

Molt sign description of the Pacific blue crab *Callinectes arcuatus* Ordway 1863 (Decapoda, Portunidae).

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Abstract

Brachyuran crabs of the genus *Callinectes* are widely distributed, inhabit coastal waters, and some species are subject of commercial fisheries. One of these commercially exploited species is *C. sapidus*, where recently molted crabs (so-called “soft crabs”) reach a considerably higher price on the market compared to the so-called “hard crabs”. *Callinectes arcuatus* is abundant between Baja California and Ecuador, and may serve as a potential resource for soft crab production. We cultivated in the laboratory for two months a total of 20 individuals of *C. arcuatus* to document molt signs. Photos were taken at least six times per week to document changes in coloration and structure of the propodus and dactylus of pereopod V. Eleven specimens molted; all of them presented a double line, in different degrees of development, on the propodus and dactylus, providing a good predictor of the forthcoming molt. We compare our results to findings reported for *Callinectes sapidus*.

Key words: premolt signs, ecdysis, soft crab, *Callinectes arcuatus*.

Introduction

Species of the genus *Callinectes* are known to occur in a variety of habitats along coastal areas (Williams, 1974). The blue crab *C. sapidus* Rathbun, inhabiting coastal zones along the Atlantic of the Americas, is perhaps the most prominent member of the genus due to its economical importance, especially in the United States (Millikin and Williams, 1984; Stagg and Whilden, 1997). Three species of *Callinectes* occurring along the Eastern Pacific are also commercially exploited (e.g., Ramírez *et al.*, 1996; López and Cosío, 2001). However, their economical impact is considerably lower compared to that of *C. sapidus*. In Costa Rica, *C. arcuatus* Ordway, 1863, is a target for artisanal fishery. The species is distributed between Baja California, Mexico, and Ecuador (Hendrickx, 1995).

Newly-molted portunid crabs (so-called “soft crabs”) are considered a “delicatessen”, with a market price substantially higher than that of hard crabs (Perry and Malone, 1989; Meyer, 2003). Most of the studies regarding soft crabs refer to *C. sapidus* (e.g., Freeman and Perry, 1985; Freeman *et al.*, 1987). In general, changes in the coloration of the propodus and dactylus of the pereopods are used to identify the “peeler crabs”, individuals close to molting (Perry *et al.*, 1979; Otwell *et al.*, 1980). These peeler crabs are separated until they molt; soft crabs are iced, frozen or consumed freshly (Roberts, 1993).

Studies regarding *C. arcuatus* in Costa Rica focused on the Gulf of Nicoya area and are related to reproductive periodicity (De Vries *et al.* 1983), feeding habits (Dittel, 1993; Saucedo, 1997) and population biology (Dittel *et al.* 1985). As far as we know, there are no published reports about the molt cycle of *C. arcuatus*.

Due to the high market value of soft crabs and the existence of almost unexploited *C. arcuatus* populations in Costa Rica, the present study was aimed to determine and document

morphological characteristics which, in time, will allow identifying individuals close to molt. For that purpose, we analyzed the changes of the coloration and structure of the fifth pereopod.

Materials and Methods

Specimens of *C. arcuatus* were collected in the estuary of Río Barranca, Puntarenas, Pacific Costa Rica (9° 57' 42"N, 84° 44' 20"W) and transported to the laboratory of the Centro de Investigaciones en Ciencias del Mar y Limnología (CIMAR), Universidad de Costa Rica, in San José. Individuals were reared individually in plastic cylindrical recipients (16 cm width and 15 cm height) to avoid cannibalism. The water temperature was maintained around 25-26°C, and the salinity at 32 ppt (Díaz, 2002). These conditions resemble those observed in the field. Crabs were fed every other day with commercial dry food for fish. Digital photos were taken from each individual at least six days per week to document changes regarding coloration and morphological structure of the propodus and dactylus of the fifth pereopod. These criteria were selected because they are reliable and widely used indicators that molting is approaching in *C. sapidus* (Oesterling, 1984). The experiments lasted for a total of 56 days. A total of 20 crabs (six males and 14 females, nine of them immature) were maintained in the laboratory. The carapace width of the collected individuals varied between 3 and 10 cm.

