

Ecology of Marine Fouling Organisms in Karapad Creek, Tuticorin Bay, Southeast Coast of India

T K RENGANATHAN*, N BALAKRISHNAN NAIR & K DHARMARAJ

Department of Aquatic Biology & Fisheries, University of Kerala, Beach P.O., Trivandrum 695 007

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Settlement of marine fouling organisms at Karapad Creek in Tuticorin has been studied for 1 yr by exposing an array of test panels. Composition of the community and major groups of foulers are described. Nature of fouling assemblages over 3 series of test panels is recorded. Barnacles, sponges, bivalves and ascidians are the dominant fouling organisms of the area. Occurrence, relative abundance and periods of peak settlement of the major groups and, intensity of fouling during different months and for varying durations are determined. Interrelationships of different fouling organisms and the impact of environmental factors on fouling are briefly discussed.

Studies on fouling organisms have been carried out intensively in different parts of the world¹⁻⁵ and, in India work has been done on this aspect in different ports and harbours⁶⁻¹². Tuticorin (Gulf of Mannar, southeast coast of India) is rapidly developing as a major port. The Bay and nearby coastal waters offer great potentialities for mariculture and have long been used for the culture of edible and pearl oysters. Mariculture operations along our coasts are seriously affected on account of the interference of fouling organisms. Alagaraswamy and Chellam¹³ have reported mortality amongst pearl oysters under culture due to fouling. The problem of fouling organisms which interfere with mariculture, therefore, deserves attention. The present study has been undertaken with a view to obtaining detailed information on the ecology of fouling organisms with special reference to seasonal variations in settlement. This information may prove useful in devising methods, to minimise their interference with navigational operations in the port and with mariculture in the creek and coastal waters.

Materials and Methods

Observations were made by exposing glass panels (10 × 10 cm) with one smooth and one rough surface. Panels were suspended in water, in a wooden frame held in position at 1 m below low water mark, for the settlement of fouling organisms for 15 days to 12 months. Three series of tests as detailed below were carried out simultaneously from June 1977 to May 1978.

A-Series (short-term): Twenty four panels, each exposed in the beginning and replaced at the end of every fortnight, were examined. B-Series (long-term):

Panels were exposed in the beginning of each fortnight and withdrawn for examination simultaneously at the end of 12 months. C-Series (long-term): In the beginning, 24 panels were simultaneously exposed and were collected one by one during each fortnight for examination.

Data regarding the time of settlement of different groups of fouling organisms, growth rates in terms of total biomass of the community and, inter and intraspecific relationships were obtained by examining the fouled test panels. Overlapping of the 3 series made it possible to get a fairly accurate record of the fortnightly settlement of foulers and, the settlement for different periods and durations of the year. Biomass of the fouling complex including mud-tubes and trapped detritus was recorded for each panel. Fouling organisms were identified up to group level and in some cases to species level. The relative abundance of different groups was noted and numerical abundance was recorded whenever possible for selected genera and species. Surface water temperature and salinity were also recorded regularly.

Study Area

Panels were suspended in Karapad Creek situated in the shallow western part of Tuticorin Bay (lat. 8°47'10"N; long. 78°9'60"E). The creek is about 40 m broad at its mouth and has a depth of about 2.5 m during low tide. Length of the creek is about 3 km and it inundates low mangrove fringed slushy areas. The bottom is essentially muddy, although towards the sea it becomes a mixture of sand and mud. Tidal movement is swift and salinity remains almost identical to that of the Bay during most of the months. Runoff water from adjacent high areas empties into the creek during NE monsoon period (October to December) and causes slight salinity fluctuations for short periods.

*Department of Zoology, V.O.C. College, Tuticorin 628 003.

On either side of the creek are salt pans using large quantities of seawater for salt production.

Results

Surface water temperature ranged from 23.9 to 31.8°C and salinity fluctuated between 16.7 and 39.57‰ (Fig.1) during the period of observation. Extreme high values of salinity were due to admixture of concentrated seawater from nearby salt pans with the creek water. Salinity remained within 30 and 38‰ during majority of the months. Rainfall was high during October to December due to the NE monsoon. Maximum salinity (39.57‰) also occurred in October consequent on the overflow of concentrated brine from salt pans into the creek.

