U. cordatus (Decapoda: Ocypodidae) restocking programs: Does the release of more developed youngsters into natural environments reduce mortality rates caused by interspecific relations?

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ABSTRACT

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In restocking programs of the mangrove crab *Ucides cordatus* presently being developed in Brazil, the releasing of cultivated youngsters in mangrove areas is carried out when they reach the megalopa phase. The aim of our study was to investigate if releasing more developed *U. cordatus* young forms could reduce mortalities related to interespecific predation. A preliminary estimate over crab community structure in a target area of restocking program was performed indicating a great dominance of fiddler crabs (Genus Uca). Based on this information, we conducted experiments accessing the social relation between *U. cordatus* megalopae and juveniles and fiddler crabs of different size classes, in the presence of mangrove sediment, simulating natural conditions, as well as in absence of any kind of refuge. We observed that fiddler crabs not only can compete with, as they can also prey on *U. cordatus* young forms both in megalopa and juvenile phase. Furthermore, it was observed that predation behavior of fiddler crabs on *U. cordatus* youngsters is exerted only by individuals with carapace width larger than 0.5 cm. The results of our assay simulating natural conditions showed that, even when sediment was provided as refuge, the same pattern was observed, with survivorship rates significantly lower in presence of genus Uca crabs. Finally, the results of our work have shown that the release of young forms during the juvenile phase, specifically on stage 1, did not significantly reduce mortalities due to interspecific relations.

KEYWORDS: *Predation, Fiddler crabs, sediment, releases.*

INTRODUCTION

The mangrove crab *Ucides cordatus* (Linnaeus), locally known as "caranguejo-uçá", has a wide geographical distribution along the western Atlantic, from Florida (USA) to the Brazilian state of Santa Catarina. This crab is considered as an important fishery resource for local populations throughout the Brazilian coast, particularly those surrounding estuarine systems (Glaser 2003).

In Brazil, efforts on the development of an *U. cordatus* restocking technology have been carried out since 2001. The consolidation of this technology has recently gaining importance among scientific community after the register of mass mortality events in the northeastern and southeastern Brazil (Silva et al., 2006). These events, caused by the Letargic Crab Disease (DCL) (Boeger et al. 2005; Schmidt, 2006), added to other factors, such as overexploitation and mangrove habitats degradation, have contributed to a drastic depression on natural stocks of *U. cordatus.*

A basic technology for *U. cordatus* larviculture is already known and restocking programs have been able to produce more than 1,000,000 megalopae per reproductive season (Silva et al. 2006). In the other hand, the post release knowledge must be improved. The behavior of the released larvae and their relation to natural factors, such as interspecific competition and predation is one of the important issues that must to be further evaluated.

Currently, *U. cordatus* youngsters produced by restocking programs are released when they reach the megalopa phase. The aim of our study was to investigate if survivorship rates of *U. cordatus* youngsters are significantly affected by the relationship to crabs of other species after the release into the natural habitat.

Furthermore, we investigated if the releasing of more developed young forms could reduce mortalities related to competition/predation factor.

MATERIALS AND METHODS

Initially, we estimated the population structure of crab communities of a mangrove target area for the restocking program, before realization of any releases. The target area is located in Santo Amaro, state of Bahia, Brazil. The population structure estimation was carried out using a wood quadrant with dimensions of 0.4x0.4x0.2m. This quadrant was randomly thrown over the mangrove area. A 15cm deep layer of sediment was removed from the area delimitated by the quadrant and sieved at the laboratory. Five samples were collected at the site and all the collected crabs were identified and had its carapace width (CW) measured.

Based on the results of this estimate, two experiments were developed. These assays were carried out in an environmental room under controlled temperature (26^{o}C) and photoperiod (16:8 h LD cycle).

