

Chromatic alteration in *Arenaeus cribrarius* (Lamarck) (Crustacea, Portunidae): an indicator of sexual maturity

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ABSTRACT. Some individuals of the species *Arenaeus cribrarius* (Lamarck, 1818) bear a characteristic pink abdomen, which is notably different from the usual white coloration. The incidence of this chromatic alteration was determined for a single population and its relation with other individual variables were examined. The individuals were monthly collected from May, 1991 to April, 1993, in Ubatuba, São Paulo, with the aid of a shrimp fishery boat provided with double-rig trawling nets. All specimens were sexed, measured (CW = carapace width), distributed in 10-mm size classes and classified according to growth phase (juvenile and adult), molting condition and development stage of gonads. The occurrence of pink-colored morphs was also recorded. From a total of 2,096 collected individuals, only 60 females (nine of those ovigerous) presented a pink-colored abdomen, which represents 2.9% of the whole sample and 5.2% of the females. Almost all of them were intermolt individuals (96.6%) and 63.3% showed mature gonads. According to published data, size at the onset of functional maturity in *A. cribrarius* females is around 60 mm CW, from which the incidence of pink morphs and ovigerous crabs were recorded. The obtained results suggest that such a chromatic alteration is associated to sexual maturity in these females. This characteristic may enhance the attraction potential for mating, shortly after the puberty molt.

KEY WORDS. Brachyura, Portunidae, reproduction, coloration

During the past few years, changes in the coloration patterns related to the breeding period of several animal species, and mainly its role in attraction for mating, have received the attention of many researchers. According to LUM-KONG & HASTINGS (1992), the nidamental gland undergoes a maturation cycle in the cephalopod *Loligo forbesi* (Ngoile, 1987). In fishes, McLEENAN (1993) observed chromatic changes in *Culae inconstans* Winn, 1960 associated to the cycle of oogenesis, and GODIN & DUGATKIN (1996) shown that females of *Poecilia reticulata* preferred colorful males.

The coloration in crustaceans bearing a calcified thick exoskeleton is a result of the pigmentation of the integument layer under the epicuticle (GHIDALIA 1985; LACERDA & SOUZA 1991). Otherwise, color patterns in crustaceans with fine translucent exoskeleton depends on the chromatophore pigments, whose dispersion and aggregation is ruled by hormones, namely the chromatophorotropins (GHIDA-

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LIA 1985). Besides the hormonal control, color in crustaceans is also dependent on exogenous factors, such as food, background color patterns and season, as related to the breeding period (RAO 1985).

During the breeding period, many decapod crustaceans show chromatic alterations (RYAN 1967), which may be a response to environmental variations commonly associated to development, growth and sexual maturity (NEEDHAM 1974). These changes were recorded for *Cardisoma guanhumi* Latreille, 1825 and *Portunus sanguinolentus* (Herbst, 1783) by GIFFORD (1962) and RYAN (1967), respectively. In Brazil, one of the earliest publications on this subject was carried out by SAWAYA (1939), who studied the physiology of chromatophores in some species of *Uca* and *Grapsus*.

The coloration of the abdomen integument is usually white in the swimming crab *Arenaeus cribrarius* (Lamarck, 1818), but some individuals present a slightly pink pigmentation. According to MALECHA (1980), studying chromatic alterations may reveal some information regarding the reproductive biology of those organisms, including the identification of their maturity status. In this sense, the purpose of the present study is to analyze the occurrence of pink-colored morphs in *Arenaeus cribrarius* within a single population in Ubatuba, São Paulo. The association between this chromatic alteration and sex, size, growth phase, molt stage and degree of gonad development were also examined.

MATERIAL AND METHODS

Arenaeus cribrarius belongs to the family Portunidae, subfamily Portuniinae. It can be identified by checking some characteristics of the carapace, which bears four small frontal teeth and a hair cover on its pterygostomian and antennal regions, and chelipeds, whose carpus and merus show two short and 3-4 anterior spines respectively, together with five longitudinal ridges in the propodus (MELO 1996). The species also shows a characteristic brown-olive coloration with white spots which remains after preserved in ethanol, thus allowing its prompt identification.

The specimens studied were captured from May/1991 to April/1993 along the coast of Ubatuba, São Paulo, using a shrimp fishery boat equipped with "double-rig" nets.

In the laboratory, the specimens were sexed and sorted according to their development stage in five categories; young male, adult male, young female, non-ovigerous adult female and ovigerous female, as performed by PINHEIRO & FRANSOZO (1993). The carapace width excluding lateral spines (CW) and the carapace length (CL) were measured for all collected specimens to the nearest 0.05 mm. The classification of individuals with respect to molt condition and development stage of gonads was carried out according to DRACH & TCHERNIGOVITZEFF (1967) and PINHEIRO & FRANSOZO (1998), respectively. Specimens with a pink-colored abdomen were recorded, being this characteristic related to sex, molt condition, development stage of gonads, size class and growth phase, as to examine possible associations.