Fouling organisms—Nature and composition of fouling assemblages over the panels (200 cm²) and relative abundance of different fouling organisms are presented in Table 1. *Protostylissa foetida* is the only sponge that fouled the panels and, on most of the panels fouled by the sponge, a layer of algae and mud was seen over them. *Obelia gracilis*, *Campanularia* sp. and *Sertularia* sp. are the hydroids and *Sagartia* sp. is the sea anemone which appeared on the panels. Hydroids appeared more frequently on the short-term than on long-term panels and anemones were usually seen towards the edges of panels.

Serpulids and, errant and mud-tube dwelling forms represented the fouling polychaetes encountered. Calcareous tube dwelling polychaetes (serpulids) were poorly represented over A-series and, on B-series, occurrence of them was moderately common from the latter half of August to the first half of January and from March to May. Almost on all the panels of C-series, considerable fouling by serpulids was discernible. Errant polychaetes did not form any significant constituent of the fouling community, while

mud-tube dwelling polychaetes formed an important element.

Several species of free living crustaceans were seen among the fouling complex. These include isopods (*Sphaeroma walkeri* and *Cirolana bovina*), amphipods (*Corophium triaenonyx* and *Caprella* sp.), decapods, picnogonids and also copepods. Mud-tube dwelling amphipods were common during rainy season and a few months after that and, they accumulated considerable quantities of mud over the panels.

The most abundant and dominant of the fouling organisms is the cirripede, *Balanus amphitrite*. Almost all the panels examined during the study contained barnacles. In general, their settlement was more abundant over the rough surface than on the smooth surface, but, growth was rapid on the latter. Peak settlement of barnacles occurred in July and August. Over B-series, maximum number of barnacles was recorded on the panel submerged in the second fortnight of October, and thereafter the number slowly declined till February, and then a slight increase occurred from March onwards. Although the panels of C-series were immersed simultaneously and removed one by one at fortnightly intervals, maximum number of barnacles was noticed on the panels removed in July. All the panels registered dense fouling by barnacles, however, the number of barnacles on the panels examined in April and May was small. In both B and C-series, heavy mortality of barnacles was observed on the panels exposed for longer durations, possibly on account of overcrowding and intraspecific competition for space for further growth.

The only bivalve collected from short-term panels is *Musculista arcuatula* and it occurred in small numbers. *Anomia achaens*, *Crassostrea madrasensis*, *Modiolus carvolhoi*, *M. arcuatula* and *Venerupis* sp. settled on long-term panels. Fouling by bivalves was erratic on B-

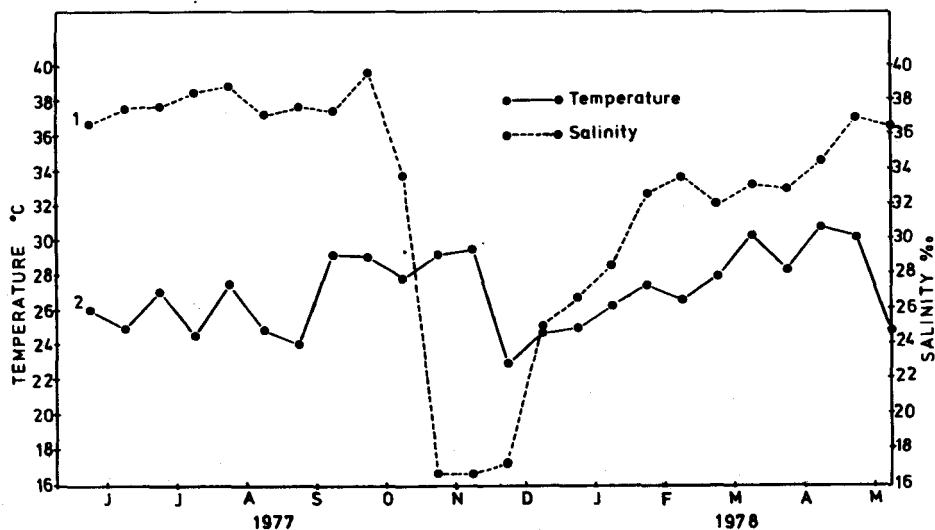


Fig. 1—Surface water temperature and salinity variations in the experimental site during the study period

