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Population structure of *Hepatus pudibundus* (Decapoda: Calappidae) in Fortaleza Bay, Brazil

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Abstract: The population of *Hepatus pudibundus* crabs in Fortaleza Bay, Ubatuba (São Paulo), was studied with emphasis on structural aspects such as sex-ratio, size, and reproductive time, based on the number of ovigerous females and on seasonal distribution. Crabs were sampled monthly from November 1988 to October 1989 using a shrimp fishing boat equipped with two otter-trawls. A total of 405 specimens (males: 133 adult and 34 immature; females: 175 adult, 19 ovigerous and 44 immature) were sampled. Mean animal size, based on the measurement of carapace width (CW), was 53.27 ± 10.59 mm for males and 46.7 ± 7.86 mm for females. Individual size frequency distribution was bimodal and skewed to larger size classes in males, and unimodal and normal in females, with the largest numbers occurring in March (83), May (70) and July (50). Reproduction occurred throughout the year, with a high incidence of ovigerous females from January to April 1989. The large number of females was probably due to the reproductive strategy of the species. The heterogeneous seasonal distribution was probably related to migration to other areas (open sea, estuaries) because of environmental conditions or particular demands during the developmental phase.

Key words: Brachyura, distribution, population dynamics, seasonality, size frequency.

Population frequency studies in small areas are increasingly more common because they provide information fundamental to understanding the dynamics and functioning of larger areas, such as the northern shore of São Paulo with its many bays and inlets.

Brachyuran are a numerous group with 50% of the approximately 10000 species described for Decapoda (Bowman and Abele 1982). Thus, despite the relative scarcity of reports about Brazilian shore populations, they represent promising material for study.

Some important works about tropical species are those by: Warner (1967), Gibbs (1974), Subramonian (1977), Colby and Fonseca (1984), Vannini and Gherardi (1988), Conde and Díaz (1989), and Díaz and Conde (1989).

Studies about the calappid crab *Hepatus pudibundus* in Brazil basically are morphological descriptions and reports on geographic distribution (Rathbun 1937, Fausto-Filho 1966, 1967, 1968, and 1979, Coelho and Ramos 1972, Melo *et al.* 1989; Sampaio 1989). In addition, reports by Forneris (1969), Melo (1985), Fransozo *et al.* (1992), and Hebling *et al.* (1994) have mentioned the occurrence of this species and/or have related it to environmental factors in specific areas of the southeastern Brazilian shore.

Additional information is needed on factors affecting the development of a population, especially at sites such as Ubatuba, where intense and disorderly expansion of tourism is occurring and affecting the adjacent marine ecosystems.

This study characterizes a population of the crab *H. pudibundus* in São Paulo, from November 1988 to October 1989, with emphasis on structural aspects, sex-ratio, individual size, and reproductive season.

MATERIAL AND METHODS

Hepatus pudibundus (Herbst, 1785) is widely distributed in the West Atlantic from Florida to Brazil (from Amapá to Rio Grande do Sul) and in the East Atlantic (From Guinea to South Africa). The species has nocturnal habits, is omnivorous, and reaches depths of 155 meters (Melo 1985).

Specimens were collected in Fortaleza Bay, located 16 km south of Ubatuba, São Paulo (23° 31' S; 45° 09' W). Monthly collections (November 1988 to October 1989) were made from a fishing boat equipped with 2 otter-trawls. The animals were stored frozen and analyses were performed after thawing to room temperature.

Sex was determined based on the shape of the abdomen and pleopods, developmental phases according to shape and adherence of the abdomen to the thoracic sternum (Taissoun 1969, Mantelatto 1991). Measurement of the CW was made with a precision pH-meter, recording the greatest distance between the two lateral extremities of the carapace, without including the lateral spines.

Other details appear in Negreiros-Fransozo *et al.* (1991) and Fransozo *et al.* (1992).

