# Fecundity of *Menippe nodifrons* Stimpson, 1859 (Brachyura, Menippidae) in the Parnapuã Beach, SP, Bazil

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## Abstract

The aim of this study was to analyze the potential fecundity of *Menippe nodifrons* Stimpson, 1859, during the period of May 2003 to January 2004 with monthly collects at low tides, in the rocky shore of Parnapuã Beach, São Vicente (SP), Brazil. A total of 75 ovigerous females, with eggs in initial embryonic stage, were weighed (WW = total wet weight) and measured (CW = carapace width). The number of eggs (NE) was quantified by the gravimetric method. Size of females (CW) varied from 37.0 to 80.3mm (58.0 ± 9.0mm), which corresponding to the total wet weight from 25.5 to 180.0g (79.3 ± 34.2g). The fecundity varied from 31,551 to 348,442 eggs (157,017 ± 66,775 eggs). The fecundity equation showed high significance in size ($NE=4.81CW^{2.54}$, $R^2=0.72$; $p < 0.05$), and weight ($NE=2468.3WW^{0.95}$, $R^2=0.83$; $p < 0.05$). A high percentage of ovigerous females were verified in the spring season. This species has an intermediate fecundity when compared to other individuals of the Superfamily Xanthoidea.

**Key words:** Fecundity, *Menippe nodifrons*, Reproduction, Brachyura.

## Introduction

The potential fecundity has been defined as the number of eggs extruded by female in a single batch (Swartz, 1978; Pinheiro and Fransozo, 1995). According to Sastry (1983) reproductive estimative of one species not solely determined by the number of eggs extruded per female in a single batch, but it also the rhythm of eggs production in a specific reproductive season and/or during all life span. This same author mentions that besides temperature and photoperiod, other abiotic factors (salinity) and biotic factors (feeding and competition for resources), should influence the reproduction of marine crustacean.

The studies about reproduction in decapod crustaceans have been increased in the last years (Pinheiro and Terceiro, 2000), which promote a substantial advance towards to management and preservation of population stocks, particularly for crustaceans with a commercial interest.

The brachyurans have a higher extractive potential, furthermore, specimens of Family Menippidae are characterized by opportunist feeding habit, long reproductive period, and a great tolerance of oxygen variations. These qualities imply a high survival rate and easier management in captivity (Bert *et al.*, 1978).

According to Fausto-Filho (1962) *Menippe nodifrons* Stimpson, 1859, has a low commercial value on northeast Brazil, probably due to lack biologic information. In USA, the specimens of Family Menippidae [*M. mercenaria* (Say, 1818) and *M. adina* Williams and Felder, 1986] has been intensively harvested since 1985 (Landry, 1992).

*Menippe nodifrons* usually has been mentioned in reports about decapod crustacean diversity (Pinheiro *et al.*, 1997). However, the reproductive biology of this crab were recently described by Oshiro (1999) which verified the fecundity in a population at Sepetiba bay (RJ), Brazil.

The purpose of the present study was to analyze the potential and the relative average fecundity of the stone crab *M. nodifrons*, from a population of the rock shore of Parnapuã beach, São Vicente (SP), Brazil. The present results were compared to those already published for other Xanthoidea species.

## Materials and methods

Specimens of *Menippe nodifrons* were monthly sampled at the intertidal and infracoastal areas in the rocky shore of Parnapuã Beach (23°59'S and 46°26'W), São Vicente (SP), Brazil, during May 2003 to January 2004. Morphological characters described by Melo (1996) were used to identify the species. The_harvest was manually with gloves and a metal hook used to make easy the female capture in the rocks. The time of capture effort was standardized in two hours by two persons for the estimative of the monthly of ovigerous females percentage. Extra individuals were captured for potential fecundity analyses. Each female was individually placed in a plastic bag to avoid loss eggs or appendages, and frozen until further analyses.

