net and transferred into a common recovery bucket filled with seawater and aerated with battery aerator (AIR PUMP D-20C). All the fishes were recovered from the clove oil anesthesia and taken to the NIO aquaculture laboratory for further analysis.

Once these specimens were brought to NIO Aquaculture laboratory, fishes were shifted to FRP tank (60 X 45 X 30cm) filled with sea water and kept with continuous moderate aeration. Fishes were first acclimatized to the laboratory for one days and fed with boiled chopped clams and commercial shrimp feed. Every specimen was identified up to species level in aquaculture laboratory with the help of www.fishbase.org (Fishbase, 2011). Morphometric measurements like total length (TL), standard length (SL) were measured to the precision of 1 mm whereas; weight in gram was recorded to the precision of 0.1 mg on electronic balance. In order to minimize the stress on fishes clove oil anesthesia (1: 9 clove oil and ethanol) was used during the experiments. After taking the measurement they were released back to their habitat. Dead fishes were photographed in aquaculture laboratory after the fins were pinned out and brushed with formaldehyde. Later, Specimens were preserved in 5.00% formaldehyde for further references.

Result and discussion

Physical characteristics of the Intertidal tide pools of the Vainguinim and Anjuna beach were showed in the table 1 and table 2. Vainguinim beach has an average surface area 0.494 m², depth

0.196 m and the volume of the tide pool 0.111m³, whereas, at Anjuna beach average surface area, depth and volume of the tide pools were 0.524 m², 0.494m and 0.166m³ respectively.

Physical parameters of water

Dimensions and volume of rock pools of Vainguinim beach (15°27'15"N; 73°44'12"E) and Anjuna beach are given in Table 1.

1) Temperature

The temperature of seawater from May 2011 to June 2011, month varied from 28°C - 35°C with an average of 30°C and air temperature during the study period was recorded average of 33.16°C. However, there was decrease in both the sea surface temperature and the air temperature on the month of June due to south west Monsoon season in India. An average values calculated for the rock pool water temperature was (30.75°C) but there was no difference in environmental variable within the rock pools of both sites; all the rock pools showed same temperature.

2) pH

There was no change in pH of seawater from May 2011 to June 2011, it remained same as 8 whereas, in the rock pool most of the pools at Vainguinim beach also showed same pH that of the sea water but at the Anjuna beach there was an decrease in pH on the month of July 8 to 7.9. An average pH value of the rock pool was 8.0 the pH variation was from 8.0 to 7.9 at Anjuna beach might be due to the monsoon season. There was not much variation in pH between two sites of the rock pools and the pH values observed from the sea water.

3) Salinity

The salinity of seawater from May 2011 to June 2011 varied widely from 16 to 35.5‰ with an average of 30.08‰ and an average value of the rock pool salinity was 30.75‰. Most of the rock pools showed same trend of salinity in the 1st month (34‰). As monsoon approached there was decrease in salinity of the sea as well as the rock pools and minimum salinity reached up to 16 ‰.

4) Dissolved Oxygen (DO)

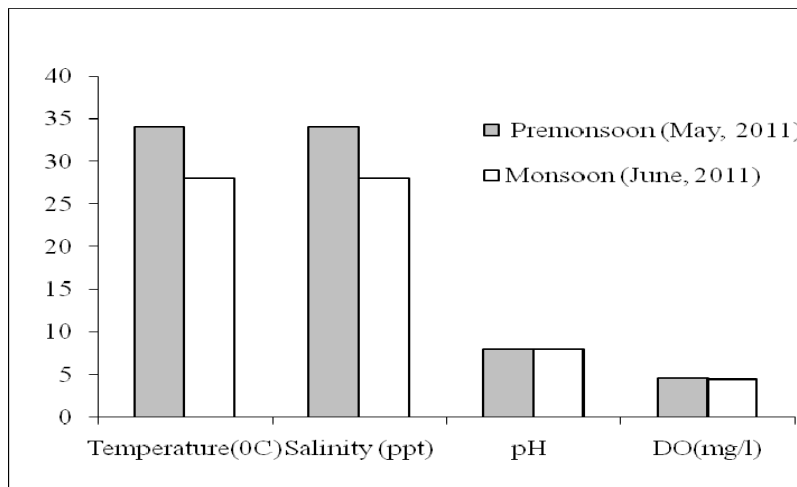
The dissolved oxygen content in seawater during the month of May and June 2011 ranged from 3.97 to 5.84 mg/l with an average of 4.71 mg/l. The average values calculated during the sampling was near-surface. The average values of the DO content in the rock pool was 4.95 mg/l and ranged from 5.845 to 3.973mg/l.