RESULTS AND DISCUSSION

A total of 405 specimens were collected. The population was higher in March and May. As shown in Fig. 1, *H. pudibundus* was recorded every month, with the greatest abundance of males in March, April, May, and October. Females were more abundant from March to July, ovigerous females from January to April, and juveniles from March to July. According to Fransozo *et al.* (1992), *H. pudibundus* is abundant in this bay, after the brachyuran species living in non-consolidated sediment.

Sex-ratio: There were less males (1 male:1.4 females) a trend absent only in December 88, August 89, and September 89 when females were 25, 40 and 44%, respectively.

Disparity in sex-ratios among crustaceans might result from differential life span, migration, mortality, and growth rates (Winget *et al.* 1974, Haley 1979).

According to Wenner (1972), for some crab species and for some marine crustaceans, it is difficult to find populations with 1:1 sex-ratios. The ratio found here, is difficult to explain, but some inferences may be made on the basis of reproductive strategies. For example, a female may copulate with several males during the reproductive period, thus guaranteeing a stock of male gametes in the spermatheca. This occurs for most portunids on the occasion of terminal ecdysis.

As suggested by Giesel (1972), deviations from the expected 1:1 ratio may internally regulate the size of a population by affecting its reproductive potential. Díaz and Conde (1989) proposed that this might be valid even for a species with a differential growth rate and/or a different life expectancy for each sex. This model may apply to *H. pudibundus*.

Reproduction: Reproductive activity, indicated by ovigerous females, was continuous. The percentage of ovigerous females in each size class, increased from the 34 - 40 mm to the 58-64 mm interval (Fig. 1). Ovigerous females were detected in class size 5 (34 - 40 mm CW), suggesting that this is the size at which the puberty molt occurs, with the animal reaching morphological sexual maturity (Mantelatto 1991). As usual, organisms inhabiting tropical zones exhibit continuous reproduction (Giese 1959).

The reproductive peak began in January, with many ovigerous females in summer (December 21st to March 21st in Brazil). The absence of ovigerous females in June and October may be considered an isolated fact. The greatest percentage of ovigerous females (21.07) was recorded in March 89, suggesting that some anomurans and brachyurans of the shore concentrate their reproductive phase in the warmest months (Negreiros-Fransozo *et al.* 1992).

This strategy is probably associated with an accelerated metamorphosis at high temperatures. The occurrence of periodic patterns