A total of 75 ovigerous females with eggs in initial embryonic stage were selected according to size variation. The female carapace width (CW) was measured between the lateral external spines using with a digital calipers (0.01mm). The total wet weight of ovigerous females (WW) was obtained by a digital scale (0.01g). After remove, the eggs from the abdomen by cutting the endopods, all females were weighted again (FW). The difference between WW and FW were used to establish the wet weight egg brood values (EWW).

All the eggs were macroscopically classified based on three embryonic stages, according to Pinheiro and Hattori (2002): 1) initial stage, eggs are yellow or orange-yellow, with great amount of yolk; 2) intermediate stage, the eggs color are brown-red due to embryos eyes, chromatophore appears, and reduced yolk; 3) final stage, dark brown colored, low amount of yolk and pre-hatching larvae.

The fecundity was determined by gravimetric method using only eggs in initial embryonic stage, to avoid underestimates fecundity since the egg loss could happen during the incubation period (Pinheiro and Terceiro, 2000). The eggs were dehydrated in ethanol 70% (48h), with transference it to ethanol 100%, for your complete dehydration. The eggs were placed on Petri plates, and taken to the oven for drying (60°C) until the stability weight. Afterwards, each brood was cleaning by remove the pleopods and setae manually using a stereomicroscope. The total wet weight eggs was obtained by an analytic scale (0.0001g) and separating three sub samples (± 1mg). Each sub sample has been the eggs dried counted using a stereomicroscope. The total number of eggs per brood was extrapolated from the dry weight eggs of three counted sub samples and the dry weight eggs of the total brood. The dependent variable (NE) was plotted as a function of the independent variables (CW, WW, EWW), and the scatter plots submitted to regression analyses by the power function ($y=ax^b$), with adjustment expressed by the determination coefficient ($R^2$). The relative average fecundity ($\overline{F}$) was monthly calculated to compare the fecundity without eliminating size effect according to Pinheiro and Terceiro (2000). The Reproductive Index (RI) was also calculated, by the multiplication of $\overline{F}$ and the percentage of ovigerous females captured in each month.

The averages of NE, CW and $\overline{F}$ were submitted to ANOVA, (one-way), with different numbers of repetitions, with posterior average comparison using Tukey test ($\alpha = 0.05$).

## Results

During the period of May 2003 and January 2004, a total of 303 females with size variation from 20.0 to 84.6mm (53.5 ± 12.2mm) were captured, which 66 were ovigerous (22.8%).

The potential fecundity analyses were determined by choosing 75 ovigerous females with carapace width (CW) from 37.0 to 80.3mm (58.0 ± 9.0mm), showing a variation of 31,551 to 348,442 eggs (157,017 ± 66,775 eggs). The female wet weight varied from 25.5 to 180.0g (79.3 ± 34.2g), while the wet weight of the eggs (EWW) presented values from 1.3 to 16.5g (6.7 ± 3.4g) corresponding a variation of 3 to 24% (11 ± 4%) from the total wet weight of the analyzed females.

The number of eggs (NE) showed a positive correlation when compared with the independent variables analyzed (CW, WW, EWW), with the best fit obtained by the power function ($y=ax^b$). The relation ship NE vs. CW was expressed by the equation $NE=4.81CW^{2.54}$ ($R^2=0.72$; $p < 0.05$), occurring the same for NE vs. WW ($NE=2468.3WW^{0.95}$; $R^2=0.83$; $p < 0.05$), and NE vs. EWW ($NE=37169EWW^{0.76}$; $R^2=0.78$; $p < 0.05$) (Fig. 1).

