Article

Species composition and distribution of marine foulers along the southeast coast of Tamilnadu, India

Ravi Murugeswari Prasanth, **Pandiyan Sureshkumar**

CAS in Marine Biology, Faculty of Marine Sciences, Annamalai University, Parangipettai – 608502, Tamil Nadu, India

E-mail: savegreenenvironment@gmail.com

Received 9 September 2019; Accepted 20 October 2019; Published 1 March 2020

Abstract

Present study was conducted to assess the diversity of faunal foulers and their distribution along the southeast coast of India. Grab and colonization sampling methods were employed. There were 14 families of faunal foulers with 28 species. Among the families, Bacillaceae constituted 31% and Mytilidae, 10%, Aeromonadaceae, 6% and Archaeobalanidae, 3%. Families numbering eight contributed to the macro faunal fouling community and the others, micro fouling community. According to the IUCN red data book, the observed faunal fouling organisms do not come under any red list category. Another striking feature was that 20 % of the recorded species were alien invasive species. This study will be helpful to the policymakers, coastal developers, researchers, fishermen, sea-based industries and government authorities, as the fouling communities pose innumerable problems in the coastal developmental activities.

Keywords faunal diversity; fouling; IUCN list; naturalized species; marine biofouling.

Proceedings of the International Academy of Ecology and Environmental Sciences
ISSN 2220-8860
URL: http://www.iaees.org/publications/journals/piaees/online-version.asp
RSS: http://www.iaees.org/publications/journals/piaees/rss.xml
E-mail: piaees@iaees.org
Editor-in-Chief: WenJun Zhang
Publisher: International Academy of Ecology and Environmental Sciences

1 Introduction

Ecosystem is a community of living organisms (microbes, plants and animals), non-living environment (minerals, climate, soil, water, sunlight, etc.) and their interrelationships (Tansley, 1935; Simmons., 1966). Large ecosystems (terrestrial and marine) embrace a wide variety of sub-ecosystems which are rich in biodiversity. Ecosystems containing endemic species also make a major contribution to the global biodiversity. There are about 8.7 million species of animals described and classified, including 4000 bio-foulers (Cao et al., 2011). Micro-fouling involves biofilm formation and bacterial adhesion and macro-fouling involves attachment of larger offender organisms like barnacles, mussels, polychaete worms and bryozoans (Melo et al., 1997; Bhadury and Wright, 2004; Railkin, 2004; Eguia and Trueba, 2007; Iyapparaj et al., 2012; Mahadevan, 2013).

In this context, present study was carried out to assess the fouling faunal communities and their distribution along the southeast coast of India. Till date, there is no such previous detailed survey in this study area and the

present investigation provides with a detailed report on the fauna of fouling communities and their distribution along the southeast coast of India, paving way to marine foulers. This study will be helpful to the policymakers, coastal developers, researchers, fishermen, sea-based industries and government authorities, as the fouling communities cause many problems in the coastal developmental activities. This work will also be a useful as a database to delineate the distribution of foulers, in future, due to the spatial and temporal variations.

2 Materials and Methods

2.1 Study area and sample collection

Survey for recording the distribution of the marine fouling organisms was carried out in MGR thittu [site 1], Mudasalodai [site 2], Parangipettai [site 3], Annan Kovil [site 4], Samiyarpettai [site 5], Periyakuppam[site 6] and Cuddalore OT [site 7] in Tamilnadu, along the southeast coast of India (Fig.1). Latitudes and longitudes of the selected sites along the study area are : 11048’70.82”N & 79078’36.32”E[site 1], 11048’69.98”N & 79076’65.12”E [site 2], 11049’63.38”N & 79077’16.49”E [site 3], 11050’36.09”N & 79077’19.60”E [site 4], 11054’99.33”N & 79076’01.53”E [site 5], 11061’25.40”N & 79075’99.19”E [site 6] and 11071’40.82”N & 79078’12.85”E [site 7]. All the seven study sites are coming under the coastline of the Cuddalore district (68km), which is one of the healthiest fishing areas in the state of Tamil Nadu and living place for a large number of fishing communities (tndistricts.nic.in).

Fig. 1 Map showing the seven selected sites for the study along the southeast coast of Tamilnadu, India.

2.2 Grab sampling and Colonization sampling

Field survey for collecting the marine fouling organisms was conducted during May 2018 to May 2019, using the Colonization sampler and Grab sampler (Noleto et al., 2019; Vijapure et al., 2019). Marine fouling organisms were sampled after sunrise for clear identification. Filed note, DSLR D5300 camera and other necessary materials were used during the entire study. All the collected organisms were preserved in 95 % ethanol and transported to the laboratory. All the faunal fouling organisms were identified using the manual (Indian Seashells) (Rao, 2003). The foulers were divided into micro and macro foulers and the checklist was prepared. Presently recorded species were evaluated using the IUCN red list and the alien invasive species categories (GISD, 2019; IUCN, 2019).

