Breeding period of the spider crab *Mithraculus forceps* (A. Milne Edwards) (Crustacea, Majidae, Mithracinae) in the southeastern Brazilian coast

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ABSTRACT. Investigations concerning to the breeding period of brachyuran crabs provide fundamental information to determine their reproductive cycle, and also to establish management plans for species mainly in protected areas. This study provides data on the breeding period of *M. forceps* (A. Milne Edwards, 1875) in the southeastern Brazilian coast. Monthly samplings were carried out during a one year-round. A catch effort of approximately four hours was allocated to each monthly survey. The breeding intensity was determined based on the percentage of ovigerous crabs within the whole adult female population. A total of 137 adult females was obtained, from which 80.3% presented eggs attached on their pleopods. Ovigerous females were observed year-round, usually comprising more than 60% of sampled adult females. The ovigerous frequency was not statistically correlated to the environmental analyzed factors.
KEY WORDS. Majidae, *Mithraculus*, breeding period, Ubatuba

The family Majidae represents one of the largest taxonomic groups within the Brachyura, with at least 900 well-known species distributed exclusively in the marine environments (PROVENZANO & BROWNELL 1977). In the Brazilian waters are known 81 species distributed in 45 genus, of those, 34 species are reported for the littoral of the São Paulo state (MELO 1996). The biological diversity and the commercial importance of those crustaceans are responsible for the great availability of studies related to many aspects of the biology of this family, especially regarding their reproduction, as reported by PAUL (1984), CONAN & COMEAU (1986), DIESEL (1986), ELNER & BENINGER (1992), FUROTA (1996), FRANSOZO & NEGREIROS-FRANSOZO (1997), among others.

In the Majidae species which occur on the southeastern Brazilian cost, the time required to complete the larval phase is often short when compared with the other families previously studied (HIYODO *et al.* 1994). According to FRANSOZO & HEBLING (1982), which analyzing the duration and the number of larval stages in Majidae, concluded that the abbreviation of the metamorphosis may represent a greater degree of specialization, could be considered responsible for the large number of species in this family.

The causes ruling the breeding period of brachyuran crabs have been calling the attention of researchers for the determination of the reproductive cycles (HAEFNER 1978; CHOY 1988; YAU 1992), and considered basic information for the application of management programs, both for organisms inhabiting protected areas as to the species commercially exploited (KENNELLY & WATKINS 1994).

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According to SASTRY (1983), the determination of breeding periods is the result of a complex interaction of endogenous and exogenous factors, allowing both intra and interspecific variations regarding the duration of the reproductive season. The breeding period is defined as the time interval during which ovigerous females may be found in the population. Peaks of higher breeding intensity may be associated to variations of temperature, salinity, photoperiod, food availability, among other environmental factors.

Along the Brazilian cost the genus *Mithraculus* White, 1847 is represented by three species, *M. coryphe* (Hersbt, 1801), *M. forceps* (A. Milne Edwards, 1875) and *M. sculptus* (Lamarck, 1818). The geographical distribution of the spider crab *M. forceps*, is restricted to the Western Atlantic, from North Carolina (USA) to São Paulo State (Brazil), commonly found in hard bottoms under rocks and corals, from the intertidal areas to approximately 100 meters deep (WILLIAMS 1984; MELO 1996).

This study provides information on the breeding period extension of the spider crab *M. forceps* in the southeastern Brazilian coast, based in the monthly frequency variation of the ovigerous females, and evaluates the correlation between the breeding intensity and the environmental factors water temperature, photoperiod and salinity.

MATERIAL AND METHODS

Samplings were monthly carried out from January to December, 2000. Crabs were found on hard bottoms at Couves Island, São Paulo State, southeastern coast of Brazil (23°25'25"S and 44°52'03"W). Each month, crabs were collected using SCUBA diving, over a standardized period of (catch effort) of 4h approximately. The specimens of *M. forceps* were captured by hand and isolated in plastic bags. The obtained specimens were frozen and transferred to the laboratory of Zoology at the Universidade de Taubaté (UNITAU). Each crab was sexed, measured at the maximum carapace width (CW) and the presence of eggs masses in the females was recorded. The monthly frequency of ovigerous crabs was determined based on the percentage of breeding females within the overall adult female sample.

The monthly average values of water temperature and salinity were kindly provided by the research unit NEBECC – Group of Studies on Crustacean Biology, Ecology and Culture, Universidade Estadual Paulista – UNESP, and the photoperiod values were supplied by the Seção de Climatologia Agrícola, Instituto Agronômico de Campinas – I.A.C., Estação Experimental de Ubatuba, São Paulo, Brazil.