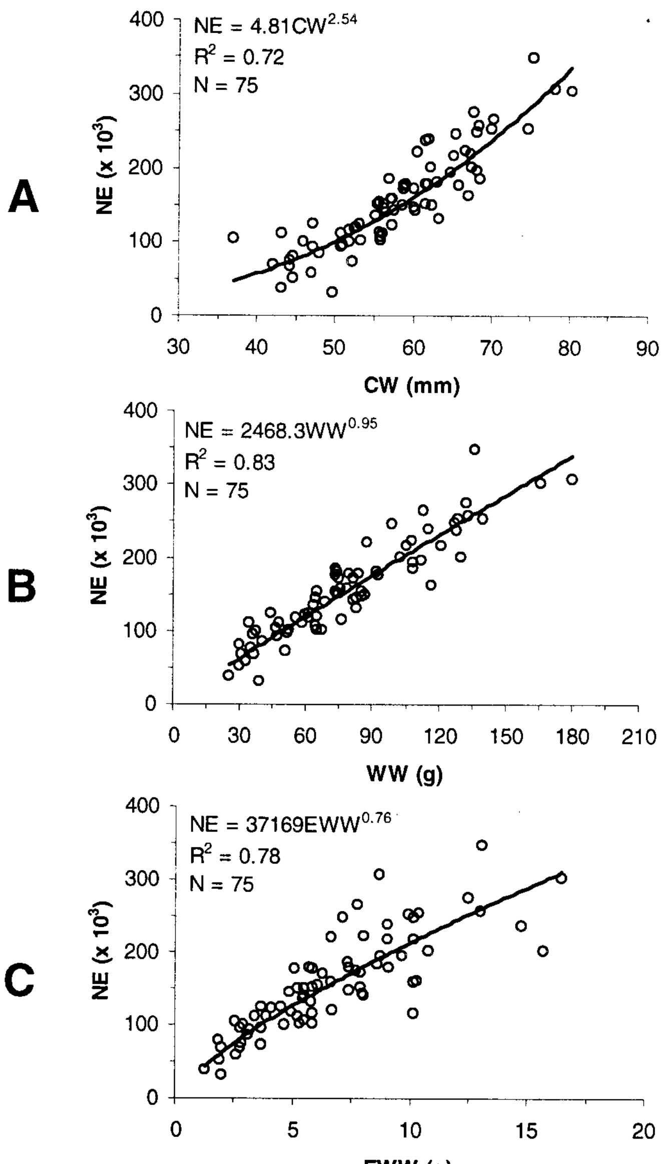


**Figure 1:** *Menippe nodifrons.* Relationship between the number of eggs (NE) and carapace width (CW) (A), wet weight (WW) (B) and eggs wet weight (EWW) (C).

The percentage of ovigerous females was reduced in the beginning of the sampling period, with an increase in September and January (Fig. 2). The ovigerous females with initial embryonic stage (Fig. 3) appearance in August and it reached its maximum in September. However, the monthly averages of the variables NE and CW did not differ significantly during the studied period ($F_{NE} = 2.09$; $F_{CW} = 0.59$; $p > 0.05$).

The relative average fecundity ($\overline{F'}$) varied from 4.4 to 5.4 showing significant difference between December and January ($F=2.67$; $p < 0.05$). The Reproductive Index (RI), analyzed for the same period, reached the maximum value in September (n = 242) and the minimum in December (n = 55) (Fig. 4).