The first experiment was performed to determine how fiddler crabs (genus Uca) of different size classes could affect the survivorship of *U. cordatus* youngsters in the megalopa and the juvenile phase. As experimental units, clear transparent plastic vials, with dimensions of 11x11x5cm, containing 0.5L of salt water were used. Treatments are described below. For convenience, they will be nominated as follows:

M control – Five *U. cordatus* megalopae
J control – Five *U. cordatus* juveniles
M 0-0.5 – Five megalopae + one 0-0.5cm genus Uca crab
J 0-0.5 – Five juveniles + one 0-0.5cm genus Uca crab
M 0.5-1 – Five megalopae + one 0.5-1cm genus Uca crab
J 0.5-1 – Five juveniles + one 0.5-1cm genus Uca crab
M 1-1.5 – Five megalopae + one 1-1.5cm genus Uca crab
J 1-1.5 – Five juveniles + one 1-1.5cm genus Uca crab

All treatments, including control groups were tested with five replicates. No food was supplied. After 24 hours, the survivorship rate of the *U. cordatus* young forms and of fiddler crabs was determined.

Finally, two assays simulating natural conditions were developed in laboratory, one with *U. cordatus* youngsters in the megalopa phase and other with juveniles. The experimental setup was the same for both assays. Ten transparent plastic boxes, with dimensions 20x32x25cm, provided with an individual draining system were used as experimental units. In this set of experiments, mangrove sediment was used as substrate. The bottom of the boxes was covered by a 7cm layer of sediment, to simulate natural refuge. Marine water (salinity 35, filtered with 0.5 micrometer sand filter, sterilized by UV device) was individually provided to all units.

The fiddler crabs were released in the experimental units at the following proportion: 2 individuals 0-0.5cm size; 5 individuals 0.5-1cm size and one 1- 1.5cm size. These densities were determined taking in account the results of the crab communities structure estimations priorly performed in the restocking target area*. The U. cordatus* young forms were only released in the following day. The water level was raised until the submersion of the sediment surface and all units (control group, containing only mangrove sediment and treatment, containing fiddler crabs) received 20 *U. cordatus* youngsters. The water level was maintained during first 3 hour after the release of *U. cordatus* and then completely drained.

Daily, the water level inside all units was raised over sediment surface during 3 hours to simulate tide. During this simulation period, newly hatched artemia nauplii were provided at a density of 0.3 individual.ml^{-1}. After 20 days, the experiment was ended and all the sediment of each unit was carefully sieved. Fiddler crabs and *U. cordatus* youngsters found alive were counted and the survivorship rates were determined.

RESULTS

Estimate of the structure of crab communities

A total of 104 crabs were captured in the 5 samplings: 100 belonging to genus Uca (average size: 0.75cm, σ 0.29cm), 3 *U. cordatus* (size 0.8; 1cm; 1.3cm) and 1 *Aratus pisoni* (size 0.7cm). In three of the samples, only fiddler crabs were identified. Carapace width (CW) distribution of frequency about fiddler crabs identified in all samples is described on figure 1. No significant differences (p>0.05) were detected between the samples in relation to abundance of genus Uca crabs in the different CW classes.

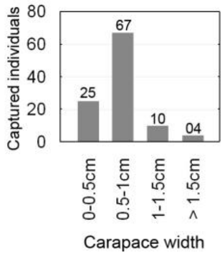

Figure 1 - Frequency distribution of carapace width (CW) of all fiddler crabs collected in a target area of *U. cordatus* restocking program, before the releases.

Fiddler crabs relationship to *U. cordatus* *youngsters*

All fiddler crab individuals released into the units have survived the entire experiment. No differences between survivorship rates of *U. cordatus* megalopae and juveniles were observed in any treatment and in the control groups. Survivorship rates of *U. cordatus* young forms observed in control groups were not significantly different of those obtained in treatments M 0–0.5 and J 0-0.5. However, survivorship rates of treatments M 0.5–1cm, J 0.5-1, M 1–1.5 and J1-1.5 were lower (n = 40, F = 28.62, p>0.0001) than control groups. In the treatments where predation were observed, no remains of dead *U. cordatus* youngsters were found after only 24 hours, indicating predation by the fiddler crabs.

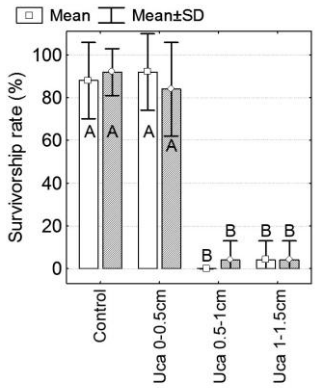

Figure 3 – Effect of presence of fiddler crabs of different carapace sizes on the survivorship rates of *U. cordatus* youngsters in a small environment without refuges White bars represent treatments using megalopae and gray bars represent juveniles survivorship rates.

