Population biology of *Callinectes ornatus* Ordway, 1863 (Decapoda, Portunidae) from Ubatuba (SP), Brazil*

M.L. NEGREIROS-FRANSOZO[1], F.L.M. MANTELATTO[2] and A. FRANSOZO[1]

[1]Departamento de Zoologia, Instituto de Biociências, Centro de Aqüicultura - UNESP.
C.P. 510 - Cep 18.618-000 Botucatu, São Paulo, Brasil.
[2]Departamento de Biologia, Faculdade de Filosofia Ciências e Letras de Ribeirão Preto – USP.
Cep 14.040-901 Ribeirão Preto, São Paulo, Brasil.

SUMMARY: Population structure and reproductive season of the portunid crab *Callinectes ornatus* were studied in animals collected from the Ubatuba bays, São Paulo, Brazil (23° 20' to 23° 35' S and 44° 50'to 45° 14' W). The samples were taken in three trawls performed every other month from January 1991 to May 1993. A total of 3,829 specimens of *C. ornatus* were obtained. Their size ranged from 9.3 to 84.6 mm (carapace width). Their median size based on their cephalothoracic width and their size frequency were determined as well. Their reproduction was continuous, with variable proportions of ovigerous females. The highest incidence of ovigerous females occurred in January 1991, 1992 and 1993 and March and November 1992. The oscillations of the environmental factors between the seasons are not so intense in subtropical regions, therefore allowing the continuity of the physiological process of growth and reproduction throughout the year.

Key words: Portunidae, reproduction, *Callinectes*, South Brazilian coast.

INTRODUCTION

The Portunidae family presents more than 300 described species. According to Williams (1974), the genus *Callinectes* Stimpson, 1860 is made up of 14 species confined almost exclusively to shallow, often brackish coastal waters. Eleven of these species are distributed throughout the Atlantic Ocean. The swimming crabs of the genus *Callinectes* are intensively exploited in estuaries and bays of the entire American continent, especially along the east coast (Perry and Malone, 1985).

*Received January 18, 1996. Accepted November 20, 1998.

Although representatives of the entire genus *Callinectes* are known as blue crabs, this name is most commonly applied to *C. sapidus* Rathbun, 1896 which is the most economically important species occurring along the Atlantic coast. Other species are: *C. bocourti, C. danae, C. exasperatus, C. larvatus, C. ornatus* and *C. similis*. Literature about blue crabs is extensive, probably because they are highly commercially exploited in North America.

Concerning the biological aspects of the species of the genus *Callinectes,* some papers can be pointed out: Kretz and Bücherl (1940) studied their anatomy and physiology; van Engel (1958,1990)