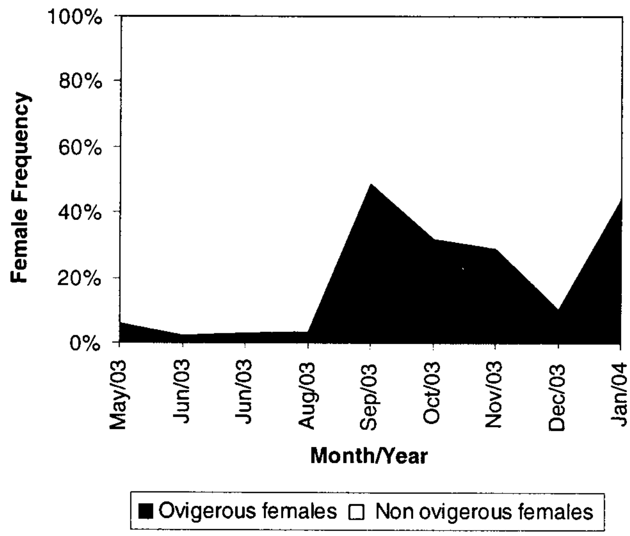


**Figure 2:** *Menippe nodifrons.* Monthly relative frequency values of ovigerous females.

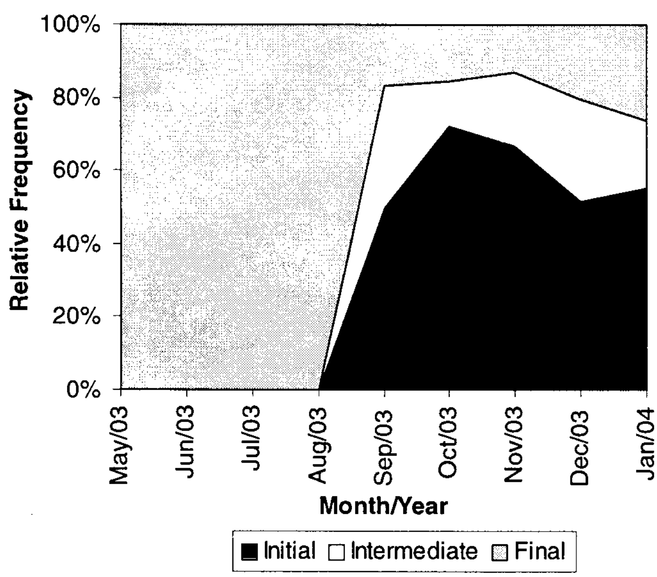


**Figure 3:** *Menippe nodifrons.* Monthly relative frequency values of embryonic stage from ovigerous females.

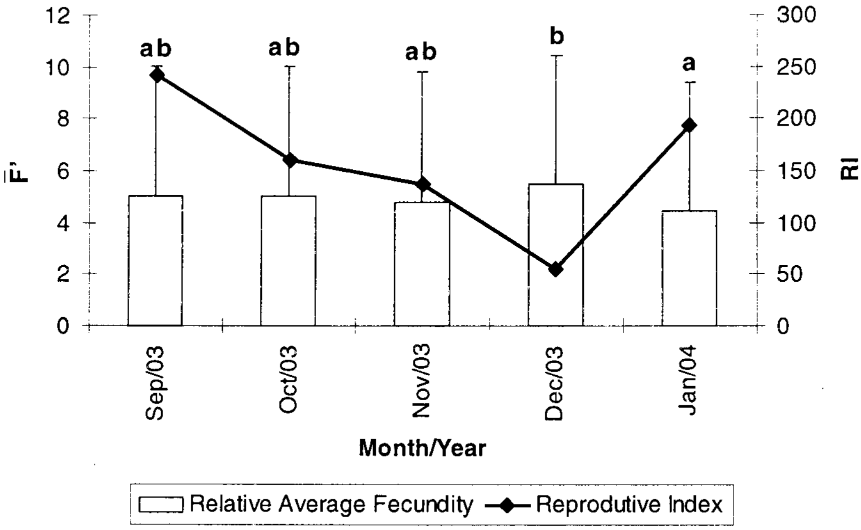


**Figure 4:** *Menippe nodifrons.* Monthly values of relative average fecundity ($\overline{F}'$) and reproductive index (RI) (bars = average; line = standard deviation). Values followed by the same letter not show statistical difference (p>0.05).

## Discussion

According to Sastry (1983), the crustaceans are considered the animal group with the best evolutionary success, as in number of species as colonization of different habitats, reflecting in a wide diversity of life patterns and reproductive strategies.

The diversity of reproductive patterns should be caused by evolutionary process directly related to optimization of growth and prole survival. Furthermore, eggs size and specific larval development were parameter ensured which a high survival rates (Hartnoll and Gould, 1988). There is a series of components that minimize the loss of eggs, as like as the extruding all eggs just once, pleopodal incubation, and the absence of a new batch during the incubation period (Hartnoll and Gould, 1988).

