BIODETERIORATION IN PORTO NOVO COASTAL AREA: SEASONAL OCCURRENCE, GROWTH RATE AND LONGEVITY OF FOULING AND BORING ORGANISMS ON THE DEAD SHELLS OF *CHICOREUS RAMOSUS*

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ABSTRACT

Shells of the muricid snail *Chicoreus ramosus* were suspended at 23 m depth from one to twelve months. The relative abundance of fouling organisms did not change with time. Only the biomass of foulers increased with time. Seasonal peaks in occurrence of groups of foulers were observed. The attached forms commonly encountered were *Sargatia* sp., *Membranipora tuberculata*, *Polydora* sp., *Hydroides* sp., *Balanus reticulatus*, *Anomia* sp., *Modiolus undulatus* and ascidians. Free living organisms commonly associated with the shells were *Perineries* sp., *Corophium* spp., *Sphaeroma* spp., *Clibanarius* sp., *Aplysia* sp., and octopus. Fouling was intense during the months of January and February, 1993.

INTRODUCTION

Studies on fouling and boring organisms of Porto Novo coastal waters of southeast coast of India have been carried out since March, 1992 (Murugan *et al.*, 1992; Rajakumar *et al.*, 1992). In August 1992, a long-term study was initiated to assess the biodeterioration by various fouling and boring organisms on the shells of *Chicoreus ramosus*. Data for the first two months were presented in the Third TMMP workshop. The present paper summarizes the results of this investigation which was extended over a ten month period from October 1992 to July 1993.

As in previous studies, the primary objective of this investigation was to obtain information on the kinds of secondary foulers and borers that deteriorate the shells of *C. ramosus*, in addition to seasonal settlement and rate of growth and longevity of different organisms.

MATERIALS AND METHODS

Occurrence of attached and free living forms associated with dead empty shells of *C. ramosus* was studied by suspending well cleaned and sterilized empty shells at a depth of 23 m with the help of floats according to Murugan *et al.* (1992). Short-term monthly observations with fresh shells, introduced each month, were also made to assess the fouling pattern during each month along with regular long-term collections. Shells collected for observation were immediately preserved in 5% neutral formalin. The monthly abundance of each species was calculated relative to the total number of individuals encountered per *C. ramosus* shell.

RESULTS AND DISCUSSION

Short term exposure of *C. ramosus* shells

A total of 35 different kinds of animals were found to settle on, or bore into *C. ramosus* shells exposed at a depth of 23 m for monthly observations. Murugan *et al.* (1992) found 28 species in a similar study. Some organisms settled every month while others settled seasonally, or rather erratically. During post monsoon (January to March, 1993) the settlement was about two times higher than in other months.

The dominant and most consistent foulers of *C. ramosus* shells were bryozoans (*Bowerbrankia* sp., *Membranipora annae* and *M. tuberculata*), annelids (*Polydora* sp., *Hydroides* sp., *Perinereis* sp.,

and *Phyllodoce* sp.) and arthropods (*Balanus reticulatus*, *B. kondakois* and *Elasmopus* sp.). Other species were less abundant and were encountered less frequently. The following paragraphs will summarize the most common organisms of each major group.

Coelenterata

Coelenterates constituted 4% annually of the associated forms. *Sargartia* sp. settled frequently every month, especially during the postmonsoon (Jan. to Mar. 1993) and the early monsoon (Oct. 1992). *Sagartia* sp., a dominant organism on the shells of *C. ramosus*. Other hydroid sea anemones were encountered in the postmonsoon and the summer (Apr. to Jun. 1993), but in lower numbers. Season-wise, the coelenterates constituted a minimum of 3% in premonsoon and maximum of 5% during postmonsoon and summer.

Bryozoa

Two species of bryozoans *Bowerbrankia* sp., *Membranipora annae* were dominant. The overall annual abundance of these bryozoans were 10% of the total number of associated forms. The minimum was 9% in premonsoon, and maximum 12% in postmonsoon.