Once sexed and their growth phase determined, the individuals were distributed in 10-mm size classes and the obtained results compared with patterns of relative growth and estimates of sexual maturity previously studied by PINHEIRO & FRANSOZO (1993, 1998).

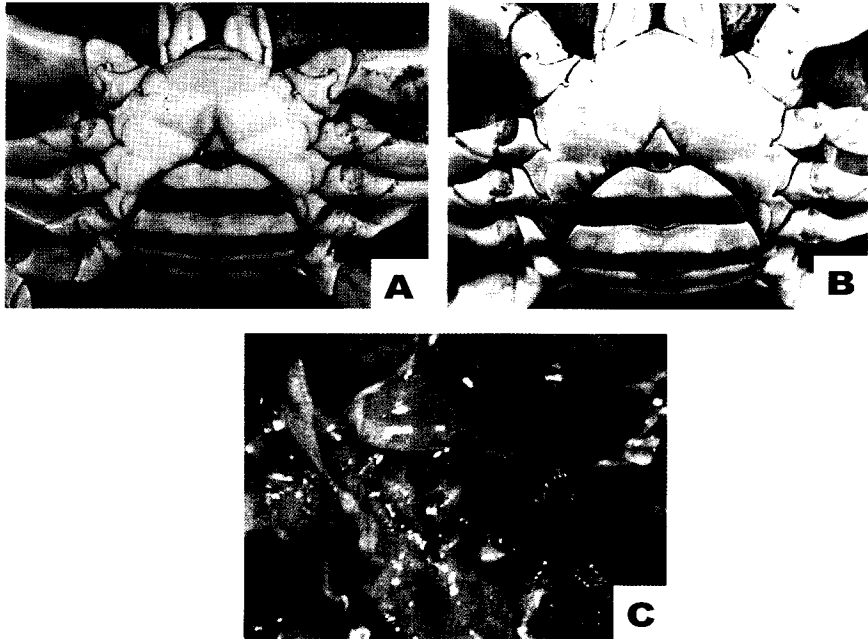


Fig. 1. *Arenaeus cribrarius*. Usual chromatic pattern of the ventral region of females (A), pink abdomen of a female (B), and gonads of a pink-colored female (C) (a = anterior lobe of gonad; b = intermediate lobe of gonad).

RESULTS

A total of 2,096 specimens, 941 males (253 young and 688 adults) and 1,155 females (250 young, 726 adults and 179 ovigerous) were analyzed (Fig. 2). Only 2.9% presented a pink-colored abdomen (Fig. 1A), which is notably different from the white coloration pattern of the species (Fig. 1B). All pink morphs were adult females, 51 without eggs and nine ovigerous crabs, distributed between the 50 and 90-mm size classes (Fig. 2) and comprising 5.2% of the females' population. Pink-colored crabs were mainly large individuals between 70 and 90mm CW.

Almost all of these individuals were intermolt crabs (96.6%), with both pre and post-molt specimens comprising only 1.7% (Tab. I). With respect to gonad development stages, 63.3% of females bearing a pink abdomen also presented mature gonads, while 36.7% showed developing gonads in different stages (Tab. II). In some females, the anterior lobe of gonads was also pink (Fig. 1C,a), in spite

of the characteristic orange color of the intermediate lobe (Fig. 1C,b) usually find in females (Fig. 1C). Smallest ovigerous females were distributed in the 50-60mm size class in this population.

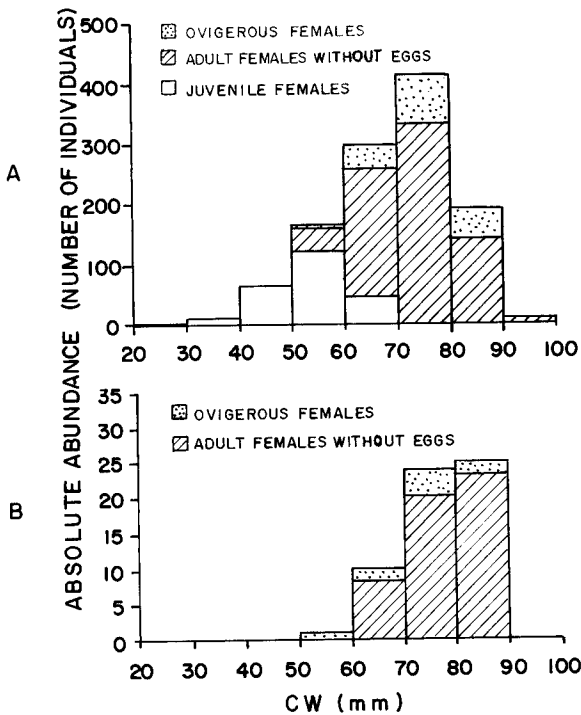


Fig. 2. *Arenaeus cribrarius*. Size frequency distributions. All female categories (A) and only pink-colored adult females (B).

