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CHAPTER 6

FOULING COMMUNITIES OF THE SEYCHELLES ISLANDS

BY

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INTRODUCTION

The phenomenon of fouling is formost among the problems presented by the deterioration of man-made objects in the sea (Reznichenko et al. 1976). The Seychelles are subjected to fouling as in other tropical coastal areas; however, to date no investigation of fouling on hydrotechnical constructions (HTC) and inter-island trade vessels (ITV) has been undertaken for the region. The fouling of an ocean-going vessel during its passage from this region to the coast of Vietnam was studied by Zvyagintsev and Mikhailov (1985).

Manmade objects near Farquhar, Aldabra, Desroches, Praslin and Mahé Islands were surveyed. A major part of the material was collected in Victoria Harbor (Mahé Island). The study focused on algal fouling communities and included the following:

1) Identification of fouling algal flora which considerably expands the list of algae for this region.
2) Comparison of the lists of fouling and epiphyton species to determine the role of epiphyton as a potential source of foulers for artificial substrata.
3) Identification of fouling species to forecast fouling in different habitats.
4) Knowledge of common algal and animal fouling species also may be useful in cultivating these species on anthropogenic substrata.

The rate of fouling on cleaned verses fouled surfaces of vessel hulls was compared to determine the efficiency of underwater cleaning in tropical waters. Observations were made on survival of the algae introduced from boreal waters.

METHODS AND MATERIALS

During the expedition 6 ITVs, 7 HTCs and the underwater surface foulings on the hull of the R/V Akademik A. Nesmeyanov were surveyed. Eighty quantitative and 14 qualitative samples were taken and analyzed in the laboratory by the methods of Zadin (1969). Five 1 m^2 experimental quadrats were cleaned at various depths below the waterline, according to the techniques given in Litvin et al. (1979). Quantitative samples (wet wt) were taken every 15 days from 0.04 m^2 of fouled (control) and cleaned surfaces simultaneously. Samples were collected using SCUBA diving in a manner similar to that of Zvyagintsev and Mikhailov (1980) and Kashin (1982).

Algae were identified to species when possible, invertebrates were generally identified to higher

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taxonomic units. A comparison of the qualitative composition of the flora of fouling and epiphyton was made using cluster analysis (Andreev 1980). Samples of the common species of fouling algae were given to specialists of the expedition's Biochemistry and Physiology groups for further research.

RESULTS

Farquhar Island

A submerged vessel at the southeastern bank was examined under conditions of strong wave activity. The sea bottom was flat with the brown alga *Sargassum* growing on the surrounding dead coral substratum. The vessel had rested on the 0-4 m deep bottom since 1975. The entire hull was covered with a layer of powdery corrosion about 3 mm thick.

A community of 8 algal and 13 animal species was found on the vessel's hull below the waterline (Table 1). The community biomass consisted of 95.5% algae (1721 $g \cdot m^{-2}$ at the waterline). Two algal species, *Jania ungulata* and *Struvea anastomosans*, dominated the biomass (57 and 38% of the total biomass, respectively) and *Ulva rigida* was a common species (3%). In spite of high species richness, the total faunistic biomass was very low (0.5%). Motile forms such as crustaceans and molluscs predominated. Maximal population density was 2000 $individuals \cdot m^{-2}$. Representatives of other groups were found as single individuals or in the qualitative samples. The same community with approximately half the total biomass was found at the 2 m depth. At a depth of 4 m, *Sargassum ilicifolium* became the predominant species (91% of the total wet biomass, 5228 $g \cdot m^{-2}$) fouling the horizontal steel surfaces of the hull. Subdominants included the same algal species as above with fewer motile animals.

Aldabra Island

A navigational buoy with a chain installed above 20 m was studied. The underwater surface of the buoy was free of fouling, probably because of an antifouling coating. The steel chain was fouled from 0 to 15 m in depth and no foulings occurred deeper. The species included 21 algae but only *Ulva rigida* provided appreciable biomass (Table 2). Red algae were responsible for most of the diversity with the maximum numbers of species at 1 m in depth. Among the six animal species. The cirripedia *Lepas anatifera* strongly dominated the biomass, while other species occurred rarely. Communities of *L. anatifera* and *U. rigida* occurred with alternating predominances from 0 to 15 m in depth while the total biomass gradually decreased with increasing depth.

Desroches Island

A navigational buoy at a yacht mooring was examined over a 3 m depth range. The underwater parts of the steel surface had no protective coating and were corroded. The buoy surface was completely covered by algal foulings, which included 31 species with red algae predominating (Table 3). *Enteromorpha* and *Polysiphonia* accounted for most of the total biomass (420 and 380 $g \cdot m^{-2}$, respectively), other algae were sparse. Among the 10 animal species, *Lepas anatifera* was responsible for 99% of the total biomass (670 $g \cdot m^{-2}$, at a population density of 1100 $individuals \cdot m^{-2}$). Algal growths were inhabited by many crustaceans, molluscs and polychaetes. No macrofouling was found on the line connecting the buoy to its anchor.