*Menippe nodifrons* may reach almost 350,000 eggs, similar to registered by Noe (1967) *apud* McConnaughey and Krantz (1992) for *M. mercenaria.* The fecundity of *M. nodifrons* in the present study was higher than another population studied in Rio de Janeiro (Oshiro, 1999), the same pattern occurred when compared with others Xanthoidea specimens: *Eriphia gonagra* (Fabricius, 1781) by Góes (2000) and *Eriphia smithii* MacLeay, 1838 by Tomikawa and Watanabe (1992). The only exception was observed in *Neopanope sayi* (Smith, 1869) studied by Swartz (1978) that shows a high fecundity (Table I).

The food availability and environmental factors as salinity, temperature, and photoperiod should also be considered in reproductive biology studies (Kennelly and Watkins, 1994). Climatic changes are associated to geographic variations (e.g., photoperiod and temperature), could influence the growth and reproductive rate in the crustaceans (Hines, 1989).

According to Cheung (1969), the ovarian development of *M. mercenaria* females was related to the warmest seasons, especially with water temperature. This author also mentioned that ovarian development was associated to warmest month but not necessarily the month with longest day-length or high light intensity. In species from higher latitudes should produce low mass eggs in specific season, principally in the winter, which usually occur unfavorable conditions to reproduction. High latitude regions have a delimited season and consequently allow a specific reproductive period (Hartnoll and Gould, 1988).

Struk and Perry (1992) verified seasonality in reproductive period for *M. mercenaria* at Mississippi (USA), with presence of ovigerous females between May to August (spring and summer), where the water temperature varied from 18 to 29°C. This information contrasts with Noe (1967) *apud* McConnaughey and Krantz (1992), which registered ovigerous females during the whole year, especially during April to September at South Carolina (USA).

The temperature in tropical regions usually started increase from September to January and could explain the high presence of *M. nodifrons* ovigerous female (Fig. 2). This reproductive strategy pattern might suggest a better larval development success in these months, probably due to the high amount of food available caused by favorable environment conditions, similar what was observed for others brachyuran, which showed a high fecundity in the spring and summer (Caldwell, 1992; Oshiro, 1999).

**Table I:** Comparative of potential fecundity among Superfamily Xanthoidea crabs (CW=carapace width; NE=number of eggs).

| SPECIE | AUTHOR (YEAR) | LOCAL | EQUATION | CW (mm) | | NE | | $\overline{X}$ |
|---|---|---|---|---|---|---|---|---|
| | | | | Min. | Max. | Min. | Max. | |
| *Eriphia smithii* | Tomikawa and Watanabe (1992) | Banda Marine Station, Japan | $NE = 0.04CW^{3.08}$ | 25.1 | 52.6 | 59,530 | 735,010 | - |
| *Eriphia gonagra* | Góes (2000) | Ubatuba (SP), Brazil | $NE = 2.68CW^{2.56}$ | 17.7 | 43.0 | 2,720 | 36,192 | 15,362 |
| *Menippe nodifrons* | Oshiro (1999) | Sepetiba Bay (RJ), Brazil | $NE = 0.5CW^{3.046}$ | 38.0 | 77.0 | 12,800 | 212,000 | 98,800 |
| | Present study | São Vicente (SP), Brazil | $NE = 4.81CW^{2.54}$ | 37.0 | 80.28 | 31,551 | 348,442 | 157,017 |
| *Neopanope sayi* | Swartz (1978) | Virginia Institute of Marine Science (Va), USA | $LogNE = 0.673+2.75LogCW$ | 6.4 | 19.0 | 686 | 14,735 | - |

According to $\overline{F}$ comparisons, December was the month which females showed a high reproductive potential along of the entire period. Although, a significant decrease of the reproductive index (RI) was verified in the same period, due to the low percentage of ovigerous females, probably caused by larval release. According to Wilber (1989), some congener species (*Menippe mercenaria* and *M. adina*) showed a preference to occupy infratidal zone, during the egg incubation. This author affirms that the tide amplitude variations influenced the distribution of ovigerous females on the rock shore. The low percentage of ovigerous females could be explained by the habit of ovigerous females hidden in the rock and make difficult the manually capture, principally in rainy days when the tidal level not expose the rocks, a common situation in the local study specifically in December.