3 Results

In the present study, 28 species of faunal foulers were recorded. Of which, 10 macro fouler species belong to 6 families (Table 1; Fig. 2) and the remaining 18 micro-foulers are represented by 8 families (Table 2). Among

the families, Bacillaceae constituted 31%, Mytilidae, 10%, Aeromonadaceae, 6% and Archaeobalanidae, 3% (Fig. 3). Macro-foulers such as *Striatobalanus amaryllis, Crassostrea madrasensis, Lepas spp, Perna viridis* and *Perna indica* and micro-foulers like *Bacillus, Halolactibacillus, Staphylococcus,* and *Pseudomonas* were dominant from present study. In the present study, majority of macro fouling species have been observed from wooden, rock, fiber and iron structures. *Striatobalanus amaryllis, Crassostrea madrasensis, Lepas spp., Perna spp.* and *Balanus spp.* were mostly found in wooden material and *Striatobalanus amaryllis, Crassostrea madrasensis and Balanus spp.* were found attached on rocks with the help of byssal threads. According to the IUCN red data book, the observed macro-faunal fouling organisms are not coming under any red list category. Another striking feature was that 20 % of the recorded species (2) fall under the alien invasive species category (Table 1 and Fig. 4).

Table 1 List of marine macro-foulers collected from the study area and IUCN- Red list categorization.

Sl.No	**Family**	**Species of foulers**	**Synonyms**	**Common Name**	**IUCN red List categories**	**Invasive Species**
1	Archaeobalanidae	*Striatobalanus amaryllis* (Darwin, 1854)	*Chirona amaryllis, Balanus amaryllis*	-	Not Found	Not Found
2	Balanidae	*Amphibalanus amphitrite* (Darwin, 1854)	*Balanus amphitrite*	Striped barnacle	Not Found	Not Found
3	Lepadidae	*Lepas anatifera* Linnaeus, C	-	Smooth, Grooved and Scaled goose-necked barnacle	Not Found	Not Found
4	Lepadidae	*Lepas anserifera* Linnaeus, C.	-	goose-neck barnacle,	Not Found	Not Found
5	Mytilidae	*Modiolus metcalfei Hanley*	*Modiola metcalfei*	Brown mussel	Not Found	Not Found
6	Mytilidae	*Perna indica* Kuriakose & Nair	*Chloromya perna, Mya perna, Perna perna, Mytilus perna, Mytilus pictus, Mytilus venezolanus*	Brown mussel, Mexilhao mussel	Not Found	Africa, Europe, and South America
7	Mytilidae	*Perna viridis* Linnaeus, C	*Chloromya viridis, Mytilus viridis, Mytilus smaragdinus*	Asian green mussel, green mussel	Not Found	Asia-Pacific Region, and Asia
8	Ostreidae	*Crassostrea madrasensis (*Preston H.B. 1916)	*Ostrea madrasensis*	-	Not Found	Not Found
9	Ostreidae	*Saccostrea cucullata* Born,	*Crassostrea cucullata*	Small rock oyster	Not Found	Not Found
10	Pteriidae	*Isognomon bicolor* (Adams, 1845)	*Melina semiaurita, Perna bicolor, Perna chemnitziana*	bicolor purse-oyster	Not Found	Not Found

Table 2 List of marine micro-foulers from the study area (Suresh and Sureshkumar, 2015; Suresh and Anandhraman, 2015).

Sl. No	Family	Species of foulers
1	Aeromonadaceae	*Aeromonas hydrophila*
2	Bacillaceae	*Amphibacillusspp*
3	Bacillaceae	*Bacillus badius*
4	Bacillaceae	*Bacillus cibi*
5	Bacillaceae	*Bacillus drentensis*
6	Bacillaceae	*Bacillus thuringiensis*
7	Bacillaceae	*Bacillus weihenstephanensis*
8	Bacillaceae	*Halolactibacillus alkaliphilus*
9	Bacillaceae	*Halolactibacillus miurensis*
10	Halomonadaceae	*Halomonas aquamarina*
11	Bacillaceae	*Oceanobacillus kimchii*
12	Planococcaceae	*Planomicrobium flavidum*
13	Morganellaceae	*Proteus vulgaris*
14	Pseudomonadaceae	*Pseudomonas aeruginosa*
15	Pseudomonadaceae	*Pseudomonas spp*
16	Staphylococcaceae	*Staphylococcus haemolyticus*
17	Staphylococcaceae	*Staphylococcus sciuri*
18	Vibrionaceae	*Vibrio alginolyticus*