Praslin Island

A concrete pier at a depth to 2 m was surveyed. Its fouling community contained 20 algal and 18 animal species (Table 4). Red algae were the most diverse in the community, with *Peyssonnelia sp.* contributing the most biomass (22.5 g·m^{-2}). Faunistically, the barnacle *Tetraclita squamosa* dominated (up to 5250 g·m^{-2}), with sponges and actinians occurring as subdominants. Biomass of motile crustaceans and gastropods did not exceed 2 g·m^{-2}. Qualitative samples contained scleractinian corals of the genera *Acropora*, *Favia* and *Pocillopora*. There was a difference in the quantitative samples taken from the pier's protected side compared with the side exposed to wave action, whereas the biomass sharply increased. Fouling decreased with increasing depth.

Victoria Harbor

Two navigational buoys with chains, a pier with steel constructions and 6 different ITVs were studied. An inlet buoy installed near Cerf Island, anchored at a depth of 15 m contained a fouling community that included 13 algal species (9 red algae) and 21 animal species (Table 5). Brown algae (2500 g·m^{-2}) were responsible for the bulk of total biomass from 0-1 m in depth, while the total biomass of red algae did not exceed 1 g·m^{-2}. From 1 m depth and deeper along the entire chain length, a community of the barnacle *Megabalanus tintinnabulum* developed, with a biomass ranging from 9100 to 19200 g·m^{-2} and a maximal population density of 3360 individuals·m^{-2}. The pearl oyster *Pinctada margaritifera* occurred most frequently among the 4 other bivalve molluscs with a biomass of 16400 g·m^{-2} at 2 m in depth. Subdominants included *Ascidia* colonies, whose biomass increased with depth. Maximal population densities of motile animals (4300 individuals·m^{-2} for amphipods) was recorded on the buoy within the stands of brown algae.

A mooring buoy (300 m from the pier) had only 2 algal fouling species with *Feldmania breviarticulata* dominating (460 g·m^{-2}). Species were similar to those of the inlet buoy but with a different quantitative composition (Table 6). The buoy chain was fouled along its entire length by the oyster *Ostrea sp.* with a biomass of up to 15200 g·m^{-2} at 10 m in depth. The cirripedia *Megabalanus tintinnabulum* dominated between 5-10 m in depth. In shallow waters *M. tintinnabulum* was replaced by *Balanus reticulatus*. Ascidians, crustaceans and polychaetes also occurred in great numbers. The pearl oyster was found only in the qualitative samples.

Algae did not occur in the fouling communities on steel constructions characterized by powdery corrosion. Instead, oyster communities predominated with up to 26 kg wet wt·m^{-2} and decreased with increasing depth. In comparison with the community of the buoy, the species of both attached and motile forms decreased (Table 7). Sediments of organic origin were abundant in all samples.

The fouling communities of a barge (inactive suction dredger) were similar to those of the pier (Table 8). At the level of the waterline (1 m), there were 4 algal species with *Feldmania breviarticulata* predominating (620 g·m^{-2}). The fauna included 19 species, the small barnacle *Balanus reticulatus* predominated at the waterline, and deeper it was replaced by the oyster *Ostrea sp.* (up to 4800 g·m^{-2}, 2000 individuals·m^{-2}). These two species comprised the bulk of the total biomass in this community. Motile forms occurred rarely and only in the qualitative samples.

Macrofoulings were not found on the four operational vessels examined. Only a self-propelled hull supported a mixed community of the small cirripedia *Balanus reticulatus*, biomass not exceeding 26 g·m^{-2} at the highest population density of 4200 individuals·m^{-2}. At the waterline, the green alga *Enteromorpha clathrata* dominated (biomass of 145 g·m^{-2}) and no algae were found deeper (Table 9).

During five consecutive surveys, a succession of fouling communities was observed on the hull of the R/V Akademik A. Nesmeyanov. On 12 January 1989 at Cöetivy Island, the fouling community was represented by two algal species: *Enteromorpha linza* and *Cladophora laetevirens*. After two weeks, at the same average biomass of algae, the cirripedia *Lepas anatifera* settled with a population density which was about three times higher than on the cleaned experimental surfaces (Table 10). Quantitative sampling revealed many motile crustaceans in the *Enteromorpha* beds. After transit to Mombasa (Kenya), a sharp decrease of *L. anatifera* was observed concurrent with a 2-fold increase in the biomass of *Enteromorpha*. On 23 January 1989 in Victoria Harbor, a decline in abundance of *Enteromorpha* occurred and the remaining plants showed morphological anomalies. The last observation on 14 March 1989 revealed that the normal thallus morphology and biomass of *Enteromorpha* was completely restored.

