



The Effects of Caging on the Colonization of Fouling Organisms in the Upper Bonny Estuary

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ABSTRACT: The effects of caging on the colonization and development of the fouling community in the upper Bonny estuary was studied. The experimental design was such that sets of wooden panels (20x20 cm) were screened with cages constructed with plastic netting while another set was left uncaged. Both sets of panels were submerged below low tide level and sampled fortnightly for seventy-four days. The species settling on the panels (as well as on the mesh of the cage) were identified and examined for percentage cover. Data obtained were subjected to Analysis of Variance or t-tests after arc-sine transformation. Faunal abundance was found to be significantly higher on the mesh of the cage than on the panels ($p < 0.001$). Differences between the caged and uncaged panels were influenced by time as total cover was found to decline with time on the caged panels. *Pennaria distichia*, *Styela sp.* and *Sabella sp.* achieved significantly higher cover on the mesh of the cage than the panels ($p < 0.001$). Some species that settled on the panels (*Balanus sp.*, *Membranipora membranacea*, *Serpula sp.*, *Halichondria sp.*, *Crassostrea gasar*) were not found on the mesh of the cage, and both *Balanus* and *M. membranacea* showed significantly higher abundance on uncaged panels ($p < 0.05$). Current speed and sedimentation may have accounted for much of the difference in settlement between caged and uncaged panels. @JASEM

The colonization and development of fouling communities may be affected by different abiotic and/or biotic factors. Abiotic factors include temperature (WHOI, 1952; Osman, 1977; Morales and Arias, 1979), Salinity (Saenger *et al.*, 1979), Light (Dahlem *et al.*, 1984), current (WHOI, 1952; Osman, 1977, Zongguo *et al.*, 1981), turbidity (Shin, 1981) and pollution (Howard *et al.*, 1980). The most important biotic factors are competition and predation (Osman, 1977).

Fish and invertebrate predators have been reported to significantly affect epifaunal community structure through selective removal of prey species (Sutherland 1974, Marshal *et al.* 1980; Russ 1980). Predation may cause increase diversity by removal of competitively dominant species to create space and allow less competitive species to coexist in the community (Dayton 1975). However, in some areas the presence of predators have been reported not to significantly alter epifaunal communities (Shin 1981; Schmidt and Warner 1984).

Most studies of the effects of predation on community dynamics employ predator exclusion techniques such as caging. In experimental fouling panels, caging also modifies the immediate environment of the panels by reduction of current speed. We report here, the effects of caging on the composition and structure of fouling community on experimental panels in the upper Bonny Estuary of the Niger Delta.

MATERIALS AND METHODS

This study was conducted at a site in the upper Bonny Estuary near the Nigeria Ports Authority (Nigeria Ship builders) Port Harcourt. An abandoned

wreck of a boat provided the frame for the attachment of cages and panels. The experiments were carried out with cages constructed using plastic netting. The cages were 44 x 20 x 20 cm in dimension. In the construction of a cage, a wooden framework was first built and the plastic netting laid on this framework. Then wooden batons were used to hold the netting firmly in place. The mesh sizes were 2 x 2mm (0.200 ± 0.005mm thick).

Five cages were constructed and in each cage the wood panels (20 x 20cm; 2cm thick) were placed edge to edge at a distance of 4cm for unrestricted water flow. The cage size also permitted 10cm gaps between panel surface and the mesh of the cage so that outward growth of organisms on the panels would not be impeded.

All cages were placed on site by tying each end of the cage to the frame in such a manner that the panels were in a vertical position. Five pairs or uncaged panels were placed alongside the caged ones in an alternating arrangement.

