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DISTRIBUTION AND DIVERSITY OF MARINE ORNAMENTAL FISHES IN GULF OF MANNAR REGION

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ABSTRACT

A present study has been undertaken to details to corals and coral reefs consists a rich variety of food and the marine aquarium fishes, referred to as marine ornamental or reef fishes are abundant in the tropical seas particularly in regions which are rich in corals, verity of shape, size and colours. It has a chain of 21 islands stretching from Mandapam to Tuticorin covering a distance of 140 kms along the coast site. The survey was conducted in five regions of Gulf of Mannar namely 1.Tuticorin, 2.Vembar, 3.Keelakarai, 4.Mandapam and 5.Rameswaram to record the resource potential during January 2013 to December 2013. Traps were used for fish collection in the reef areas such like Mandapam, Keelakarai, and Rameswaram. Here Tuticorin and Vembarregions fishes were collected from the trawl by catches. Immediately on capture the fishes were thoroughly cleaned and photographed. A total of 113 finfish species belongs to 24 families were collected during the study period. The species-rich families were Acanthuridae, Acanthuridae, Balistidae, Chaetodontidae, Labridae, Lutjanidae, Pomacentridae, Scaridae, Scorpaenidae, Siganidae, Tetraodontidae and Theraponidae. The findings of this study show that all the sites selected for study maintains a relatively rich assemblage of ornamental fishes. The ultimate solution to a long term sustainable trade of marine ornamental fishes can be achieved only through the development of fool proof aquaculture technologies.

KEYWORDS: Gulf of Mannar, marine ornamental fishes, diversity, resource potential, coral fishes.

1. INTRODUCTION

The marine ornamental fishes are one of the most popular attractions in worldwide due to their adaptability to live in confinement. The trade of marine ornamentals as been expanding in recent years and has grown into a multimillion dollar enterprise. The worldwide market of marine ornamental fishes has shown a steady increase over the past few years and the annual trade varies between 2 and 7 billion US$ (Jayalal and Ramachandran, 2012).

The marine aquarium fishes, referred to as marine ornamental or reef fishes are abundant in the tropical seas particularly in regions which are rich in corals, seaweeds, sea grasses and also in the regions which have rocky bottom place. In present study area Gulf of Mannar also surrounded with abounded with coral reef fishes include the most unique assemblage of vertebrates on earth. The variety of shapes, sizes, colours, behavior and ecology exhibited by reef fishes is amazing. The marine ornamental fishes are classified into more than 100 different families. The vast majority is bony fishes and a small minority is cartilaginous. Ornamental fishes are the most diverse elements in the reef fauna and because of their wider ecological significance, some families of ornamental fish are valuable groups for monitoring the health of reefs and for investigating factors underlying the high species diversity characteristics of reef ecosystem.

Some fishes such as species of butterfly fish have been proposed as useful indicator species of reef development as well as health (Reese, 1981and Ohman *et al*., 1998). Our resources in the reefs are fast dwindling; hence the study of diversity in the coral reef ecosystem is of great significance to assess the changes over a period of time. The strength of association between organisms and their habitat can provide an indication of the level of habitat change (Jones and Andrew, 1993) and an array of studies have documented positive relationships between fish abundance as well as diversity and coral cover (Bell and Galzin,1984; Findley and Findley, 1985; Hart *et al*., 1996). Studies on the most diverse element i.e., fish species in the coral reef ecosystem help to understand the presence status and the changes taking place over a period of time.

Gulf of Mannar in the Southeast coast of India extends from Rameswaram Island in the North to Kanyakumari into the South. It have a chain of 21 islands enlarge from Mandapam to Tuticorin covering a distance of 140 km along the coast site. Gulf of Mannar is considered as ‘Biologists paradise’ for it has 3600 species of flora and fauna.

In Gulf of Mannar, a total of 113 marine ornamental finfish species, have been recorded and their biodiversity and standing stock biomass were also assessed (Venkataramani and Jawahar, 2004). The recorded species have exclusive ornamental value and are not considered as food fishes unlike other coral living species, such as nemipterids, lutjanids, serranids, carangids, etc., the recorded 113 marine ornamental fishes come under 24 families of which the family Acanthuridae, Balistidae, Chaetodontidae, Haemulidae, Labridae, Pomacanthidae, Pomacentridae, Scaridae and Syngnathidae have a very rich biodiversity perspective in Gulf of Mannar. The biodiversity and biology of these families have been studied in detail in the Gulf of Mannar province (Venkataramani *et al.*, 2005). In this present study also recorded along with (Venkataramani *et al.*, 2005) families of Acanthuridae, Acanthuridae, Balistidae, Chaetodontidae, Labridae, Lutjanidae, Pomacentridae, Scaridae, Scorpaenidae, Siganidae, Tetraodontidae and Theraponidae were recorded.

Total of 1471 species of ornamental fish are traded globally (Wabnitz *et al.*, 2003). They are found on tropical reef bottom, extensive in the Atlantic, Indian and pacific oceans (Murugan and Durgekar, 2008). The worldwide market of marine ornamental fishes has shown a steady increase over the past few years and the annual trade varies between 2 and 7 billion US$ (Jayalal and Ramachandran, 2012). In this present study investigate in the distribution and diversity of ornamental fishes present in the Gulf of Mannar region.

2. MATERIALS AND METHODS

Throughout the one year study period January 2013 to December 2013 samples were collected in monthly intervals at 5 stations. Totally 60 samples were collected with replicates. Sampling stations such as stations 1. Rameswaram, 2. Mandapam, 3. Keelakarai, 4. Vembar and 5. Tuticorin. The sampling was conducted during January 2013 to December 2013. Trap fishing was done in Keelakarai, Mandapam and Rameswaram and traps were kept in water for a minimum period of 24 hours to a maximum period of 120 hours. The traps were covered with a nylon mesh of 10 mm size to prevent the escape of small fishes. Traps, the best environment friendly gears, do not cause any destruction to corals. In Vembar and Tuticorin fishes have been collected from trawl by catches as there was no scope for trap fishing. Immediately on capture, fishes were thoroughly cleaned, the fins were well spread and fixed among needles on cardboard and few drops of 10% formalin to prevent the fins from folding back. After completing the photography work, specimens were preserved in 10% formalin and transported to the laboratory in suitable containers for detailed investigation.

Accordingly, the preserved the material were transported tolaboratory and identified up to species level, through referring the publication of (Day, 1878; Fischer and Bianchi, 1984 and Nelson 1994).

2.a. Species richness

This is one of the oldest and most basic diversity measurements, based directly on the total number of species at a site: the term species richness is often preferred since the exact number of species in a community is rarely known. Various indices have been developed in this regard but there is little point in calculating them all, as they are all strongly correlated (Gray, 2001). So the most commonly used Margalf index (d) has been used presently.

