Diversity of reef associated fishes in hook and line fishery at Mandapam, Gulf of Mannar, south-east coast of India

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ABSTRACT

Reef associated fishes landed by hooks and lines at Mandapam landing centre in Ramanathapuram District, Tamil Nadu for a period of four years from October 2008 to May 2012 were studied based on fortnightly samplings. The hook and line fishing is seasonal in Gulf of Mannar and lasts for six months annually from October - November to April - May, as this area remains rough during the rest of the year. The average annual landing of fish during the study period was 171 t with a peak of 295 t in 2008-09 and showed a decline since then. A total of 32 species of reef associated fishes belonging to 14 families were landed. Among them, *Sphyraena barracuda* contributed the maximum with a share of 42% followed by *Caranx heberi* (15%). Family-wise landings indicated the dominance of Sphyraenidae (46%). The diversity index (H') was the highest during 2008-09 and the evenness of distribution of individuals among different species did not show significant variation in different years. Funnel plots of average taxonomic distinctness (Δ^+) and variation in taxonomic distinctness (λ^+) indicated that the values in most of the years are within the normal limits.

Keywords: Diversity, Gulf of Mannar, Hook and line, Reef associated fishes, South-east India

Introduction

The coral reef ecosystem of Gulf of Mannar supports a wide spectrum of flora and fauna of taxonomic and economic importance. Among the fauna, finfishes form a dominant component and different types of fishing methods are practiced in this ecosystem including fishing using hooks and lines. The hook and line fishery off Mandapam is seasonal and takes place from October-November to April-May as the Gulf of Mannar remains rough during the other months. Even though some studies have been carried out on hook and line fishery in south-east coast of India (Menon *et al*., 1993; Durai *et al*., 2011; Radhakrishnan *et al*., 2016), a systematic study on this fishery on reef associated fishes alone from Mandapam was not reported earlier. Hence, an attempt was made to study the diversity of reef associated fishes landed by hooks and lines at Mandapam from the Gulf of Mannar.

Materials and methods

Fortnightly samples and fish landing data were collected from Mandapam fish landing centre (79° 8' N; 9°15' E) landed by hooks and lines from Gulf of Mannar (GOM), for a period of four years from October, 2008 to May, 2012. The area of the GOM under the Indian EEZ is about 15000 sq. km, where commercial fishing takes place in about 5500 sq. km (Nammalwar and Edwin Joseph,

2002). The fishes landed were identified up to species level as per Fischer and Bianchi (1984), Smith and Heemstra (1986) and Munro (2000). The weight as well as numbers of each species landed were estimated. From the total landings, the data pertaining to reef associated fishes alone was separated, as fishes other than reef associated fishes are also landed here by hooks and lines. Species-wise, family-wise, month-wise and year-wise catch data of reef associated fishes were generated and analysed using *PRIMER* (*v.6*) software (Clarke and Gorley, 2006). Conventional diversity indices like Shannon diversity index (H' log e), Margalef's richness index (d), Pielous evenness index (J') and Simpson index (1-Lambda') were derived to understand the fish diversity in different years. To compare the diversity between the years, dominance plot was drawn. The data were fourth root transformed before the computation of diversity indices, similarity and cluster analysis. The similarity in species composition was studied by calculating the Bray-Curtis coefficient and similarity matrices were constructed. In the cluster analysis, the hierarchical agglomerative clustering, Bray-Curtis similarity was used to construct the map. Diversity indices like taxonomic diversity index (Δ), average taxonomic distinctness index (Δ^+) and variation in taxonomic distinctness (λ^+) were used to compare diversity between different years (Clarke and Warwick,

2001). Deviation from the normal distribution and variance between the samples were tested by plotting 95% funnel plots using Δ^+ and λ^+ values.

Results and discussion

Qualitative and quantitative abundance

The hook and line fishery at Mandapam indicated that 50% by weight of the fishes landed were reef associated fishes. A total of 32 species of reef associated fishes belonging to 17 genera under 14 families were recorded during the study period (Table 1).

Molly Varghese *et al.* (2017) recorded 98 species of reef fishes from trap fishery at Keelakarai while Molly Varghese and Joshi (2017) reported 69 species from bottom-set gillnet landings at Pamban from Gulf of Mannar. Thus, the number of species recorded was found to vary with type of gear and comparatively lower number of species was recorded in hook and line landings during the present study. Venkataramani (2011) also observed the lowest number of fishes in hook and line landings from Gulf of Mannar. Along with species number, the species composition also was found to differ with fishing gear. Species-wise dominance (%) among total reef associated fishes landed during the present study is depicted in Fig. 1 (species which contributed less than 1% are not included in the figure).

