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Epibiosis Reduction on Productivity in a Mussel Culture of *Perna perna* (Linné, 1758)

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ABSTRACT

*Cultivated mussels (*Perna perna*) were studied to test for the effects of cleaning on their growth. These effects were examined by experimentally cleaning mussels and by changing mussel density. Treatment was performed twice, at two and four months after immerging the ropes. Two months after the first treatment and three months after the second treatment, mussels were harvested and measured (weight, length, width and thickness). Analysis of variance showed that none of the treatments resulted in increased growth of the mussels, nor did increased density result in decreased growth when compared with the control. It was concluded that it was not necessary to clean the shells to increase harvest.*

Keywords: Mussels culture, *Perna perna,* Epibiosis, Cleaning management

INTRODUCTION

Space is a limiting resource in various marine ecosystems with many organisms attaching themselves to the hard surfaces of other organisms. Mussels create such secondary space, and their shells may be colonized by other invertebrates and algae. Commercial mussel cultivation uses ropes of mussels that hang and form a hard substrate barrier that intercepts the flow of water and consequently larvae in the water column. That results in ropes of mussels containing a large quantity of additional organisms, called epibiosis. Mussel growth may be inhibited by this potentially competitive encrusting community in various ways, causing economic loss. Mussels might suffer direct and indirect effects related to competition for both food and space (Arakawa, 1990). Young mussels may be overgrown and experience poor water circulation, which can cause mortality due to either smothering (Dayton, 1973) or food competition (Lesser et al., 1992). Additional problems may result from increased weight of the mussel racks that could reduce the flotation of the whole structure and eventually cause it to fall (Waterstrat et al., 1980). Also, epizoans could increase the height of individual mussels to which they are attached, and amplify drag forces and increase the risk of dislodgement (Witman and Suchanek, 1984). Another prejudicial effect of epizoans is the reduction of space for attachment of the mussel larvae themselves, reducing production of juveniles for the next season (Arakawa, 1990).

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To minimize all of these potentially detrimental effects, mussels are usually submitted to different methods of cleaning to eliminate the encrusting community. On the other hand, the treatments themselves require time and money, so that their cost/benefit relationship should be evaluated. In Southern Brazil, the species cultured is *Perna perna* and the rope culture is the most usual technique. In the present work we evaluated some of these methods by experimentally cleaning mussels and by changing mussel density to test the prediction that mussel intra-competition could reduce mussel productivity.

MATERIALS AND METHODS

Study site: The study took place at Praia Grande do Itapocorói, municipality of Penha, Santa Catarina State (26°58'S and 48°35'W). Mussels are cultivated there in a protected bay, with a maximum depth of 15m and mean depth of the cultivated area of 5m. This commercial mussel culture exists since 1992 and in 1996 Santa Catarina State became the number one mussel producer in Brazil (Marenzi et al., 1997).

Experimental treatments: In January 1999, 30 ropes (1.5 m in length) formed by mussel seeds (at approximately 2 cm) were submerged. Two months later, 9 ropes were cleaned in the following treatments: a) three ropes were exposed to air for 6h (air), b) three were washed with freshwater under pressure water, and c) three were taken apart and the mussels were mixed in a rotating peeling machine to scrape the epibiosis from their shells (abrasion). To test the effect of intraspecific competition, we changed the mussel density in each rope by d) dividing the mussels of two ropes into four (low density - Ldens) and e) combining six ropes into three (high density - Hdens). The number of mussels in each rope was not controlled, but there were around 500 individuals per rope. Three ropes of mussels remained in the water untreated and served as controls. All treatments were performed on the same day and the ropes were randomly returned to the water.

In May 50 mussels from each of these ropes were harvested and conserved in formaline. All ropes from the freshwater treatment and one from each of the low density and the high density treatments were lost, either because of missing labels or because they fell from their support. On the same day, two new treatments (abrasion and air exposure) were performed with the other ropes that stayed immersed since January. A power analysis was performed to verify how many samples (mussels) would be necessary to find similar results obtained from the initial sample of 750 mussels (50 from each of 15 ropes). The analysis indicated that 20 mussels from each rope were sufficient and hence, in August, 20 mussels were harvested from each of the March and May treatment ropes and the controls. In the laboratory the shells were cleaned and the animals were weighed (fresh weight) and measured (length, width, and thickness).

Data analysis: One–way ANOVAs were used to compare the size and weight of treatments with controls. Size and weight were not transformable to a normal distribution, so groups of 10 mussels were randomly selected from different ropes of the same treatment. Means were calculated for each group of 10 mussels and these means were then used in the ANOVA. The analysis of May samples included 10 or 15 replicates while analysis of August samples included 10 replicates with 4 or 6 mussels in each one, depending on how many ropes were recovered. Dunnett's test was used to compare all treatments with controls (Sokal and Rohlf, 1981).