Annelida

Although nine species of annelids were recorded, only *Polydora* sp., *Hydroides* sp., *Perenereis* sp. and *Phyllodoce* sp., were common. They were the most consistent settlers. Murugan *et al.* (1992) and Rajakumar *et al.*(1992) also found these species dominant among the annelids. Small specimens of *Mercinella* sp., *Pista indica*, *Ceratonereis* sp. and *Eulalia* sp. settled more during postmonsoon and summer seasons. The species *Serpula sp.* was countered throughout the study period. October to December 1992 and April to July 1993 were periods of minimum settlement. January to March 1993 were the months of maximum settling. The worms seemed to prefer grooves near the shell spines as their shelter and mostly made holes near the spines. The annual average abundance of this group was 19% (minimum 15% in monsoon and maximum 23% in postmonsoon).

Arthropoda

Free living and tube-dwelling amphipods and occasionally small crabs were seen on the shells, but only the barnacle *Balanus reticulatus* was encountered regularly. This species was clearly the dominant fouling organism (33-77 individuals, per shell) Small barnacles were seen on the shells during every month of the year. Monsoon (Oct. to Nov. 1992) and summer (Apr. to Jun. 1993) were clearly periods of minimal settling, while postmonsoon was the period of high settlement. Barnacles settle everywhere on the surface of the *C. ramosus* shells. *Balanus kondakoris* and *Elasmopus* sp. were dominant forms, especially during postmonsoon (Jan. to Mar. 1993). Other attached forms, *Lepas* sp., and free living forms like *Corophium madrasensis*, *C. friaenonynx*, *Cyathura* sp., *Sphaeroma annandali*, *S. trite*, *Charybdis cruciata*, *Sesarma minuta* and *Clibanarias padavensis* were also found associated with the *C. ramosus* shells in small numbers and in irregular patterns of occurrence.

Mollusca

Modiolus undulatus, *Pholas* sp., *Anomia* sp. and *Martesia* sp. were commonly encoutered. All these settle as larvae. The free living *Aplysia* sp., *Octopus* sp., and *Hemifusus* sp. stayed only temporarily for food and substrate. Only one individual of octopus was found inside a shell where it had replaced the hermit crab *C. padavensis*. Annual abundance of molluscs was 13%. Abundance ranged from 11% in summer to 16% in premonsoon seasons.

Urochordata

From 2 to 9 ascidians were found on the shells throughout the study period. Only one species was present. Its average abundance was 2%, which varied from 1% (premonsoon) to 2% (summer).

Long-term exposure of *C. ramosus* shells

Long-term exposure up to 12 months resulted in settling of 7 species of polychaetes, crutaceans and starfish which were not recorded in short-term exposure of shells, but the 7 species were not quantitatively important. A total of 42 species of animals were identified.

Colenterata

As in the case of the short-term shells, the *Sagartia* sp. was observed regularly. It was most abundant on shells carrying 2 species of sea anemones. The sea anemones (1.5cm in diameter) increased in numbers from postmonsoon to premonsoon. The overall

annual abundance of coelenterates was 6%, where the minimum was 4% in premonsoon and the maximum 9% in summer.

Bryozoa

Bryozoans are dominant fouling organisms in Vellar Estuary (Prabakaran, 1980), but in the open waters of the Porto Novo coast there are fewer species and individual colonies. During the long-term exposures, a total of 3 species were recorded and 5 to 38 colonies were found on single shells. *Bowerbrankia* sp. *Membranipora annae* and *M. tuberculata* were encountered quite often on older shells. Annual abundance on shells was 10% with a postmon-soonal minimum of 8% and a premonsoon maximum of 11%.

Annelida

Hydroides elegans was found after 2 months on the shells. *Polydora* sp., *Hydroides* sp., *Serpula* sp., and *Phyllodoce* sp. were the dominant polychaetes, while *Mercinella* sp., *Pista indica*, *Ceratonereis* sp., *Perinereis* sp. and *Eulalia* sp. were encountered in lower numbers. Calcareous tubes, once attached to the shell surface, do not break off easily. The sandy tubes were most often wedged in between barnacles. Some of the tubes were over 4cm in length. Their seasonal abundance fluctuated from a minimum of 16% in the postmonsoon to a maximum of 22% in the monsoon.