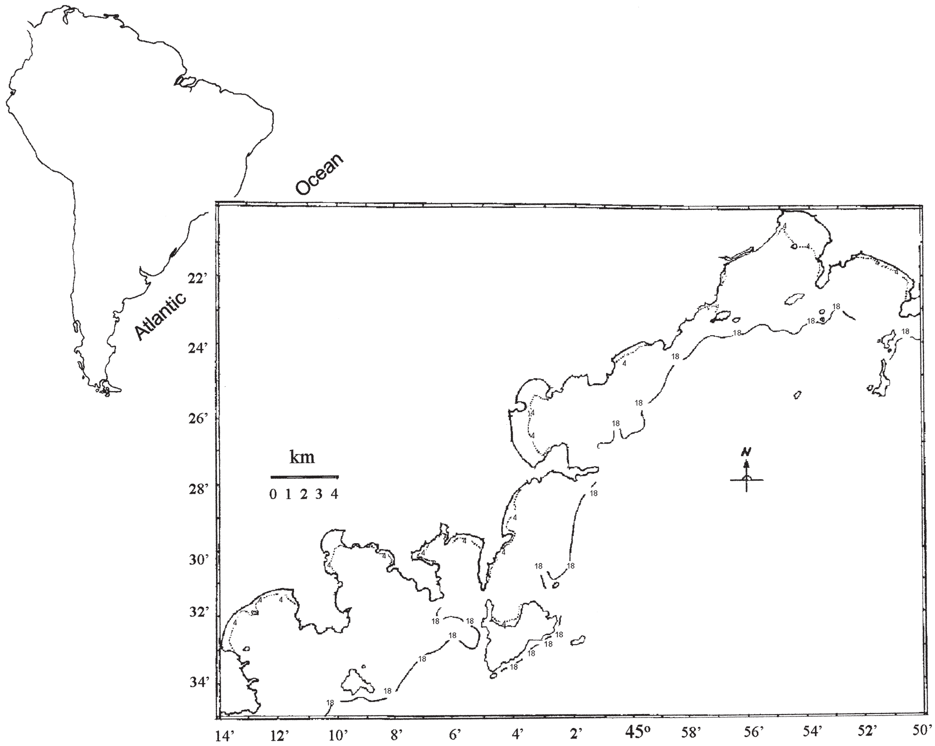

FIG. 1. – Ubatuba bays, São Paulo, Brazil.

investigated the fishery biology and reproduction of *C. sapidus*; Haefner and Schuster (1964) studied the growth of *C. sapidus*; Devries *et al.* (1983) analyzed the reproduction periodicity of *C. arcuatus*; Román-Contreras (1986), Hines *et al.* (1987), Buchanan and Stoner (1988), Lipcius and van Engel (1990) studied the population dynamics and distributional aspects of several species.

In a particular reference to *Callinectes ornatus* Ordway, 1963, Williams (1966) and Gore (1977) dealt with its diagnostic features and its distinction from *C. similis*. Haefner (1990a, 1990b) investigated the morphometry and natural diet of *C. ornatus*. Negreiros-Fransozo and Fransozo (1993 and 1995) analyzed comparatively some aspects of the biology and the ecological distribution of *C. ornatus* and *C. danae* in a South American bay.

The biology of tropical decapods is still poorly reported and new information is necessary for a more complete and comparative comprehension of their biological strategies.

The swimming crab *C. ornatus* is distributed in the western Atlantic from North Carolina down to Florida, Bermuda, Gulf of Mexico, Central America, Antilles, Guyannas and Brazil (from Amapá to Rio Grande do Sul). It can be found near river mouths and bays but is most common in moderate salty waters, inhabiting sand, mud or shell bottoms (Williams, 1974). The depth range of this species is from the intertidal zone to 75 m of depth (Melo, 1985).

The species *C. ornatus* constitutes an artisanal commercialized species in the Ubatuba region. Recently an increase in crustacean rearing activities of this species has been observed and in order to proceed, a more detailed knowledge of their biology, particularly with reference to growth, reproduction and dietary aspects is necessary.

This paper describes the results of some aspects of the biology, including population structure, sex-ratio and reproductive season, of a tropical shallow water swimming crab, *C. ornatus* in Ubatuba, a region of the Brazilian coast.

MATERIALS AND METHODS

The specimens were collected by otter-trawl (with 10 mm cod mesh), every other month from January 1991 to May 1993 in the Ubatuba bays (from 23°20' to 23° 35' S and from 44° 50' to 45° 14' W), São Paulo, Brazil (Fig. 1). The samples were taken in a depth range from 4 to 18 m along the coast. The sampled area represented 15,000 m^2 every other month.

Identification of species was based on Williams (1974). *C. ornatus* has morphological peculiarities that can be used in identification: i.e., it often presents small submesial frontal teeth, almost completely rudimentary and the first gonopods do not overlap the 5th thoracic sternite. The adult male is easily separated from other congeners.

In the laboratory, the following data were recorded: sex, carapace width (except the lateral teeth: with a caliper with an accuracy of 0.1 mm) and for females, the ovigerous condition.

