Eco. Env. & Cons. 29 (3) : 2023; pp. (1384-1389)
Copyright@ EM International
ISSN 0971–765X

DOI No.: http://doi.org/10.53550/EEC.2023.v29i03.058

Study on the Diversity of Marine Macro Fouling Organisms of Cuddalore Coast, India

Mohamed Muhsin[1]*, Prashanth[2] and Gyanakkan Ananthan[1]

[1]Center of Advanced Study in Marine Biology, Faculty of Marine Sciences, Annamalai University, Parangipettai 608 502, Tamilnadu, India
[2]Department of Environmental Science, RVS Agricultural College, Thanjavur 613 402, Tamilnadu, India

(Received 4 February, 2023; Accepted 1 April, 2023)

ABSTRACT

The knowledge on diversity and distribution of fouler's in southeast coast of Cuddalore district, Tamilnadu state, India is sparse as compared to other regions. There is a dire need of research regarding fouling species composition, distribution pattern so that their role in controlling marine boring sessile could be ascertained.Present study is a novel approach for documenting the diversity of fouling fauna in coastal region of Cuddalore, Tamilnadu, India. A regular survey of fouling fauna complex was conducted in extra-large size artificial boat structures made up of Wooden, Iron, Copper and resin. Maximum number of foulers was found in site 8 and 9 minimum numbers of foulers were collected and identified from site 4. Similarly, diversity indices viz., Shannon-Weiner (H' and H max), Pielou's index (J') and Raunkiaer's frequency law also indicated the maximum species richness in *Perna indica* and minimum in *Oyster* spp. In Over all, *Mytilidae* and *Balanidae* were found as most abundant families. Ostreidae and Archaeobalanidae were found as minimum in families.

Key words: *Diversity, Foulers, Pielou index, Raunkiaer index, Shannon weaver index*

Introduction

Most of the organisms in marine spend their life in dual mode Deepa *et al*., 2015 motile form and Dehmordi *et al*., 2011 sessile/ sedentary adult form. The sessile forms of organisms have the tendency to attach in marine environment. This colonization, often causing undesirable consequences to natural and artificial structures, such as mangroves, macro fauna, offshore platforms, ship hulls, ship machinery etc., it is called biofouling. The sequence of biofouling includes a primary micro fouling involves a biofilm formation and bacterial adhesion and secondary macro fouling organisms includes soft fouler like macro algae and corals, sponges, anemones, tunicates and hydroids and hard foulers like barnacles, mussels and tubeworms etc., (Salta *et al*., 2009; Deepa *et al*., 2015). Biofouling causes great operational hazards in different marine artificial structures across the globe. Biofouling reported that Shut down of 235 MW power station (Sahu *et al*., 2015). Although a plethora of research has been carried out on biofouling organisms in and around world, most of the studies were focused on antifouling strategies (Dehmordi *et al*., 2011; Deepa *et al*., 2015). Present study was undertaken to explore the distribution and diversity of macro foulers along the coastal areas of Cuddalore, Tamilnadu, India. Macro foulers being prominent community in artificial and natural structures in coast and till date there is no

such previous detailed distribution survey in this study area. The study provides with a detailed report on the macro fouler diversity and distribution in southeast coast of India.

Materials and Methods

Study area

The research work was conducted in Cuddalore district of Tamilnadu (Fig. 1) in 2018. The study area is coastal environment. Maximum and minimum temperature was recorded at 40 °C during summer and 12 °C during winter, respectively and average relative humidity (RH) was 69.08 %. Sampling quadrate comprising nine different places with same substratum type viz., medium size made up of wooden, iron, copper and fiber material were selected to cover the fouler diversity of the experimental region.