Table 1—Settlement of Major Fouling Organisms on Panels of A-series (short-term), B-series (long-term) and C-series (long-term) during June 1977 to May 1978
[A = abundant; C = common; R = rare; — = absent; PL = panel lost]

Organism	1977						1978					
	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May
	A ₁ [*] A ₂ [*]	A ₁ A ₂	A ₁ A ₂	A ₁ A ₂	A ₁ A ₂	A ₁ A ₂	A ₁ A ₂	A ₁ A ₂	A ₁ A ₂	A ₁ A ₂	A ₁ A ₂	A ₁ A ₂
<i>Prostylyssa foetida</i>	—	—	—	—	—	—	—	—	—	—	—	—
Hydroids	A	—	—	—	—	—	—	—	—	—	—	—
<i>Sagarita</i> sp.	—	—	—	—	—	—	—	—	—	—	—	—
Serpulids	—	—	—	—	—	—	—	—	—	—	—	—
Errant polychaetes	—	—	—	—	—	—	—	—	—	—	—	—
Mud tube-dwelling Polychaetes	R	—	—	—	—	—	—	—	—	—	—	—
<i>Balanus amphitrite</i>	110	50	149	38	139	5	15	21	—	—	—	—
<i>Musculista arcuata</i>	—	—	—	—	—	—	—	—	—	—	—	—
<i>Didemnum psamathodes</i>	—	R	—	—	—	—	—	—	—	—	—	—
<i>Diplosoma macdonaldi</i>	—	R	C	R	—	—	—	—	—	—	—	—
<i>Symplegma viride</i>	—	—	R	—	—	—	—	—	—	—	—	—
	A	A	A	A	A	A	A	A	A	A	A	A
<i>Prostylyssa foetida</i>	—	—	—	—	—	—	—	—	—	—	—	—
Hydroids	7	10	5	11	PL	PL	PL	PL	PL	PL	PL	PL
<i>Sagarita</i> sp.	—	—	—	—	—	—	—	—	—	—	—	—
Serpulids	—	3	—	—	—	—	—	—	—	—	—	—
Errant polychaetes	R	R	R	R	R	R	R	R	R	R	R	R
Mud tube-dwelling polychaetes	—	R	—	—	—	—	—	—	—	—	—	—
<i>Balanus amphitrite</i>	87	128	71	63	PL	44	70	76	103	141	106	79
<i>Anomia achaens</i>	—	—	—	—	—	—	—	—	—	—	—	—
<i>Crasostrea madrasensis</i>	3	2	1	—	—	—	—	—	—	—	—	—
<i>Modiolus carvalhoi</i>	4	2	—	—	—	—	—	—	—	—	—	—
<i>Notirax</i> sp.	1	1	—	—	—	—	—	—	—	—	—	—

Contd

Table 1—Settlement of Major Fouling Organisms on Panels of A-series (short-term), B-series (long-term) and C-series (long-term) during June 1977 to May 1978—*Contd*

[A = abundant; C = common; R = rare; — = absent; PL = panel lost]

Organism	1977						1978					
	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May
	A ₁ [*]	A ₁ [*]	A ₂	A ₁	A ₂	A ₁	A ₂	A ₁	A ₂	A ₁	A ₂	A ₁
<i>Prostylyssa foetida</i>	—	—	—	—	—	—	—	—	—	—	—	—
<i>Sagartia</i> sp.	—	—	—	—	—	—	—	—	—	—	—	—
<i>Serpulids</i>	—	—	—	—	—	—	—	—	—	—	—	—
<i>Errant poly-chaetes</i>	—	—	—	—	—	—	—	—	—	—	—	—
<i>Mud tube-dwelling polychaetes</i>	R	R	R	R	R	R	R	R	R	R	R	R
<i>Balanus amphitrite</i>	110	301	405	382	270	324	300	352	315	329	289	236
<i>Anomia achaens</i>	—	—	—	—	—	—	—	—	—	—	—	—
<i>Crassostrea madrasensis</i>	—	—	—	—	—	—	—	—	—	—	—	—
<i>Modiolus carvalhoi</i>	—	1	2	6	3	5	8	12	4	5	17	8
<i>Musculista arcuata</i>	—	—	—	—	—	—	—	—	—	—	—	—
<i>Notirax</i> sp.	—	—	—	—	—	—	—	—	—	—	—	—
<i>Venerupis</i> sp.	—	—	—	—	—	—	—	—	—	—	—	—
<i>Didemnum psamathodes</i>	—	—	—	—	—	—	—	—	—	—	—	—
<i>Diplosoma macdonaldi</i>	—	—	—	—	—	—	—	—	—	—	—	—
<i>Lissoclinum fragile</i>	—	—	—	—	—	—	—	—	—	—	—	—
<i>Styela bicolor</i>	—	—	—	—	—	—	—	—	—	—	—	—
<i>Sympyga viride</i>	—	—	—	—	—	—	—	—	—	—	—	—