The adult swimming crabs were distinguished from the juveniles by the examination of their abdomens. Juveniles have an abdomen sealed to the thoracic sternites while adults have a flexible one.

The median values of the densities of swimming crabs obtained for each demographic category (AM = adult male; AF = adult female; JM = juvenile male; JF = juvenile female) were analyzed by means of the Kruskal-Wallis one way analysis of variance on ranks ($p< 0.05$). To compare the densities of *C. ornatus* in the Ubatuba region, data from a previous work by Pires-Vanin (1989) was used for depth ranges from 0 to 100 m and data of the present project in 1991 ranging from 4 to 18 m.

In order to evaluate the sex-ratio and to estimate the reproductive period based on ovigerous female rates, a multinomial proportion comparison test was used and complemented by the Tukey test (Goodman, 1964, 1965).

The temperature data were obtained from the Oceanographic station of the University of São Paulo located in Ubatuba. Each value used corresponds to a monthly mean water temperature.

A linear correlation of Pearson was used to study the relation between ovigerous-ratio and mean water temperature, during each sampling period. The significance level adopted was 5 %.

RESULTS

Population structure

A total of 3,829 specimens of *C. ornatus* was obtained, of which 2,394 were males (62.5%) and 1,435 were females (37.5 %). The density median value obtained for this swimming crab during the study period was 15.3 specimens per 1,000 square meters.

The differences in the median values for density between each demographic category of *C. ornatus* in the sampled area were greater than would be expected by chance and there is a statistically significant difference. The density of adult males differed from that of adult females, juvenile males and females (Fig. 2).

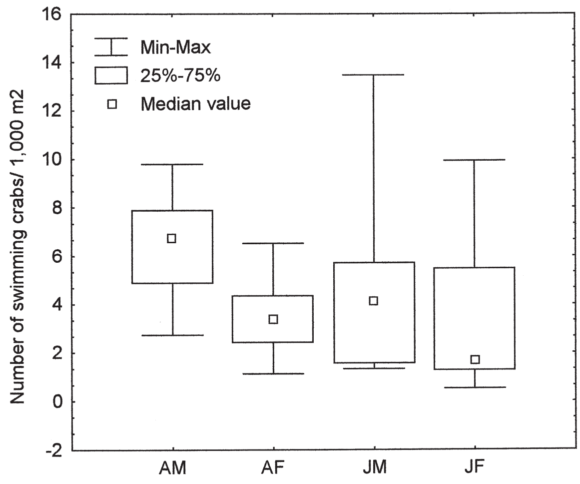

FIG. 2 – *Callinectes ornatus*: median density of each demographic category obtained in the Ubatuba region (between 4 and 18 m of depth). (Demographic categories: AM = adult males; AF = adult females; JM = juvenile males and JF = juvenile females).

As can be seen in Figure 3, the density of *C. ornatus* in the Ubatuba region differed in depth range ($P<0.01$), the highest density being observed in the region from 4 to 18 m of depth. Unfortunately, there is no available data for the comparison of demographic categories in such a wide depth range.

The size frequency distributions for each collecting month are shown in Figure 4. Carapace

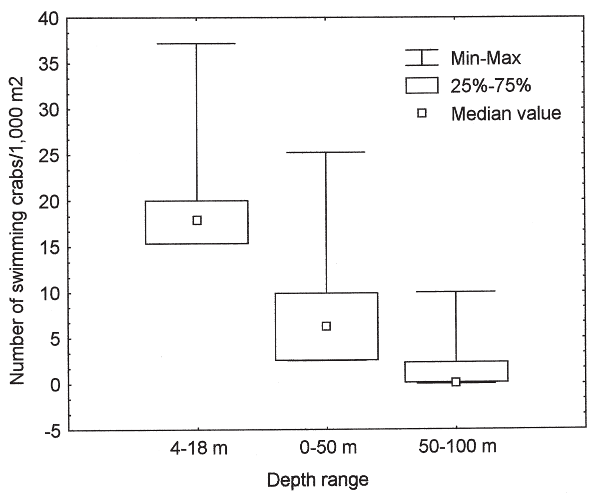

FIG. 3 – *Callinectes ornatus*: comparison of swimming crab densities. (4-18 m data obtained by the authors during the samples of 1991; 0-50 m and 50-100 m data from Pires-Vanin, 1989)