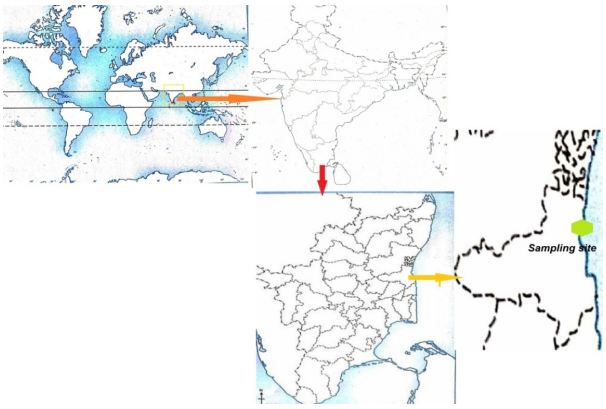

Fig. 1. Study area for diversity and distribution of foulers of Cuddalore, Tamilnadu

Sampling and collection

Fouler was collected by scraping 10 cm^2 area at 0 m depth from the artificial structures described by Pati *et al*., 2011 was adopted in the current study to sample the fouling fauna from selected study sites. Quadrate sampling was done from the same selected study sites in 2018 during day.

Identification

The collected foulers were identified using Subba rao, 2003. Because of the difficulty in identifying juveniles, only adults were identified and used in subsequent analyses. The collected specimen were preserved in 5% neutral formalin and stored in laboratory for further reference.

Statistical analysis

Fouler's assemblages were analyzed using two parameters i.e. relative abundance of fouling fauna and percentage abundance of fouler families in different site. Analysis of fouler diversity across each site type was preceded by using statistical measures viz., species richness (S), Shannon Index (H), Shannon Evenness (E), Pielou's evenness Index (J) and Raunkiaer's frequency law as described by Pati *et al*. (2011).

Shannon Weaver Index

$H = -SUM [(pi) * \ln(pi)]$

$E = H/H_{max}$

SUM = Summation

$$pi = \frac{\text{Number of individuals of species}}{\text{Total number of samples}}$$

S = Number of species (or) species richness

H_{max} = Maximum diversity possible

E= Evenness $= H/H_{max}$

$$\text{Density of the species} = \frac{\text{Total no of individual species in all the quadrates studied}}{\textit{Total no of quadrates studied}}$$

$$\textit{Frequency of a species} = \frac{\textit{Total no of qadrates in each species occured}}{\textit{Total no of quadrates studied}} \times 100$$

Frequency class

Class A = 0-20%, Class B = 21-40%, Class C = 41-60%, Class D = 61-80%, Class E = 81-100%

Raunkiaer's frequency law = A>B>C>=<D<E

$$\text{Abundance} = \frac{\text{Total no of individual species in all the quadrates studied}}{\text{Total no of quadrates in which species occured}}$$

Abundance class

Rare = 1-4, Occasional = 5-14, Frequency = 15- 29, Abundant = 30-90

Very abundant = 91-100

Pielou's evenness index (J')

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

$J' = H'/\text{Log } 2\ S$ (or) $J' = H'/\ln S$

Where J' = evenness,

H' = species diversity in bits of information per individual,

S = total number of species.

Results

A total of 6 distinct species representing 4 families were recorded and identified during sampling (Table 1).

Table 1. Fouler species collected from the study area

Species : *amaryllis* (Darwin) Genus : *Striatobalanus* Species :*amaryllis* (Darwin)	
Family : Balanidae Genus : *balanus* Species : (Darwin) Common name : Striped barnacle	
Family : Mytilidae Genus : *Perna indica* Species : (Kuriakose and Nair) Common name : Brown mussel, Mexilhao mussel	
Family : Mytilidae Genus : *Perna* Species : *viridis* Linn Common name : Asian mussel, green mussel	
Family : Ostreidae Genus : *Crassostrea* Species : *madrasensis* (Preston H.B)	
Family : Osteridae Genus : *Oyster* Species : (Born) Common name : small rock oyster	

Out of all these, 6 species have been recorded by quadrate sampling. The Diversity indices like Shannon-Wiener index (H') and evenness (E), Pielou's evenness index (J) and Raunkiaer's frequency law of fouling families within each site is outlined in Table 2.

