ECOLOGICAL VIEW OF LIMB REGENERATION IN THE MANGROVE CRAB GONIOPSIS CRUENTATA (LATREILLE 1803) (CRUSTACEA: BRACHYURA: GRAPSIDAE), MACEIÓ, ALAGOAS, BRAZIL.

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INTRODUCTION

Studies focusing regeneration are incomplete without considering autotomy (Maginnis 2006). According to this author, autotomy is the process of limb loss, allowing multiple benefits to an organism (the most prevalent is predator avoidance), commonly improving the immediate survivorship. Factors such as contact with toxins and pesticides, long limbs stuck in crevasses during foraging, crabs harvest by fisherman, cannibalistic attacks and intra and interspecific may also promote shed of appendages.

Regeneration is the physiological process to form a new limb, as a way to maintain the fitness of an individual on its habitat. According to Hopkins (2001), regeneration is a special type of growth found in many crustaceans, and occurs in two phases: the basal growth, immediately following the limb loss, and the proecdysial growth, that occurs when the animal is preparing for the ecdysis. Regenerative process vary widely across and within taxa (Maginnis 2006). According to Chapple and Swain (1990), regenerated appendages are commonly adequate to reestablish some of the locomotor, foraging, reproductive, and/or metabolic disadvantages caused for the lost of the limb.

In arthropods, limb regeneration occurs upon molting, and crabs require a number of molts before full limb length is restored (Smith & Hines 1991; Hopkins 1982). Its successful is hardly influenced for the number of limbs lost (Davis *et al.*, 005; Juanes & Smith 1995), and also for environmental factors such as temperature (Weis 1976).

Fibroblast growth factors' releases is assumed to be important to the successful of the regeneration, since start a cascade organization and positional signals necessary to this process. An active molt hormone - secreting organ may also play a role. According to Hopkins (2001), the hormones that control molt are the same that control limb regeneration, directly influencing molt cycle. This interdependency was observed to the land crab Gecarcinus lateralis (Fréminville, 1835) for Skinner & Graham (1972) and Holland & Skinner (1976). Regenerative process may also affect reproduction, such as decreased fecundity of an individual (Maginnis 2006).

The red mangrove crab Goniopsis cruentata is commonly found in mangrove areas, on the upper beach, in burrows or between mangrove roots, occupying most of the microhabitats in the mangrove ecosystem (Cobo & Fransozo 2003).

OBJECTIVES

The aim of the present investigation is to point out the ecological consequences of limb regeneration in the crab G. cruentata (Latreille 1803), proceeding a preview study realized with this species in the same area.

MATERIAL AND METHODS

Collections were accomplished monthly from August/2007 to July/2008 during low tides in a mangrove area of the Mundaú/Manguaba Estuarine Lagoon Complex (35º42'30"-35º57'30"W and 9º35'00"-9º45'00"S) (Calado & Sousa 2003). The crabs were captured by hand and placed into containers filled with alcohol 70%. Salinity and water temperature were measured with a salinometer and a toluene thermometer, respectively. In the laboratory, the crabs were counted, sexed according to abdomen morphology, and had their carapace width measured. The Individuals with Regenerating Legs (IRL) were distributed into 9 size classes (12mm— 16mm to 44mm — 48mm) and month by month. The Chi - square test (χ^2) was used to search for significant differences in the sex ratio (males:females) among the size classes, temporally and also to compare the total number of males and females. The temporal frequency of IRL was correlated to salinity and to water and air temperatures.

RESULTS AND DISCUSSION

A total of 1123 crabs were collected (571 males and 552 females). Males ranged from 12,0 to 43,5 mm, showing a higher mean carapace width ± SD (28,66 ± 5,39 mm). Females varied from 12,6 to 42,45 mm, with a medium size of 27,72 ± 4,84 mm.