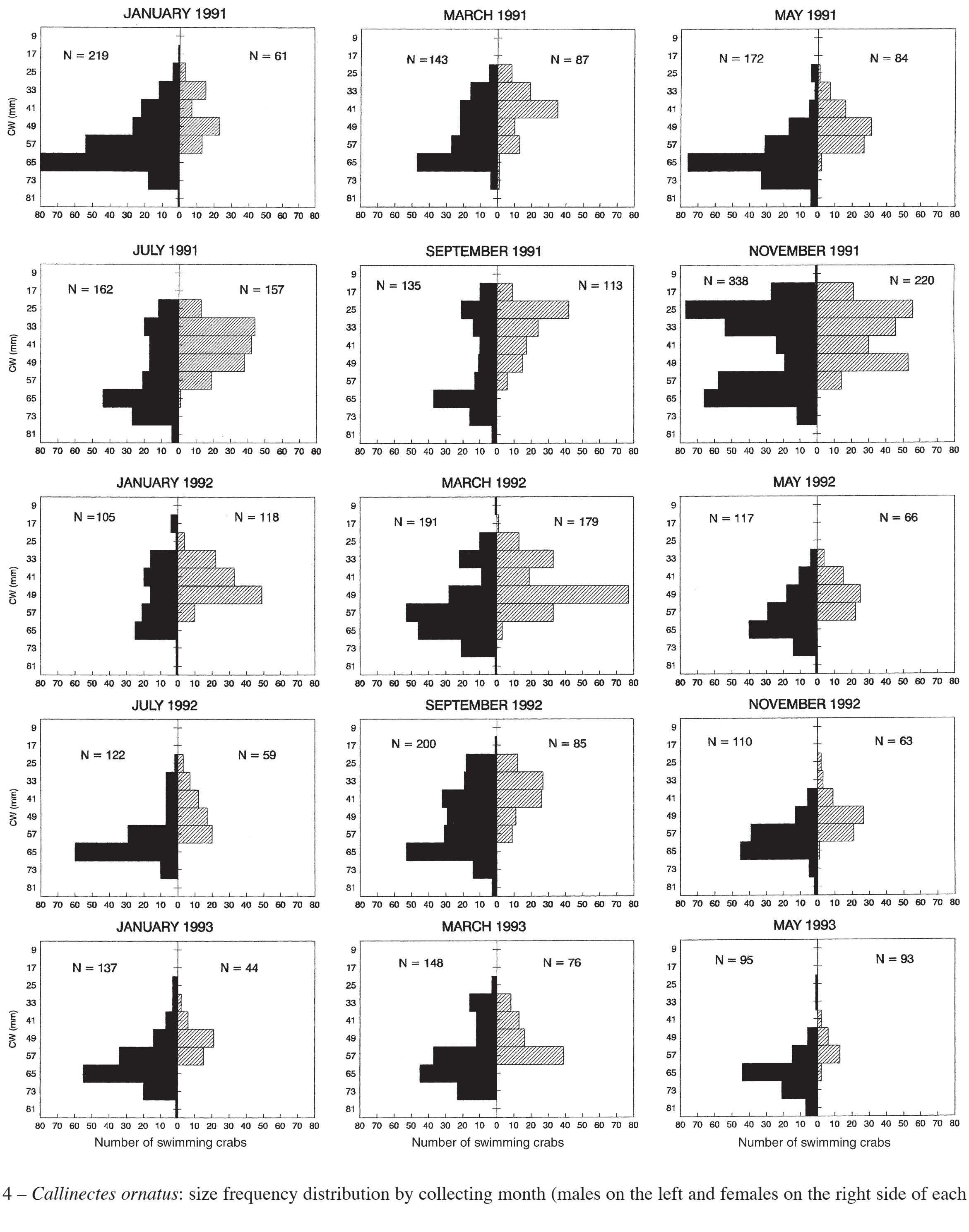

FIG. 4 – *Callinectes ornatus*: size frequency distribution by collecting month (males on the left and females on the right side of each graph).

