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The effect of salinity on larval development of the spider crab *Libinia spinosa* (Brachyura, Majidae) reared in the laboratory

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ABSTRACT

Ovigerous females of *Libinia spinosa* were collected in the oceanic region adjacent to the Patos Lagoon and were maintained in the laboratory at 20°C and 30 PSU until spawning. After hatching larvae were transferred to compartmented plastic boxes of approximately 25 ml with filtered sea water of different salinities (25, 30 and 35 PSU) and kept under photoperiod of 12 h light: 12 h dark. Water was changed every other day, and larvae were checked daily to assess molt and death rates. Larvae were fed *Artemia* sp. nauplii newly hatched. Survival to megalopa was higher at salinities of 30 and 35 than at salinity 25. Although larvae reached megalopal phases in all three salinities mortality was 100% during this phase. Salinity had no effect on duration of zoea stage I whereas development of zoea II was significantly delayed in the lowest salinity tested. The results obtained were compared to other species of the same genus which were maintained under similar conditions. Nevertheless, there is a difference between the larval development length reported in another study for this species, where the mean length of larval stages was longer.

1 INTRODUCTION

Salinity is one of the factors that may influence larval development in aquatic ecosystems. Salinity effects have been reported for larvae of several decapod species. A change in salinity can modify developmental pathways and behavior of decapod larvae (Criales & Anger 1986, Forward 1989). The minimum change in salinity necessary to induce behavioral response can vary ontogenetically within a species. The response to differences in salinities will depend on the salinity regime experienced by individuals in their natural habitat (Costlow & Bookhout 1962, Sastry 1983, Foward 1989, Anger et al. 1998).

The present study deals with the larval development and the effect of salinity in the spider crab, *Libinia spinosa*, under laboratory conditions. This species is distributed from Brazil (Espirito Santo State), to Argentina (Santa Cruz State) (Souza 1994). Ovigerous females are found throughout the year along the southern Brazilian coast and larval hatching occurs in all seasons, with a larval peak in spring and summer

(Hereu 1999). Larvae may be exposed to reduced salinities with higher influence of continental water discharges from the Patos Lagoon and La Plata River estuaries during winter and spring months.

2 MATERIAL AND METHODS

A female of *Libinia spinosa* carrying eggs in advanced stages of embryonic development was collected in the oceanic region adjacent to the mouth of Patos Lagoon estuary. It was maintained at laboratory temperature (20°C) and local salinity (30 PSU) until larval hatching.

Four days later, newly hatched larvae in first zoeal stage were transferred to compartmented plastic boxes of 25 ml capacity with filtered sea water. Experiment was conducted with larvae in three salinities: 25, 30 and 35. Larvae tested at 25 and 35 were kept previously in intermediate salinities for a couple of hours until exposed to the final salinity. Larvae were fed *ad libitum* on *Artemia* sp. nauplii newly hatched. Checking for molts and deaths was done every day and change of water every other day. It was maintained at a 12L:12D regime and a constant temperature of 20°C during the experiment.

A one way ANOVA was employed to test treatment effects and when significant differences were detected, a Tukey's test of comparison of means complemented the analysis. Survival data to megalopa the phase were compared applying a Chi-square test (Sokal & Rohlf 1981).

3 RESULTS

The effect of salinity on survival of larval stages of *Libinia spinosa* is shown Table 1. Mortality was significantly higher at salinity 25 ($p = 0.00$), where 47.8% molted to zoea II and only 6.8% molted to a megalopa stage. Higher survival was obtained in the highest salinities tested: 75.9% of zoea I molted to zoea II and 51.7% attained mega-

Table 1. *Libinia spinosa* survival and development times of larval stages in three salinities tested. n_0, initial number of larvae; $X \pm SD$, mean duration and standard deviation (in days); x_m *e* x_M, minimum and maximal duration of larval stage; n, number of larvae that reached next stage; % S, survival percentage from initial number of larvae. ZI, zoea I; ZII, zoea II; M, megalopa. Same letters means no differences in mean duration of larval stages (Tukey Test, $\alpha = 0.05$).