The distribution normality of the ovigerous crabs was evaluated by Kolmogorov-Smirnov test, and the degree of association among ovigerous frequency with environmental factors were performed using the Pearson's correlation, (ZAR 1999). The significance level adopted was $\alpha = 0.05$

RESULTS

A total of 137 adult females was obtained, from which 110 crabs were ovigerous, representing 80.3% of the adult females observed in the whole study period. Average size of sampled adult females was 11.2 ± 1.5 mm LC, ranging from 6.7 to 14.2 mm LC, distributed seven size classes with interval of 1.5 mm CW.

Females with eggs were recorded during the whole study period, presenting a normal distribution (Kolmogorov-Smirnov; $p > 0.05$) (Fig. 1). The frequency of ovigerous females was always higher than 60%, except in November when breeding crabs comprised 57.1% of the adult female sample. In September, all mature females were found to be ovigerous. The variation of the monthly frequency of both ovigerous and non-ovigerous females is shown in figure 2.

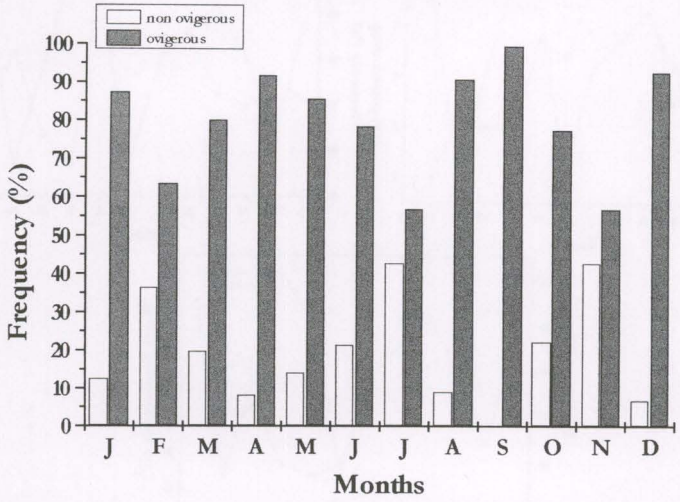


Fig. 1. Monthly variation of the frequency of ovigerous and non-ovigerous females of *M. forceps*.

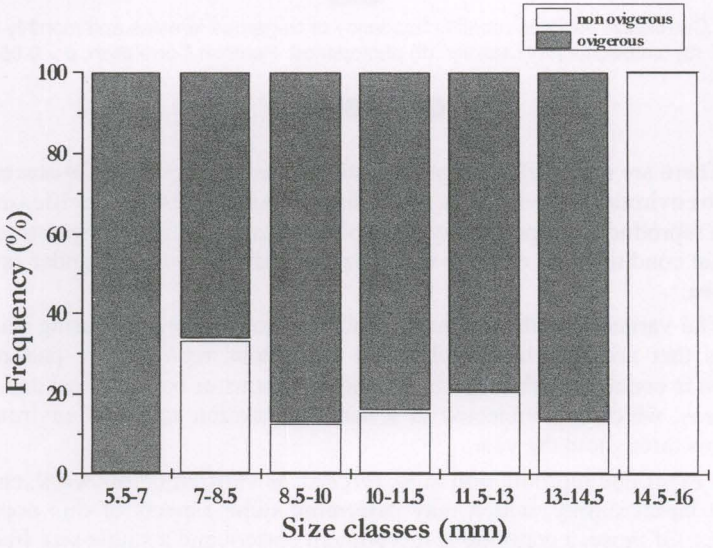
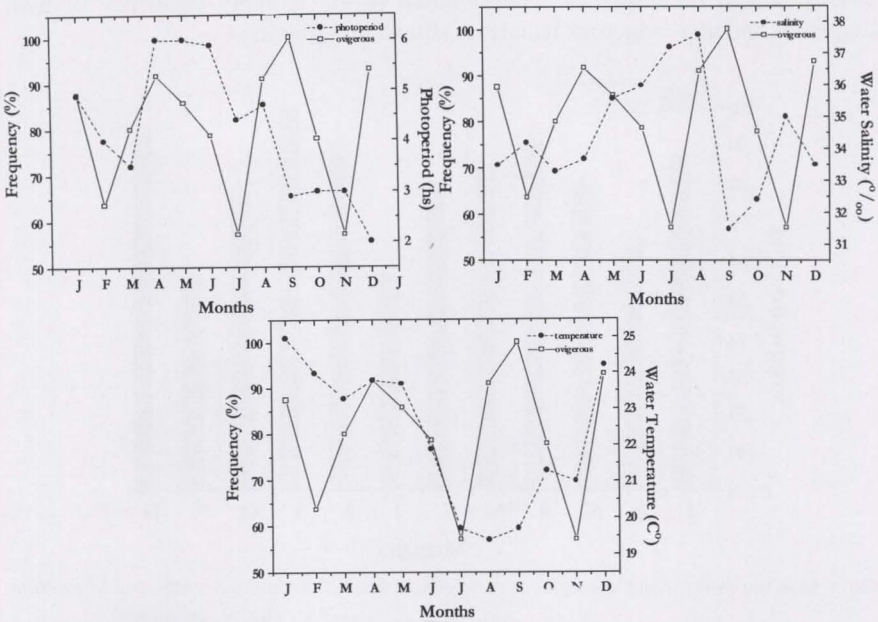


Fig. 2. Size classes variation of the frequency of ovigerous and non-ovigerous females of *M. forceps*.