Species composition indicated the dominance of *Sphyraena barracuda* (42%) followed by *Caranx heberi* (15%), *Scomberoides tol* (13%), *Lethrinus nebulosus* (9%) and rest of the species contributed less than 5% each. A study conducted by Jayasankar (1990) at Pamban, near Mandapam revealed the dominance of *Lethrinus* spp. and *Lutjanus* spp. in total landings by hook and line fishery. During his study, plank-built boats were used for operating hook and line at a depth of 18-25 m, while during the

Table 1. List of reef associated fishes landed by hook and line at Mandapam during the study period

| Species	Family	Common name
Acanthurus gahhm	Acanthuridae	Black surgeonfish
Strongylura leiura	Belonidae	Banded needlefish
Caranx heberi	Carangidae	Blacktip trevally
Megalaspis cordyla	Carangidae	Torpedo scad
Scomberoides commersonnianus	Carangidae	Talang queenfish
S. tala	Carangidae	Barred queenfish
S. tol	Carangidae	Needlescaled queenfish
Chirocentrus dorab	Chirocentridae	Dorab wolf-herring
Amblygaster sirm	Clupeidae	Spotted sardinella
Ephippus orbis	Ephippidae	Orbfish
Platax teira	Ephippidae	Longfin batfish
Plectorhinchus diagrammus	Haemulidae	Striped sweetlips
Plectorhinchus pictus	Haemulidae	Trout sweetlips
Pomadasys maculatus	Haemulidae	Saddle grunt
Lethrinus miniatus	Lethrinidae	Trumpet emperor
L. nebulosus	Lethrinidae	Spangled emperor
L. ornatus	Lethrinidae	Ornate emperor
Lutjanus bohar	Lutjanidae	Two-spot red snapper
L. fulviflamma	Lutjanidae	Dory snapper
L. gibbus	Lutjanidae	Humpback red snapper
L. lutjanus	Lutjanidae	Bigeye snapper
L. russellii	Lutjanidae	Russell's snapper
Gymnothorax favagineus	Muraenidae	Laced moray
G. punctatus	Muraenidae	Red Sea whitespotted moray
Rachycentron canadum	Rachycentridae	Cobia
Scarus ghobban	Scaridae	Blue-barred parrotfish
Epinephelus malabaricus	Serranidae	Malabar grouper
E. merra	Serranidae	Honeycomb grouper
E. tauvina	Serranidae	Greasy grouper
E. bleekeri	Serranidae	Duskytail grouper
Sphyraena barracuda	Sphyraenidae	Great barracuda
S. jello	Sphyraenidae	Pickhandle barracuda
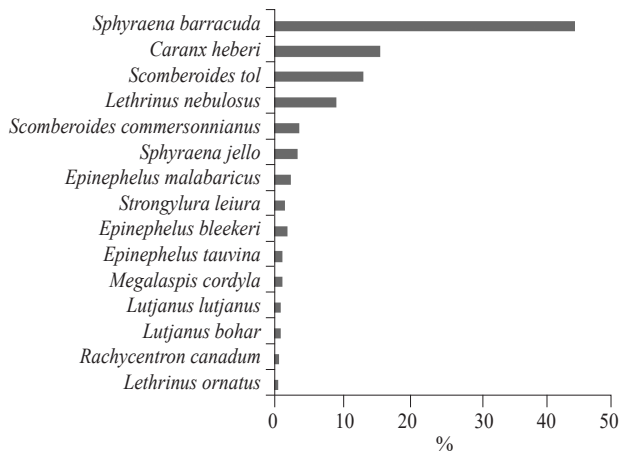
Fig. 1. Species composition of reef associated fishes at Mandapam during 2008-2012

present study, fibre glass boats operated the gear at a depth of 24-84 m and this change in craft and depth of operation along with the period of study could be the reason for the difference in catch composition. An unusual hook and line fishery of *S. barracuda* was recorded along Cuddalore coast of Tamil Nadu during January 2009 (CMFRI, 2009) which coincides with the period of the present study. Lal Mohan and Nandakumaran (1988) studied the hand line fishing along Malabar coast during October - January and observed the dominance of *Sphyraena* spp. and *Rachycentron canadum* wherein the gear was operated along the rocky beds about 12-15 km away from the shore at a depth of 20-30 m using catamaran. These findings indicate that the species composition differ with locality, gear and craft, type of ecosystem, depth of operation and period of study.