Fouling communities during the study provided 65 algal species (about 25% of the total algal species in the natural benthos) and 36 animal taxa. Maximum species diversity was represented by the red algae (47 species). The marine flora of the Seychelles was supplemented by some species found only on substrata of anthropogenic origin.

DISCUSSION

It is difficult to compare data of different authors who study sedentary organisms on various substrata. The use of the term "fouling" for communities of organisms inhabiting solid substrata of different origins is being widely discussed in the Soviet literature (e.g., Reznichenko et al. 1976, Protasov 1982, Seravin et al. 1985, Galtsova et al. 1985). As a rule, most authors deal with solid non-living substrata of either artificial or natural origin. However, they avoid analysis of attached communities on living substrata (algal thalli, stems and leaves of seagrasses, valves and shells of molluscs), although the question of epiphytism needs resolution. Zernov (1934) suggested two different Russian terms: "narost" for living and "obrost" for non-living substrata, but these terms have not been generally accepted. A majority of works, devoted to communities of epibionts and borers of molluscan valves use the term "fouling." Those who study communities growing on macrophytes are more consistent. Some authors usually avoid the term "fouling" and use the more neutral terms "community" (Zavodnik 1967) or simple "peuplement" (Bellan-Santini 1964). More often, they use terms with the prefix "epi-": "epiphyton" (Makkaveeva 1979), "invertebrate epiphytes" (Hayward 1980) and "algal epifaunas" (Seed and O'Connor 1981). Reznichenko and coauthors (1976) regard all anthropogenic substrata submerged in the sea as special, differing markedly from the natural benthic and pelagic substrata. These authors believe that anthropogenic substrata with a total area greater than 2000 m^2 often produce a critical effect on surrounding populations and play a role in subsequent changes of all communities. This approach makes it reasonable to distinguish an independent human-induced zone, along with the zones mentioned above.

The present studies of fouling and epiphyton communities of the Seychelles Islands resulted in substantiation of the independent nature of the anthropal zone. Since the material was collected from different zones simultaneously using consistent methods, it is possible to compare the results. The degree of similarity of algal lists on different substrata was estimated using the coefficient of Serensen-Chekanovsky. A dendrogram of similarity based on the data represents a hierarchy of all possible groups of objects (Figure 1). The dendrogram shows that the objects at the level of 35% similarity can be divided into two groups: algae of epiphyton (to the left) and algae of anthropogenic substrata. It appears that substrata are united into types irrespective of the sampling area. Accordingly, the level of similarity of epiphyton algae from different areas is higher than that for fouling and epiphyton algae of the same area. The only exception is made by the species list of epiphyton algae for Mahé and Cerf Islands (object No. 10), which are separated into a special branch, probably explained by anthropogenic influences on the water of Victoria Harbor and also by the absence of *Thalassodendron ciliatum*, the usual substratum for the epiphyton on other islands.

Similar estimates of fouling and benthos similarity were made for the coastal waters of Vietnam and resulted in the same result; however the similarity of intertidal and fouling species was even lower (about 10%). Thus, the data form the basis for distinguishing anthropal substrata as an independent zone. Based on the peculiarity of communities of sessile organisms inhabiting living substrata, it would be reasonable to accept the phytocoenological term "epibioses" and "epiphyton" for plant substrata. Such a division would permit a strict discrimination of the terms "benthos" and "fouling" and eliminate their possible use as synonyms.

In spite of their qualitative diversity, fouling algae did not develop high biomass on the substrata studied. A submerged vessel near Farquhar Island represents an exception: the *Sargassum ilicifolium* biomass on its horizontal surface reached 5 $kg \cdot m^{-2}$. However, this value was also relatively low compared with the biomass of brown algal foulings recorded for boreal waters. Algal foulings with high species diversity and small biomass were characteristic of small oceanic islands (Farquhar, Aldabra, Desroches). Attached animals were represented only by *Lepas anatifera*. Similar fouling communities of the oceanic type are characteristic of long-voyage vessels and the various artificial objects drifting in open oceanic waters.

The fouling community on a pier situated in an enclosed bay on Praslin Island included approximately equal numbers of algal and animal species with a predominance of the cirripedia *Tetraclita squamosa*. The waters of Victoria Bay are subjected to considerable anthropogenic influence. Towards the inner bay, algae in fouling communities decreased in species number and were absent on steel constructions. Cirripedia and bivalves were the main components of foulings in the port, with maximum biomass of 26 $kg \cdot m^{-2}$ on pier constructions. Fouling communities on hydrotechnical constructions in Victoria Bay were dominated by the same species of bivalve molluscs (pinctads, oysters, pterias and the barnacle *Megabalanus tintinnabulum*) that were found on VIETSOVPETRO platforms in the South China Sea (Zvyagintsev, in press).