Table 1. *Arenaeus cribrarius*. Number of females with pink abdomen in each category and molt condition.

Molt stage	Adult females (without eggs)	Ovigerous females	Total
Intermolt	49	9	58
Recently molted	1	—	1
Pre-molt	1	—	1
Total	51	9	60

DISCUSSION

After the puberty molt, brachyuran crabs undergo major morphologic changes in the transition between the last young instar and the first adult stage, when secondary sexual characters are developed (HARTNOLL 1974, 1978). While some alterations are evident, e.g. the male's chelipeds and the female's abdomen, others, not less important, are not very perceptible, e.g. alterations of coloration pattern or intensity.

Table II. *Arenaeus cribrarius*. Number of females with pink abdomen in each size class, category and development stage of gonads.

Size class CW (mm)	Adult females without eggs		Ovigerous females		Total
	Developing	Mature	Developing	Mature	
50-60	–	–	–	1	1
60-70	6	2	2	–	10
70-80	4	15	2	2	23
80-90	7	16	1	1	25
90-100	–	1	–	–	1
Total	17	34	5	4	60

In some male portunids, the color of the chelipeds becomes more intense during the breeding season which, together with their larger size, ensure the attraction of mating pre-molt females. RYAN (1967) verified that *P. sanguinolentus* males exhibit the inner surface of chelipeds to females during courtship displays, an area in which significant chromatic alterations are observed during the puberty molt. A similar courtship pattern was observed in *A. cribrarius* (PINHEIRO & FRANSOZO 1999), but any perceptible alteration in the pattern of coloration of the chelipeds.

The obtained results show that the chromatic alteration registered herein for *A. cribrarius* is sex-dependent occurring only in females. The reduced proportion of pink morphs in pre and post-molt stages, compared to the intermolt, suggests that the chromatic intensification occurs while the exoskeleton hardens after the puberty molt. If so, the production of a new subtegumentar carapace, as found by HOENIG *et al.* (1994) for *Chionoecetes opilio* (Fabricius, 1788) or a post-molt colorful condition of the exoskeleton, as mentioned by MCGAW *et al.* (1992) for *Carcinus maenas* (Linnaeus, 1758), are discarded for *A. cribrarius*.

As long as it was only observed in adult females, chromatic change is also probably related to the maturation stage of gonads. In fact, from the individuals bearing this characteristic, the frequency of those with mature gonads is the double of those with developing gonads, and null in the case of crabs with immature gonads.

According to Jim Welch from the Duke University Marine Lab, North Carolina, EUA (personal communication), the abdomen of ovigerous females of the blue crab *Callinectes sapidus* Rathbun, 1896 changes to dark blue or black at the first oviposition. If this is the case of *A. cribrarius*, the small frequency of pink-colored ovigerous females indicates that the time length of this initial reproductive activity is reduced, taking place after the puberty molt and ceasing shortly after oviposition. This would explain why this proportion remain low, even for *A. cribrarius* which is capable to extrude four viable egg masses after mating during the puberty molt (PINHEIRO & FRANSOZO 1999).

In one occasion, a young female was collected at the moment of the puberty molt. While carrying a standard colored exuvia, the recently molted crab exhibited a pink abdomen. This fact, further supports the hypothesis that this chromatic change is related to the puberty molt in females ($55 < CW < 70$ mm, PINHEIRO & FRANSOZO 1993), which is synchronous with the onset of gonad maturity ($LC > 60$ mm, PINHEIRO & FRANSOZO 1998).

As mentioned by HARTNOLL (1969) and CHRISTY (1987), the attraction and mating in aquatic brachyurans involve visual, tactile and/or chemical stimuli. The results obtained by PINHEIRO & FRANSOZO (1999) show that visual attraction of females intensifies the courtship display of males. The pink coloration of the females' abdomen may probably favor the success of mating since their ventral region is always exhibited to their mates after undergoing the puberty molt.

The present results indicate that there is a strong relationship between the incidence of pink morphs and the onset of gonad maturity, supporting the statement of KNOWLES & CALAN (1940) on the association between some chromatic alterations and development phase, growth and sexual maturity.

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