Average water parameters during pre-monsoon and monsoon are depicted in Fig. 1

Table 1. Physical features of intertidal selected five rock pools

Vainguinim beach			
	Surface area m ²	Depth m	Volume of the pool m ³
average	0.439	0.196	0.1116
max	0.715	0.49	0.35
min	0.25	0.1	0.025
Anjuna beach			
average	0.5274	0.494	0.1664
max	0.861	0.7	0.344
min	0.216	0.37	0.06

Fig 1. Average physical parameters of Vainguinim and Anjuna beach rock pools sea water during May 2011 and June 2011



Species abundance

Total of 386 fishes were collected from two sites of the study areas, belonging to 5 families and 9 species. Morphometric measurements like total length, standard length as well as weight values with mean and standard deviation of collected species during pre-monsoon and monsoon is presented in Tale 2 & 3. Blenniidae family was dominated with 80% of all the total fishes which includes 3

species of *Istiblennius* namely *Istiblennius dussumieri*, *Istiblennius omobranchus* and *Istiblennius banditus*. Followed by Gobiidae 12%, 3 species, 2 from *Pseudogobius sp.* and an *Istigobius ornatus*. Pomacentridae 5.24% with a single species, *Abudefduf sordidus*. Mugilidae 0.52% *Mugil cephalus* and Terapontidae 0.26% *Terapon jarbua* all these species are grouped as Pre-Monsoon collection and Monsoon collection (Fig. 3 & 4). The most abundant species found from both the sites was *Istiblennius dussumieri*. Griffiths (2000) classification at the 2 sites of the study area has been conducted 1) permanent resident, Blenniidae and Gobiidae were fishes that spend their entire life (juvenile to adult) in the pool, 2) opportunists or secondary resident, Pomacentridae family, *Abudefduf sordidus* species where only part of the life is in the intertidal rock pool, usually juveniles were found in the rock pools and 3) transient, Mugilidae and Terapontidae families *Mugil cephalus* and *Terapon jarbua*, these fishes were present in the rock pool occasionally and they don't have any specialized adaptations for intertidal life.

Table 2. Pre-monsoon (May 2011) collection (Mean±std of total length, standard length and total weight)

Sr. No.	Family	Species	Standard length (Mean±SD)	Total length (Mean±SD)	Weight (Mean±SD)
1	Blenniidae	<i>Istiblennius dussumieri</i>	4.43±1.25	5.25±1.63	1.289±1.19
2	Bleninidae	<i>Istiblennius banditus</i>	5.2±1.72	5.98±1.95	2.2±1.85
3	Blenniidae	<i>Istiblennius banditus</i>	3.89±0.961	4.59±1.04	0.741±0.59
4	Gobiidae	<i>Istigobius ornatus</i>	3.88±0.71	4.48±1.02	1.12±0.63
5	Gobiidae	<i>Pseudo goby</i>	3.43±1.22	4.13±1.01	1.08±0.72
6	Gobiidae	<i>Istigobius sp.</i>	4.33±1.2	4.5±0.69	1.3±0.91
7	Pomacentridae	<i>Abudefduf sordidus</i>	3.06±0.546	3.75±0.576	0.99±0.536
8	Mugilidae	<i>Mugil cephalus</i>	3.5	4.3	0.862

Fig. 2 Species composition of rock pool of premonsoon (May, 2011)

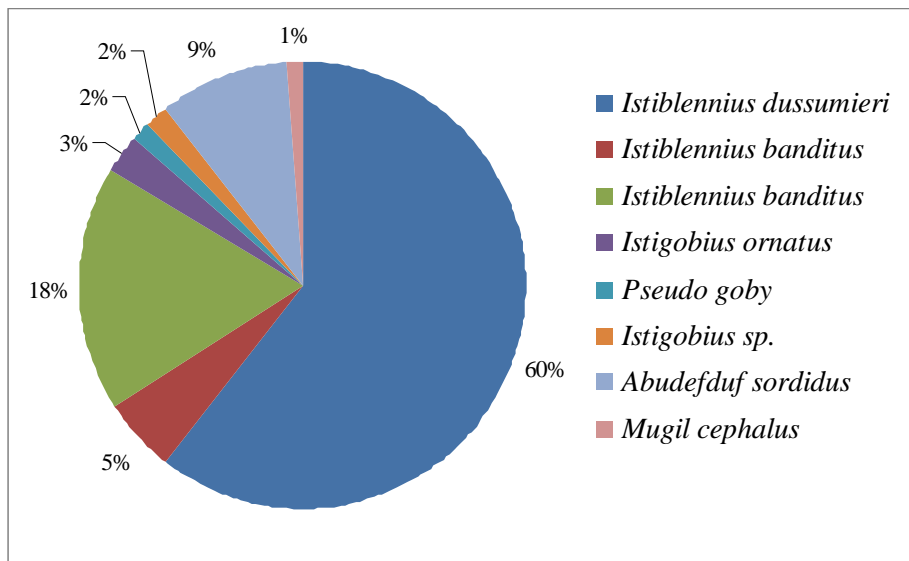
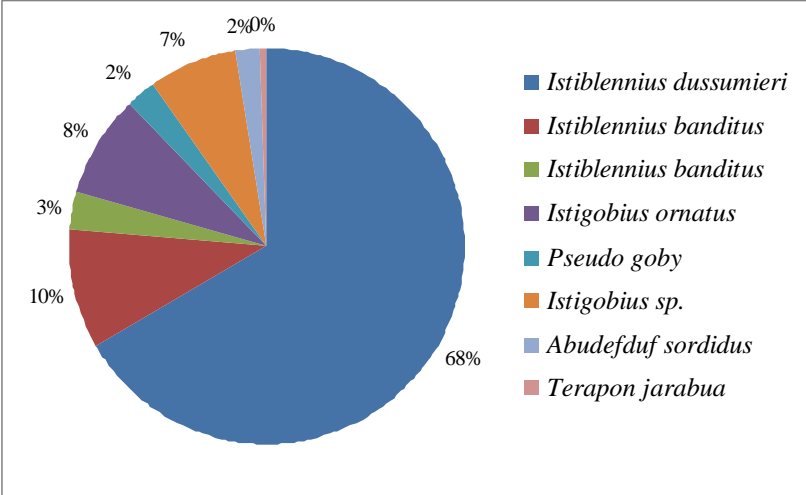