The majority of ITV's examined appeared to be unfouled, due probably to being covered with anti-fouling paints. The dominant species *Balanus reticulatus* on fouled vessels produced a mean biomass of about 26 $g \cdot m^{-2}$; these were small individuals (3 mm diameter at the shell base) and apparently did not cause enough increase in hydrodynamic resistance to critically slow vessel speed.

An analysis of the foulings on previously cleaned and untreated underwater hull surfaces of the R/V Akademik A. Nesmeyanov showed that within two weeks, cleaned quadrats were more extensively fouled than untreated control surfaces (Table 10). Further succession of fouling communities on both areas was similar. Thus, cleaning of underwater surfaces does not appear to be universally effective in tropical waters, but most likely promotes the rapid development of newly settled fouling organisms.

The massive development of some commercially valuable species in the fouling communities of vessels and hydrotechnical constructions can be considered as prospects for cultivation. To provide recommendations for the cultivation of attached forms, different anthropogenic substrata should be tested experimentally. Such experiments would be time-consuming and expensive. Fouling of a variety of anthropogenic substrata - vessels, piers, buoys, - represent natural experiments. Every object can be regarded as an "experimental plate" and the results of observations are useful for developing practical recommendations. Accordingly, our investigation of the composition and distribution of fouling organisms on hydrotechnical constructions in the Seychelles did not reveal promising prospects for the cultivation of bivalve molluscs for the majority of the study areas. Only in Victoria Harbor were bivalve molluscs found abundantly on buoy and pier constructions, but the possibility of cultivating edible organisms under anthropogenically disturbed conditions is questionable.

CONCLUSIONS

About a fourth of all algal species recorded in the Seychelles Islands as well as a majority of animal taxa were found in the fouling communities of the coastal waters. Some of the species did not occur in the natural benthos. Comparisons of the species composition between fouling and epiphyton algal associations documented the special character of anthropogenic substrata as producing an independent biotope. Epiphyton may comprise a potential source of fouling organisms since a number of common species were found on artificial substrata as well as marine plants.

Fouling of ITVs in the area under study does not present a critical problem as in boreal waters. Long-voyage vessels have somewhat heavier fouling and lose 1-1.5 knots in cruising speed after 2-3 months following cleaning. The manipulative experiment on the R/V Akademik A. Nesmeyanov showed that underwater cleaning is not effective in the long term in tropical waters.

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Table 1. Composition and distribution of fouling organisms on a submerged vessel at Farquhar Island. A represents population density in individuals·m^{-2}. B represents biomass in g·m^{-2}. + indicates qualitative presence and - indicates absence in the samples.

Taxon	0 m B	0 m A	2 m B	2 m A	4 m B	4 m A
Algae						
Struvea anastomosans	650.0	-	250.0	-	175.0	-
Ulva rigida	52.5	-	27.5	-	14.4	-
Dictyopteris delicatula	10.0	-	6.2	-	10.0	-
Padina minor	7.5	-	1.0	-	-	-
Sargassum ilicifolium	-	-	-	-	4750.0	-
Gelidium pusillum	5.0	-	2.5	-	20.0	-
Jania ungulata	975.0	-	650.0	-	225.0	-
Animals						
Actiniaria	0.5	25	-	-	-	-
Nereidae	0.2	100	+	+	+	+
Sabellidae	-	-	+	+	-	-
Spirorbidae	-	-	+	+	-	-
Sipunculidae	0.5	100	0.2	25	-	-
Amphipoda	2.5	2000	0.2	125	0.5	300
Isopoda	1.0	75	0.7	75	2.5	125
Paguridae	4.0	75	-	-	-	-
Decapoda	0.2	5.0	-	-	-	-
Mitrella sp.	-	-	-	-	0.2	50
Triphora sp.	-	-	-	-	+	+
Bryozoa	-	-	+	-	-	-

Table 2. Composition and distribution of fouling organisms on a buoy and chain at Aldabra Island. A represents population density in individuals·m^{-2}. B represents biomass in g·m^{-2}. + indicates qualitative presence and - indicates absence in the samples.