One cage containing two panels, and two uncaged panels were randomly collected at bi-weekly intervals and transported to the laboratory. Fouling organisms on the panels (and areas of the netting materials opposite panel surface) were then identified and scored for percentage cover using the point method (Schmidt and Warner, 1984; Daka and Abby-Kalio, 1997). All sessile organisms within the central 15 x 15 cm of each panel were identified and their percentage cover was determined from 150 regularly spaced points on a grid. The peripheral 5 cm of panel sides were not scored to reduce edge effects (see Marshall *et al.*, 1980; Hirata, 1987). Percentage cover was calculated as a ratio of the number of points of a

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species to the total number of points using the

$$\text{formula } \%Cover = \frac{x_i}{150} \times 100$$

where x_i = total number of points of species i .

Those species, which were present on a panel but were not recorded by the 150 regular points were assumed to occupy 0.5% cover each (Osman, 1977; Shin, 1981).

Data Analysis

Percentage data were arcsine transformed before subjecting to parametric statistics (Zar, 1984). Significant differences in colonization between treatments were tested by means of One-Way Analysis of Variance (ANOVA), ignoring the effects of time (Osman, 1977). In some cases where colonization occurred on only two treatments, t-tests were performed. All analyses were carried out using MINITAB for Windows.

RESULTS AND DISCUSSION

Out of eleven species of fouling organisms that were found in the course of this experiment, five species (*Serpula sp.*, *Crassostrea gasar*, *Syndunene kameruniensis*, *Halichondtia sp.* and an unidentified amphipod) accounted individually for less than 1% average coverage on the panels and were therefore excluded from the analyses. It is worthy of note, however, that for the duration of exposure none of these species settled on the mesh of the cage. Fig 1 shows the mean number of species and abundance (percentage cover) of fouling organisms that settled on the experimental substrata. The species richness for caged and uncaged panels were similar two weeks after submergence (Fig 1a), but while the number of species subsequently declined on caged panels, there

for the duration of the study. Faunal abundances were consistently higher on the mesh of the cage than the panels (Fig 1b). There were significant differences in mean total cover (ANOVA, $p < 0.001$, Table 1) with Tukey tests ($p < 0.05$) indicating thus: cage material > uncaged panel > caged panel.

The colonization of the hydroids *Pennaria distichia* and *Sertularia marginata* are shown in Fig 2a and 2b. The highest cover of *P. distichia* was recorded on the mesh of the cage after two weeks of submergence and its cover reduced progressively afterwards. Analysis of Variance showed that there was a significant difference in colonization by *P. distichia* ($p < 0.001$, Table 1) with Tukey tests ($p < 0.05$) indicating caging material > uncaged panel = caged panel. *S. marginata* was not recorded on caged panels; it was found on uncaged panels and the mesh of the cage but there was no significant difference in cover between the two treatments ($t_7 = 0.95$, $p = 0.37$).

The ascidian, *Styela sp.* and the polychaete *Sabella* had similar patterns of colonization except that *Sabella* had a much higher percentage cover (Fig. 2c and 2d. Both species had highest percentage cover on the mesh of the cage with the cover on the panels being orders of magnitude lower. ANOVA (Table 1) and Tukey tests showed significant differences in the form: caging material > uncaged panel = caged panel.

The barnacle *Balanus sp.* and the bryozoan *Membranipora membranacea* did not settle on the mesh of the cage and for both species the percentage cover was higher on uncaged panels than caged panels (Fig. 2e and 2f). Student's t-tests showed that there were significant differences in cover for both

species between caged and uncaged panels

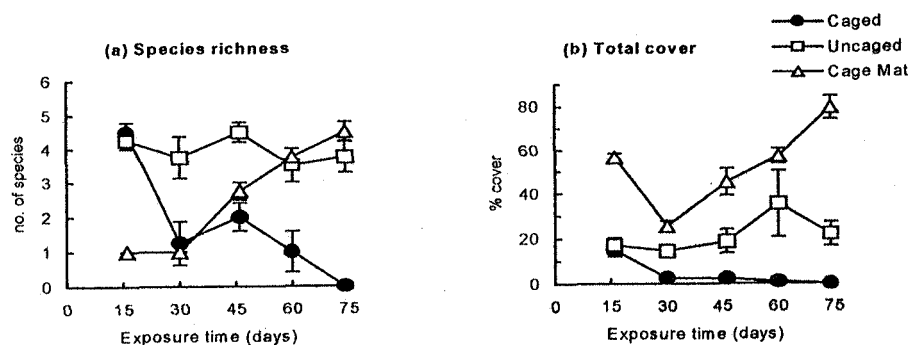


Fig. 1. Species richness and abundance of fouling organisms on caged and uncaged panels, and caging material.