The smallest ovigerous female captured in a population should provide evidence of the size at onset sexual maturity and permitting to establish the minimum legal size for fishing (Pinheiro and Fransozo, 1998). In the coast area of Mississippi (USA), the smallest ovigerous female measured 43mm CW (Struck and Perry, 1992). These sizes are a little superior when compared with size of the ovigerous females registered to *M. nodifrons* in the present study (37mm), which was similar to Oshiro (1999) data at Sepetiba Bay (RJ), where the smallest ovigerous female and the gonadal maturation were 38 and 37.8mm, respectively.

The positive correlation between NE vs. CW of *M. nodifrons* followed the same pattern previously observed to other species (Swartz, 1978; Almaça, 1987; Hines, 1988; Santos and Negreiros-Fransozo, 1997; Pinheiro *et al.,* 2003). The high determination coefficient in NE vs. CW and NE vs. WW relationship and the high number of ovigerous females distributed in a wide size class permit the use of this fecundity equation in conversion among variables. The same pattern was observed for other relationship studied, described in Table I.

Information about other aspects of reproductive biology of *M. nodifrons* is necessary to establish management practices to preserve this fishery resource. This species could be harvest and used to crab meat production, similar what happen with *M. mercenaria* in North America.

## Acknowledgements

We would like thank CNPq/PIBIC (Proc. 0032 Ofício 148/2003) that supplies DAFO with a Scientific Initiation Grant. We are grateful to CRUSTA members from UNESP São Vicente who helped with sampling and laboratory analysis.


## References


Almaça, C. 1987. Egg number and size in *Pachygrapsus maurus* (Lucas, 1846) from Praia da Laginha (Faial, Azores islands). Investigación Pesquera, 51 (supl.1): 157-163.

Bert, T. M.; Warner, R.E. and Kessler, L.D. 1978. The biology and Florida fishery of the stone crab, *Menippe mercenaria* (Say), with emphasis on southwest Florida. Florida Sea Grant. Technical Paper, Gainesville, 9: 82 p.

Caldwell, M. A. 1992. Aspects of the biology of the stone crab, *Menippe mercenaria* (Say), from South Carolina, with comments on the South Carolina stone crab fishery. Florida Marine Research Publications, 50: 99-106.

Cheung, T. S. 1969. The environmental and hormonal control of reproduction in the adult female stone crabs, *Menippe mercenaria* (Say). Biological Bulletin, 136: 327-346.

Fausto-Filho, J. 1968. Crustáceos decápodos de valor comercial ou utilizado como alimento no nordeste brasileiro. Boletim da Sociedade Cearense de Agronomia, 9: 27-28.

Góes, J. M. 2000. Biologia do caranguejo *Eriphia gonagra* (Fabricius, 1781) (Crustacea, Brachyura, Xanthidae) na região de Ubatuba, São Paulo. 175 p. Doutoral thesis. Zoologia, Instituto de Biociências - UNESP, Botucatu, São Paulo, Brazil.

Hartnoll, R. G. and Gould, P. 1988. Brachyura life history strategies and the optimization of egg production. Symposia of the Zoological Society of London, 59: 1-9.

Hines, A. H. 1988. Fecundity and reproductive output in two species of deep-sea crabs, *Geryon fenneri* and *Geryon quinquedens* (Decapoda, Brachyura). Journal of Crustacean Biology, 8 (4): 557-562.

Hines, A. H. 1989. Geographic variation in size at maturity in Brachyuran Crabs. Bulletin of Marine Science, 45 (2): 356-368.

Kennelly, J. S. and Watkins, D. 1994. Fecundity and reproductive period, and their relationship to catch rates of spanner crabs, *Ranina ranina*, off the east coast of Australia. Journal of Crustacean Biology, 14 (1): 146-150.

Landry Jr., A. M. 1992. Characterization and fishery development potential of Galveston Bay, Texas, stone crab (*Menippe adina*) stocks. Florida Marine Research Publications, 50: 67-73.

McConnaughey, R. A. and Krantz, G. E. 1992. Hatchery production of stone crab, *Menippe mercenaria* (Say), megalopae. Florida Marine Research Publications, 50: 60-66.