2.b.Margalef's index (d)

Margalef index is denoted by 'd' and was calculated using the following formula

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

Where, S = total numbers of species and N = total number of individuals

2.c.Pielou's evennes index (J')

The equitability (J') was computed using the following formula of Pielou (1966):

$J' = H'/H'$ max,

Where, H' is the observed species diversity and H' Max is the logarithm of the total number of species (S) in the sample, for example, 2 species with 50 individuals each would represent complete equitability or evenness with a value of 1. Two species with one and 99 individuals each, would score only 0.08.

3. RESULTS

3.1. Species composition of ornamental fishes

From the present study revealed the occurrence of 46 species of ornamental fishes belonging to 27 genera and 11 families. As follows the families were Acanthuridae, Balistidae, Chaetodontidae, Labridae, Lutjanidae, Pomacentridae, Scaridae, Scorpaenidae, Siganidae, Tetraodontidae and Theraponidae, No. of species were recorded in each family was 2, 3, 5, 6, 5, 10, 3, 4, 2, 3 and 3 respectively (Table.1).

a. Percentage composition of ornamental fishes in Gulf of Mannar

Percentage composition of ornamental fishes at Gulf of Mannar recorded were Pomacentridae (32.25%) followed by Theraponidae, (11.86%), Labridae (11.11%),

Chaetodontidae (10.36%), Balistidae (7.02%), Tetraodontidae (5.60%), Lutjanidae (5.43%), Scorpaenidae (5.35%), Scaridae (4.01%), Siganidae (3.43%) and Acanthuridae (3.43%) (Fig.1).

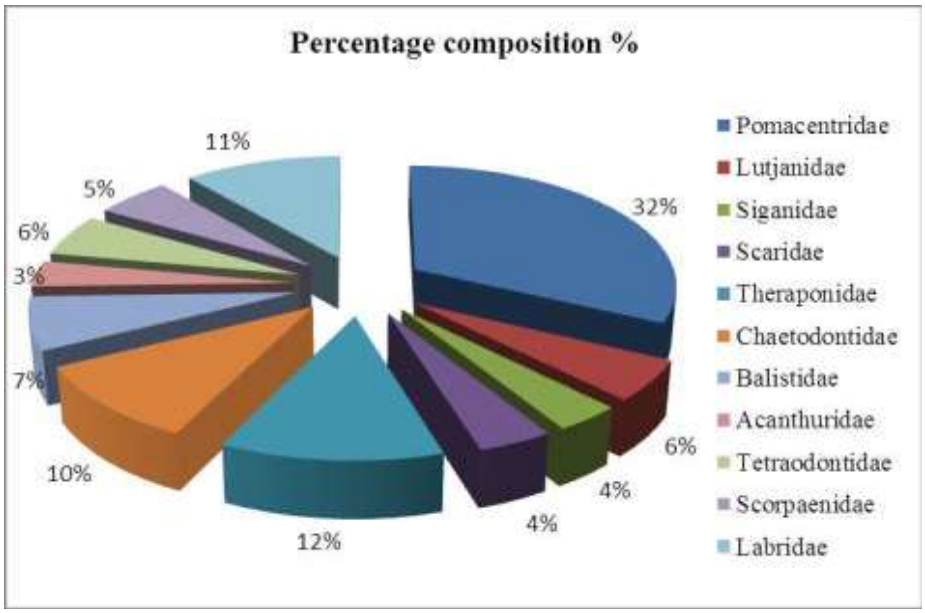

Fig.1. Percentage composition of ornamental fishes at Gulf of Mannar

3.2.1. Percentage composition of ornamental fishes in Rameswaram

Percentage composition of ornamental fishes at Rameswaram recorded were Pomacentridae 35.14%, Lutjanidae 2.24%, Siganidae 2.56%, Scaridae 3.83%, Theraponidae 18.85%, Chaetodontidae 9.27%, Balistidae 6.71%, Acanthuridae 4.47%, Tetraodontidae 2.56%, Scorpaenidae 7.03% and Labridae 7.35% (Fig.2.).

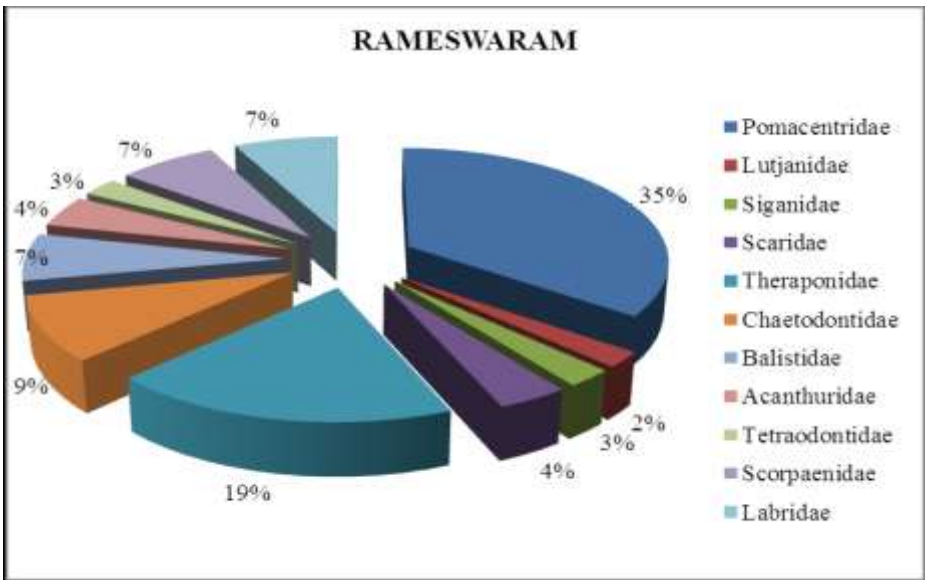

Fig.2. Percentage composition of ornamental fishes at Rameswaram

3.2.2. Percentage composition of ornamental fishes at Mandapam

Percentage composition of ornamental fishes at Mandapam recorded were Pomacentridae 30.08%, Lutjanidae 6.91%, Siganidae 4.07%, Scaridae 2.44%, Theraponidae 13.82%, Chaetodontidae 10.57%, Balistidae 6.50%, Acanthuridae 2.44%, Tetraodontidae 3.66%, Scorpaenidae 8.13% and Labridae 11.38%(Fig.3).