The frequency of ovigerous females was not found to be correlated with neither water temperature, salinity nor photoperiod (Pearson's Correlation, $p > 0.05$) (Figs 3, 4 and 5). Differences among monthly average values of temperature, salinity and photoperiod were also not significant (t-test; $p > 0.05$).



Figs 3-5. Correlation between monthly frequency of ovigerous females and monthly average values of: (3) temperature; (4) salinity; (5) photoperiod. Pearson Correlation, $p > 0.05$.

DISCUSSION

There are many different reproductive patterns among the Crustacea, often related to environmental variation. According to SASTRY (1983), specific variations of some reproductive aspects may be explained as a genotypic response to environmental conditions, in order to maximize reproductive success under favorable conditions.

The variation of the ovigerous frequency of *M. forceps* during this study indicates that this population follows a continuous reproductive pattern. This condition is commonly observed in marine organisms of both tropical and subtropical areas, which are subjected to a narrow variation range of environmental conditions throughout the year.

Year-round reproduction in *M. forceps*, as verified in this work, ensures a constant larval supply, which may determine some aspects of this population dynamics. Of those, a continuous recruitment pattern and a stable size frequency distribution contribute to the maintenance of population size (CONDE & DIAZ 1989).

Among the marine Brachyura species the number of zoeal stages varies from two, as in Majidae (FRANZOSO & HEBLING 1982), to eight as in the Portunidae (DITTEL & EPIFANIO 1984), and the number of zoeal stages can vary within the family, for example in the Leucosiidae, Xanthidae, Grapsidae, etc. The Majidae present peculiar features, one being the number of zoeal stages (NEGREIROS-FRANSOZO & FRANSOZO 1991). The shortened developmental times result in the more rapid production of a juvenile form possessing the general morphological characteristics of the adult (RABALAIS 1991).

As suggested by SASTRY (1983), the seasonal nature of reproductive cycles is the result of a complex combination of interacting endogenous factors, responding to environmental variability. Initially, the temperature was pointed out as one of the main factors affecting the breeding period of marine organisms. However, the literature shows that the reproductive pattern is not only determined by isolated factors, but by a complex interaction of external events.

The duration of the breeding period in *M. forceps* does not seem to be greatly influenced by temperature, salinity and photoperiod variations, since no correlation were observed among those factors and the frequency of ovigerous females. No rhythms according to the variation of temperature, salinity and photoperiod are therefore evident. The factors that regulate reproduction in the studied species, allowing a continuous breeding pattern, are still to be demonstrated by interpreting proper experiments.

It is still largely unknown how do the environmental variables precisely influence the life cycles and reproductive strategies. However, populations subjected to a marked environmental variability may have to adjust their life cycle processes to the prevailing conditions (SASTRY 1983).

In that sense, the responses of different species in relation to a given pool of environmental variables in a certain geographical locality may vary as a function of their genetic tolerance to environmental change. According to STEARNS (1977), such a situation may be viewed as a response to the pressure imposed by physical limitations and phylogenetic history of each organism for the adaptive solutions of ecological problems.

The breeding period of *M. forceps*, as observed in this study, indicates a continuous reproduction pattern, with the presence of ovigerous females year-round. Such a pattern is probably determined by an interaction of external factors, favoring the development and survival of planktonic larvae over the year.

The extension of the breeding period of *M. forceps* is probably a result of the narrow environmental change at which the population at the study area is exposed, combined to a wide tolerance for alterations of key external factors, thus allowing the maximization of its reproductive output.

ACKNOWLEDGEMENTS. I wish to express my gratitude to the Universidade de Taubaté – UNITAU, for the financial support (Process # 251/2001- PRPPG) and OMNI-MARE Dive Center, for the logistical support. I am especially indebted to Dra. Maria Lucia Negreiros-Fransozo for her appreciated comments, Dr. Augusto A.V. Flores, for his help with the English version and to Dr. Itamar Alves Martins for his skilled assistance during the dive sessions.

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Received in 07.XII.2001; accepted in 27.VI.2002.