Melo, G. A. S. 1996. Manual de Identificação dos Brachyura (caranguejo e siris) do Litoral Brasileiro. Editora Plêiade, São Paulo, 603 p.

Noe, C. D. 1967. Contribution to the life history of the stone crab *Mennipe mercenaria* Say with emphasis on the reproductive cycle. University of Miami, Coral Gables, 56 p.

Oshiro, L. M. Y. 1999. Aspectos reprodutivos do caranguejo guaiá, *Menippe nodifrons* Stimpson, 1859 (Crustacea, Decapoda, Xanthidae) da Baía de Sepetiba, Rio de Janeiro, Brasil. Revista Brasileira de Zoologia, 6 (3): 827-834.

Pinheiro, M. A. A. and Fransozo, A. 1995. Fecundidade de *Pachycheles haigae* Rodrigues da Costa, 1960 (Crustacea, Anomura, Porcellanidae) em Ubatuba SP, Brasil. Revista Brasileira de Biologia, 55 (4): 623-631.

Pinheiro, M. A. A.; Bertino, G.; Fernandes-Góes, L. C. and Fransozo, A. 1997. Decapod crustaceans associated to sand reefs *Phragmatopoma lapidosa* Kinberg, 1867 (Polychaeta, Sabellariidae) at Praia Grande, Ubatuba, SP, Brazil. Nauplius, 5 (2): 77-83.

Pinheiro, M. A. A. and Fransozo, A. 1998. Sexual maturity of the speckled swimming crab *Arenaeus cribrarius* (Lamarck, 1818) (Decapoda, Brachyura, Portunidae), in the Ubatuba littoral, São Paulo State, Brazil. Crustaceana, 71 (4): 434-452.

Pinheiro, M. A. A. and Terceiro, O. S. L. 2000. Fecundity and reprodutive output of speckled swimming crabs *Arenaeus cribrarius* (Lamarck, 1818) (Brachyura, Portunidae). Crustaceana, 73 (9): 1121-1137.

Pinheiro, M. A. A. and Hattori, G. Y. 2002. Embriologia do siri *Arenaeus cribrarius* (Lamarck, 1818) (Crustacea, Brachyura, Portunidae). Revista Brasileira de Zoologia, 19 (2): 571 –

583.

Pinheiro, M. A. A.; Baveloni, M. D. and Terceiro, O. S. L. 2003. Fecundity of the mangrove crab *Ucides cordatus* (Linnaeus, 1763) (Crustacea, Brachyura, Ocypodidae) at Iguape, SP, Brazil. Invertebrate Reproduction and Development, 43 (1): 19-26.

Santos, S. and Negreiro-Fransozo, M. L. 1997. Fecundity in *Portunus spinimanus* Latreille, 1819 (Crustacea, Brachyura, Portunidae) from Ubatuba, São Paulo, Brazil. Revista Interciencia, 22 (5): 259-263.

Sastry, A. N. 1983. Ecological aspects of reproduction.*In*: Vern berg, F.J. and Vern berg, W.B. (Ed.). The Biology of Crustacean. Environmental Adaptation. vol. 8, Academic Press, New York, 179-269

Struck, K. C. and Perry, H. M. 1992. Life history characteristics of *Menippe adina* in Mississippi Coastal Waters. Florida Marine Research Publications, 50: 82-98.

Swartz, R. C. 1978. Reproductive and molt cycles in xanthid crab *Neopanope sayi* (Smith, 1869). Crustaceana, 34 (1): 15-32.

Tomikawa, N. and Watanabe, S. 1992. Reproductive ecology of the xanthid crabs *Eriphia smithii* McLeay. Journal of Crustacean Biology, 12 (1): 57-67.

Wilber, D. H. 1989. Reproductive biology and distribution of stone crabs (Xanthidae, *Menippe*) in the hybrid zone on the northeastern Gulf of México. Marine Ecology Progress Series, 52: 235-244.

Received: 15th Dec 2004
Accepted: 17th Mar 2005