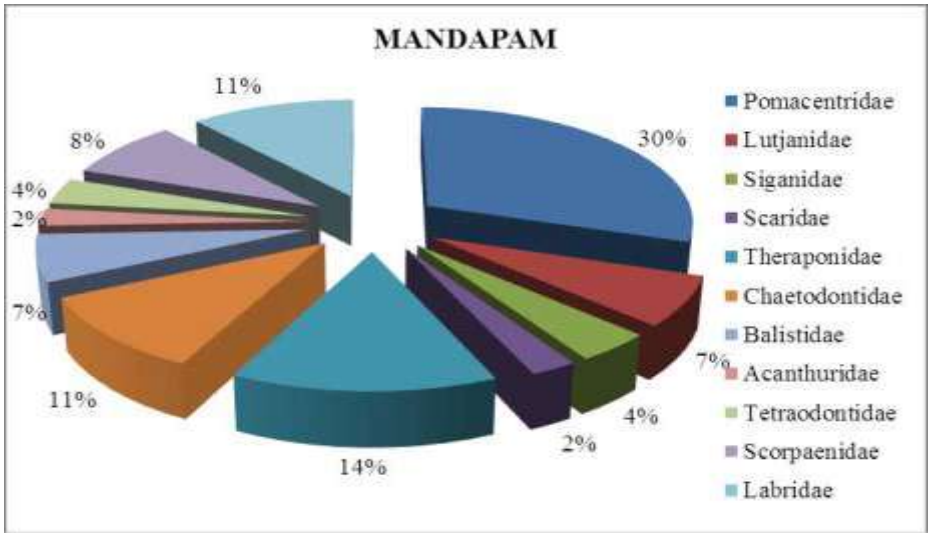

Fig.3. Percentage composition of ornamental fishes at Mandapam

3.2.3. Percentage composition of ornamental fishes at Keelakarai

Percentage composition of ornamental fishes at Keelakarai recorded were Pomacentridae 30.77%, Lutjanidae 7.69%, Siganidae 3.30%, Scaridae 4.40%, Theraponidae 17.69%, Chaetodontidae 10.44%, Balistidae 8.79%, Tetraodontidae 6.04%, Scorpaenidae 7.14% and Labridae 13.74% (Fig.4).

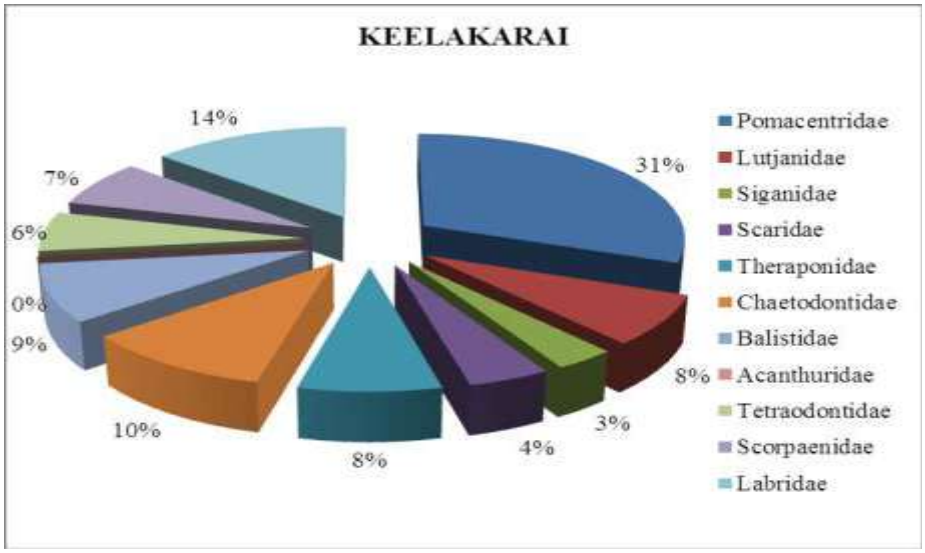

Fig.4. Percentage composition of ornamental fishes at Keelakarai

3.2.4. Percentage composition of ornamental fishes at Vembar

Percentage composition of ornamental fishes at Vembar recorded were Pomacentridae 24.49%, Lutjanidae 4.08%, Siganidae 4.08%, Scaridae 5.10%, Theraponidae 5.61%, Chaetodontidae 16.33%, Balistidae 10.20%, Acanthuridae 4.59%, Tetraodontidae 4.59%, Scorpaenidae 9.18% and Labridae 11.73% (Fig.5).

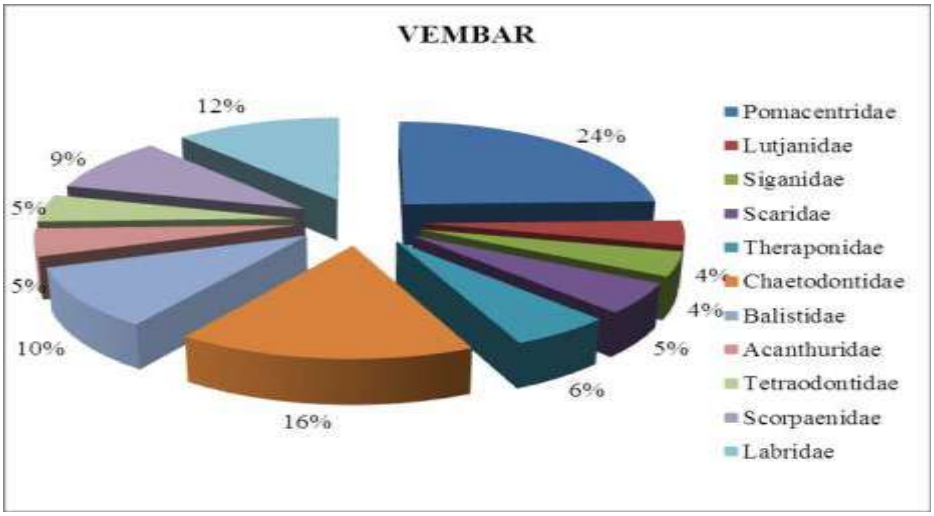

Fig.5. Percentage composition of ornamental fishes at Vembar

3.2.5. Percentage composition of ornamental fishes at Tuticorin

Percentage composition of ornamental fishes at Tuticorin recorded were Pomacentridae 35.44%, Lutjanidae 8.86%, Siganidae 3.80%, Scaridae 5.06%, Theraponidae 6.33%, Chaetodontidae 7.17%, Balistidae 4.64%, Acanthuridae 5.06%, Tetraodontidae 4.64%, Scorpaenidae 6.33% and Labridae 12.66%(Fig.6.).

