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DELAYED HARDENING IN SOFT SHELL BLUE CRABS

The freshly molted (soft shell) blue crab, *Callinectes sapidus*, is consumed in its entirety and forms the basis for the soft shell blue crab industry in the western Atlantic and northern Gulf of Mexico regions (Otwell and Cato, 1982; Perry *et al*, 1982). Recent innovations and improvements in the design of the biological filter for recirculating seawater systems have made the crab shedding process an economically feasible operation for fishermen and non-fishermen alike and have provided a means of holding crabs away from a natural source of seawater (Manthe *et al*, 1984). In such systems the crabs are maintained until ecdysis and then removed for preparation as a soft shell crab. Since the crabs often molt at night, and can harden to the paper shell condition in 3-4 hours, someone must monitor the holding tanks for freshly molted crabs throughout the evening and early morning hours, thus making the shedding operation labor intensive. In this paper, we report the use of low calcium seawater (LCW) to retard the initial stages of hardening in laboratory-held blue crabs.

METHODS

Blue crabs of 40-120mm carapace width (CW) were collected at Dauphin Island, Alabama and maintained individually in the laboratory in disposable animal cages in artificial seawater at 5-6 ppt and 24-26 °C. The water was changed daily. The crabs were fed four times per week on fish and beef liver until the onset of premolt and then were not fed again. Crabs were considered to be in premolt if apolysis was observed at the lateral edge of the paddle. The normal (control) seawater consisted of Rila@ seasalts dissolved in well water with crushed oyster shell added to each tank. Low calcium water was the same except that the oyster shell was not added. The calcium level in the water was measured with an Orion calcium electrode attached to a computer aided titrimeter calibrated with calcium standards from 10-1000ppm according to the manufacturers recommended methods. The calcium levels were found to be 253ppm in control seawater (pH = 8.2 - 8.3) and 68-90ppm in LCW (pH = 7.4-7.6).

Crabs were checked daily for shed cuticles between 8:00 and 9:00 AM. Molted crabs were removed from the seawater and the phase of postmolt and the texture of the cuticle determined. Crabs that had not hardened were observed several times per day for up to a week, or until the hard crab state was observed. The cuticle was determined to be either soft, leathery, or paper shell as determined by gently pressing the tip of the lateral spins. The crab was categorized as soft if the cuticle was deformable and pressure on the lateral spine resulted in the spine curving or bending anywhere along its length. If the spine bent only at the base and the cuticle had a rough texture, the crab was determined to be in the leathery condition. A crab was considered to be in the paper shell condition if no bending occured in the lateral spine. The carapace width of the old and new exoskeleton was measured, and compared, to give the percent increase in CW (% inc CW = [CW new cuticle-CW old cuticle]CW old cuticle).

RESULTS AND DISCUSSIONS

Blue crabs that molted while in LCW (n = 24) were always found to be in the soft shell or leathery condition several hours after shedding, when examined

the morning after ecdysis. The crabs remained in this condition for at least eight hours after the initial observation time (8:00-9:00 AM). Crabs in control seawater ($n^{5}17$), however, had reached the paper shell condition by the initial observation period, or, if not, were always found to be in paper shell by noon of that day. Although the paper shell condition was finally reached in some crabs held for extended periods in LCW, a truly hardened condition was never attained and in some cases the crabs died within one week after ecdysis. These results show that the initial stages of hardening (paper shell condition) can be delayed by placing the crabs in LCW. Although the effect of the low calcium seawater was considered to be the result of low levels of calcium, it is also possible that the pH of the seawater may have also contributed to the reduced hardening.

Another result of maintaining the crabs in LCW was that the increase in size obtained after ecdysis was significantly greater ($p< 0.01$, F-test) in animals kept in LCW than in normal seawater (Fig. 1). These findings suggest that the cuticular event that physically halts the expansion of the soft cuticle is perturbed in an environment that has low calcium levels. Whether this is a result of: 1) the lack of calcium for enzymatic or cellular activities associated with postmolt tanning, calcification or internal osmotic regulation or, 2) whether it reflects a level of calcium that is too low to support calcification cannot be determined from these data. However, the fact that expansion of the cuticle did stop in the crabs in LCW suggests that it was the initial events of postmolt that were affected by the low calcium levels. Further research will have to be done before we can determine whether one or more of the integumental events of early postmolt are dependent on the presence of calcium. Since *Callinectes* stores little calcium internally and must absorb almost all of the calcium from the ambient seawater (Vigh and Dendinger, 1982; Cameron, 1985), the LCW probably caused a reduction in the calcium levels in the hemolymph, and the epidermal cells.

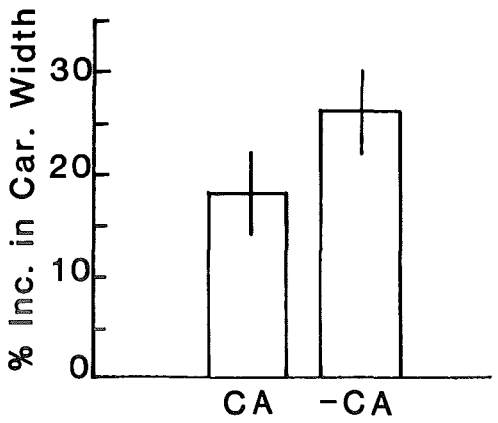

Figure 1. A comparison of postmolt increase in carapace width (spine tip to spine tip) (ordinate) in crabs held in normal (CA) (n = 17) and low calcium (-CA) (n = 24) seawater. Each bar equals mean +/- 95% confidence intervals.

The findings reported here make the use of LCW a potential labor reduction device in the soft shell shedding operation. The fact that the crabs do not enter the paper shell condition for at least eight hours may obviate the need to check the crab shedding tanks at hourly intervals for soft, freshly molted crabs. It is possible, however, that the use of LCW in the recirculating systems may require some modification of the filtering capacity of the system and that potential water quality problems may arise as a result of the lack of the oyster shell to buffer alkalinity (Perry *et al*, 1982; Manthe *et al*, 1984).

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