Arthropoda

The common *Balanus reticulatus* (14-27% abundance) was clearly the dominant fouling organism in terms of total biomass and numbers of individuals encountered on the long-term exposed shells. Both living and dead barnacles were counted. During the first part of this study living barnacles were found on all shells exposed from August through October 1992, but by the first of November 1992 all were dead and no new live ones appeared until December 1992. The shells carried a heavy load of dead barnacle shells. But from January 1993 new barnacles were encountered on exposed shell surfaces. On one shell removed after for 5 months, all the barnacles were dead. The barnacles, or their bases, measured up to 7 mm in diameter and covered 70% of the shell surface. Possibly some predator moved over this *Chicoreus* shell and killed all the barnacles. The steep decrease in salinity due to monsoon rain and river run-off could also be the reason for the death of *Balanus reticulatus*.

One of the objectives of this study was to determine the possible breeding season of dominant fouling organisms. Larvae released by the adult barnacles were found attached to the shell surface on a shell exposed on 1st August 1992 and removed on October 1, 1992. After two months the shell surface was covered with tall, tubular barnacles and many of these were releasing clouds of nauplii. *Balanus reticulatus* can therefore become reproductively mature and release larvae at an age of 2 months or less during summer.

Other arthropods encountered were *Balanus kondakois*, *Lepas* sp., *Elasmopus* sp., *Corophium madrasensis*, *C. friaenonynx*, *Cyathura* sp., *Sphaeroma annandali*, *S. triste*, *Charybdis cruciata*, *Sesarma minuta*, *Portunus pelagicus*, *Podopthalmus vigil*, *Portunus sanguinolentus* and the hermit crab, *Clibanarius padavensis*.

Mollusca

The abundance of *Modiolus undulatus*, *Pholas* sp., *Anomia* sp. and *Martesia* sp. ranged from 1to 8%. Free-living juveniles of *Hemifusus*, *Octopus* and *Aplysia* sp. were encountered regularly. Molluscs were the third largest groups of foulers on the *C. ramosus* shells. Abundance ranged from 8 (monsoon) to 17% (summer). The annual average of this group was 14%.

Echinodermata

Only single individual of a single species of star fish was encountered.

Urochordata

A single species of ascidians was encountered only on older shells. So it was showing some increasing trend of attachment with the flux of time. The overall annual abundance of this ascidian was 4% with a minimum during the monsoon (3%) and maxinum in the summer (6%).

The present investigations showed that mainly coelenterates, bryozoans, annelids, arthropods, and molluscs contributed to the bio-deterioration of *C. ramosus*. Eventhough there is some seasonal fluctuation, the fouling is always intense in tropical waters. In a period of 7 to 8 months a shell of *C. ramosus* is liable to deteriorate severely.

Boring organisms

The borers encountered in the present study belong to the sponges, polychaetes, crustaceans and molluscs. The numerical presence of sponges could not be ascertained as they are clustered colonies. Yet, clionid sponges were found to be abundant on the shell surface. They were found throughout the year both in short and long term shell exposure and it may be the only dominant form among the borers. The damage caused by the bivalve *Pholas* sp. to *C. ramosus* cannot be ignored. *Pholas* sp. obtained 5-7 mm length in one month exposed shells (Jan. 1993) and would reach 22 mm length after 11 to 12 months. They were all alive throughout the year. About 3-4 holes per 50 mm^2, with maximum hole depth of penetration of 25 mm and an average of 17 mm. Thus the present study showed that the economically important shells of *C. ramosus* can be destroyed within a year by the various fouling organisms in general, and the borers: *viz.*, clionid sponges, the polychaetes *Mercinella* sp. and *Hydroides* sp., the arthropods *Sphaeroma annandali* and *S. triste* and the pelecypod mollusc *Pholas* sp. in particular.

REFERENCES

Murugan, A., T. Rajakumar and K. Ayyakkannu. 1992. An experimental study of fouling patterns on shells of *Chicoreus ramosus* in Porto Novo waters, Southeast Coast of India. *Phuket mar. biol. Cent. Spec. Publ. no.* **10**: 194-198.

Prabakaran, V. 1980. Some aspects of the biology of marine fouling in Porto Novo waters. M.Phil.Thesis, C.A.S. in Marine Biology, Annamalai University. 66 p.

Rajakumar, T., A. Murugan and K. Ayyakkannu 1992. Bio-deterioration in the Porto Novo Coastal Area: a pilot study on fouling and boring organisms on dead shells of *Chicoreus ramosus*. *Phuket mar. biol. Cent. Spec. Publ. no.* **11**: 96-97.