Family-wise quantitative abundance of reef associated fishes landed at Mandapam by the hook and line fishery is illustrated in Fig. 2. Among the 14 families, Sphyraenidae
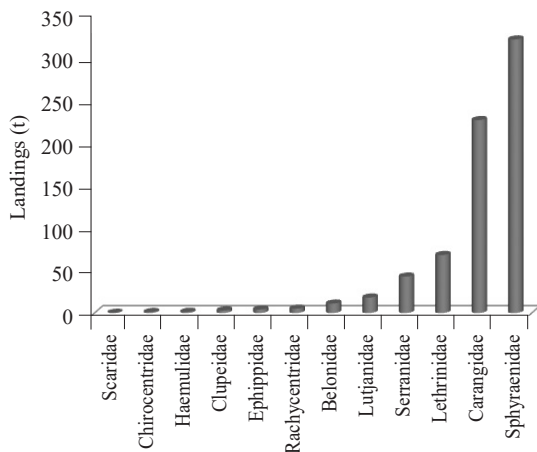

Fig. 2. Family-wise reef associated fish landings during the study period

formed the maximum with a share of 46% followed by Carangidae (32%), Lethrinidae (10%), Serranidae (6%) and the rest of the families contributed less than 4%. While studying the hook and line fishery in Kombuthurai coast, Tamil Nadu, Radhakrishnan *et al.* (2016) observed major contributions by food fishes in handline fishery, as needle fish (33%), barracuda (32%), carangids (22%) and groupers (13%) dominated. This finding is in agreement with the present study except in the case of needle fishes, which may be due to the difference in the locality and period of the study.

Year-wise landings indicated an average of 171 t per year during the study period with a maximum of 295 t during 2008-09. Afterwards it showed a decline during the rest of the study period (Fig. 3). A similar trend in landings by traps at Keelakarai was also recorded by Molly Varghese *et al.* (2017).
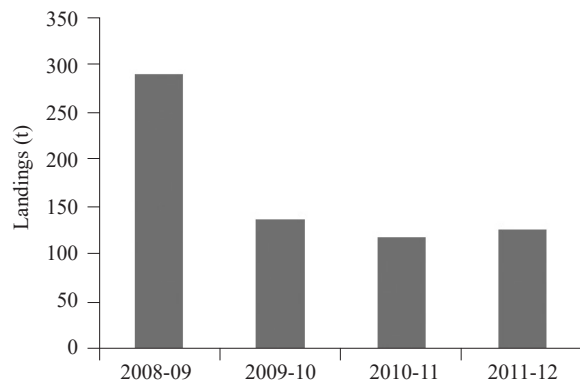

Fig. 3. Year-wise landings of reef associated fishes during the study period

Diversity indices

The diversity indices along with some attributes of community structure of reef associated fishes in different years are given in Table 2. The Shannon-Wiener's diversity index (H') which is the most commonly used diversity measure showed slightly higher value during 2008-09 which indicate that species composition was slightly different in this year than the rest of the years. The Margalef's Richness index (d) which incorporates the number of individuals (N) and species number (S) also showed higher value during 2008-09. The equitability or Evenness index (J') which expresses the evenness of distribution of individuals among the different species did not show much variation and the values ranged from 0.94 to 0.98.

In the dominance plot, the curve for 2008-09, which lies on the lower side, extends further and rises slowly due to the presence of more number of species when

Table 2. Diversity indices and taxonomic attributes of reef associated fishes landed by hooks and lines at Mandapam during 2008-2012

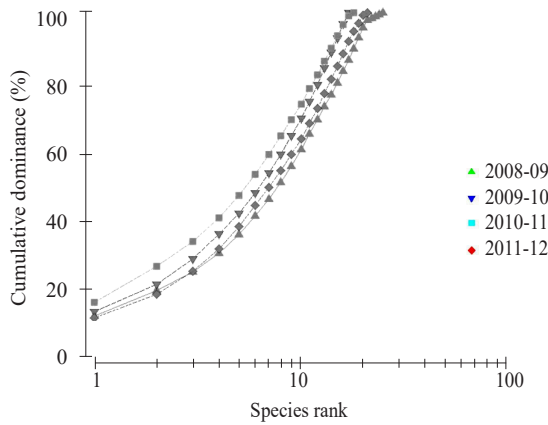| Year	S	N	d	J'	H'(loge)	1-Lambda'	Delta	Delta+	Lambda+
2008-09	25	183.86	4.60	0.94	3.04	0.95	48.20	51.56	132.77
2009-10	17	130.39	3.29	0.98	2.77	0.94	43.73	46.32	104.95
2010-11	18	120.38	3.55	0.95	2.74	0.93	48.16	50.65	144.82
2011-12	21	155.79	3.96	0.97	2.94	0.95	47.61	51.03	116.66

Fig. 4. Dominance plot of reef associated fishes landed at Mandapam during the study period

compared to rest of the years (Fig. 4). Since the percentage contribution of each species is added, the curve extends horizontally along with species numbers in the X-axis before reaching the cumulative 100%.