The overall sex ratio was around 1:1 (ratio = 096; χ^2 = 0,32, d.f = 1, p < 0,05) and so the population is assumed to be at equilibrium (Góes & Fransozo 2000; Pianka 1995). Considering the temporal distribution, the sex ratio for each month did not differ significantly, except for August (ratio = 1,51;1, χ^2 = 4,72, d.f = 1, p > 0,05). In the size class distribution, only the class 40—44 mm showed significant difference in the male:female proportion (ratio = 4, χ^2 = 4, d.f = 1, p > 0,05). In the class 44—48 mm, females were not present, and so the ratio could not be obtained.

The IRL is represented for a total of 104 males and 85 females. Males ranged from 14,9 to 44,2 mm, with 29,53 ± 7,05mm as the medium size. Females ranged from 15,9 to 42,1mm, and have a mean size of 28,95 ± 6,16mm. These crabs must have differential growth, since energy source is not enough to maintain the normal growth and regenerate the legs (Skinner & Graham 1972; Holland & Skinner 1976) The overall sex ratio of IRL did not escape from the expected proportion 1:1 (ratio = 1,22, χ^2 = 1,91, d.f. = 1, p <0,05). This result corroborate with Juanes & Smith (1995) that assumed regenerative process as being sex independent. Regarding the size class distribution, only the ratio of the class 40—44 is assumed to be significant different (ratio = 5, χ^2 = 5,33, d.f. = 1, p > 0,05). The frequency of IRL showed to be similar among size classes, and so there is no evidence for size - dependency, such as confirmed for the correlation coefficient to males (r = 0,13) and females (r = 0,007). Males showed a higher proportional frequency of IRL in the class 44—48, what can be just a consequence of the low number of individuals in this size class. In addition, females invest a larger portion of the available energy to the production of eggs, and so cannot attain big sizes as males do.

Considering IRL monthly distribution, except done for February/2008 (ratio = 5,5, χ^2 = 6,23, d.f. = 1, p > 0,05), sex ratio did not significantly differ from the proportion 1:1. There is an indicative of tendency of higher IRL frequency in monthly distribution, since peaks were observed in August/2007, January/2008 and July/2008. This result could be attributed to favorable environmental factors occurring in the respective period. Although, in the present study, the environmental factors analysed are weak correlated to salinity (r = 0,42), water (r = 0,18) and air (r = 0,07) temperatures. The result obtained to temperature do not corroborate to Weis (1976), who assumed this factor as playing a role to regenerative process.

A total of 13 males (12,5%) and 15 females (15,64%) showed regenerating cheliped, what may be caused for intra and interspecific competition. These limbs are specialized to feeding, and for this importance they may regenerate more quickly than less important appendages (Maginnis 2006; Juanes & Smith 1995; Smith & Hines 1991). The autotomy and regeneration of these limbs assume a special importance. According to Juanes & Smith (1995), during this period (autotomy to regeneration) the crab has a decrease on feeding, what directly affect growth and reproduction. The crab also can change its feeding habit. In addition, the species that presents different - sized chelipeds, when the major chela suffer autotomy it may regenerate in a minor chela and the another change into a major one. This mechanism may improve survivorship, since with a major chela an individual can face predators in good conditions and have more successful on predating its prey.

Three males and one female presented regenerating legs in the molt period, evidencing the proecdysial growth described by Hopkins (2001). According to Smith & Hines (1991), the regenerative process may continue molt by molt until the new appendage is completely formed. In the present study, the limb stage of regeneration was not observed.

One male and two females were observed with three regenerating appendages. This low frequency may be a response of higher mortality experienced for those specimens.

Another interesting observation is ovigerous females presenting limb regeneration. In this case, regeneration must directly affect the fitness of the population, since can promote lower fecundity of brooding females (Maginnis 2006). Luppi *et al.*, 1997) observed the autotomy influence on the fecundity in Cyrtograpsus angulatus and Chasmagnathus granulata. Since autotomy and regeneration compete with reproduction for the same energy source, this result can be extend to regeneration.

CONCLUSION

Regenerative process is not sex and size - dependent, varying seasonally, possibly due to variation in environmental factors. Chelipeds regeneration is much faster, for their importance in feeding habits. The crabs with regenerating chelipeds may have decreased feeding and successful on predation. Regeneration may play a role on reproduction, since energy source is the same for both phenomenons.

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