width median size distributions by month reflect the absence of dramatic changes in population structure. This fact characterizes a unimodality for the population. The median size of individuals for each sample varied throughout the study period, with the smallest males and females found in November/91. Juvenile swimming crabs appeared in September/91, November/91 and January/92, March/92 and September/92.

The sex-ratio for all collected individuals was 1.7:1.0. Male occurrence was significantly ($P<0.05$) higher than female in eleven months, but was not significant in July/91, September/91, January/92 and March/92 (Table 1). Sex-ratio seasonality was not verified.

TABLE 1. – Comparison of the sex-ratio of *C. ornatus* sampled from Jan/91 to May/93 in the Ubatuba (SP) region of Brazil, analyzed by Multinomial proportions test. (The proportion without asteriks in the line means no difference between male and female, P>0.05).

Month/Year	Sex Males	Groups Females
January/91	0.782 *	0.218
March/91	0.622 *	0.378
May/91	0.672 *	0.328
July/91	0.508	0.492
September/91	0.544	0.456
November/91	0.606 *	0.394
January/92	0.471	0.529
March/92	0.516	0.484
May/92	0.639 *	0.361
July/92	0.674 *	0.326
September/92	0.702 *	0.298
November/92	0.626 *	0.374
January/93	0.758 *	0.242
March/93	0.661 *	0.339
May/93	0.814 *	0.186

The male proportion of *C. ornatus* increased towards larger sizes. Sex-ratio did not differ from 1:1 in the small sizes, but becoming progressively and significantly biased towards males in the largest sizes, finally reaching 100% of males in the largest sizes (from 53.0 mm of CW).

Reproductive period

The occurrence of adult non-ovigerous females was higher than ovigerous females, except in November/92. In general, ovigerous females were found throughout the year. However, none was sampled in November/91, July/92, September/92, March/93 and May/93. The greatest proportions of ovigerous females for *C. ornatus* occurred in January/91/92/93, May/92 and November/92 (Fig. 5).

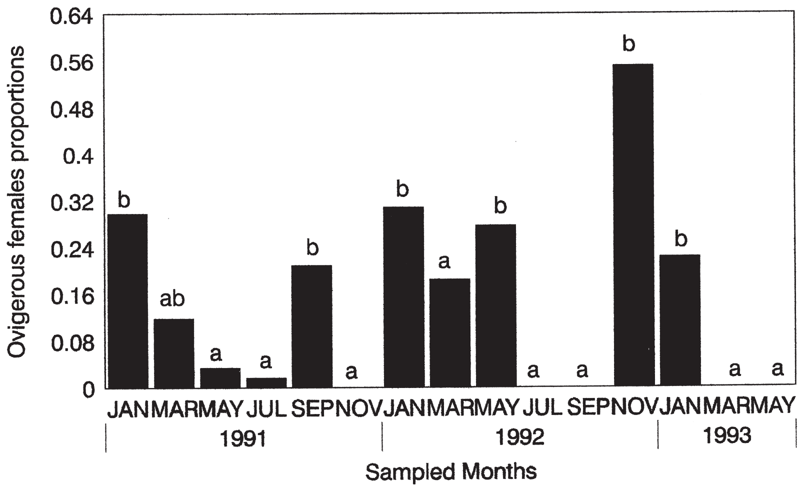

FIG. 5 – *Callinectes ornatus*: frequency of ovigerous females from January/1991 to May/1993. (Bars with the same letter do not differ statistically, P<0.05).