Results

A total of seven individuals were still alive after 56 days, including three specimens that molted during the study period. Eleven crabs (nine immature females and two males) molted while maintained in the laboratory. One additional specimen (immature female) died during ecdysis.

The formation of the new cuticle became visible by the appearance of an internal line on both propodus and dactylus of the fifth pereopod, resulting of the separation from the old cuticle (external line), thus forming a double line (Fig. 1). The premolt double line period of *C. arcuatus* can be divided in three phases based on the distance between these two lines as well as the coloration (Table I). These phases allowed us to estimate proximity to ecdysis. Specimens in Phase 1, when the internal line became visibly separated from the external line, required on average 7.9 days to molt, while crabs in Phase 3 molted within 24 hours (Table II).

Discussion

All individuals observed to molt ($n = 11$) presented the double line. Thus, this feature should be used on a general basis to determine the proximity of the forthcoming molt in *C. arcuatus*. Individuals with a CW of 7 – 10 cm did not molt, probably because the intermolt period of these specimens was longer than our study period. Therefore, we cannot provide evidence that the data presented in Table I and II are also valid for larger specimens. However, these molting features are size-independent in specimens larger than 3 cm CW (UNC Sea Grant, 1984) and should apply to larger *C. arcuatus*.

No mature female of *C. arcuatus* molted during the study period. This seems to collaborate similar observations in *C. sapidus*: once an adult, females do not molt again (Oesterling, 1984). However, mature females of *C. arcuatus* can reach sizes considerably larger than those maintained by us in the laboratory (Mena-Castañeda, pers. obs.), which may indicate that the maturity molt is not a terminal molt. The results of the present study do not provide support for this hypothesis, and mature females of *C. arcuatus* need to be maintained in the laboratory for a longer time span than our study period to verify if they do molt after reaching maturity.

Table I: Description of the characteristics used to differentiate the different phases regarding the presence of the double line in the propodus and dactylus of the fifth pereiopod in *Callinectes arcuatus*.

Phase	Characteristics
1	The presence of the new cuticle becomes visible by the appearance of an internal line, forming a double line; both lines are separated by a short distance
2	Clear separation of the two lines; the internal line is dark; the external line (old cuticle) is reddish.
3	Ample separation of the two lines; internal line is thick and blackish; external line is reddish; propodus and dactylus darker than in the previous phase.

Table II: Duration between each phase and the next molt in cultivated individuals of *Callinectes arcuatus*. SD: standard deviation; n: number of observations.

Phase	Duration (days)			
	Average	± SD (n)	Maximum	Minimum
1	7.9	2.1 (9)	11	4
2	3.2	0.9 (9)	4	2
3	1	0 (11)	1	1