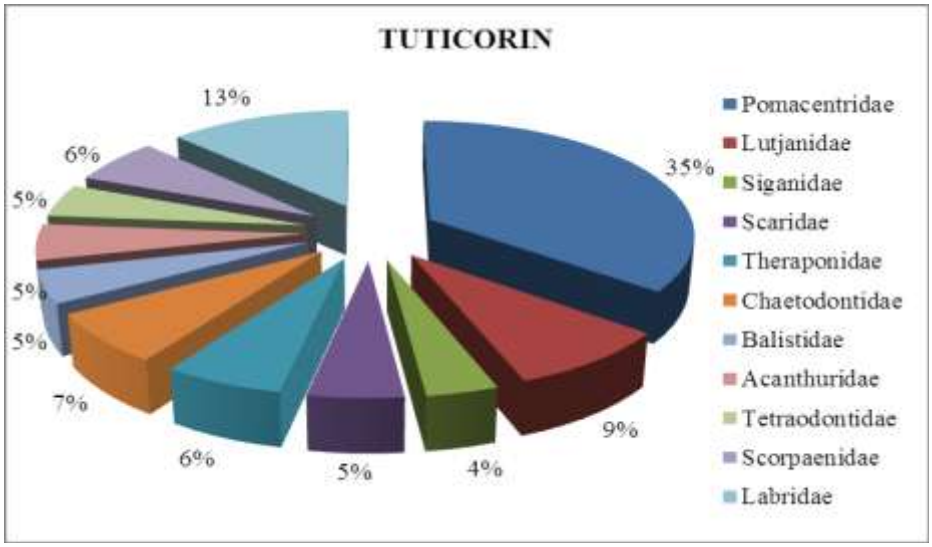

Fig.6. Percentage composition of ornamental fishes at Tuticorin

3.3. Population density (No/m^2)

The Population density was ranged from 15 No/m^2 (Vembar, monsoon) and 45 No/m^2 (Mandapam, premonsoon).

Station wise

In Rameswaram, population density was ranged from 25 No/m^2 (monsoon) and 41 No/m^2 (premonsoon). In Mandapam, it was ranged from 26 No/m^2 (monsoon) and 45 No/m^2 (premonsoon). In Keelakarai, was ranged from 21 No/m^2 (monsoon) and 37 No/m^2 (premonsoon). In Vembar, it was ranged from 15 No/m^2 (monsoon) and 38 No/m^2 (premonsoon). In Tuticorin, was ranged from 25 No/m^2 (monsoon) and 39 No/m^2 (premonsoon). The lower value of population density was observed in Vembar during monsoon and maximum in Mandapam during premonsoon season. (Fig.7.).

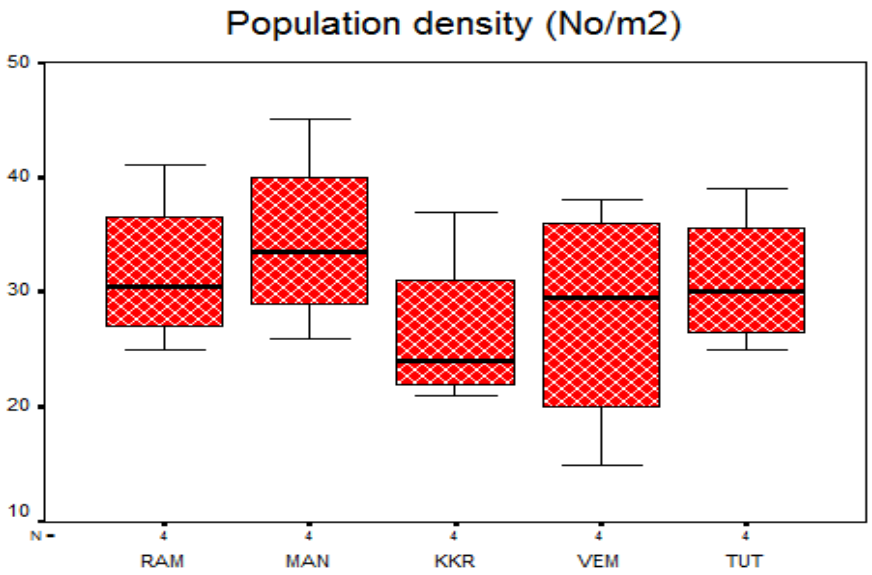

Fig.7. Station wise Population density (No/m^2)

Season wise

During postmonsoon, it was ranged from 23 No/m^2 (Keelakarai) and 32 No/m^2 (Mandapam). During summer, was ranged from 25 No/m^2 (Keelakarai) and 35 No/m^2 (Mandapam). During premonsoon, was ranged from 37 No/m^2 (Keelakarai) and 45 No/m^2 (Mandapam). During monsoon, it ranged between 15 No/m^2 (Vembar) and 28 No/m^2 (Tuticorin). The lower values of population density were observed during monsoon seasons and an increase trend was observed during premonsoon season. (Fig.8).

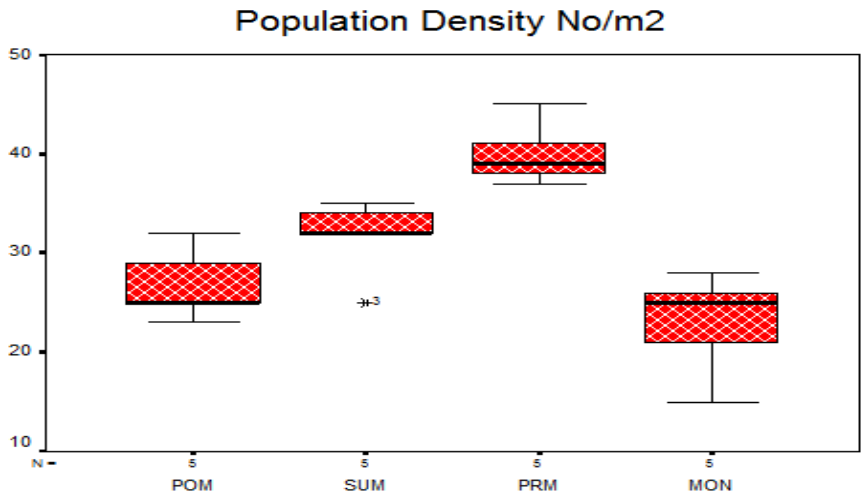

Fig.8. Season wise Population density (No/m^2)

3.4. Shannon Wiener diversity (H')

The diversity ranged between 2.636 (Vembar, monsoon) and 3.548 (Mandapam, premonsoon).

Station wise

In Rameswaram, diversity was ranged from 2.973 (monsoon) and 3.419 (premonsoon). In Mandapam, it was ranged from 3.122 (monsoon) and 3.548 (premonsoon). In Keelakarai, it ranged between 2.936 (monsoon) and 3.426 (premonsoon). In Vembar, it was ranged from 2.636 (monsoon) and 3.427 (premonsoon). In Tuticorin, it ranged between 3.082 (postmonsoon) and 3.426 (premonsoon). The lower value of diversity was observed in Vembar and maximum in Mandapam. (Fig.9).