Taxon	1 m		2 m		5 m		10 m		15 m	
	B	A	B	A	B	A	B	A	B	A
Algae										
Derbesia marina	+	-	-	-	+	-	+	-	-	-
Enteromorpha clathrata	+	-	+	-	-	-	-	-	-	-
Enteromorpha kylinii	+	-	-	-	-	-	+	-	-	-
Ulva rigida	186	-	190	-	76	-	7	-	0.1	-
Lobophora variegata	+	-	-	-	-	-	-	-	-	-
Acanthophora spicifera	60	-	-	-	-	-	-	-	-	-
Acrochaetium seriatum	-	-	+	-	+	-	-	-	-	-
Antithamnionella sp.	+	-	-	-	-	-	+	-	-	-
Caloglossa adnata	-	-	+	-	-	-	+	-	-	-
Centroceras clavulatum	+	-	+	-	-	-	-	-	-	-
Ceramium gracillimum	-	-	-	-	-	-	+	-	-	-
Ceramium mazathlanense	-	-	-	-	+	-	+	-	-	-
Ceramium fastigiatum	+	-	-	-	-	-	-	-	-	-
Gelidiella myrioclada	-	-	-	-	+	-	-	-	-	-
Gelidiella tenuissima	+	-	-	-	-	-	-	-	-	-
Herposiphonia tenella	-	-	+	-	-	-	+	-	+	-
Hypnea pannosa	-	-	-	-	+	-	+	-	-	-
Lophosiphonia villum	+	-	-	-	+	-	-	-	-	-
Polysiphonia sp.	-	-	+	-	-	-	+	-	-	-
Spyridia filamentosa	+	-	+	-	-	-	-	-	-	-
Taenioma perpusillum	-	-	+	-	-	-	+	-	-	-
Animals										
Obelia sp.	+	-	+	-	+	-	+	-	+	-
Sabellidae	0.1	-	-	-	-	-	-	-	-	-
Pantopoda	+	+	-	-	-	-	-	-	-	-
Lepas anatifera	284	110	145	50	62	30	53	30	15	10
Bryozoa	0.1	-	-	-	-	-	-	-	-	-
Ascidiacea	+	-	-	-	-	-	-	-	-	-

Table 3. Composition and distribution of fouling organisms on a navigational buoy at Desroches. A represents population density in individuals·m^{-2}. B represents biomass in g·m^{-2}. + indicates qualitative presence and - indicates absence in the samples.

Taxon	0 m B	0 m A	1 m B	1 m A
Algae				
Enteromorpha clathrata	420	-	21	-
Enteromorpha intestinalis	+	-	+	-
Enteromorpha kylinii	+	-	+	-
Dictyota bartayresiana	+	-	+	-
Dictyopteris delicatula	+	-	+	-
Giffordia mitchellae	+	-	+	-
Lobophora variegata	+	-	+	-
Antithamnionella sp.	+	-	+	-
Champia parvula	+	-	+	-
Centroceras apiculatum	+	-	+	-
Centroceras clavulatum	+	-	+	-
Ceramium gracillimum	+	-	+	-
Ceramium mazathlanense	+	-	+	-
Ceramium sp.	+	-	+	-
Crouania sp.	+	-	+	-
Dasia mollis	+	-	+	-
Dictyurus prupurascens	50	-	30	-
Griffithsia metcalfii	+	-	+	-
Griffithsia subcylindrica	+	-	+	-
Herposiphonia tenella	+	-	+	-
Heterosiphonia wurdemannii	+	-	+	-
Heterosiphonia sp.	+	-	+	-
Hypnea pannosa	+	-	+	-
Hypnea esperi	+	-	+	-
Jania capillacea	+	-	+	-
Laurencia sp.1	+	-	+	-
Laurencia sp.2	+	-	+	-
Plocamiun sp.	+	-	+	-
Polysiphonia mollis	380	-	400	-
Peyssonelia sp.	-	-	20	-
Animals				
Hydroidea	+	-	-	-
Neridae	-	-	2	200
Serpulidae	+	+	1	+
Lepas anatifera	670	1100	-	-
Balanus reticulatus	3	200	-	-
Amphipoda	3	2300	3	3000
Isopoda	+	+	-	-
Decapoda	0.2	100	-	-
Mitrella sp.	-	-	+	+
Ascidiacea	+	+	-	-

Table 4. Composition and distribution of fouling organisms on a pier at Praslin Island. A represents population density in individuals·m^{-2}. B represents biomass in g·m^{-2}. + indicates qualitative presence and - indicates absence in the samples. * represents sides exposed to wave action and ** denotes the protected side.