*A₁ and A₂ refer to panels submerged during the 1st fortnight and 2nd fortnight respectively

series panels. Over C-series also, settlement of *A. achaens* and *C. madrasensis* was sporadic, while, *M. carvolhoi* and *M. arcuatula* appeared in fair numbers, the former throughout the year and the latter from July to December. Maximum settlement of *M. carvolhoi* occurred in November and that of *M. arcuatula* on the panels examined during August and September. *Notiras* sp. appeared on all the panels of C-series, except on those removed during June and April.

Didemnum psamathodes, *Diplosoma macdonaldi*, *Lissoclinum fragile* and *Symplegma viride* are the colonial ascidians and *Styela bicolor* is the simple ascidian noticed on the panels. On A-series panels, *D. psamathodes*, *D. macdonaldi* and *S. viride* appeared sporadically up to October and they did not settle on any of the panels submerged from November to May. Fouling by ascidians was discernible up to November over C-series also, and B-series panels did not show any evidence of fouling by ascidians. Eggs and larvae were noticed in the colonies of *D. macdonaldi* from July to October on both A and C-series panels, indicating that this ascidian attains sexual maturity in less than a fortnight after settlement. The simple ascidian *S. bicolor*, settled abundantly on the panels of C-series examined during August and September and, panels of the other two series were not fouled by this ascidian. At times, ascidians were found to cover more than half of the surface area of test panels.

Biomass of fouling—Total weight of fouling settlement and growth, on each of the panels, is given in Fig. 2. Test panels of A-series showed that the biomass was comparatively light from June to October, heavy

from November to February and, again light during the rest of the study period. Maximum accumulation occurred in January despite the poor settlement of barnacles (in terms of numbers) during the month. Probably, this was due to the luxuriant growth of hydroids, dense settlement of sea anemones and comparatively larger sized barnacles noticed during the month. No clear pattern was evident on the variations of fouling biomass over B-series panels. However, the test panels initially exposed in June and October were almost equally fouled, while, those exposed from July to the first half of September showed poor biomass accumulations. On C-series, maximum biomass was noted during February, and then it declined although the panels continued to receive further settlement, indicating that the fouling community of the area reaches its climax in about 9 months (June to February) over the substrata initially exposed in June.

Discussion

The results indicate the seasonality in the settlement of fouling animals and some interrelationships of different groups of organisms represented in the community. Barnacles and sponges are the most abundant representatives of the community in Karapad Creek and, anemones, hydroids, polychaetes, bivalves and ascidians also constituted considerable portions of the community. Bryozoans and serpulids reported to be abundant in some other localities along the coasts of India¹²⁻¹⁵ were not of much importance here. The poor representation of bryozoans was

