

Larvae of fouling organisms and macrofouling at New Mangalore Port, west coast of India

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Polychaetes, bryozoans, barnacles and ascidians were the dominant groups in the fouling community at New Mangalore Port. Polychaete and cirripede larvae were encountered throughout the year. Even though bivalve larvae were present in the planktonic hauls throughout the year, their representation in the macrofouling community was not prominent and yielded a poor correlation with recruitment. Bryozoan and ascidian larvae were sparsely encountered but indicated a significant correlation with their recruitment in macrofouling community.

Macrofouling studies in Indian waters have been on the process of community development, independent of observations on the distribution of the larvae of the sedentary species in a given environment¹⁻⁴. Dispersal of marine fouling organisms occurs by the drift of planktonic larvae⁵ and anthropogenic activities of man such as shipping and transportation⁶⁻⁸. Prevalence of larvae is one of the important requirements for macrofouling community development. The duration of pelagic life of the larvae of marine sessile invertebrates as well as their settlement depend on the environmental factors⁹⁻¹¹. The objective of the present work was to ascertain if there existed any correlation between the prevalence of larvae of the sessile organisms and their concurrent appearance on the test panels.

Materials and Methods

Two stations namely, oil jetty (st. 1) and ore jetty (st. 2) were selected at New Mangalore Port (12°56'N; 74°48'E) for the present study. Monthly observations (March 1992-March 1993) on hydrographic parameters were carried out by standard procedures. Vertical haul of Heron Tranter plankton net (100 µm mesh size; mouth area of 0.25 m²) was made at sts 1 and 2 once every month for sampling zooplankton. Macrofouling community development over aluminium test panels (15 × 10 cm) was also observed every month. The panels were exposed to the environment at both stations. The retrieved panels were fixed with 5% formalin and major fouling organisms were enumerated in the laboratory. In order to understand the relationship between the abundance of larvae and its representation in

macrofouling community, regression analysis of the prevalence of larvae and the composition of its adult population in the macrofouling community was carried out with log (X + 1) transformation of the data.

Results and Discussion

Environmental parameters such as water temperature, salinity, dissolved oxygen, pH, chlorophyll-*a* and suspended load were monitored at monthly intervals. During the study period no major fluctuations in any of the environmental parameters studied was observed (Table 1).

Barnes¹² stated that in boreal regions the fouling community varies considerably according to the season of substrate immersion. In tropical regions it is largely non-seasonal though some influence of fresh water runoff arising from monsoon conditions is evident. At New Mangalore Port no large variations in the environmental parameters were observed. Salinity data indicated the existence of marine conditions throughout the year. Fouling in this area therefore is expected to be free from the influence of fluctuating salinity if any.

Variation in the larval population of each of five groups of fouling organisms namely polychaetes, bryozoans, cirripedes, bivalves and ascidians was studied. The data on the prevalence of the larvae of polychaetes, bryozoans (cyphonautes), bivalves (veliger and pediveliger), cirripedes (nauplii and cyprids) and ascidians (tadpole) during different months of the year as well as the observations on the corresponding adult settlement on aluminium panels are summarised in Table 2. The polychaete larvae