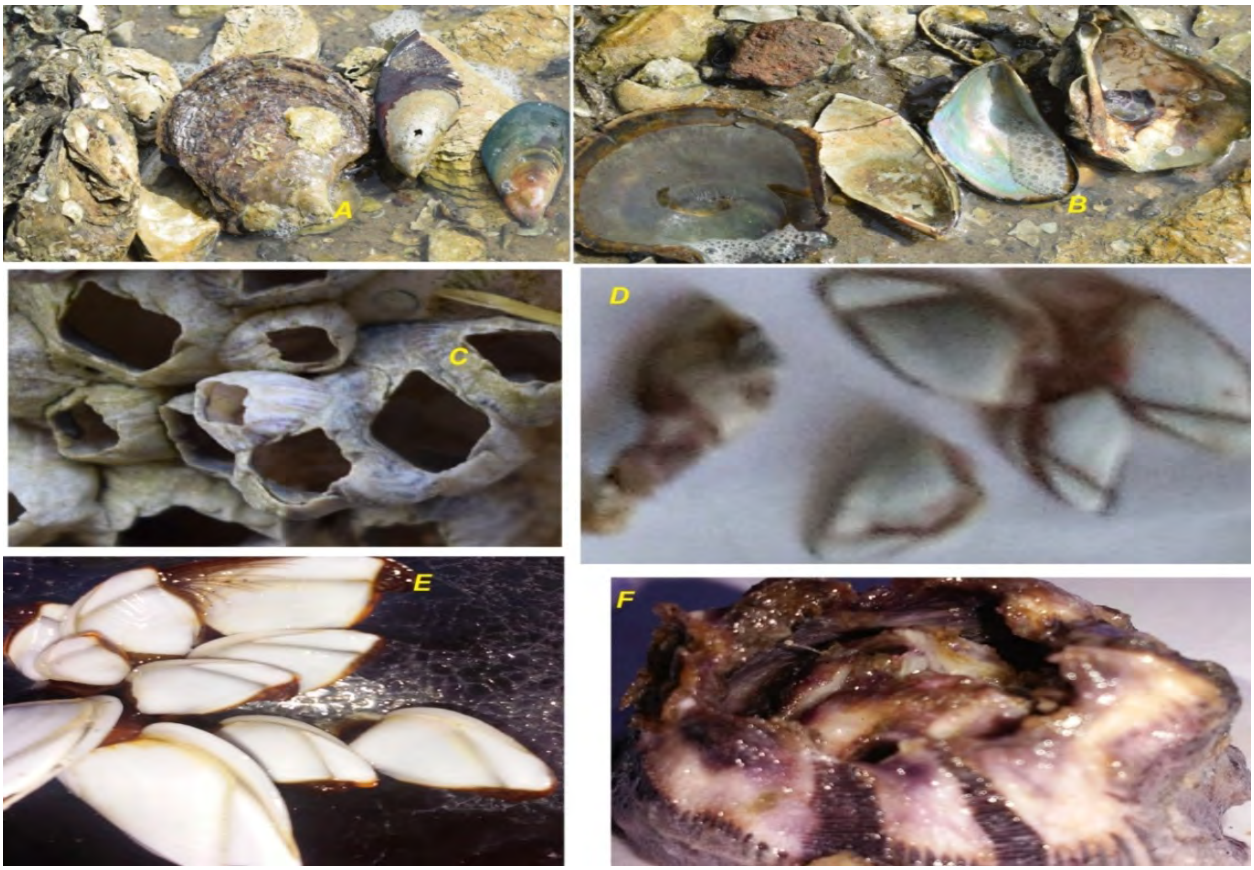

Fig. 2 Macro foulers recorded from the study area (*A –Crassostrea madrasensis, B- Perna indica and Perna viridis, C- Balanus spp, D- Lepas spp, E – Lepas spp and F – Balanus spp*).