Stage	N_0	25 88	30 87	35 88
Z I	$X \pm SD$	$5.3 \pm 0.5\ a$	$5.1 \pm 0.4\ a$	$5.3 \pm 0.6\ a$
	x_m-x_M	5-7	5-6	5-7
	N	42	66	66
	% S	47.8	75.9	75
Z II	$X \pm SD$	$6.0 \pm 0.6\ b$	$4.9 \pm 0.5\ a$	$5.1 \pm 0.5\ a$
	x_m-x_M	5-7	4-6	4-7
	n%	6	45	57
	S	6.8	51.7	64.8

lopa in salinity 30 and in salinity 35, 75% molted to zoea II and 64.8% molted to megalopa. The megalopae lived for a longer period in salinities of 30 and 35, but in salinity of 25 they survived only for 2 days.

Duration of development did not show differences within the salinities tested during first zoeal stage ($p = 0.08$). Mean duration of zoea I was 5.3, 5.1, and 5.3 days in salinities 25, 30, and 35, respectively. Nevertheless, developmental time of zoea II in the lowest salinity tested was significantly longer ($p = 0.00$) than in salinities 30 and 35, with mean duration of 6.0, 4.9 and 5.1 days, respectively (Table 1).

4 DISCUSSION

It was verified that the effect of salinity on development of larvae of *Libinia spinosa* was that survival in salinities 30 and 35 were higher than in salinity 25. At this salinity survival was higher in zoea stage I but decreased abruptly in zoea stage II and, although megalopa stage was reached, larvae survived only for two days. In other species with larvae developing in coastal or oceanic waters, development is not affected in the lower range of higher salinities, whereas larvae from estuarine or brackish waters show a more euryhaline response and tolerate a wider range of salinities. In natural habitats, larvae of *Libinia spinosa* are found in coastal areas where surface salinities can be lowered with higher runoff of continental waters from the Patos Lagoon estuary. A migratory pattern in the water column during larval development may be an important way to allow the presence of larvae in an area with such characteristics. Nevertheless, larval abundance decreases when higher runoff of continental waters and lower temperatures occur, mainly in winter (Hereu 1999).

Total mortality of megalopae in all three salinities may indicate deficiencies in culture conditions to this stage, such as quality of food source, the absence of an adequate substrate, or chemical stimuli to allow megalopae molt to first crab stage. For megalopae of *Libinia emarginata* better survival rates were obtained when fed on a diet based on *Artemia* nauplii with a supplemental food source such as rotifers and algae (Bigford 1978). Anger et al. (1989) studying development of *Libinia ferreirae* reported an extremely high mortality at metamorphosis that continued in the juveniles, and they concluded that causes could be inadequate food quality and the absence of a particular substrate. Harms & Anger (1990) observed that for the megalopa stage of the spider crab *Hyas araneus* survival was strongly affected by nutritional conditions.

Salinity effect on development duration was not so strong. Development of the zoeal phase lasts 10-11 days, and larvae would stay in the water column for about 20 days until metamorphosis to crab I. Boschi & Scelzo (1968) reported for the same species an average duration of 8-10 days for each zoeal stage and 20-30 days required to reach first crab. The longer period for larval development observed by the authors may be typical for this species that develops in colder waters at higher latitudes.

Duration of development also varies within the genus *Libinia*, being in general shorter for *L. spinosa* than that usually reported. *Libinia erinacea* required 14 days or 9 days to reach first crab stage at 20° and 25°C, respectively (Yang 1967 in Johns & Lang 1977). For *L. emarginata*, the duration of pelagic phases until the first crab

stage reported was 14 days in rearing conditions of 20° and 25°C and 30 of salinity (Jhons & Lang 1977). Bigford (1978) reported for the same species a period of about 10 days until the megalopa, and about 16-19 days to reach first crab stage in the same conditions of salinity and temperature and varying food concentrations. Anger et al. (1989) found that larvae of *L. ferreirae* required about 15 days to complete larval development at 25°C, whereas *L. dubia* required only 9 days (Sandifer & Van Engel 1971). This shortness of developmental time in this species may have been in part due to the higher temperature of culture (25.5°-28.5°C).

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