RESULTS

Mussels treated at 2 months and measured 2 months later showed no difference from controls (Fig. 1). However, when measured 5 months later, mussels from all treatments, except abrasion, had reduced size and weight compared with control (Fig. 2; Table 1). Abrasion favored growth in 2-month-old mussels compared to other treatments (Fig. 2) but on 4-month-old mussels it produced the opposite effect (Fig. 3). All mussels treated at 4 months and measured 3 months later showed reduced size and weight compared with control mussels (Fig. 3; Table 1).

DISCUSSION

The encrusting community on cultivated mussels at Penha is formed mainly by hydrozoans, tunicates and sponges. Barnacles are also important during part of the year. A myriad of vagile animals also live inside the structure formed by the combination of mussels and associated organisms. Despite the first prediction that competition would be important, our results showed that neither the elimination of epibiosis, nor the reduction of mussel densities was associated with increased growth of the mussels. Cleaning treatments seemed to be unimportant both during the growth season (first months) and during the fattening season (last months). In this region, cultivated mussels reached commercial size at 8 months of submersion; thus our first measurements were at the middle of the growth period and the last measurements at the end. This showed that it was better to not remove the ropes from the water during the entire period of cultivation, because the mussels were larger and heavier at harvest.

All treatments used in this study were in fact mixed treatments to some extent because the ropes were always exposed to the air during each manipulation. Air exposure is one of the most used treatments to clean cultivated mussels. Monteiro and Silva (1995) used exposure to the air to reduce epizoans in Rio de Janeiro. In their study, size, weight, and condition index were monitored over six months and did not differ between treatments and controls. In another mussel culture, Freitas (1997) observed a slight reduction of mussel size due to air exposure. Both studies included frequent exposure to air and did not show increase in treatment mussels compared with controls. It seemed that either the treatment was not efficient to reduce epibiosis, or the exposure itself reduced mussel productivity. Air treatment always reduced the size and weight of the mussels compared with controls. Even if performed only once, it was difficult to imagine that this treatment could increase epibiosis during the following months. When collected at 7 months, the treatment ropes were visually monitored for epibiosis and they had no more epibiosis than the control ropes. Thus, air exposure seemed to affect the growth of the mussels in a more important way than competition with the encrusting community does.

The abrasion treatment that could effectively insure mortality of the epibiosis and cleaning of the shells did cause an increase in mussel productivity compared with air treatment, when performed in two-month-old ropes (Fig. 1 e 2), showing that interspecific competition could be important in this culture. On the other hand, controls had still larger animals than either of these treatments.

Our conclusion therefore, was that the associated fauna did not accumulate in quantities large enough to cause competition, at least in Penha. Alternatively, we hypothesized that intra-specific competition instead could have an important effect in mussel growth. This hypothesis was also not supported and even the ropes with reduced mussel density resulted in smaller animals than in the control.

In many regions of the world competition is a major cause of reduced growth in cultivated bivalves hanging from racks (Arakawa, 1990). On the other hand, Lesser et al. (1992) showed that cultivated *Mytilus edulis* had higher feeding rates for all particle sizes and types tested, than its major competitors on rope cultures. That study showed selective feeding on small phytoplankton (3-5µm) whereas the major encrusting epizoans preferred large phytoplankton (> 16 µm). Their conclusion was that for mussel rope culture, it appeared that in the absence of significant food limitation, mussels should always do better in regard to feeding.

The river Itajaí-açu is probably the major source of organic and inorganic particles for this mussel culture. It discharges 20km south of Penha and its plume disperses northward. Nitrogen, organic compounds and inorganic ammonia and phosphates are released from the estuary. The re-suspension of sediment from the bottom is also important for this mussel culture. Chlorophyll-a increased over three years but still was at half the values found in cultures in Canada and Europe, thus indicating the oligotrophic character of the water in Praia Grande do Itapocorói beach (Chevarria, 1999). The small amount of food could explain why associated fauna did not accumulate as much on mussel shells. On the other hand, resources were probably not low, nor limiting as suggested by the lack of intraspecific competition in this culture. In some circumstances epibiosis may benefit hosts because it stimulates growth of the border of the shell (Arakawa, 1990) or provides protection from predation (Vance, 1978). Because of this, Arakawa (1990) suggested that no treatment should be performed during the growing season.