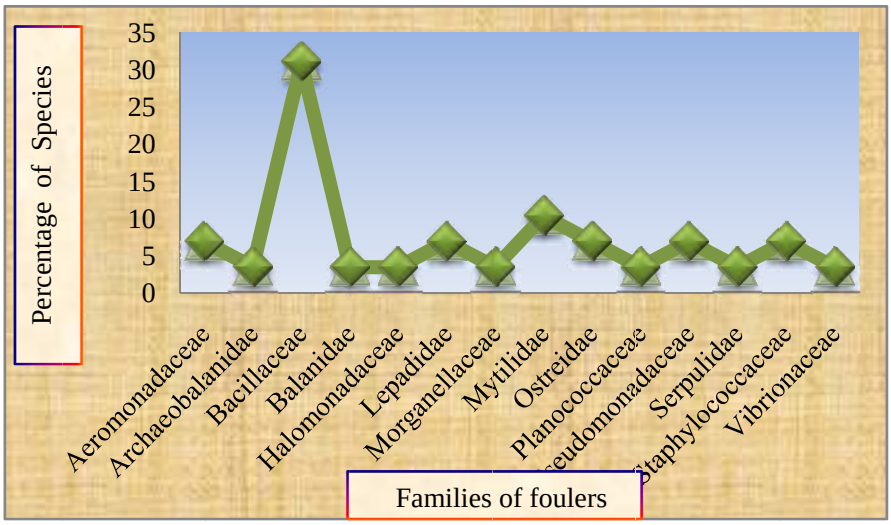

Fig. 3 Percentage of family-wise contribution of faunal foulers.

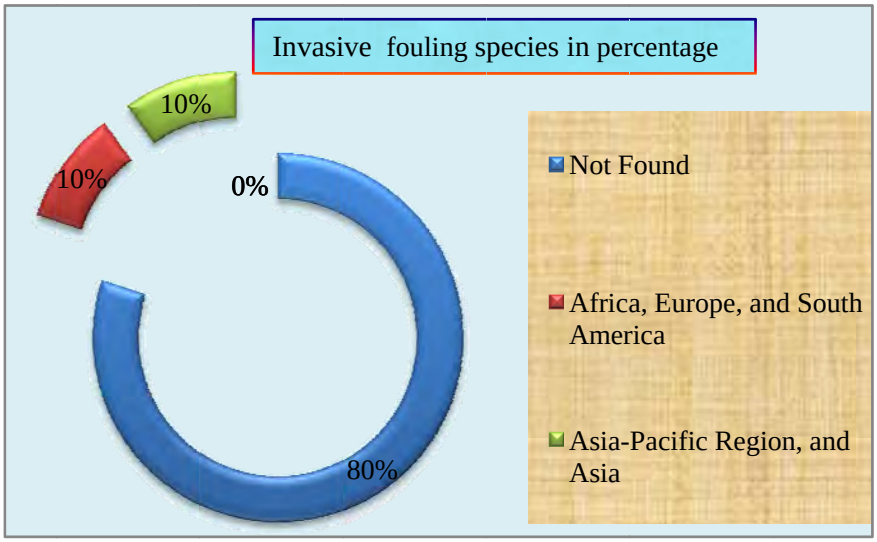

Fig. 4 Percentage of invasive alien species of marine fouling organisms, recorded.

4 Discussion

Several researchers have carried out marine fouling related studies along the southeast coast of India. Keasavan et al. (2009) reported the presence of four species of macro faunal foulers from Vellar estuary to Pondicherry. Similarly, 3 species of marine macro foulers were reported from the Pulicat lake, southeast coast of Tamilnadu (Mohan et al., 2013); 5 species of macrofaunal marine foulers were reported from the coast of Andhra Pradesh (Pati et al., 2011; Monolisga and Patterson, 2015; Darwin and Padmavathi, 2017). Marine fouling community was also surveyed in the Amazon estuary, Para, Northern Brazil by Chagas et al. (2018) reported that five groups with 37 species belonging to 20 families. Manila Bay in the Philippines encompasses 23 species of foulers belonging to 17 families (Trinidad et al., 2019). An alien invasive species of fouler, *Amphibalanus amphitrite* has been reported found Para state, North Brazil (Avila et al., 2018). *Hydroides spp*. has been reported as the most abundant alien invasive species from the Manila Bay (Vallejo et al., 2019). However, the marine fouling species recorded in the present study are relatively more in number than the previously reported studies (28). However, further studies are needed to understand the ecology and

community structure of the marine foulers to trace their interactions with the environment.

5 Conclusions

In the present study, 28 species of marine faunal foulers were recorded from seven sites along the southeast coast of India where *Balanus spp. and Perna spp.* were dominant. This study will be helpful to the policymakers, coastal developers, researchers, fishermen, sea-based industries and government authorities to curtain the marine foulers since the fouling communities pose many problems in the coastal developmental activities. This work will also be a useful to develop on marine faunal foulers to delineate the distribution pattern of the marine foulers in future due to the spatio-temporal variations.