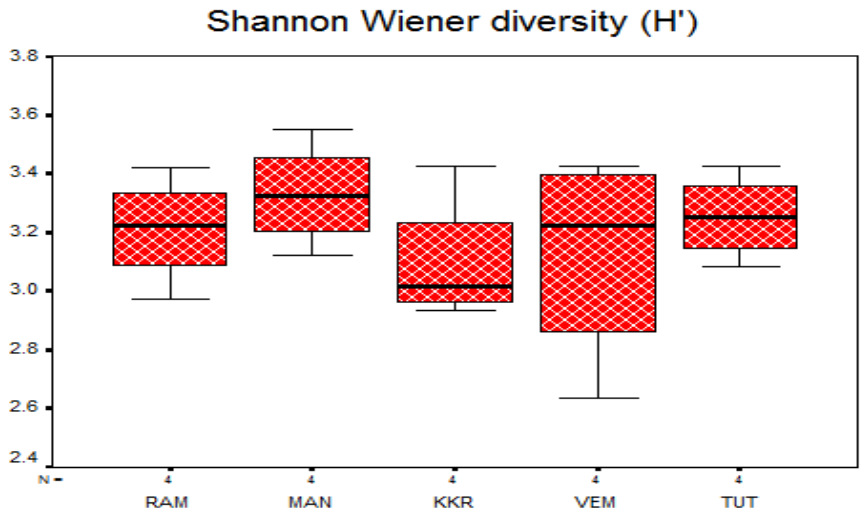

Fig.9. Station –wise variation in diversity

Season wise

During postmonsoon, it was ranged from 2.99 (Keelakarai) and 3.287 (Mandapam). During summer, was ranged from 3.039 (Keelakarai) and 3.361 (Vembar). During premonsoon, was ranged from 3.419 (Rameswaram) and 3.548 (Mandapam). During monsoon, it ranged between 2.636 (Vembar) and 3.211 (Tuticorin). The lower range of species diversity was observed during monsoon seasons and maximum was observed during premonsoon season. (Fig.10).

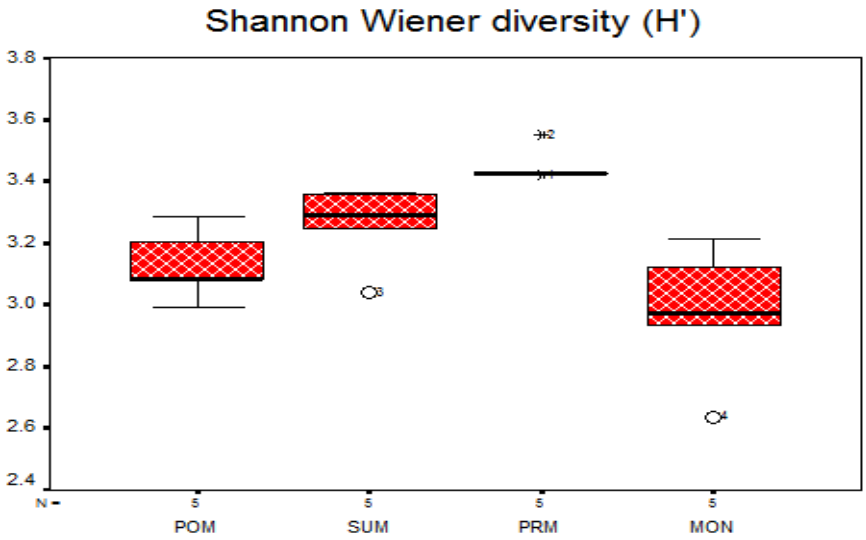

Fig.10. Season –wise variation in diversity

3.5. Species Richness Margalf (d)

The species richness ranged between 4.807 (Vembar, monsoon) and 8.906 (Mandapam, premonsoon).

Station wise

In Rameswaram, species richness was ranged from 5.883 (monsoon) and 8.092 (premonsoon). In Mandapam, it was ranged from 6.766 (monsoon) and 8.906 (premonsoon). In Keelakarai, it ranged between 5.923 (monsoon) and 8.29 (premonsoon). In Vembar, it was ranged from 4.807 (monsoon) and 8.235 (premonsoon). In Tuticorin, it ranged between 6.514 (postmonsoon) and 8.198 (premonsoon). The lower value of diversity was observed in Vembar and maximum in Mandapam. (Fig.11).

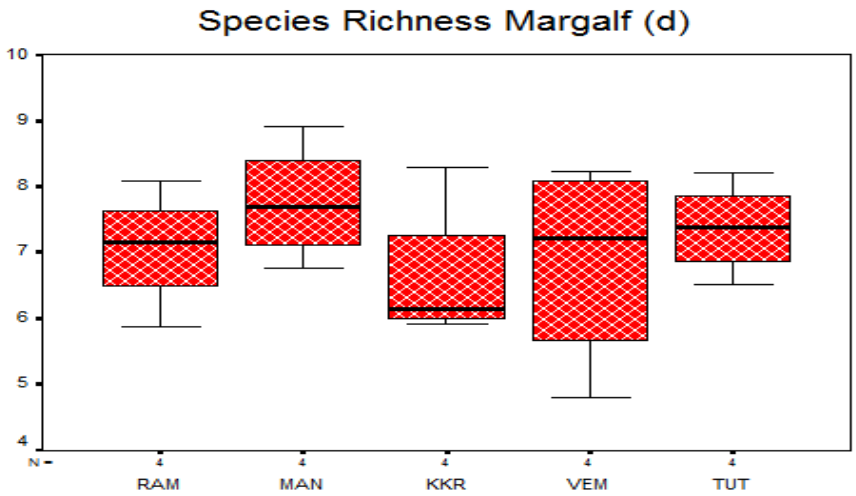

Fig.11. Station –wise variation in species richness

Season wise

During postmonsoon, it was ranged from 6.062 (Keelakarai) and 7.472 (Mandapam). During summer, was ranged from 6.232 (Keelakarai) and 7.932 (Vembar). During premonsoon, was ranged from 8.092 (Rameswaram) and 8.906 (Mandapam). During monsoon, it ranged between 5.883 (Rameswaram) and 7.238 (Tuticorin). The lower range of species richness was observed during monsoon seasons and maximum was observed during premonsoon season. (Fig.12).