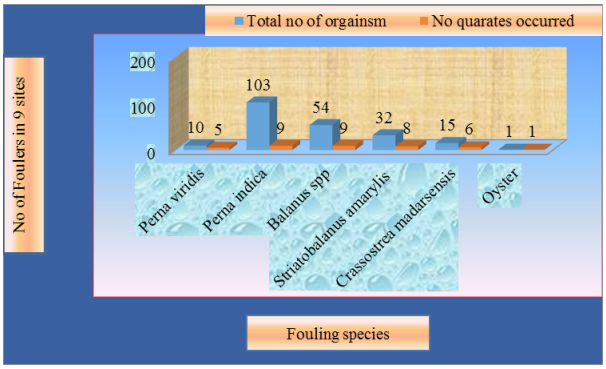

Fig. 2. Number of foulers from the nine sites (9 Quadrate)

In all 9 sites, species *Perna indica* followed by *Balanus spp* were found to be most abundant species (11.44% and 6% abundance, respectively.

Families Mytilidae and Balanidae were found as most abundant families in all 9 quadrate sites (13.44% and 6% abundance, respectively). In overall, species density *Perna indica* and *Balanus spp* were found most density (11.44 % and 6% density, respectively) Fig. 3.

Fouling species frequency *Perna indica* and *Balanus spp* were found most frequent (100% and 100%, frequency, respectively) Fig. 4.

Abundance of fouler's all sites viz., rare (*Perna viridis, Striatobalanus amaryli, Crassostrea madarsensis and Oyster spp*) and occasional (*Balanus spp and Perna indica*) Fig. 5.

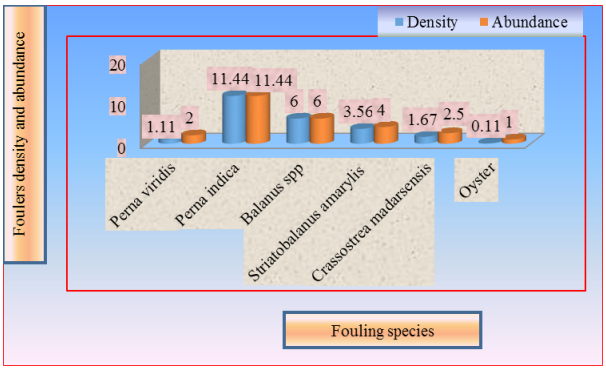

Fig. 3. Fouler's density and abundance in different sites

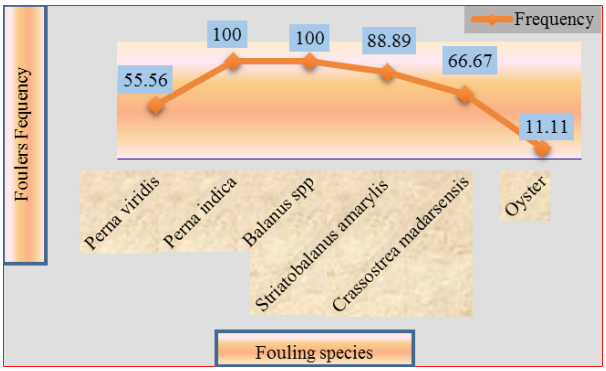

Fig. 4. Frequency of the foulers from study site

Families Mytilidae, Balanidae and Archeobalanidae occupied 50% Frequency class others area are below then 20% (Table 2 and Fig. 6). A synchrony was found between immersions and fouler densities because the maximum percentage of fouler (*P.indica* 11.44%) found in all sites deep immersion and minimum percentage of fouler (Oyster *spp* 1 %). Because of this, number statistical measures were employed to analyze the data from the