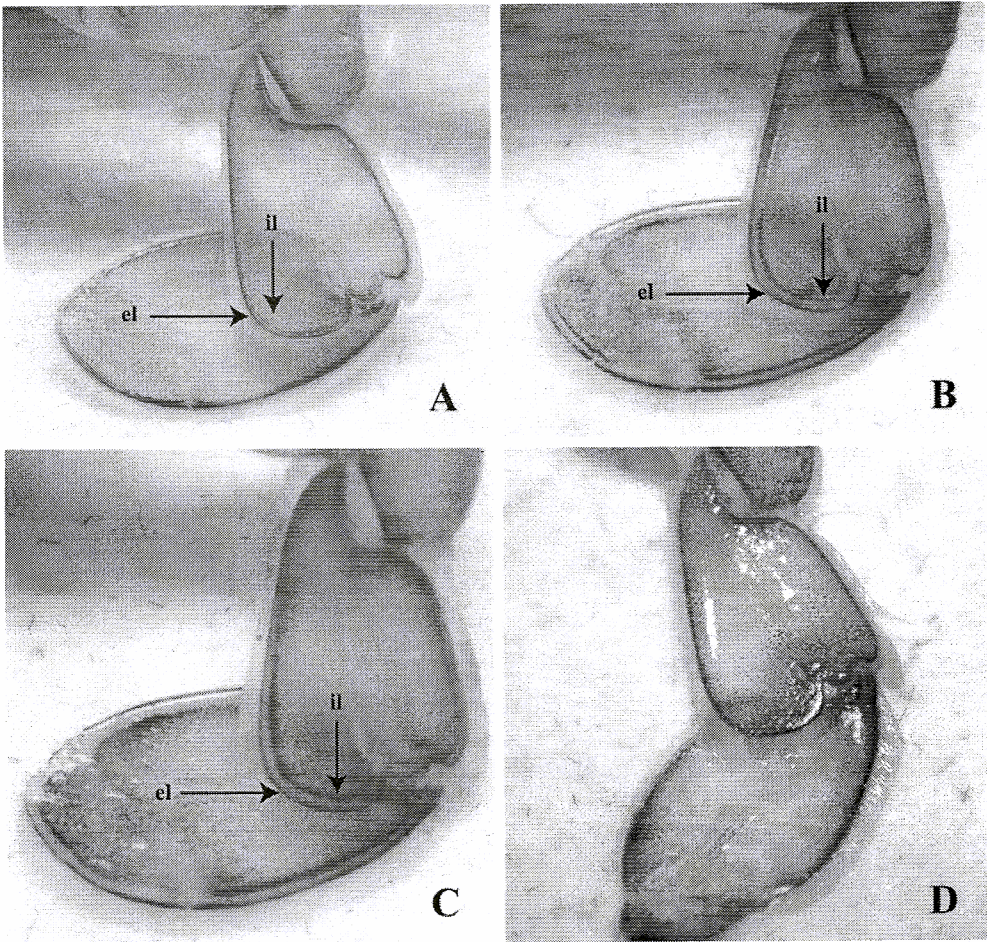


Figure 1: Presence of the double line in laboratory-reared specimens of *Callinectes arcuatus*. Phases 1 - 3 (see Table I) correspond to the photos A -C; photo D represents a freshly-molted individual; el = external line (old cuticle); il = internal line (new cuticle).

Our results regarding molt signs are comparable to those obtained for *Callinectes sapidus* (Freeman and Perry, 1985; Oesterling, 1984; Oesterling and Provenzano, 1985): in *C. arcuatus* as well as in *C. sapidus* occurs a "red sign" on the exterior margin of the propodus and dactylus of the fifth pereopod, and the time between this phase and the forthcoming molt is in both species between one and three days.

The "double line" feature is comparable to that reported for *C. sapidus* (Oesterling, 1984), and the average time between the first molt sign and ecdysis of 14 days in *C. sapidus* (see Roberts, 1993) is close to the 12 days observed in our study with *C. arcuatus* (Table II).

Our results clearly demonstrate that it is possible to identify specimens of *C. arcuatus* which are close to molt based on the presence of the "double line" in the fifth pereopod. Much more information about the molt cycle and other aspects of the life history of *C. arcuatus* are needed, however, the information about these molt signs may be transferred to the local fishermen to initiate a selective artesanal fishery for soft crabs.

Acknowledgments

The study was financially supported (ISW) by the Center of International Migration and Development (CIM, Germany). The logistic support provided by the "Centro de Investigaciones en Ciencias del Mar y Limnología" (CIMAR), Universidad de Costa Rica, is greatly appreciated. We are thankful to Mr. Randy Saborío and Mrs. Elizabeth Castañeda for their collaboration during the course of this study. Comments from Dr. Ana Dittel (University of Delaware) and those provided by the referees helped us to improve different aspects of the manuscript.

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Received: 06th Jan 2004

Accepted: 10th May 2004