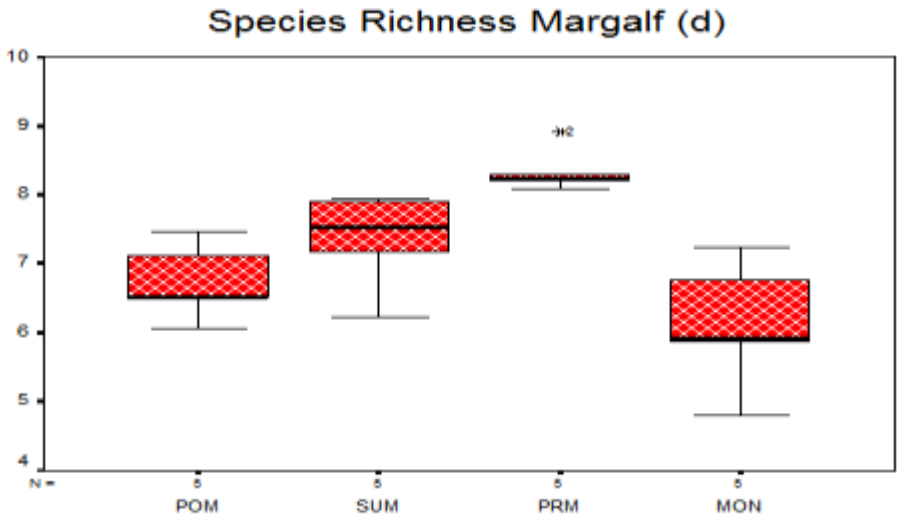

Fig.12. Season –wise variation in species richness

3.4. Evenness Pielou's (J')

The species evenness ranged between 0.9925 (Rameswaram, monsoon) and 0.9987 (Vembar, monsoon).

Station wise

In Rameswaram, species evenness was ranged from 0.9925 (monsoon) and 0.9959 (summer). In Mandapam, it was ranged from 0.9958 (monsoon) and 0.9978 (premonsoon). In Keelakarai, it ranged between 0.9972 (monsoon) and 0.9983 (summer). In Vembar, it was ranged from 0.998 (postmonsoon and summer) and 0.9987 (monsoon). In Tuticorin, it ranged between 0.9971 (postmonsoon) and 0.998 (summer). The maximum and the minimum range of evenness were recorded in monsoon season. (Fig.13).

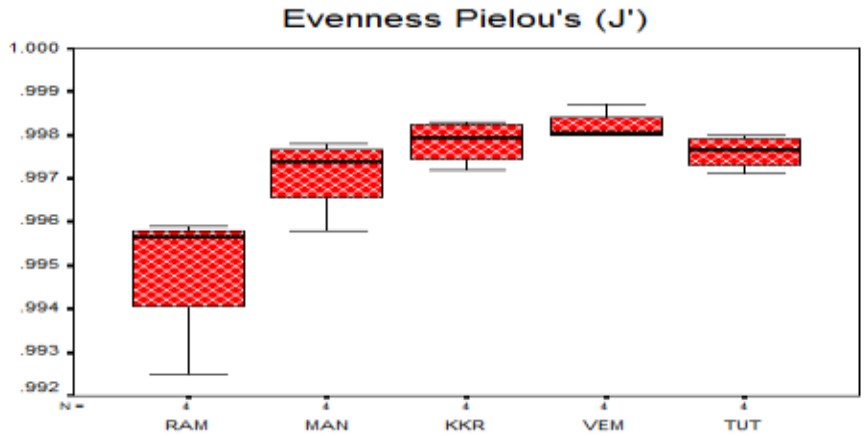

Fig.13. Station –wise variation in species evenness

Season wise

During postmonsoon, it was ranged from 0.9956 (Rameswaram) and 0.9982 (Keelakarai). During summer, was ranged from 0.9959 (Rameswaram) and 0.9983 (Keelakarai). During premonsoon, was ranged from 0.9957 (Rameswaram) and 0.9981 (Vembar). During monsoon, it ranged between 0.9925 (Rameswaram) and 0.9987 (vembar). The maximum and minimum values were recorded during monsoon season. (Fig.14).

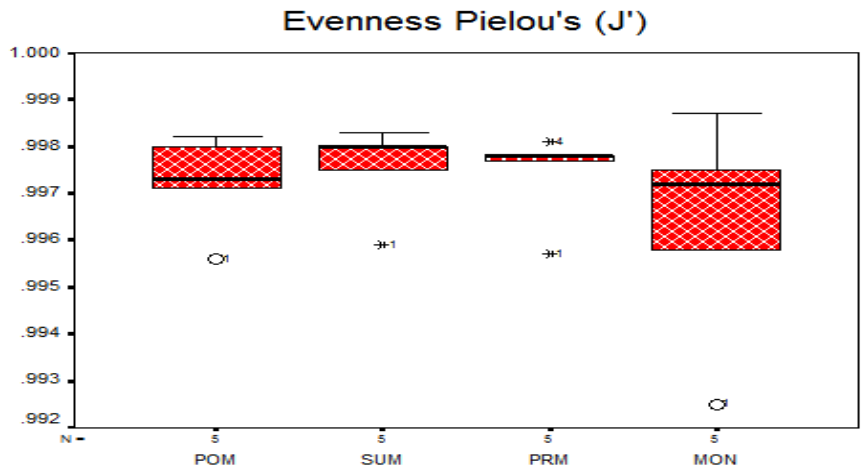

Fig.14. Season –wise variation in species evenness

Table.1. ANOVA (2-way) for differences in density, diversity, evenness and richness between station and season

DENSITY						
Source of Variation	***SS***	***df***	***MS***	***F***	***F crit***	***P-value***
Stations	159.8	4	39.95	4.78443	3.25917	< 0.05
Seasons	806.55	3	268.85	32.1976	3.49029	< 0.05
Error	100.2	12	8.35			
Total	1066.55	19				
DIVERSITY						
Source of Variation	***SS***	***df***	***MS***	***F***	***F crit***	***P-value***
Stations	0.14059	4	0.03515	2.22575	3.25917	NS
Seasons	0.60387	3	0.20129	12.7466	3.49029	< 0.05
Error	0.1895	12	0.01579			
Total	0.93397	19				
RICHNESS						
Source of Variation	***SS***	***df***	***MS***	***F***	***F crit***	***P-value***
Stations	3.1024	4	0.7756	2.34351	3.25917	NS
Seasons	13.4651	3	4.48837	13.5618	3.49029	< 0.05
Error	3.97148	12	0.33096			
Total	20.539	19				
EVENNESS						
Source of Variation	***SS***	***df***	***MS***	***F***	***F crit***	***P-value***
Stations	2.7E-05	4	6.7E-06	10.947	3.25917	< 0.05
Seasons	4.4E-06	3	1.5E-06	2.40211	3.49029	NS
Error	7.4E-06	12	6.2E-07			
Total	3.9E-05	19				

Table.2. Check list of ornamental fishes recorded at different stations and seasons