Table 2. Diversity indices like Shannon-Wiener index (H') and evenness (E), Pielou's evenness index (J) and Raunkiaer's index recorded at various study area

Foulers	No of quadrate occurred	No of foulers (9 site)	Frequency class (Raunkiaer's index)	Abundance class (Raunkiaer's index)
Perna viridis	5	10	C	Rare
Perna indica	9	103	E	Occasional
Balanus spp	9	54	E	Occasional
Striatobalanus amarylis	8	32	E	Rare
Crassostrea madarsensis	6	15	D	Rare
Oyster spp	1	1	A	Rare
Shannon Weaver index (H)		**1.34**		
Shannon Weaver index (Hmax)		**2.2**		
Shannon Weaver index (Evenness)		**0.610**		
Pielou's Evenness index (J)		**0.610**		

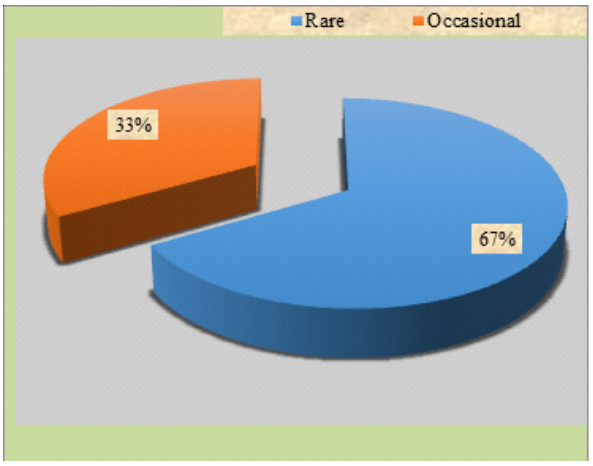

Figure 5. Abundance classes for the fouling organism

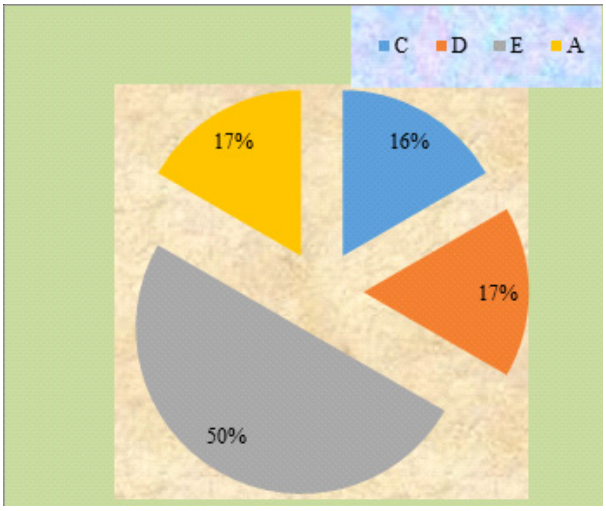

Fig. 6. Frequency classes for the fouling organisms

present study (Table 2). The diversity indices used here were Shannon weaver index (H'), which sensitive to changes in the abundance of rare species in a community and Raunkiaer's frequency law, which is sensitive to change in the most abundant and frequency species community.

Species richness (S) examiners the number of species occurring in a habitat and when all species in a sample are equally abundant an evenness index (E) will be at its maximum, relatively higher species richness and Shannon index value (S = 0.61; H' = 1.33) were recorded in overall site.

