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Biodiversity of coral reef associated fishes along southeast coast of India

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HIGHLIGHTS

- Coral reef associated fish diversity along southeast coast of India was surveyed.
- Increased number of fishes in these areas indicates the presence of reef patches.
- The result indicates the seasonal variation in reef associated fish abundance.
- Maximum diversity indices were recorded in premonsoon compared to other seasons.
- The fish ban period increases spawning and hence increases fish production.

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ABSTRACT

A random sampling survey of coral reef associated fishes was conducted in Cuddalore (site 1), Parangipettai (site 2) and Nallavadu (site 3) along the southeast coast of India during January 2012 to December 2013. The aim of the present investigation was to reveal the biodiversity of coral reef associated fishes in these areas. Across the three study sites, a total of 162 species of coral reef associated fishes were recorded, belonging to 17 orders, 41 families and 94 genera. Among three regions, the values of Shannon diversity index (5.775), species richness (13.74) and phylogenetic diversity (4217) were found to be maximum in site 1 during premonsoon 2012, and the taxonomic diversity (55.86) was found to be maximum in site 2 during premonsoon 2012. But the evenness index (0.869) was maximum in site 1 during postmonsoon 2013. The Shannon diversity (4.326), evenness index (0.705) and taxonomic diversity (51.50) were found to be minimum in site 3 during summer 2012. But the species richness (8.479) and the phylogenetic diversity (2467) were minimum in site 3 during summer 2013. Hence the present study provided information regarding the biodiversity of coral reef associated fishes and analysis of data undertaken with conventional tools like univariate and multivariate methods clearly revealed the healthy nature of diversity of coral reef associated fishes along these areas.

1. Introduction

Coral reefs serve as a habitat for numerous commercially important species targeted for fishing. The diversity of fishes found on the coral reefs are overwhelming. Coral reefs provide approximately 25% of the total marine fish catches in India (Rajasuriya et al., 2002). Coral reefs, occupying less than 0.1% of the ocean surface and host approximately one-third of the estimated 15,000 marine fish species on the earth (Helfman et al., 1997). Coral reef fishes hold the most specious assemblages of vertebrates on the earth. The variety of colors, shapes, sizes, behavior and ecology exhibited by reef fishes is astounding. The shape, color, feeding habits of the reef fishes are specifically adapted to live in the coral reef environment. The body of these fishes are structured to operate in the complex underwater landscape and the confines spaces of the coral reefs. Reef-associated fish assemblages respond to changes in the environmental factors with fluctuations in abundance at various spatial and temporal scales (Anderson and Millar, 2004). The physical structure of the reef is a key characteristic that determine the organization of reef fish communities (Kingsford and Battershill, 1998). Studies related to the distribution and abundance of fishes in relation to the habitat structure is primarily common from tropical coral reefs (Kuffner et al., 2007).

Analyzing changes in the diversity components is a way of measuring these effects (Aguilar et al., 2004). In spite of complete periodical reviews, the selection of proper measures of diversity continues to be notorious (Lamb et al., 2009). Shannon's total diversity index and Pielou's evenness index ($J' = H'/H'$ max) extend to be the two most popular indexes (Gotelli and Graves,

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1996) and have normally been used for assemblages of reef fish studies (Walter and Haynes, 2006; Mallela et al., 2007).

Studies on coral reef associated fishes of Indian seas are mainly limited to the Lakshadweep groups of islands, Andaman and Nicobar islands and observation are lacking for other coral reef ecosystems, particularly, along the southeast coast except in the Gulf of Mannar. Only a few studies of coral reef associated fishes along the Coromandel Coast of Tamil Nadu are available. Hence the present study mainly focuses on diversity of coral reef associated fishes of the three areas, namely Cuddalore, Parangipettai and Nallavadu along southeast coast of India.

2. Materials and methods

The coral reef associated fishes were collected twice in a month from the landing centers in Cuddalore (site 1) (Lat. 11°43′N; Long. 79°49′E), Parangipettai (site 2) (Lat. 11°24′N; Long. 79°46′E) and Nallavadu (site 3) (Lat 11°46′03′N; Long 79°49′45′E), Southeast coast of India (Fig. 1) during January 2012 to December 2013. The fishes were identified by standard fish identification manuals (Day, 1878; Fischer and Bianchi, 1984; Ramaiyan et al., 1987; Talwar and Jhingran, 1991; Froese and Pauly, 2015). The habitat and IUCN status of the fishes were also identified by standard references (Froese and Pauly, 2015; IUCN, 2015). The diversity indices and multivariate analyses were performed by using PRIMER (Version 6.1.5) statistical software (Clarke and Gorley, 2006).