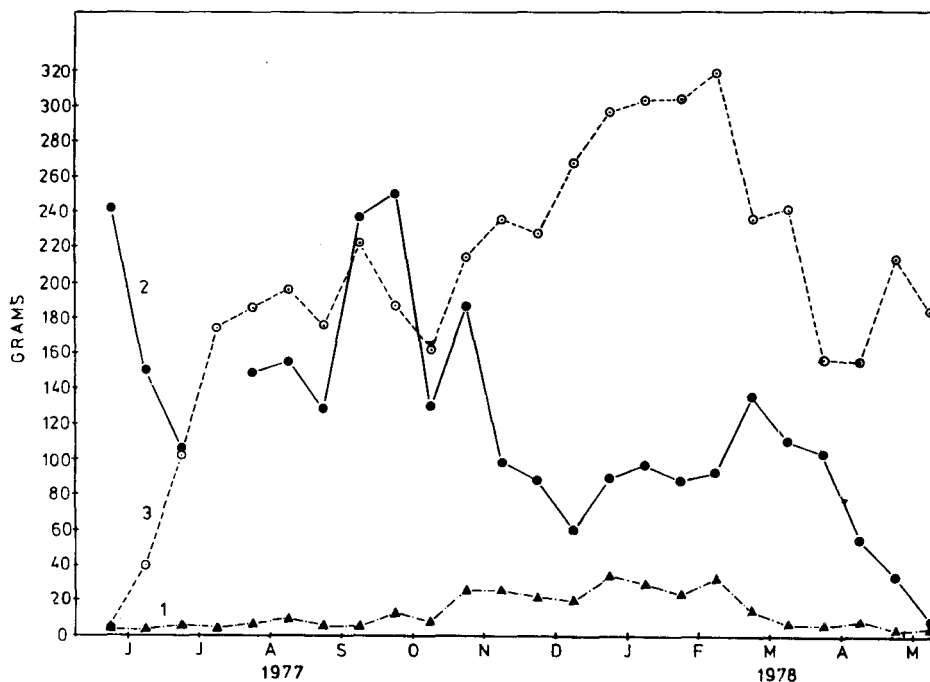


Fig. 2—Biomass of fouling accumulations over the panels of (1) A-series, (2) B-series and (3) C-series

probably due to heavy silt load and high rate of sedimentation in the creek water especially during rainy season and, dense settlement of encrusting sponges.

When sponges are abundant, they were found to inhibit the settlement of other major fouling animals by covering the substrata almost completely. Consequently, abundance of sponges led to a reduction in the total biomass of the fouling complex. Goodbody¹⁶ also reported that initial settlement of sponges inhibits the settlement of other fouling organisms. However, sponges entangle diatoms, algae and detrital matter. A few varieties of algae were reported from the fouling assemblages of wooden piles in the creek¹⁷. In the present study, no attention was paid to algal components of the community.

Breeding season and availability of the larvae of fouling animals largely determine the period and duration of their settlement in any locality. But, this aspect pertaining to many of the fouling animals of Karapad Creek is least known and remains to be investigated in detail. Local hydrographical factors play a significant role in regulating the period of settlement and abundance of fouling and timber boring animals¹⁸. Abnormal high salinity of the creek water during certain months has altered the nature of fouling accumulations in the study site from that in the Tuticorin Bay. Poor occurrence of serpulids and other polychaetes may also be due to the abnormally high salinity owing to the nearness of salt pans.

In the present investigation, peak settlement of barnacles was recorded during July-August. Ganapati *et al.*⁸ reported April-May as the peak period of barnacle settlement in Visakhapatnam harbour, while, Antony Raja⁶ could not observe any period of intense settlement in Madras harbour. The *Balanus amphitrite* group of barnacles contains several varieties in Indian waters¹⁹. These varieties may have different breeding seasons governed by local hydrographical characteristics. Therefore, since the identity of different varieties from various regions is not known, a comparison of the results from different regions may not be reliable. The heavy mortality of barnacles noticed on B and C-series panels could be attributed to severe intra and interspecific competition for space, the latter mainly with ascidians and sponges. Over B-series, there was more settlement of barnacles on the panels exposed in October than on the earlier ones. This was due to the

result of lesser settlement of sponges during October than on the panels exposed earlier. Predation by turbellarians, gastropods and fishes would also have led to large scale mortality of barnacles. Absence of the settlement of ascidians in the latter half of the study period seems to be due to some local environmental factors which prevent the settlement of their larvae.

It is indicated that the settlement of fouling animals over artificially submerged substrata is continuous throughout the year in Karapad Creek with varying intensities and dominance of some groups during certain months. This largely determines the nature of fouling community for the respective period of immersion.

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