Discussion

The present study reports marine macro organisms such as barnacle *spp*, polychates and bivalves were the major constituents of the fouling community.The statistical measures in diversity studies may yield more fitting or consistent results, but no single measure or index can perfectly reflect the diversity of a given area (Routledge, 1979: Kumari *et al*., 2017). Our result were similar with the fouling diversity reported in other parts of India and Globally. Pati *et al*., 2011 studied fouling diversity and biomass estimation in Visakhapatnam harbour in various season and different stations it showed low in pre-monsoon both inner and outer harbour and post-monsoon inner is low and outer harbor is more than the pre-monsoon. Spatial and temporal changes in bio-fouling community were assessed by Pati *et al*., 2015 at Visakhapatnam harbour and reported that the salinity and pollution reduce the richness, evenness and diversity of species. Macro fouler's distribution and diversity in Port Blair, Andaman and Nicobar Islands were carried by Deepa *et al*., 2015. They also similarly reported the *Balanus spp* were dominant in all stations and arthropods and mollusks are predominant in fouling community. Our study in concurrent with the results of Sahu *et al*., 2015 who studied the biofouling diversity at Kalpakkam coastal waters and found that the barnacle sp. is pioneer as macro foulers and *Perna viridis* was climax in this community. In Manila Bay, Philippines the macro biofouling diversity were assessed and reported the *Balanus spp* is dominant in initially later succeed by polychaetes Trinidad *et al*., 2019.

Conclusion

The present study revealed that the diversity of fouling organisms was material specific and *Balanus spp* is Pioneer and *Perna Viridis* was climax in Succession. Shannon Index (H), Shannon Evenness (E), Pielou's evenness Index (J) and Raunkiaer's frequency law were found to be useful statistical tools for the diversity study of marine foulers. The diversity of the macro marine faunal fouling organisms of Cuddalore coastal region indicates the challenges of the Cuddalore fisherman's. This study initiated to know the dense and frequent occurring macro fouler.

References

Deepa, S., Sathish, T., Vinithkumar, N. V., Limna Mol, V.P. and Kirubagaran, R. 2015. Distribution and Diversity of Macrofoulers in the Coastal Areas of Port

Blair, Andaman and Nicobar Islands. *International Journal of Environmental Research.* 9(4): 1315-1324.

Dehmordi, L. M., Karami, L., Safarpor, N. and Alesadi, B. 2011. Taxonomic identification and distribution of biofouling organisms in Deilam port in Iran. *Journal of Ecology and the Natural Environment.* 3(14): 441-445.

Kumari, V., Saini, K. C. and Singh, N. P. 2017. Diversity and distribution of spider fauna in arid and semi-arid region of Rajasthan. *Journal of Biopesticides.* 10(1): 17-24.

Ocampo, M.A.B. and Vallejo Jr, B.M. 2019. Macrofouler Community Succession in South Harbor, Manila Bay, Luzon Island, Philippines during the Northeast Monsoon Season of 2017–2018. *Philippine Journal of Science.* 148(3): 441-456.

Pati, S.K., Rao, M.V. and Balaji, M. 2015. Spatial and temporal changes in biofouling community structure at Visakhapatnam harbour, east coast of India. *Tropical Ecology.* 56(2).

Pati, S.K., Rao, V. and Balaji, M. 2011. Fouling communities of the static substrata in a tropical Indian harbour. *Journal of the Marine Biological Association of India.*

Pielou, E.C. 1966. Shannon' formula as a measure of specific diversity: its use and misuse. *Amer. Nat*. 100: 463-465

Routledge, R. D. 1979. Diversity indices: which ones are admissible?. *Journal of theoretical Biology*. 76(4): 503-515.

Sahu, G., Mohanty, A.K., Achary, M.S., Prasad, M.V.R. and Satpathy, K.K. 2015. Recruitment of biofouling community in coastal waters of Kalpakkam, southwestern Bay of Bengal, India: a seasonal perspective.

Salta, M., Chambers, L., Wharton, J., Wood, R., Briand, J.F., Blache, Y. and Stokes, K.R. 2009. Marine fouling organisms and their use in antifouling bioassays. In: *Proc. EUROCORR*.

Subba Rao, N.V. 2003. Indian Seashells (Part-I) : Polyplacophora and Gastropoda, Rec. zool. Surv. India, Occ. Paper No. 192: i-x, 1-416. (Published: Director, *Zoo I. Surv. India,* Kolkata)