The similarity in species composition and abundance among different years as derived from Bray-Curtis similarity matrix indicated that the maximum similarity of 75% was between 2009-10 and 2011-12 and the similarity was found to be minimum (65%) between 2009-10 and
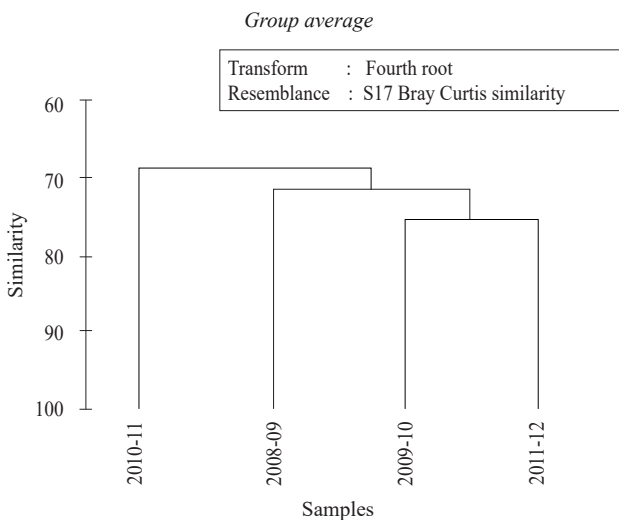
2010-11. The dendrogram (Fig. 5) revealed separate grouping based on similarity in species composition and abundance of different years. The years 2009-10 and 2011-12 formed a group with the maximum similarity percentage of 75 and other years got linked to them at different levels of similarity percentages.

The degree to which species in a sample are taxonomically related to each other can be measured using the average taxonomic distinctness (Δ^+) and variation in taxonomic distinctness (λ^+). The average taxonomic distinctness was found to be the minimum during 2009-10 and maximum during 2008-09 (Table 2). This indicates that more closely related species are available during 2009-10 while the taxonomic distance between species was the highest during 2008-09.

In the funnel plot of Δ^+ against number of species (Fig. 6), only 2009-10 falls outside the confidence funnel but very near to the funnel and majority of the points are within the normal limits which indicate that the taxonomic distinctness between the years is not statistically significant.

The variation in taxonomic distinctness (λ^+) ranged between 104.95 in 2009-10 and 144.82 in 2010-11 which indicates the wide range in taxonomic distances between pairs of species in different years (Fig. 7). Hence, the
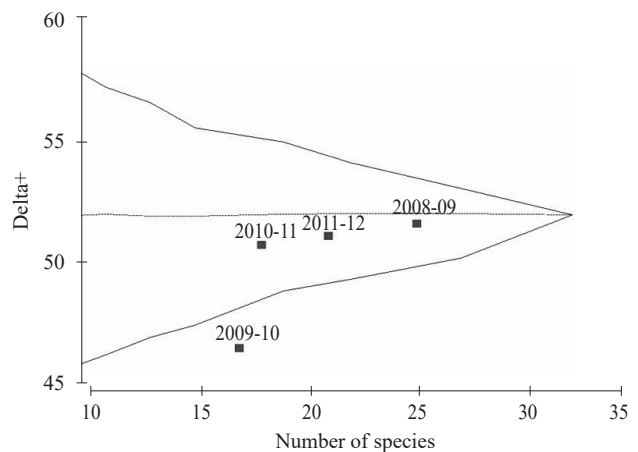

Fig. 5. Dendrogram of reef associated fishes landed at Mandapam during 2008-2012

Fig. 6. Funnel plot for average taxonomic distinctness (Δ^+) showing the diversity of reef associated fishes landed at Mandapam in different years and its deviation from the normal distribution
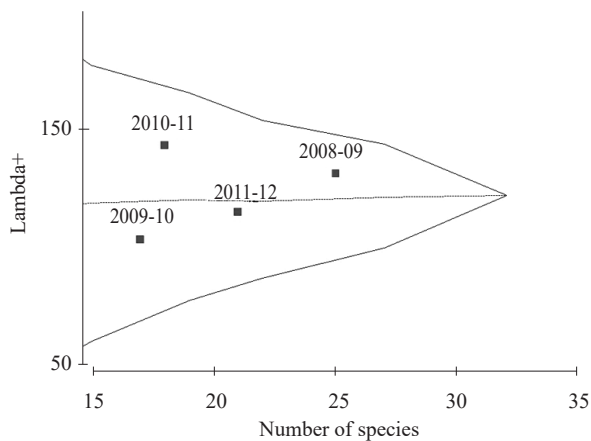
Fig. 7. Funnel plot for variation in taxonomic distinctness (λ⁺) of reef associated fishes landed at Mandapam in different years during the study

unevenness of the taxonomic tree structure was greater during 2010-11 when compared to that of other three years. As all the values of λ^+ lies inside the funnel plot, it is considered that they are within the normal limits. The annual fish landings were also found to be almost the same during the study period. Thus, it is assumed that the hook and line fishery at Mandapam is steady at present and regular monitoring is necessary for the sustenance of the fishery.

Acknowledgements

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