Taxon	1 m*		1 m**		2 m*		2 m**	
	B	A	B	A	B	A	B	A
Algae								
Bryopsis pennata	+	-	+	-	+	-	+	-
Chlorodesmis comosa	+	-	+	-	-	-	-	-
Cladophoropsis sundanensis	+	-	+	-	-	-	-	-
Enteromorpha intestinalis	+	-	+	-	-	-	-	-
Lobophora variegata	2.5	-	+	-	-	-	-	-
Sargassum ilicifolium	+	-	+	-	-	-	-	-
Antithamnion lherminieri	1	-	21	-	0.2	-	0.1	-
Centroceras clavulatum	+	-	+	-	-	-	-	-
Ceramium gracillimum	+	-	+	-	-	-	-	-
Gelidiella lubrica	+	-	+	-	-	-	-	-
Gelidium pusillum	+	-	+	-	+	-	-	-
Griffithsia metcalfii	+	-	+	-	+	-	-	-
Gymnothanmion bipinnata	1	-	23	-	0.1	-	0.1	-
Hypnea esperi	+	-	+	-	-	-	-	-
Hypoglossum sp.	+	-	+	-	-	-	-	-
Jania capillacea	+	-	+	-	+	-	+	-
Laurencia sp.1	+	-	+	-	-	-	-	-
Lophocladia trichoclados	+	-	+	-	+	-	-	-
Fosliella farinosa	+	-	+	-	-	-	-	-
Peyssonnelia sp.	22	-	20	-	+	-	+	-
Animals								
Spongia	230	-	20	-	-	-	-	-
Actiniaria	10	175	-	-	-	-	-	-
Obelia sp.	+	-	-	-	-	-	-	-
Hydroidea	+	-	-	-	-	-	-	-
Acropora pulchra	+	-	-	-	+	-	+	-
Favia pallida	+	-	+	-	-	-	-	-
Pocillopora damicornis	+	-	+	-	+	-	+	-
Nereidae	0.2	125	-	-	-	-	-	-
Serpulidae	2.5	-	-	-	-	-	-	-
Sipunculidea	2.5	50	-	-	-	-	-	-
Tetraclita squamosa	5250	600	-	-	170	75	-	-
Decapoda 1	+	-	+	+	-	-	-	-
Decapoda 2	-	-	+	+	-	-	-	-
Isopoda	-	-	0.5	125	-	-	-	-
Druppa sp.	-	-	+	-	-	-	-	-
Morula sp.	-	-	+	-	-	-	-	-
Patella sp.1	+	-	+	-	-	-	-	-
Ophiuroidea	1	50	-	-	-	-	-	-

Table 5. Composition and distribution of fouling organisms on an inlet buoy and chain at Victoria Harbor, Mahé. A represents population density in individuals·m^{-2}. B represents biomass in g·m^{-2}. + indicates qualitative presence and - indicates absence in the samples.

	0 m	1 m	1.5m	2 m	3 m	5 m	10 m
Taxon	B/A	B/A	B/A	B/A	B/A	B/A	B/A
Algae							
Bryopsis pennata	-	-	-	-	-	-	+
Derbesia marina	-	-	-	-	-	-	+
Feldmannian breviarticulata	1200	-	-	-	-	-	-
"Heterochordaria"	1300	-	-	-	-	-	-
Antithamnion lherminieri	-	-	-	+	-	-	-
Antithamnionella sp.	-	-	-	-	-	-	+
Champia salicornioides	-	-	-	-	-	-	+
Ceramium fastigiatum	-	-	-	-	+	+	+
Griffithsia tenuis	-	-	-	+	-	-	-
Heterosiphonia wurdemannii	-	-	-	+	+	-	+
Lophosiphonia villum	-	-	-	-	-	+	+
Spermothanmion investiens	-	-	-	-	+	+	+
Sphacelaria furcigera	-	-	-	-	-	+	-
Animals							
Spongia	-	-	-	20	8	2	32
Actiniaria	-	90/ 3200	35/ 1500	44/ 1800	+	2/ 120	1/ 120
Hydroidea	+	+	2	+	+	+	+
Nereidae	.5/300	2/1200	5/800	12/880	32/1200	120/1000	72/1400
Sabellidae	-	-	-	6	4	8	4
Serpulidae	-	-	150	8	4	+	4
Sipunculidea	-	-	-	4/120	-	4/80	3/160
Balanus reticulatus	190/800	-	-	-	-	-	-
Megabalanus tintinnabulum	-	14000/ 3000	9100/ 2600	3840/ 1120	7200/ 1280	7600/ 1800	19200/ 3360
Amphipoda	8/4000	10/4300	7/3500	4/1800	2/1200	1/800	2/1000
Decapoda 1	-	-	-	-	68/120	+	44/200
Decapoda 2	1/200	-	+	-	-	16/1600	12/160
Pantopoda	+	-	-	-	-	+	+
Stomathopoda	-	-	-	-	-	-	28/120
Thais sp.	-	-	-	-	-	+	-
Pinctada margaritifera	-	8000/ 100	-	16400/ 1600	+	2680/ 1600	+
Pteria penquin	-	-	+	-	-	-	-
Ostrea sp.	-	-	-	-	-	+	-
Barbatia lima	-	-	-	-	-	+	-
Bryozoa	-	-	200	-	-	-	-
Ascidiacea	20	180	4500	1680	5600	9600	4800

Table 6. Composition and distribution of fouling organisms on a mooring buoy and chain at Victoria Harbor, Mahé. A represents population density in individuals·m^{-2}. B represents biomass in g·m^{-2}. + indicates qualitative presence and - indicates absence in the samples.