Values are mean \pm S.E.M. (*Balanus*: $t_{28} = 2.3$, $p = 0.029$; *Membranipora*: $t_{36} = 3.61$, $p = 0.0009$).

was minimal change on uncaged panels. On the mesh of the cage, the number of species rose steadily

Total abundance of fouling organisms was significantly greater on uncaged panels than cage panels. However fouling was highest on the mesh of the cage and was significantly more on the mesh than both uncaged and caged panels. Caging is known to modify the physical environment by reducing light intensity and water current velocity. The reduction in water current velocity encourages sedimentation within the cages. This was observed in this experiment in which sedimentation was higher on caged panels than uncaged panels. This was probably responsible for the low settlement on caged panels. Moreso, cover on caged panels reduced over time as sedimentation increased.

Schmidt and Warner (1984) reported that the hydroids *Tubularia larynx* and *Pulmunaria setacea* were largely confined to the outside mesh with rapid water flow favourable for growth of passive suspension feeders. Sutherland (1974) and Marshall *et al.* (1980) have reported similar findings for *Tubularia crocea* and *Tubularia larynx*, and Otsuka and Dauer (1982) for *Obelia sp.* Similar results were obtained from this study where the hydroid *Pennaria distichia* was found to be significantly more abundant on the mesh of the cage than both uncaged and caged panels. Again, *Sertularia marginata* was completely inhibited on caged panels while it was present on uncaged panels and the mesh of the cage with no significant difference.

The polychaete *Sebella sp.* and the ascidian *Styela sp.* also probably reacted to water current speed having achieved significantly higher cover on the mesh of the cage than caged and uncaged panels. Their settlement on caged panels was also less than uncaged panels though the difference was not significant.

The bryozoan *M. membranacea*, barnacle *B. balanoides*, and tubicolous polychaete *Serpula sp.* were not recorded on the mesh of the cage. *M. membranacea*, barnacle *B. balanoides* achieved significantly higher cover on uncaged than caged panels. While it might be true that sedimentation was responsible for the differences in settlement or these species between caged and uncaged panels, it cannot be the case between the mesh of the cage, and the caged/uncaged panels. Apparently, the reason may be that settling larvae of these species were negative attracted to the cage mesh material. It is interesting to note that the species reacting this way all had calcareous skeletal material. Hence it might be possible that settling larvae found it difficult to metamorphose and secrete shells on this material. More investigation, possibly covering a longer period of time is necessary. But if this reaction is confirmed on further investigation, then this material will prove useful as enclosing net in mariculture practices.

Table 1. Summary of Analysis of Variance on percentage cover (arc-sine transformed data) of fouling fauna and total abundance between caged, uncaged panels and caging material.

Source	DF	SS	MS	F	p-value
Total abundance					
Treatment	2	9629	4815	45.11	<0.001
Error	57	6084107			

<i>Pennaria distichia</i>					
Treatment	2	2087.9	1044.0	19.92	<0.001
Error	57	2987.5	52.4		

<i>Sabella sp</i>					
Treatment	2	1750.9	875.4	18.06	<0.001
Error	57	2763.5	48.5		