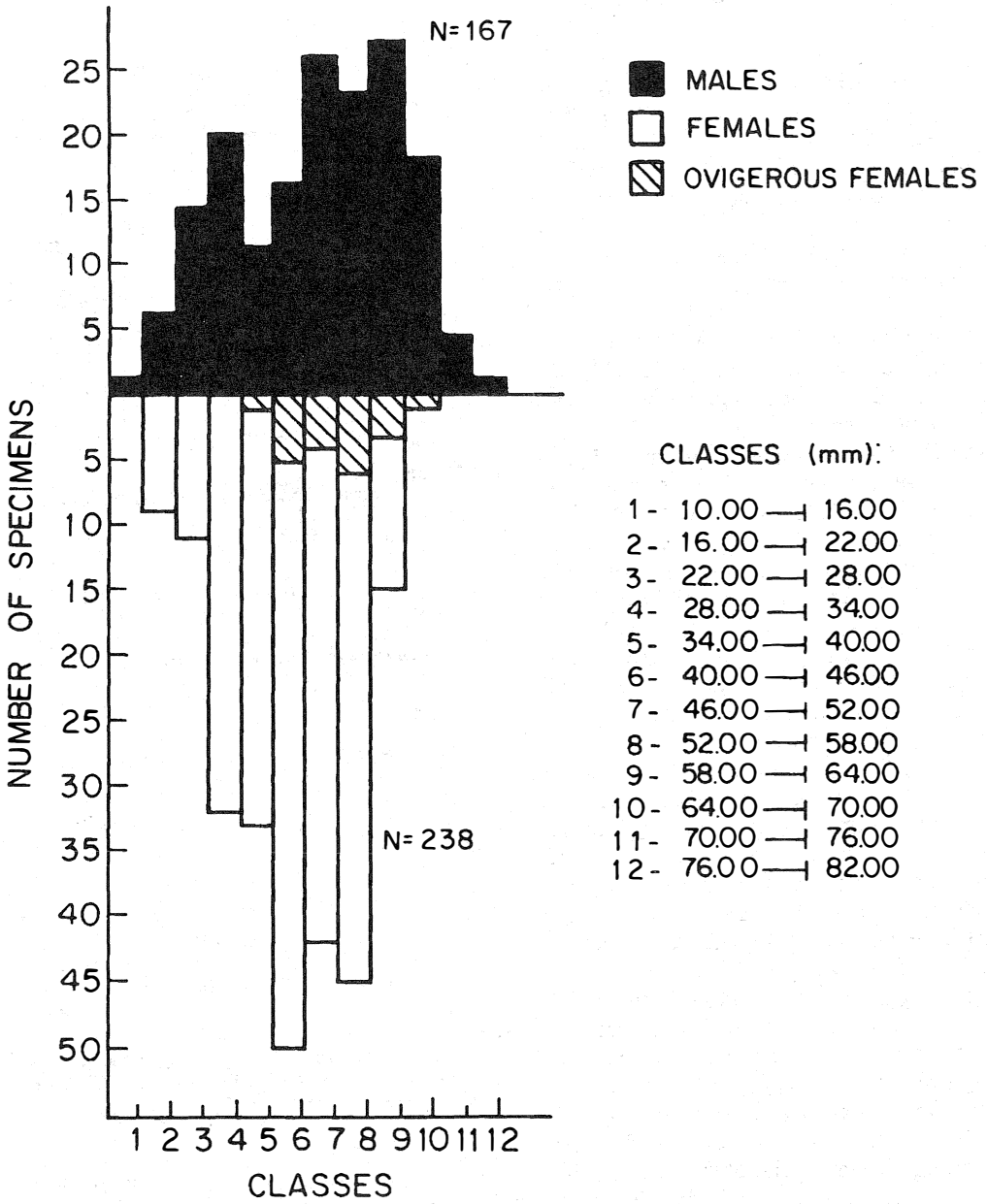

Fig. 1. *H. pudibundus*. Size frequency distribution of individuals collected in Fortaleza Bay, Ubatuba (São Paulo), from November 88 to October 89.

seems to be proximally correlated with latitude (Pillay and Nair 1968, Samuelson 1970, Donaldson *et al.* 1981), further enhanced by food and environmental conditions favorable to larvae and immature individuals at this time of year.

Population structure: The CW range was: males: 13.40 - 78.24 mm, females: 18.30 - 66.48 mm, ovigerous females: 37.46 - 61.98 mm and immatures: 13.40 - 35.50 mm. Mean and standard deviations: males (53.27 ± 10.59 mm, n = 167), significantly larger (t = 7.12, P < 0,01) than in females (46.73 ± 7.86 mm, n = 238). Ovigerous females: 50.12 ± 7.21 mm, n = 19.

CW distribution in females was less variable and more symmetrical than in males (Fig. 1). Modes of males were also higher (58 - 64 mm) than those of females (40 - 46 mm).

Monthly, CW values were, in general, unimodal or bimodal and slightly asymmetrical (Fig. 2), with more size classes to the left of the median in males.

Male modal size fluctuated monthly between 30 and 66 mm (females: only 30 - 53 mm).

Fig. 1 shows a population with few young, which will need more attention in future studies. For example, the size frequency distribution may indicate a recruitment period.

Studies of this type have been done on some portunids of economic importance (Gray and Powell 1966, Furtado-Ogawa 1972, Haefner 1976). The heterogeneous distribution to *H. pudibundus* may be related with migration to adjacent areas (Flamengo Bay, Enseada Bay) caused by environmental conditions or different requirements during the life cycle.