Thus we predicted that our May treatments (4-month-old mussels) of reduction of epizoans to result in the best growth of mussels, because leaving the encrusting fauna during the first months of culture would stimulate growth. However, this prediction was also not supported; comparing the abrasion treatment between Figs 2 and 3, the opposite trends for the expected length, thickness and weight indicated that epizoans were not beneficial in this culture.

In this study we did not address possible effects of epizoans on mortality rate, but this could be another type of prejudicial effect. Dislodgement of the mussels caused by increased weight (Waterstrat et al., 1980) or drag force (Witman and Suchanek, 1984) remains to be investigated. Witman and Suchanek (1984) also pointed out that mussels living in protected sites were usually less attached to the substrate and suffered the higher risk of dislodgement when submitted to strong currents. Since mussel cultures are grown at protected sites, unusual events of strong waves and water currents could dislodge many animals and it would be necessary to study if epizoans could increase this amount of dislodgement.

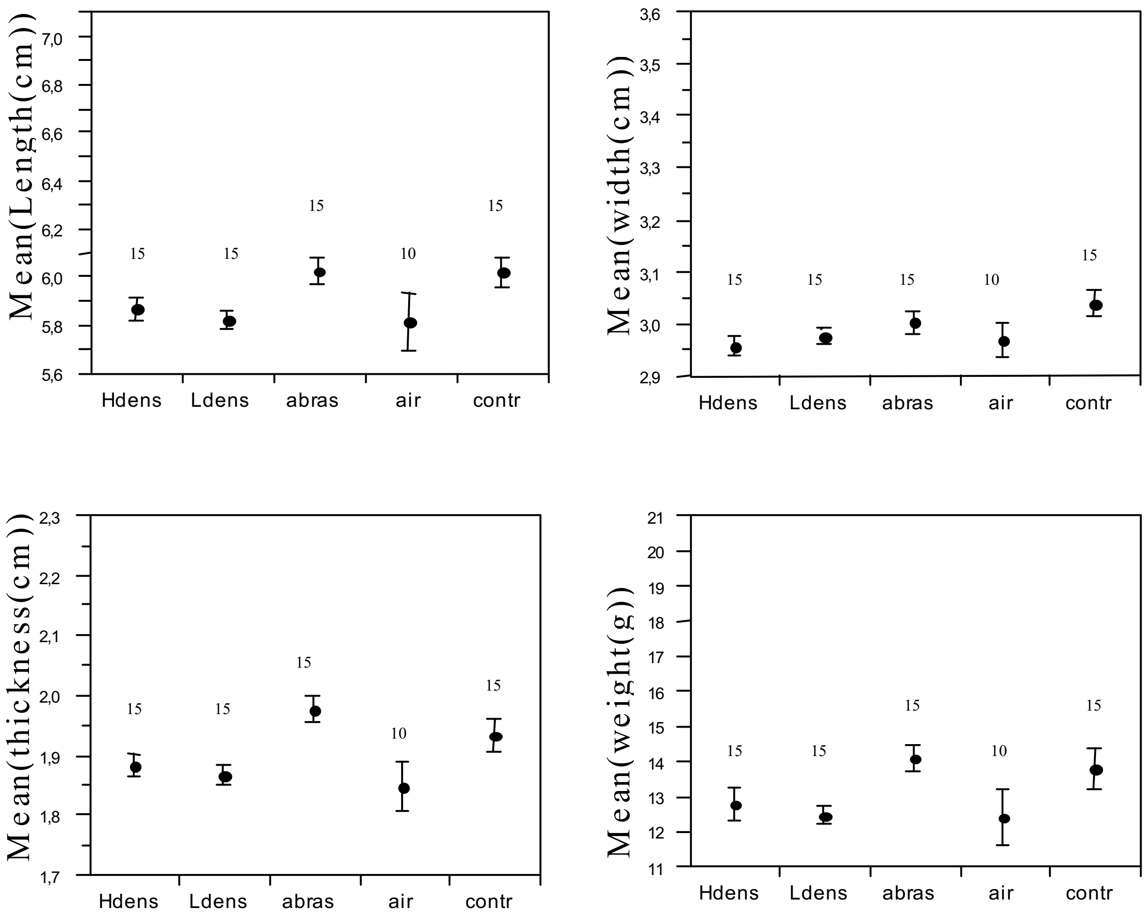

Figure 1 - Size and weight of 4-month-old mussels treated when they were 2-months-old. Means (± 1 standard error) and number of replicates are shown. Treatments: Hdens = double density; Ldens = half density; abras = abrasion; air = air exposure, and contr = control.