Assays simulating natural conditions

Survivorship rates observed for *U. cordatus* megalopae as well as for juveniles in the treatments occupied by fiddler crabs were significantly lower (N=20, F=10.35, P=0.0004) than observed for both in the control groups. No significant differences (p>0.05) were detected between control groups, neither between the treatments.

DISCUSSION

The results of our estimate about the structure of crab community have shown a great dominance of fiddler crabs (Genus Uca) in the studied location. The abundance of these crabs in Brazilian mangroves had already been described by other authors (Masunari, 2006, Silva, 2007).

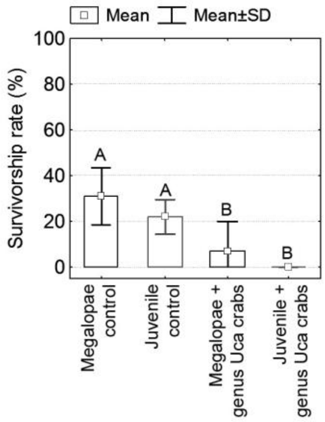

Figure 2 – Effect of presence of fiddler crabs on the survivorship rates of *U. cordatus* youngsters in a natural refuge simulating environment..

The diet of fiddler crabs are based on benthic microflora, such as bacteria, diatoms and blue algae associated to organo-mineral substrate (Crane, 1975). These crabs are commonly cited as prey for a set of animals such as mammals, birds and fishes (Masunari, 2006) and even as competitor to *U. cordatus* settlers (Silva, 2006). However, no reports about predation behavior of fiddler crabs were found in literature. Our results showed that fiddler crabs play an important role as predators of *U.cordatus* crab settlers. We observed that these crabs can actively prey on *U. cordatus* young forms both in megalopa or juvenile phase.

Burrowing is commonly cited as an important behavior to avoid predation of post-larvae of many aquatic organisms, including *U. cordatus*. Dittel et al. (1996.), studying interspecific relations of *Chasmagnatus angulatus* and *C. granulate,* report that a important factor to influence on mortalities due to predation on settlers is the access of the predator to the prey refuge.

In our first assay about predation, no substrates were provided to *U. cordatus* youngsters, not enabling them to burrow or hide. Therefore, it is possible that mortality rates registered in this experiment were much higher than it would be observed in natural conditions. In the other hand, the results of our assay simulating natural mangrove habitats showed that, even when sediment was provided as refuge, a similar pattern is observed, with survivorship rates significantly lower in presence of fiddler crabs. Based in these results, it is possible to suggest that in natural environments the predation exerted by fiddler crabs is a key factor influencing on *U. cordatus* recruitment.

Furthermore, the results of our work showed that the release of young forms during the juvenile phase, specifically on stage 1, did not significantly reduce mortalities due to interspecific relations. In both assays, conducted without any substrates and that simulating natural conditions, juveniles showed survivor performances similar to individuals in the megalopa phase.

One of the most important patterns observed in our work pointed that predation of fiddler crabs on *U. cordatus* young forms was exerted only by individuals with CW larger than 0.5 cm. This pattern is a clear indication that size difference between fiddler crabs and *U. cordatus* young forms (first instar crab CW = 1.71mm, Dielle, 2000) is a limiting factor of predation.

Considering that most fiddler crabs found in the studied area were smaller than 1cm, it is possible to hypothesize that releasing *U. cordatus* juveniles with larger CW could be a possible way of reducing mortality rates related to predation by fiddler crabs.

Considering the results of our assays, we recommend that *U. cordatus* restocking programs consider the implementation of a secondary rearing phase, in which juveniles could achieve suitable size to protect themselves from predation, with the aim of improving the effectiveness of the restocking. Furthermore, investigations of optimum release sizes of *U. cordatus* juveniles still need to be developed to determine for how long this second rearing phase should last, considering the natural low growth rate of *U. cordatus*.

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