<i>Styela sp</i>					
Treatment	2	96.02	48.01	18.30	<0.001
Error	57	149.55	2.62		

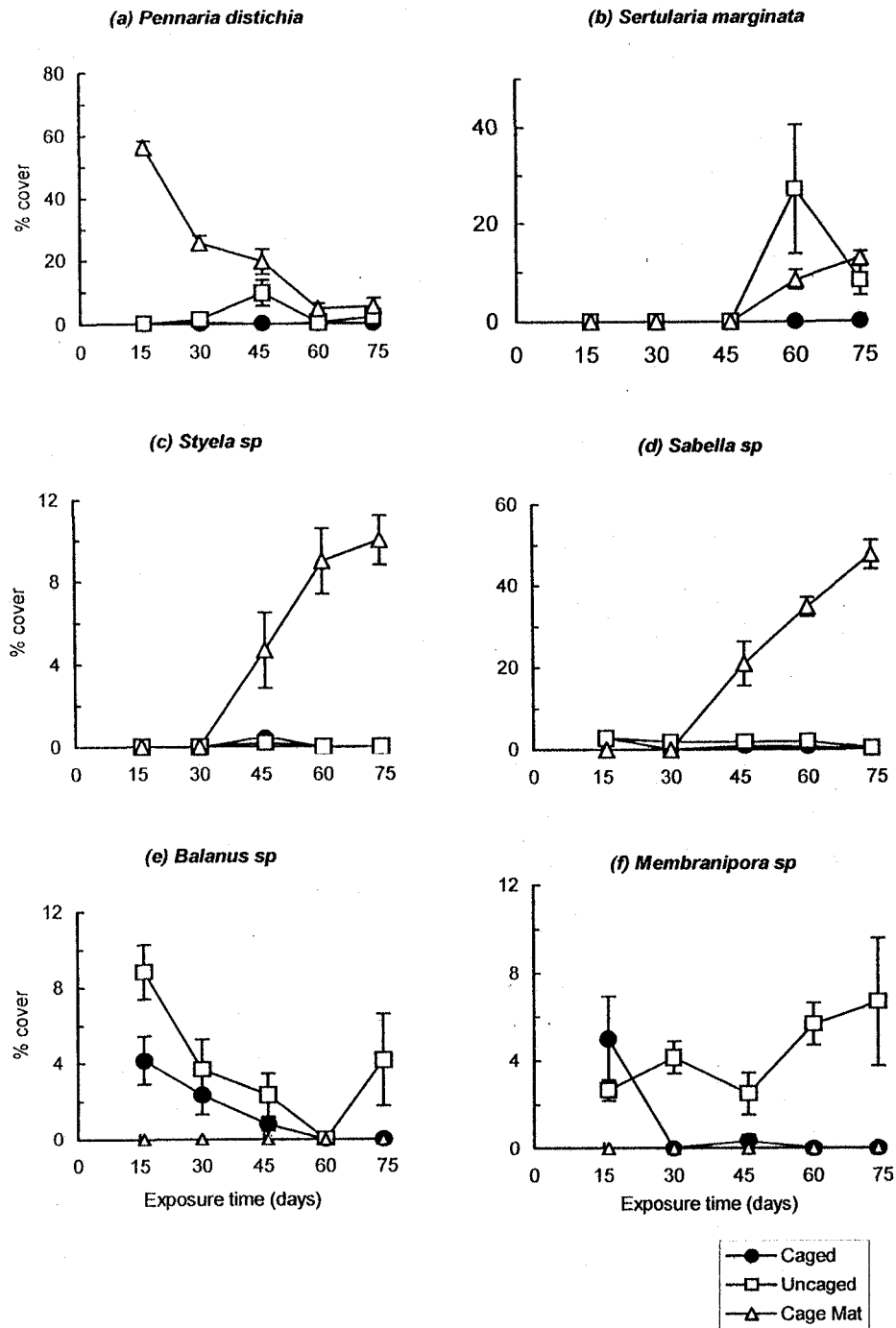


Fig. 2. Mean (\pm s.c.m.) percentage cover of sessile invertebrate species on uncaged and caged panels, and caging material.

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