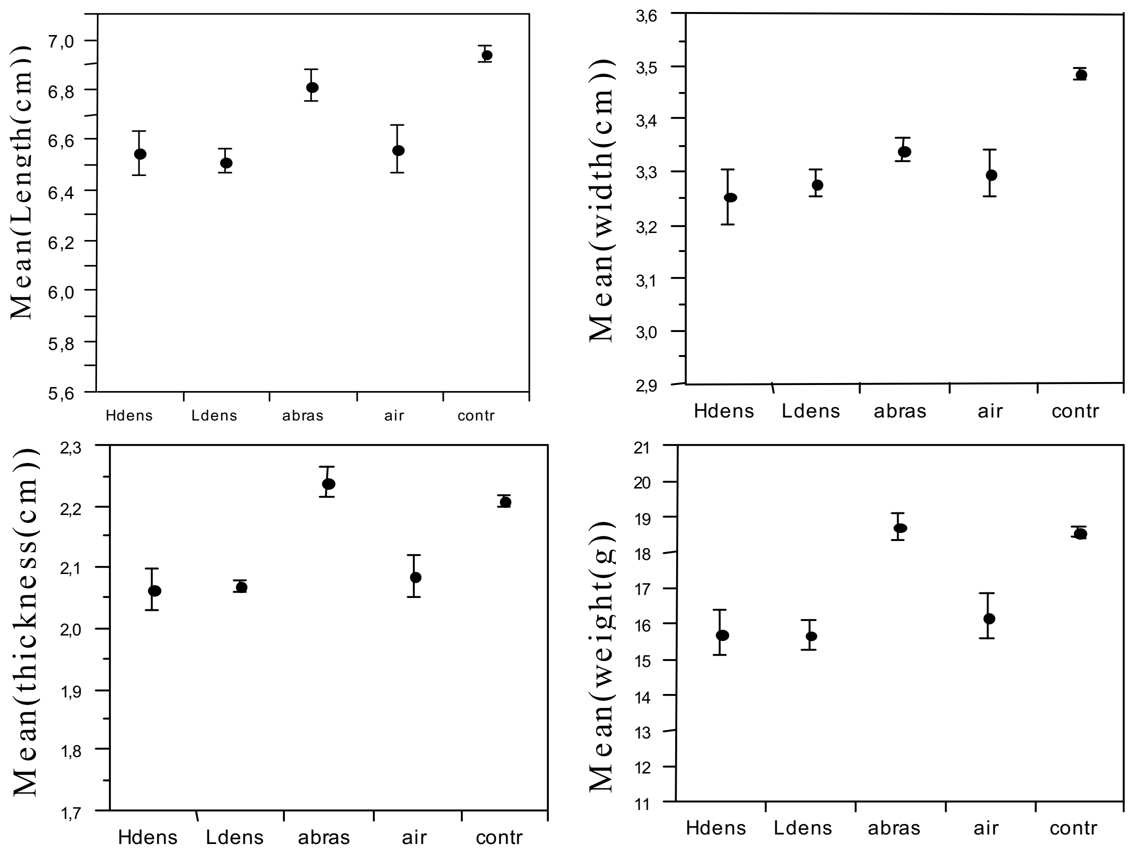

Figure 2 - Size and weight of 7-month-old mussels treated when they were 2-months-old. Means (± 1 standard error) are shown. All treatments had 10 replicates. Treatments: Hdens = double density; Ldens = half density; abras = abrasion; air = air exposure, and contr = control.

Table 1 - ANOVAs and Dunnet's comparisons between mussels treated at 2 months and 4 months and observed at 7 months with control. No differences were observed at 4 month-old mussels, and so these results are not shown here. All ANOVAs had $p < 0.05$. DF indicates degrees of freedom, * indicates significant difference at α=0.05 (+ higher or – less than control) for Dunnet's comparisons, NS indicates no significant results, and NP indicates that the treatment was not performed.

		ANOVAs	Treatments (Dunnet's test)			
Treatment	Variables	F (DF)	Low Density	High Density	Abrasion	Air
2 months	Length	4.24 (4, 45)	* (-)	* (-)	NS	* (-)
	Width	6.51 (4, 45)	* (-)	* (-)	* (-)	* (-)
	Thickness	6.15 (4, 45)	* (-)	* (-)	NS	* (-)
	Weight	4.33 (4, 45)	* (-)	* (-)	NS	* (-)
4 months	Length	10.77 (2, 27)	NP	NP	* (-)	* (-)
	Width	24.87 (2, 27)	NP	NP	* (-)	* (-)
	Thickness	8.00 (2, 27)	NP	NP	* (-)	* (-)
	Weight	5.35 (2, 27)	NP	NP	* (-)	* (-)