Taxon	0 m B/A	1 m B/A	1.5 m B/A	2.5 m B/A	5 m B/A	10 m B/A
Algae						
Ulva rigida	+	-	-	-	-	-
Feldmannia breviarticulata	460	-	-	-	-	-
Animals						
Spongia	-	-	-	-	124	8
Hydroidea	-	-	+	+	+	4
Nereidae	-	-	6/500	140/320	14/320	32/320
Sabellidae	-	8	14	440	84	48
Serpulidae	+	-	-	+	+	+
Sipunculidea	-	-	+	-	-	-
Balanus reticulatus	460/ 1500	950/ 3500	1950/ 1500	2200/ 320	480/ 190	-
Megabalanus tintinnabulum	-	-	-	400/ 40	880/ 160	1680/ 2300
Amphipoda	1/1200	4/2500	22/11000	1/480	2/750	-
Isopoda	1/300	-	4/600	-	-	-
Decapoda 1	+	-	12/300	24/320	24/100	20/80
Decapoda 2	-	+	5/200	8/160	84/240	96/1600
Pantopoda	-	-	-	-	+	+
Stomatopoda	-	+	-	-	-	-
Ostrea sp.	-	1340/ 500	-	9600/ 1400	12800/ 2040	15200/ 1680
Pinctada margaritifera	-	-	-	-	-	+
Spondylus sp.	-	-	-	-	-	+
Bugula sp.	-	520	960	44	-	+
"Membranipora"	-	-	240	+	-	-
Acidiacea	12	190	420	960	320	720
Pisces	-	-	-	-	+	-

Table 7. Composition and distribution of fouling organisms on a pier with steel construction at Victoria Harbor, Mahé. A represents population density in individuals·m^{-2}. B represents biomass in g·m^{-2}. + indicates qualitative presence and - indicates absence in the samples.

Taxon	0 m B/A	1 m B/A	2.5 m B/A	5 m B/A	8 m B/A
Animals					
Spongia	-	-	10	-	2000
Hydroidea	4	5	22	15	-
Nereidae	+	4/1200	80/1000	65/800	4/500
Sabellidae	-	6	20	20	15
Serpulidae	+	4	15	5	2
Balanus reticulatus	680/ 5500	10/ 300	6/ 200	10/ 200	10/ 200
Amphipoda	-	-	-	1/500	1/600
Decapoda 1	-	29/400	6/200	50/800	450/100
Decapoda 2	-	12/300	7/300	+	8/200
Sipunculidea	-	-	-	-	+
Mitrella sp.	-	+	1/300	1/300	-
Ostrea sp.	-	26000/ 5200	17000/ 35000	19000/ 4100	8500/ 1100
"Membranipora"	-	13	+	2	-
Ascidiacea	-	20	70	55	-

Table 8. Composition and distribution of fouling organisms on an inactive dredge at Victoria Harbor, Mahé. A represents population density in individuals·m^{-2}. B represents biomass in g·m^{-2}. + indicates qualitative presence and - indicates absence in the samples.

	0 m		2 m		4 m	
Taxon	B	A	B	A	B	A
Algae						
Ulva rigida	-	-	+	-	-	-
Feldmannia breviarticulata	-	-	620	-	-	-
Acrochaetium seriatum	-	-	+	-	-	-
Hypnea pannosa	-	-	+	-	-	-
Animals						
Hydroidea	-	-	-	-	38	-
Nereidae	+	-	8	700	2	600
Sabellidae	-	-	+	-	3	-
Serpulidae	-	-	+	-	1	-
Balanus reticulatus	160	1800	200	2500	130	1400
Amphipoda	-	-	8	5500	8	3000
Isopoda	2	600	-	-	+	+
Decapoda 1	-	-	-	-	5	200
Decapoda 2	-	-	-	-	1	100
Pantopoda	-	-	-	-	+	+
Littorina sp.	4	400	+	+	+	+
Patella sp.1	14	100	-	-	-	-
Patella sp.2	15	100	-	-	-	-
Planaxis sp.	36	500	-	-	-	-
Trochus sp.	1	200	-	-	+	-
Ostrea sp.	-	-	2250	800	4800	2000
Modiolus	-	-	10	300	-	-
Bugula sp.	-	-	18	-	-	-
Ascidiacea	-	-	+	-	-	-

Table 9. Composition and distribution of fouling organisms on an operational vessel in use at Victoria Harbor, Mahé. A represents population density in individuals·m^{-2}. B represents biomass in g·m^{-2}. + indicates qualitative presence and - indicates absence in the samples.