Table 1—Monthly variations in the environmental parameters

Parameters	1992										1993		
	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March
Oil Jetty													
Temp. (°C)	27.25	28.00	29.00	30.00	24.00	21.50	21.60	25.75	27.00	25.00	24.00	26.25	26.00
Sal. ($\times 10^{-3}$)	34.85	34.99	34.86	34.57	36.05	32.74	35.02	34.10	34.31	35.58	34.60	36.09	36.64
Diss. O ₂ (ml. l ⁻¹)	3.92	3.75	3.89	4.12	4.11	3.08	2.78	3.02	2.61	3.94	4.24	4.23	4.09
pH	7.50	7.80	7.90	7.75	7.90	8.05	7.95	8.15	8.15	8.40	8.05	8.10	8.30
Susp. load (mg. l ⁻¹)	0.39	0.05	0.14	0.13	0.04	0.04	0.03	0.04	0.03	0.03	0.04	0.03	0.04
Ore Jetty													
Temp. (°C)	28.00	28.00	29.00	30.50	23.75	21.15	21.15	26.00	26.40	25.00	23.75	25.75	25.25
Sal. ($\times 10^{-3}$)	34.07	35.00	35.38	33.46	34.32	32.62	35.15	36.10	34.91	36.49	34.43	35.34	34.44
Diss. O ₂ (ml. l ⁻¹)	3.59	3.88	3.55	3.15	2.46	3.03	2.87	2.96	1.43	3.30	3.88	4.38	3.69
pH	7.60	7.95	7.90	7.90	8.00	8.05	7.75	8.15	8.05	8.45	8.10	8.15	8.25
Susp. load (mg. l ⁻¹)	0.39	0.04	0.05	0.12	0.05	0.03	0.04	0.04	0.04	0.03	0.04	0.04	0.24

Table 2—Monthly variations in larvae of fouling organisms and settlement on the panels

Parameters	1992										1993			
	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	
Oil Jetty														
Polychaete larvae (no. m ⁻³)		215	176	73	13	110	72	116	5	18	12	4	4	4
Polychaete settlement (no. m ⁻²)		1495	1824	51967	466	—	8094	99	92585	480	13020	2400	1044	13628
Bryozoan larvae (no. m ⁻³)		6	1	—	—	—	—	—	—	—	—	—	1	1
Bryozoan settlement (% cover)		0.36	0.03	—	0.06	—	0.04	0.01	0.35	0.22	4.26	6.10	17.81	10.52
Bivalve larvae (no. m ⁻³)		282	262	248	230	306	90	119	527	2063	332	37	47	54
Bivalve settlement (no. m ⁻²)		251	217	—	17	—	2276	36	440	2563	652	361	698	495
Cirripede larvae (no. m ⁻³)		98	76	65	59	314	367	992	302	86	479	128	108	353
Cirripede settlement (no. m ⁻²)		6806	55	1380	112	13591	20078	36784	3224	15183	31495	2827	11156	2524
Ascidian larvae (no. m ⁻³)		1	3	2	9	—	—	—	—	—	—	—	—	7
Ascidian settlement (% cover)		24.70	53.45	68.69	0.14	—	—	—	—	—	0.10	2.00	32.25	42.99
Ore jetty														
Polychaete larvae (no. m ⁻³)		18	60	83	78	262	19	18	10	9	17	29	33	8
Polychaete settlement (no. m ⁻²)		2435	3664	58446	3759	469	26066	956	93426	845	20581	5558	1074	25123
Bryozoan larvae (no. m ⁻³)		3	—	1	—	—	—	—	—	—	—	11	4	1
Bryozoan settlement (% cover)		12.17	—	0.26	0.32	1.45	—	—	0.01	0.01	0.04	27.24	8.82	15.96
Bivalve larvae (no. m ⁻³)		78	254	238	259	235	100	80	239	1724	565	44	143	43
Bivalve settlement (no. m ⁻²)		74	974	—	—	74	917	104	492	1191	77	56	1195	212
Cirripede larvae (no. m ⁻³)		117	83	25	75	131	128	210	55	47	257	93	143	184
Cirripede settlement (no. m ⁻²)		6107	43	3068	4336	40626	33878	53708	32016	50954	28835	5503	10089	3368
Ascidian larvae (no. m ⁻³)		1	1	1	—	—	—	—	—	—	—	—	—	—
Ascidian settlement (% cover)		30.78	41.27	12.70	3.31	1.09	—	—	—	—	—	0.47	—	22.86

— = Not present

were present in abundance from March to September '92 (abundant in March, April at st. 1 and July at st. 2). Their settlement on the panels however, was notable during May, August and October. This shows that high incidence of polychaete larvae did not coincide with their higher participation in the macrofouling

community. The incidence of polychaete larvae and their settlement on panels indicated the year-round breeding activity of these organisms. Tube dwelling polychaetes were found to have higher covering capacity than barnacles^{13,14}. A delayed appearance in the macrofouling community, therefore suggests

that their larval life could be longer than that of barnacles.

