NOTE

Artifactual effects of caging on the recruitment and survivorship of a subtidal colonial invertebrate

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ABSTRACT: As an aid to interpreting previous experiments and designing future experiments, I tested the hypothesis that the presence of cages has the same effect as the absence of invertebrate grazers on the recruitment of a subtidal colonial ascidian at Goat Island, New Zealand. Recruitment of the ascidian Pseudodistoma novaezelandiae (Brewin) (Polyclinidae: Euherdmaniinae) under cages was compared to recruitment in uncaged quadrats, while both treatments were manually kept clear of 2 invertebrate grazers, the echinoid Evechinus chloroticus (Val.) and the large gastropod Cookia sulcata (Gmelin). Thus, any effect of the cages could not be due to the absence of grazers and was considered artifactual. Although the effect of caging was initially non-significant, in later samples there were significantly more recruits outside than inside cages. Possible causes of the caging effect include the activities of blennies which sheltered within cages, and the increase of sediment within cages.

Cages have been widely used in benthic field experiments to exclude predators, but increasing evidence suggests that cages have effects on their interior environment other than the simple exclusion of predators (Dayton & Oliver 1980, Hulberg & Oliver 1980, Kennelly 1983, Schmidt & Warner 1984, Underwood & Denley 1984). One method of assessing the importance of these artifactual effects is by the use of partial cages which ideally are meant to simulate the regime created by the full cage in all respects except for the exclusion of predators (Russ 1980, Breitberg 1985). These ‘caging controls’, however, may themselves produce unpredictable or, worse, undetected effects (Dayton & Oliver 1980, Choat 1982, Keough 1984) such as the alteration of behaviour patterns of surrounding animals, which in turn produces artifacts (Otsuka & Dauer 1980, Keough 1984). An alternative method of isolating artifacts produced by cages from the effects of predation involves the deployment of cages in the absence of predators (Kennelly 1983). Any difference between the caged and uncaged treatments cannot be due to the hypothesised predators and can be considered artifactual. Such a test for the effects of cages per se is made in tandem with a test for the effects of predators.

The work described here was part of a larger study (Stocker & Bergquist unpubl.) on factors affecting recruitment of the ascidian Pseudodistoma novaezelandiae (Brewin). As cages had proved convenient in previous studies, they would be a desirable method of excluding grazers in future experiments, if their artificial effects could be shown to be small. In the present study, the possibility of artifactual effects of cages on recruitment was investigated by establishing caged and uncaged treatments in areas from which 2 hypothesised agents of mortality, the urchin Evechinus chloroticus and the large grazing gastropod Cookia sulcata, had been manually removed. These grazers occur at high densities and the echinoids are known to be omnivorous (Ayling 1981). The experiment, it should be stressed, was not an attempt to distinguish preferential settlement from post-settlement mortality, but to measure the effects of cages, other than the exclusion of invertebrate grazers, on recruitment. In this paper, I use the term ‘settlement’ to mean the attachment of larvae to the substratum and their metamorphosis, and ‘recruitment’ to refer to settlers that have survived long enough to be observed (Keough & Downes 1982).

Materials and methods. The study was made at inner North Reef on the north-western point of Goat Island in the Leigh Marine Reserve, north-east New Zealand (36°15'S; 174°48'E). The site is 5 to 8 m deep and is characterised by numerous boulders 1 to 3 m in diameter. The boulders are largely covered with a mixture of turfing and encrusting coralline algae, and the barnacle Balanus trigonus Darwin. Pseudodistoma nova-
Pseudodistoma novaezelandiae occupied a mean of 9.1% (SE = 5.6; n = 20) of the available space on boulders. The colonies are vivid orange and gelatinous, in the form of lobes growing up from a basal mat. The echinoid *Evechinus chloroticus* and the gastropod *Cookie sulcata* occurred at mean densities of 8.8 m⁻² (SE = 1.2; n = 25) and 3.2 m⁻² (SE = 0.8; n = 20), respectively.

A 2-factor design was used to determine the variability among boulders in the recruitment of *Pseudodistoma novaezelandiae* and the effects of caging on recruitment. Recruitment was measured within quadrats marked out on the natural substratum of turfing corallines and barnacles; these quadrats did not contain *P. novaezelandiae* colonies. Eight quadrats were established on the tops of each of 5 randomly-selected boulders bearing *P. novaezelandiae*. Cages were then assigned randomly to 4 quadrats, and 4 quadrats were left uncaged. Thus, the factor 'Boulders' was random with 5 levels and was orthogonal with the factor 'Caging' which was fixed with 2 levels.

The cages were of plastic mesh 2 mm thick with a grid size of 2 × 2 cm, covered an area of 25 × 25 cm, and were 6 cm high. Skirting edges of the cages were nailed to the substratum under strips of plastic to prevent the entry of grazers. Invertebrate grazers were removed from all boulders approximately twice a week. The sides of the boulders acted as buffer zones across which grazers could rarely proceed, so the boulder-tops remained free of invertebrate grazers. Numbers of recruits in the quadrats were recorded at 6, 12, and 18 wk after the experiment was started.

Numbers of the blenny *Parablennius laticlavius* Griffin on caged and uncaged quadrats were counted, and light intensity on caged and uncaged quadrats was measured with a Licor Quantum Photometer/Radiometer.

**Results and Discussion.** The experiment had been established for 4 wk when recruitment of *Pseudodistoma novaezelandiae* was first observed, but a large swell prevented immediate sampling. At the first sampling, 6 wk after the experiment was established, there was no significant effect from Caging (Table 1a, Fig. 1). Thus, although cages caused a 27% decrease in light intensity relative to uncaged quadrats (mean light intensity inside cages was 438 µE s⁻¹ cm⁻²; SE = 10.5; n = 5, and outside cages was 596 µE s⁻¹ cm⁻²; Table 1. Analysis of variance tables for number of recruits at (a) 6 wk (b) 12 wk and (c) 18 wk after initiation of experiment. Data were ln(x + 1) transformed for (b) and (c) to homogenise variances. "**" p < 0.005
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LITERATURE CITED


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