S. No	SPECIES NAME	RAMESWARAM				MANDAPAM				KEELAKARAI				VEMBAR				TUTICORIN			
		POM	SUM	PRM	MON	POM	SUM	PRM	MON	POM	SUM	PRM	MON	POM	SUM	PRM	MON	POM	SUM	PRM	MON
	Family: Pomacentridae																				
1	*Amphiprion sebae*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
2	*Amphiprion frenatus*	*	*	*	*	*	*	*	*	-	*	*	-	*	*	*	*	*	*	*	*
3	*Chromis viridis*	*	-	*	*	-	-	-	-	*	*	*	*	*	-	*	-	*	*	*	*
4	*Chromis caeruleus*	-	-	-	-	*	*	*	*	-	*	*	-	*	*	*	*	*	-	*	*
5	*Chrysiptera parasema*	-	*	*	-	*	*	*	-	-	-	*	*	-	*	*	-	*	*	*	*
6	*Chrysiptera cyanea*	*	*	*	*	-	*	*	-	-	-	-	-	-	*	-	-	*	-	*	*
7	*Dascyllus trimaculatus*	*	*	*	*	-	-	-	-	*	-	*	*	*	-	-	-	*	*	-	*
8	*Pomacentrus cyanomos*	*	*	*	*	*	-	*	*	-	-	-	-	-	*	*	-	*	-	*	-
9	*Abudefduf septemfasciatus*	-	-	-	-	*	*	*	*	-	*	*	-	*	-	-	-	-	*	*	-
10	*Abudefduf biocellatus*	*	*	*	-	-	*	*	-	-	-	*	-	-	-	-	-	-	-	*	-
	Family: Lutjanidae																				
11	*Lutjanus lineolatus*	-	-	-	-	*	-	*	*	-	*	-	-	-	-	-	-	*	-	*	*
12	*Lutjanus rivulatus*	-	*	-	*	-	-	-	-	*	-	-	*	-	-	-	-	-	*	-	*
13	*Lutjanus fulviflamma*	*	-	*	-	*	*	*	*	-	*	*	-	-	-	-	-	*	*	*	-
14	*Lutjanus russelli*	-	*	-	-	-	-	-	-	*	-	*	-	-	*	*	-	-	*	*	*
15	*Lutjanus kasmira*	-	-	-	-	-	*	-	-	-	*	-	*	-	*	*	-	-	-	*	*
	Family: Siganidae																				
16	*Siganus oramin*	*	-	*	-	-	*	*	-	-	*	*	-	*	-	*	*	-	*	-	*
17	*Siganus javus*	-	*	*	*	*	-	-	*	*	-	-	*	-	-	*	*	*	*	*	-
	Family: Scaridae																				
18	*Callyodon oktodon*	*	-	*	-	-	*	*	-	-	*	*	-	*	*	-	-	-	*	*	-
19	*Callyodon dussumieri*	-	*	-	*	-	-	-	-	*	-	-	-	-	*	*	*	*	-	*	*
20	*Callydon ghoban*	-	*	*	-	*	-	*	*	-	-	*	-	*	*	-	-	-	-	*	*
S. No	SPECIES NAME	RAMESWARAM				MANDAPAM				KEELAKARAI				VEMBAR				TUTICORIN			
		POM	SUM	PRM	MON	POM	SUM	PRM	MON	POM	SUM	PRM	MON	POM	SUM	PRM	MON	POM	SUM	PRM	MON

	Family: Theraponidae																			
21	*Pelates quadrilineatus*	*	-	*	*	*	*	*	*	-	-	*	-	-	-	*	-	-	*	*	*
22	*Eutherapon theraps*	-	-	-	-	-	*	*	-	-	-	-	*	-	*	-	-	*	*	-	*
23	*Therapon jarbua*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	-	-	*	*
	Family: Chaetodontidae																			
24	*Heniochus acuminatus*	-	*	*	-	*	-	*	-	*	-	*	-	*	*	*	*	-	*	-	-
25	*Chaetodon collare*	*	*	*	*	-	*	*	*	-	-	*	-	-	*	*	*	*	-	*	*
26	*Cheatodon decussatus*	-	-	-	-	*	-	*	*	-	*	*	*	*	*	*	-	-	*	-	-
27	*Chaetodon melannotus*	-	*	*	*	-	-	-	-	*	-	*	-	-	*	*	-	-	-	*	-
28	*Chaetodon octofasciatus*	*	-	*	-	*	*	*	*	-	*	-	*	*	-	*	-	-	*	-	-
	Family: Balistidae																			
29	*Odonus niger*	*	-	*	-	*	*	*	-	*	*	*	*	*	-	*	-	*	-	*	-
30	*Abalistes stellaris*	*	-	*	-	-	*	*	*	*	-	*	-	*	*	*	-	-	-	*	*
31	*Balistoides viridescens*	*	*	*	*	*	*	*	*	-	*	-	*	*	*	*	*	-	*	*	-
	Family: Acanthuridae																			
32	*Acanthurus bleekeri*	-	*	-	*	-	*	*	-	-	-	-	-	*	*	-	*	*	*	*	-
33	*Acanthurus dussumieri*	-	*	-	*	*	-	-	*	-	-	-	-	-	*	*	-	-	*	-	*
	Family: Tetraodontidae																			
34	*Chelonodon patoca*	*	*	*	-	-	*	-	-	-	-	-	-	*	-	*	-	-	*	*	-
35	*Arothron immaculatus*	-	*	-	-	-	-	*	-	*	*	*	*	-	*	*	-	-	*	-	*
36	*Arothron hispidus*	-	-	-	-	*	*	*	-	*	-	*	-	-	-	-	-	*	-	*	-
	Family: Scorpaenidae																			
37	*Scorpaenopsis venosa*	-	*	*	*	*	-	*	-	-	*	-	*	-	*	-	*	-	*	-	*
38	*Scorpaenopsis neglecta*	*	-	*	-	-	*	-	*	*	-	*	-	-	-	-	-	*	-	*	-
39	*Pterois volitans*	*	*	*	*	*	*	*	*	*	-	*	*	-	*	*	-	-	*	*	-
40	*Brachypterois serrulata*	-	-	*	-	*	*	*	*	*	-	*	-	*	*	*	-	-	*	*	*
S. No	**SPECIES NAME**	**RAMESWARAM**				**MANDAPAM**				**KEELAKARAI**				**VEMBAR**				**TUTICORIN**			
		POM	**SUM**	**PRM**	**MON**	**POM**	**SUM**	**PRM**	**MON**	**POM**	**SUM**	**PRM**	**MON**	**POM**	**SUM**	**PRM**	**MON**	**POM**	**SUM**	**PRM**	**MON**
	Family: Labridae																			

41	*Anampses lineatus*	*	-	*	-	*	-	*	*	-	*	-	*	*	*	*	*	*	*	*
42	*Coris formosa*	*	*	*	-	*	-	-	-	*	-	*	*	-	*	*	-	*	-	*	-
43	*Halichoeres centriquadrus*	-	*	-	*	*	*	*	-	*	-	*	-	*	-	*	-	-	*	-	*
44	*Halichoeres fasciatus*	*	*	*	-	-	*	*	*	-	*	*	-	-	*	*	*	*	*	*	-
45	*Thalassoma purpureum*	*	-	-	*	*	*	-	*	-	*	*	*	-	-	-	-	-	*	*	*
46	*Iniistius pavo*	*	-	*	-	*	*	*	-	*	*	*	-	*	*	*	-	*	*	*	-