Bryozoan settlement was almost negligible during the monsoon months. The incidence of bryozoan larvae was found to be generally poor and during the monsoon (June-September) and postmonsoon (October-January) season particularly they were not encountered in planktonic samples. The recruitment of bryozoans to the macrofouling community in terms of percent cover was high during December to March 1993. Scheltema & Carlton¹⁵ noted that certain bryozoans belonging to cheilostomatous genera (*Membranipora*, *Electra*, *Conopeum*) have planktotrophic larvae that remain planktonic for several weeks. The information available on the life history of the bryozoan larvae in Mangalore waters is scanty. Hence correlating the bryozoan settlement with the abundance of their larvae will require more understanding of their developmental biology.

The bivalve larvae (no. m^{-3}) in the planktonic hauls were present throughout the year. They were abundant during November at both st. 1 (2063) and st. 2 (1724). Their representation, however in macrofouling community was poor ($r = 0.049$; $P = \leq 0.1$) (Table 3). This can be attributed to i) transportation of larvae to distant places, ii) lower succession capability when compared to other fouling organisms and iii) substratum preference. Menon *et al.*¹ observed that settlement of oysters at Mangalore Port, was well spaced on short term panels (7 days). This pattern was not exhibited on the long term panels. This possibly indicates their poorer capability to compete for space in the macrofouling community at this locality over aluminium panels.

Balanus amphitrite was the dominant sessile barnacle species in the macrofouling community. The occurrence of cirripede nauplii was sparse whereas the cyprid larvae were present regularly in all the collection. Barnacle settlement was intense during July-December '92 months. Variations in larval abundance as well as the recruitment was found to follow a similar trend.

The ascidian tadpole larvae (no. m^{-3}) whose prevalence was found to be generally poor (maximum 9) occurred only during premonsoon (February-May) with an exception in June 1992 (st. 1). Settlement of ascidians occurred during March-May, and January-March '93. The presence of ascidians in the fouling community at Mangalore Port was not reported in the investigation carried out prior to the commissioning of the harbour by Menon *et al.*¹. Presently the ascidians are one of the dominant forms in macrofouling community during premonsoon (February-May) and late postmonsoon (December-January) months. The ascidians have short larval life cycle lasting only a few hours¹⁵ and this could be one of the reasons for their rare occurrence in plankton collections. Ascidian larvae were not encountered during monsoon (June-September) and early postmonsoon (October-November) months. The sudden appearance of ascidians in the macrofouling community during late postmonsoon (December-January) and premonsoon (March-May) may be due to their ability to undergo dedifferentiation and redifferentiation¹⁶. The ascidians dedifferentiate and form a clump of cells within a small ectodermal bag and when favourable conditions set in, the cells rebuild the tissues and redifferentiate into an adult ascidian.

The results of the regression analysis between the incidence of planktonic larvae of fouling organisms and their respective sessile forms participating concurrently in macrofouling community revealed a statistically significant correlation in case of bryozoa, cirripedes and ascidians. This preliminary study suggests that the variations in larval abundances is a likely factor that plays an important role in the development of macrofouling community at New Mangalore Port. The influence of other factors such as breeding, larval life periods, dispersal and succession capabilities of the fouling organisms should also be of much consequence which needs further investigations.

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Table 3—Regression analysis between the abundance of the larvae of fouling organisms and the recruitment observed on panels

Organism	Correlation coefficient	P
Polychaetes	0.44	≥ 0.1
Bryozoans	0.65	≥ 0.01
Cirripedes	0.54	≥ 0.05
Bivalves	0.049	≤ 0.1
Ascidians	0.63	≥ 0.02

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