	0 m		2 m		4 m	
Taxon	B	A	B	A	B	A
Algae						
Enteromorpha clathrata	145	-	-	-	-	-
Acrochaetium seriatum	+	-	-	-	-	-
Erythrotrichia carnea	+	-	-	-	-	-
Hypnea pannosa	+	-	-	-	-	-
Leveillea jungermannioides	+	-	-	-	-	-
Animals						
Serpulidae	-	-	4	-	7	-
Balanus reticulatus	6	1000	18	3200	26	4200
Amphipoda	+	+	+	+	-	-
Isopoda	+	+	+	+	-	-

Table 10. Succession of fouling communities on the submerged hull of the R/V Akademik A. Nesmeyanov during the expedition (December, 1988 - March, 1989). A represents population density in individuals·m^{-2}. B represents biomass in g·m^{-2}. + indicates qualitative presence and - indicates absence in the samples. * represents values for untreated surfaces, ** denotes values for previously cleaned surfaces near the waterline.

	12/1/89		28/1/89		10/2/89		23/2/89		14/3/89	
	*	**	*	**	*	**	*	**	*	**
Taxon	B	-	B/A	B/A	B/A	B/A	B/A	B/A	B/A	B/A
Algae										
Enteromorpha linza	900		975	875	1550	1750	20	47	465	862
Cladophora laetevirens	+		.5	.1	+	+	+	+	1	1
Ulva rigida	-		+	+	+	+	-	-	-	-
Animals										
Serpulidae	-		+	+	+	+	2	7	1	1
Nereidae	-		-	-	+	-	+	-	-	-
Lepas anatifera	-		3/350	13/975	2/50	5/150	-	-	.1/125	.2/225
Balanus reticulatus	-		+	+	.1/200	.1/300	.5/75	.4/50	.1/250	.1/200
Amphipoda	-		+	+	-	+	+	+	-	-
Isopoda	-		-	-	-	-	-	+	-	-
Decapoda	-		+	+	-	+	-	-	-	-

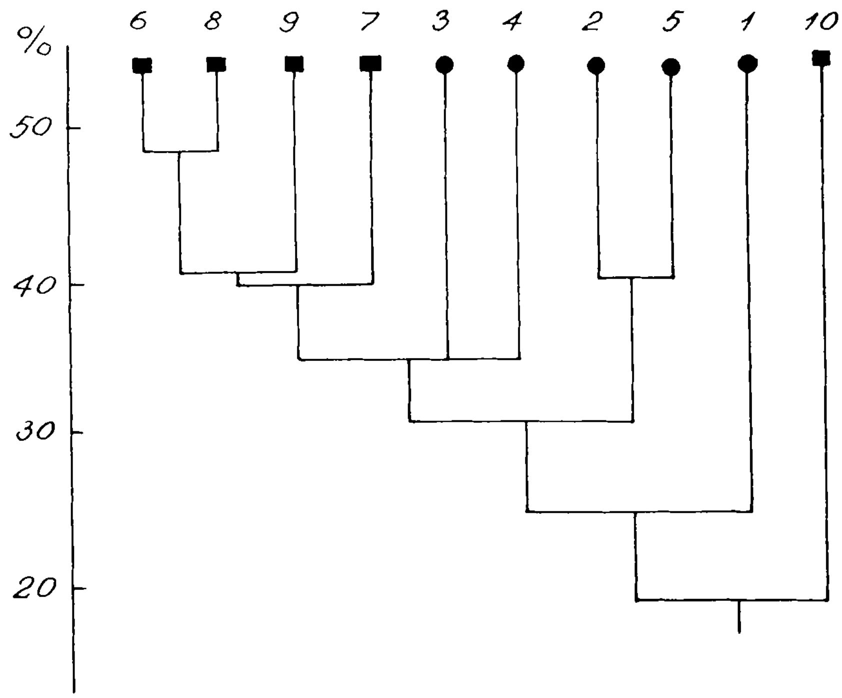

Figure 1. Dendrogram of similarity of qualitative composition of fouling algal flora (●): 1 - submerged vessel, Farquhar Is.; 2 - buoy, Aldabra Is.; 3 - buoy, Desroches Is.; 4 - pier, Praslin Is.; 5 - buoy, pier, Victoria Harbor; and epiphyton (■): 6 - Cöetivy Is.; 7 - Farquhar Is.; 8 - Aldabra Is.; 9 - Desroches Is.; 10 - Mahé, Cerf Is.