(*) – Species present (-) – Species absent

Table.3. Diversity of benthic macro fauna during study period

1. DENSITY					
Stations/Seasons	**Rameswaram**	**Mandapam**	**Keelakarai**	**Vembar**	**Tuticorin**
Post-monsoon	29	32	23	25	25
Summer	32	35	25	34	32
pre-monsoon	41	45	37	38	39
monsoon	25	26	21	15	28
2. DIVERSITY					
Post-monsoon	3.205	3.287	2.99	3.085	3.082
Summer	3.245	3.359	3.039	3.361	3.289
pre-monsoon	3.419	3.548	3.426	3.427	3.426
monsoon	2.973	3.122	2.936	2.636	3.211
3. RICHNESS					
Post-monsoon	7.108	7.472	6.062	6.516	6.514
Summer	7.183	7.893	6.232	7.932	7.52
pre-monsoon	8.092	8.906	8.29	8.235	8.198
monsoon	5.883	6.766	5.923	4.807	7.238
4. EVENNESS					
Post-monsoon	0.9956	0.9973	0.9982	0.998	0.9971
Summer	0.9959	0.9975	0.9983	0.998	0.998
pre-monsoon	0.9957	0.9978	0.9977	0.9981	0.9978
monsoon	0.9925	0.9958	0.9972	0.9987	0.9975

3. DISCUSSION

Total of 46 species were recorded belonging to 27 genera and 11 families along the five stations of Gulf of Mannar regions. The species rich family Pomacentridae (32.25%) followed by Theraponidae, (11.86%), Labridae (11.11%), Chaetodontidae (10.36%), Balistidae (7.02%), Tetraodontidae (5.60%), Lutjanidae (5.43%), Scorpaenidae (5.35%), Scaridae (4.01%), Siganidae (3.43%) and Acanthuridae (3.43%). As the order wise distribution is worried, Perciformes is the major with maximum number of fishes. Among the five locations selected for the study Rameswaram and Mandapam was high abundance of ornamental fishes (Rejitha and Pillai, 2014). Ornamental fishes are important to the biological processes occurring in the marine environment and its loss would affect the health of the ecosystem (Sujitha Thomas *et al*., 2011). No uniformity has been observed regarding the distribution of ornamental fishes in the present observation. Muralitharan (1998) has recorded 213 species of marine ornamental fishes from the Gulf of Mannar which is considered nationwide biosphere source. Further, the essential parts of the Indo-west Pacific have also been considered as one of the richest reef fishing grounds. However, the numerical abundance of ornamental fishes, along the Gulf of Mannar area all through the time, effectively suggests that this shore is to be surveyed adequately for the existence of coral formation in order to conserve the frag ile ecosystem and the efficient management of the marine ornamental fishes associated with reef configuration. Global warming, coral bleaching, and overfishing are all competent of varying biodiversity and reducing the quality of reefs over big areas. Evidently, if we wish to defend global biodiversity, we have to appreciate the richness of biodiversity, processes that maintain diversity at the best level.

The data were analyzed with approached to various statistical methods such as a univariate, graphical/distributional and a multivariate method was used for univariate and multivariate data analysis. Species richness was expressed by considering the number of species (D), and species diversity and homogeneity were determined using the Shannon Wiener diversity index (H') and the evenness index (J') (Pielou1966). Venkataramani and Jawahar (2004) recorded about 113 marine ornamental finfish species in Gulf of Mannar and also claimed that this region could be exploited more for ornamental fish trade in India. The abundance of marine ornamental fishes in this study was comparatively higher especially in coral reef rich regions such as Rameswaram, Mandapam comprising Kilakkarai, Vembar and Tuticorin compared to other regions. In addition to this, MDS ordination plots were also revealed that

the diversity was higher in the premonsoon season and Mandapam and were grouped separately with high level of similarity (79.66%). The abundance and distribution of fishes is dependent on several distinct factors such as conscription, environment structure, food accessibility, and environmental factors (Jones, 1991and Williams, 1991). Roberts and Ormond (1987) stated that most of the coral reef fishes tend to increase in both abundance and number of species with increasing depth on fringing reefs. In contrast, Olivotto e*t al.,* (2006) stated that the vertical distribution of angelfishes was increasing with depths, where the highest average abundance of ornamental fishes was recorded on 20 m (93.0 ± 6.1 fish/600 m).

However, due to unavailability of the comparable available literature, it is safe to say this is the primary as well as pioneer attempt on this commercially important ornamental fish group which could be useful for better understanding of the status of diversity and distribution pattern of marine ornamental fishes along Gulf of Mannar, in India.

The Population density was ranged from 15 No/m^2 (Vembar, monsoon) and 45 No/m^2 (Mandapam, pre monsoon).The Shannon Wiener diversity (H') ranged between 2.636 (Vembar, monsoon) and 3.548 (Mandapam, pre monsoon). The species richness ranged between 4.807 (Vembar, monsoon) and 8.906 (Mandapam, premonsoon). The species constancy ranged between 0.9925 (Rameswaram, monsoon) and 0.9987 (Vembar, monsoon). In the past, Asta Lakshmi and Sundaramanicam, (2011), were recorded same trend in Cuddalore coastal areas.

From the cluster and MDS analyses of present study, it was observed that maximum similarity 79.66% was found between premonsoon at Rameswaram and postmonsoon at Rameswaram. Pre monsoon at Mandapan and summer at Mandapam similarity 77.2% was found. Tuticorin premonsoon and Tuticorin post monsoon joined with this group at the level of 70.72%. These groups were joined with Keelakarai postmonsoon and Keelakarai monsoon at the level of 48.78%. The minimum similarity was found in Vembar during monsoon season with the level of 42.08% K-dominance curve of Tuticorin, the curve for the premonsoon season was lying at the bottom showing highest diversity while lowest diversity was noticed in monsoon as the curves representing this station were lying at the top. The same trend of MDS, Cluster and K-Dominance plat was observed in Gulf of Mannar region by (Rajeswari and Balasubramanian, 2014).

The present study conclusion of this study demonstrate that the sites selected support relatively rich assemblage of ornamental fishes and most of the species are abundant in distribution thereby offering immense scope for the export and development of aquarium industry in the country. But a policy for sustainable exploitation of the resources is yet to be formulated as breeding of coral fishes in captivity has not been fully successful till date. Unlike freshwater ornamental species in which over 90% of the species are produced in farms, the marine ornamental species are collected from the coral reefs and adjacent habitats, which are natural ecosystems. Hence, sustainability of this industry is controversial as overexploitation may lead to sudden resource depletion, making several species endangered. The ultimate solution to a long term sustainable trade of marine ornamental fishes can be achieved only through the development of fool proof aquaculture technologies.

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