Beginning at class size 9 (58 - 64 mm CW), males become more abundant (Fig. 1), suggesting a greater growth rate or growth period for males (Fig. 2). An analogous situation was reported for *Aratus pisonii* by Warner (1967) and Díaz and Conde (1989) and for *Ovalipes punctatus* by Du Preez and McLachlan (1984). Our results suggest that females allocate an important amount of their energy for reproductive purposes.

For the same sample, Mantelatto and Fransozo (1992), suggested that females fattened more than males during the adult period and in reproductive phases or perhaps young

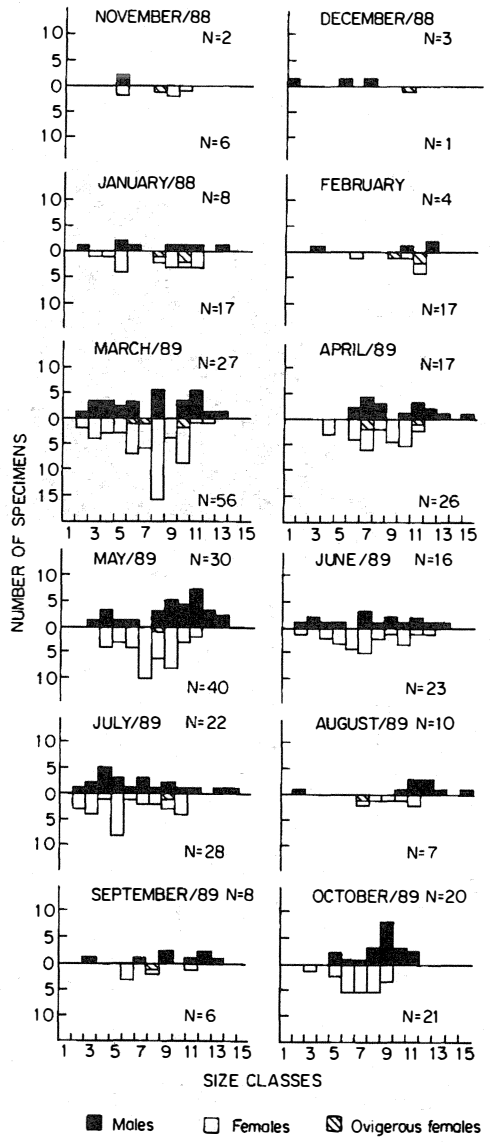

Fig. 2. *H. pudibundus.* Monthly size frequency distribution of individuals colletected in Fortaleza Bay, Ubatuba (São Paulo), from November 88 to October 89.

males mature early to gain a reproductive advantage.

A similar demographic distribution for both sexes has been reported before (Wenner and Fusaro 1979). In agreement with Díaz and Conde (1989), bimodality or polymodality in the size frequency distribution usually reflects recruitment pulses, differential or catastrophic

mortality or behavioral differences. Unimodality usually results from a continuous recruitment without class disruptions, and from constant mortality rates. A similar distribution was found in the same species in the Brazilian Northeast for animals with a CW of 19.5 - 73.5 mm (Nomura and Fausto-Filho 1966)

In higher latitudes, seasonal changes in size frequency distribution are common (Samuelson 1970, Simons and Jones 1981, Reilly and Sailla 1978, Thurman, 1985).

H. pudibundus showed a non-continuous recruitment with some class disruptions, and some variations on size distribution, but with a tendency toward stability, an idea supported by female unimodality throughout the year.

In these limited areas (bays, inlets), biotic factors such as competition and predation, may play decisive roles in the distribution of benthic organisms. Forneris (1969) and Negreiros-Fransozo *et al.* (1991). Low density or the absence of ovigerous females in certain sites or periods may result from non-intensive exploitation or from the time of collection.

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