2.1. Univariate methods

(a) Shannon–Wiener index

In the present study, the data were analyzed for diversity index (H') using the following Shannon–Wiener's formula (1949)

$$H' = -\sum^{S} Pi \log 2\, Pi \ldots\ldots \quad i = 1$$

This can be rewritten as,

$$H' = \frac{3.3219(N \log N - \sum ni - \log ni)}{N}$$

Where, H' = species diversity in bits of information per individual ni = proportion of the samples belonging to the ith species (Number of individuals of the ith species) N = total number of individuals in the collection and $\sum$ = sum.

(b) Margalef richness index (d)

Margalef richness index (d) was calculated using formula given by Margalef (1958)

$$d = (S - 1)/\log N$$

where, S = total number of species N = total number of individuals in the sample

(c) Pielou's evenness index

The equitability (J') was computed using the following formula of Pielou (1977):

$$J' = \frac{H'}{\log_2 S} \text{ or } \frac{H'}{\ln S}$$

Where, J' = evenness, H' = species diversity in bits of information per individual and S = total number of species.

(d) Taxonomic diversity index and Total phylogenetic diversity

The taxonomic diversity (Δ) and the total phylogenetic diversity indices were calculated by following Clarke and Warwick (2001).

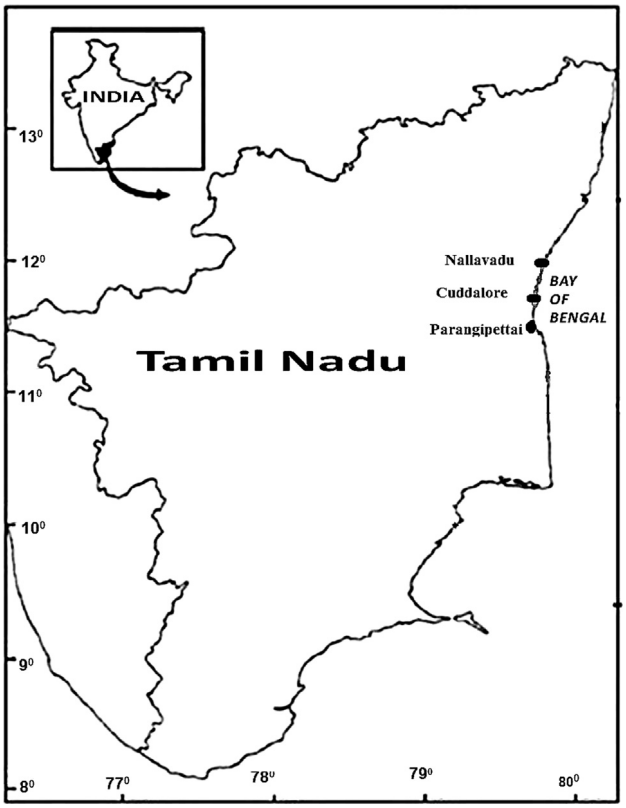

Fig. 1. Study area map showing the location where sampling was done.

2.2. Multivariate methods

Multivariate methods of classification and ordination were used to compare communities on the basis of the characteristics of the component species as well as their relative significance in terms of abundance or biomass. Multivariate analysis can be accommodated beneath two collective terms, namely classification and ordination. Classification analyses look for to assign entities to groups, whereas ordinations attempt to place these spatially, so that similar entities will be close and dissimilar ones will be faraway. The commonly used classification method is cluster analysis. In the present study, the data were approached to cluster analysis method.

2.3. Cluster analysis

Cluster analysis were used to find out the similarities between seasons. The most commonly used clustering technique is the hierarchical agglomerative method. The results of these are represented by a tree diagram or dendrogram with the x-axis representing the full set of samples and the y-axis defining the similarity level at which the samples or groups are fused. Bray–Curtis coefficient (Bray and Curtis, 1957) was used to produce the dendrogram. The coefficient was calculated by the following formula:

$$S_{jk} = 100\left\{1 - \frac{\sum_{i=1}^{p} |y_{ij} - y_{ik}|}{\sum_{i=1}^{p}(y_{ij} + y_{ik})}\right\}$$

$$= 100\frac{\sum_{i=1}^{p} 2\min(y_{ij}, y_{ik})}{\sum_{i=1}^{p}(y_{ij} + y_{ik})}$$

Where, y_{ij} represents the entry in the ith row and jth column of the data matrix i.e. The abundance or biomass for the ith species in the