Acknowledgements

Authors thank and acknowledge the Department of Science and Technology (DST), Ministry of Science and Technology, New Delhi for the financial support to carry out this work. They also thank the Director and Dean, CAS in Marine Biology, and the University authorities for their encouragement and support.

References

Bhadury P, Wright PC. 2004. Exploitation of marine algae: Biogenic compounds for potential antifouling applications. Planta, 219: 561-578

Cao S, Wang J, Chen H, Chen D 2011. Progress of marine biofouling and antifouling technologies. Chinese Science Bulletin, 56: 598-612

Ch D, Padmavathi P. 2017. Diversity of Malacofauna from the Paleru and Moosy backwaters of Prakasam district, Andhra Pradesh, India. Journal of Entomology and Zoology Studies, 5(4): 881-887

Das Chagas RA, Barros MRF, dos Santos WCR, Herrmann M. 2018. Composition of the biofouling community associated with oyster culture in an Amazon estuary, Pará State, North Brazil. Revista de Biología Marina y Oceanografía, 53(1): 9-17

District portals of Tamilnadu. 2019. http://tndistricts.nic.in

Eguia E, Trueba A. 2007. Application of marine biotechnology in the production of natural biocides for testing on environmentally innocuous antifouling coatings. Journal of Coatings Technology and Research, 4(2): 191-202

Enrique Ávila, Araujo-Leyva OR, Rodríguez-Santiago MA, López-Rosas H. 2018. Alien barnacle Amphibalanusamphitrite epizoic on two native oyster species in the southern Gulf of Mexico: spatio-temporal variability and current status of its epibiosis, Marine Biology Research (DOI: 10.1080/17451000.2018.1459723)

Global Invasive species database (GISD). 2019. http://issg.org/database/welcome/

International Union for Conservation of Nature and Natural Resources. 2019. IUCN Global Species Programme Red List Unit, Version (2019) 1

Iyapparaj P, Ramasubburayan R, Raman T, Das N, Kumar P, Palavesam A and Immanuel G (2012). Evidence for antifouling potentials of marine macroalgae *Sargassum wightii.* Advances in Natural and Applied Sciences, 6(2): 153-162

Jolkifli ZH, Wahab RH. 2018. Plate settlement: Determination of fouling organisms in Brunei. ASEAN Journal on Science and Technology for Development, 35(1-2): 11-16

Kesavan K, Babu A, Ravi V, Rajagopal S. 2009. A checklist of malacofauna from Pondicherry mangroves. AES Bioflux, 1(1): 31-36

Kesavan K, Palpandi C, Shanmugam A. 2009. A checklist of malacofauna of the Vellar Estuarine Mangroves, India. Journal of Threatened Taxa, 1(7): 382-384

Mahadevan G, Murugan A, Mahendran S, Gautaam K and Ravi V. 2013. Antifouling activity of the green seaweed *Ulva reticulate* and its epiphytic bacterial strains against marine biofilm bacteria. International Journal of Advanced Life Sciences, 6: 417-424

Melo LF, Bott TR. 1997. Biofouling in water systems. Experimental Thermal and Fluid Science, 14: 375-381

Mohan D, Elumalai V, Subbulakshmi G, Jayalakshmi S, Srinivasan M. 2013. Biodiversity of cultivable molluscan resources from Pulicat Lake, southeast coast of India. Arthropods, 2(2): 53-65

Monolisha S, Edward JK. 2015. Biodiversity of marine mollusc from selected locations of Andhra Pradesh coast, South Eastern India. Indian Journal of Geo-Marine Sciences, 44(6): 842-855

Ocampo MAB, Vallejo Jr BM. 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 SK, Rao V, Balaji M. 2011. Fouling communities of the static substrata in a tropical Indian harbour. Journal of the Marine Biological Association of India, 53(1): 81-88

Railkin AI, Zubakha MA. 2000. Primary settlement of *Mytilus edulis* larvae. Transactions of Biol. Nauchno-Issled. Inst. St. Petersburg State University, 46, 65

Simmons IG. 1966. Ecology and land use. Transactions of the Institute of British Geographers, 38: 59-72

Subba Rao NV. 2003. Indian Seashells (Part-I): Polyplacophora and Gastropoda. Records of Zoological Survey of India, Occ. Paper No. 192: i-x, 1-416. Kolkata, India

Tansley AG. 1920. The classifi cation of vegetation and concept of development. Journal of Ecology, 8: 118-49

Vallejo BM, Aloy AB, Ocampo M, Conejar-Espedido J, Manubag LM. 2019. Manila bay ecology and associated invasive species. In: Impacts of Invasive Species on Coastal Environments. 145-169, Springer