Table 3. Monsoon collection (mean±std of total length, standard length and weight)

Sr.No	Family	Species	Standard length (Mean±SD)	Total length (Mean±SD)	Weight (Mean±SD)
1	Blenniidae	<i>Istiblennius dussumieri</i>	4.23±1.013	4.92±1.26	1.13±1.03
2	Blenniidae	<i>Istiblennius banditus</i>	3.83±0.88	4.4±1.05	3.4±0.6
3	Blenniidae	<i>Istiblennius banditus</i>	3.46±0.54	4.03±0.53	0.45±0.12
4	Gobiidae	<i>Istigobius ornatus</i>	3.71±0.51	4.45±0.67	1.04±0.46
5	Gobiidae	<i>Pseudo goby</i>	3.1±0.561	3.76±0.687	0.6054±0.269
6	Gobiidae	<i>Istigobius sp.</i>	3.58±0.60	4.17±0.630	0.91±0.4
7	Pomacentridae	<i>Abudefduf sordidus</i>	2.55±0.53	3.27±0.65	0.43±0.16
8	Terapontidae	<i>Terapon jarbua</i>	3.3	4.5	1.6748

Fig. 3. Species composition of rock pool of monsoon (June 2011)



Plates – Rock pool fishes collected from Vainguinim and Anjuna beach



Istigobio ornatus



Istigobio ornatus (Top view)



Istiblennius dussumieri



Abudegduf sordidus

Acknowledgement

The authors are grateful to Dr. Satish R. Shetye, Director of the National Institute of Oceanography, Goa (India), for facilities and encouragement. We are thankful to Mr. Suresh, Mr. Kurle, Mr. Ghansham and Mr. Carlos for their help during sample collection.

References

- CASTELLANOS-GALINDO, G. A., GIRALDO, A. AND RUBIO, E.A. (2005). Community structure of an assemblage of intertidal pool fishes on a tropical eastern pacific rocky shore, Colombia. *Journal of Fish Biology* **67**, 392-408.
- CHARGULAF, C.A., TOWNSEND, K.A. AND TIBETTS, I.R. (2011). Community structure of soft sediment pool fishes in Moreton Bay, Australia. *Journal of Fish Biology* **78**, 479-494
- FARIA, C. AND ALMADA, V. (2001). Microhabitat segregation in three rocky Intertidal fish species in Portugal; does it reflect Interspecific Competition? *Journal of Fish Biology* **58**, 145-159.
- FISHBASE (2011). World Wide Web electronic publication. <http://www.fishbase.org>
- GIBSON, R.N. (1972). The vertical distribution and feeding relationships of intertidal fish on the Atlantic coast of France. *Journal of Animal Ecology* **41**, 189-207.
- GRAHAM, J.B. (1997). Air Breathing Fishes: Evolution, Diversity, and Adaptation. San Diego: Academic Press; 299 pp.
- GRIFFITHS, S. P. (2003). Rockpool ichthyofaunas of temperate Australia: species composition, residency and biogeographic patterns. *Estuarine and Coastal Shelf Science* **58**, 175-185.
- GRIFFITHS, S. P., WEST, R. J. AND DAVIS, A. R. (2003). Effects of intertidal elevation on the rock pool ichthyofauna of temperate Australia. *Environmental Biology of fishes* **68**, 197-204.
- KRISHAMURTHY, V. AND SUBBRAMIAH, K. (1972). The Importance of shore types in intertidal ecology of Indian Marine Algae. *Proceedings of Indian national Science Academy* **38B**, 259 – 266.
- NIEDER, J. (1997). Seasonal variation in feeding patterns and food niche overlap in the Mediterranean blennies *Scartella cristata*, *Parablennius pilicornis* and *Lipophrys trigloides* (Pisces: Blenniidae). *PSZN Marine Ecology* **18 (3)**, 227-237.
- VELASCO, E. M., GOMEZ-CAMA, M.C., HERNANDO, J. A. AND SORIGUER, M.C. (2010). Trophic relationships in an intertidal rock pool fishes assemblage in the gulf of Cadiz (NE Atlantic). *Journal of Marine Systems* **80**, 248-252.