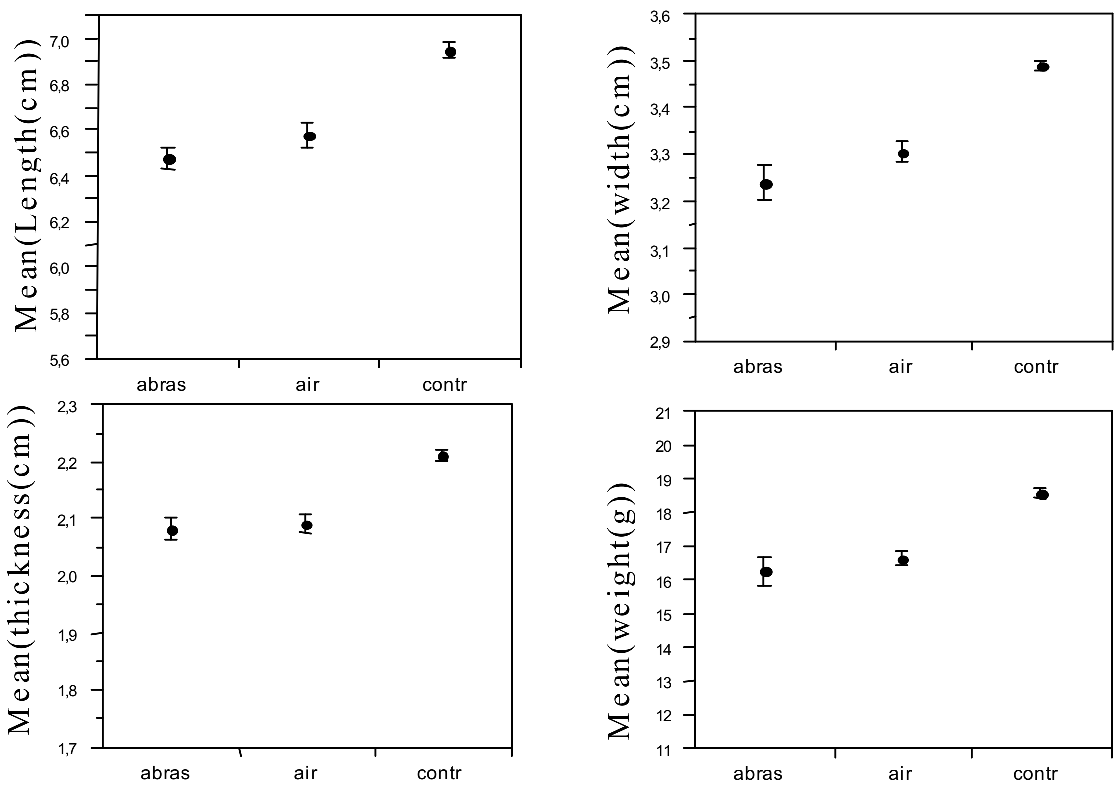

Figure 3 - Size and weight of 7-month-old mussels treated when they were 4-month-old. Means (± 1 standard error) are shown. All treatments had 10 replicates. Treatments: Hdens = double density; Ldens = half density; abras = abrasion; air = air exposure, and contr = control.

In conclusion, less dense or cleaned mussel ropes showed no increase of mussel size or weight when compared with controls. Therefore, there was no need to spend time and money to eliminate epizoans in this culture.

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RESUMO

Foi realizado um estudo no cultivo de mexilhões *Perna perna* no município de Penha, SC para testar alguns tratamentos de limpeza da fauna associada e qual seu efeito no crescimento dos mexilhões. A abundância da mesma foi reduzida por meio de: a) exposição das cordas de cultivo ao ar por 6h e b) abrasão das conchas por fricção entre elas. Competição intraespecífica foi testada de duas maneiras: a) reduzindo a densidade de mexilhões pela metade e b) dobrando-se a densidade de mexilhões em cada corda. Três cordas foram mantidas no mar como controle. Os tratamentos foram realizados duas vezes, em cordas de 2 meses e 4 meses. Tanto no quarto como no sétimo mês de cultivo, foram coletados mexilhões em cada corda, pesados e medidos (comprimento, largura, e espessura).
A análise de variância mostrou que nenhum dos tratamentos resultou em maior crescimento ou

ganho de peso dos mexilhões em relação aos controles. Assim, sugere-se aos cultivadores desta região que não há necessidade de nenhum tipo de manutenção nas cordas anterior à retirada dos mexilhões para comercialização.

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