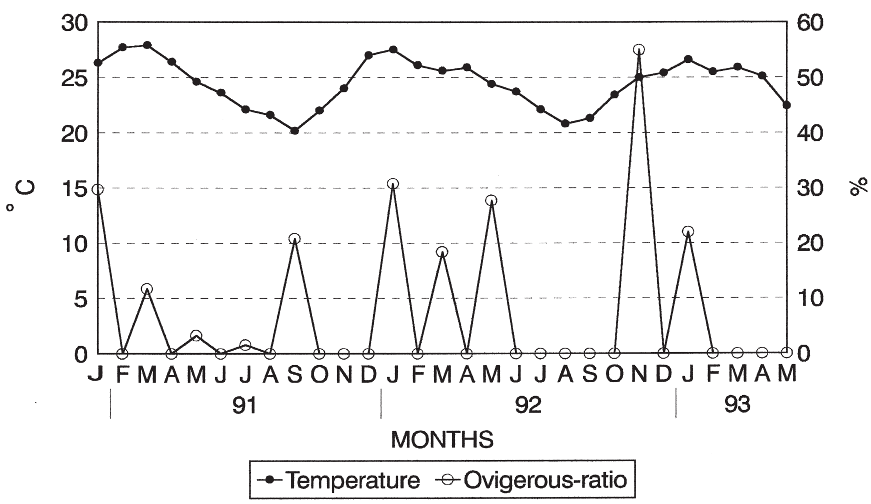

FIG. 6. – *Callinectes ornatus:* proportions of ovigerous females and mean water temperature (°C) in the Ubatuba bay, Brazil, from January, 1991 to May, 1993.

However, only in November/92 did the incidence exceed 50%.

The correlation analysis carried out for water temperature with the proportions of ovigerous females did not reveal any relation (p>0.05) (Fig.6).

DISCUSSION

Unimodality in size frequency distributions usually provides evidence of continuous recruitment, without interruptions, in the size classes and constant mortality rates.

From the sex-ratio obtained (1.7:1), some inferences can be made. There are some possible explanations for such a pattern, which support the hypothesis that this pattern might be due to reversal or sexual differences in longevity, mortality and growth rate. As suggested by DuPreez and McLachlan (1984) regarding the portunid *Ovalipes punctatus*, the deviation between the sex proportions may be due to differential adult mortality rates. However, in this study of *C. ornatus* none of these parameters are known. Nonetheless, one female can mate several males during the same reproductive period and the adult females can move offshore where the temperature and/or salinity conditions are good for spawning (Negreiros-Fransozo and Fransozo, 1995).

According to Giesel (1972), deviation from the expected sex-ratio can regulate the population size by acting on the reproductive potential. Díaz and Conde (1989) proposed that this condition can be seen in species with different growth rates and/or different life expectancy for each sex. The *C. ornatus* obtained data might fit this model.

Sex-ratio as a function of size follows the "anomalous pattern" described by Wenner (1972), and has previously been reported in other portunids: *Liocarcinus depurator* by Mori and Zunino (1987) and Abelló (1989b), *Macropipus tuberculatus* by Abelló *et al.* (1990), and several other species of decapods (Wenner, 1972; Swartz, 1976).

Although the samples were taken as deep as 18 meters and the species occurs down to 75 meters, the size range of the swimming crabs described in the present paper is comparable to others in literature (Table 2).

Hartnoll and Bryant (1990) mention that in sampling living decapods there are, in many cases, substantial problems in obtaining unbiased samples, since the methods of collecting and sorting normally select against smaller specimens, and different size-groups may be spatially segregated. Habitat partitioning by different sizes of swimming crabs have been studied by Hines *et al.* (1987) and was also reported by Negreiros-Fransozo and Nakagaki (1998).

TABLE 2. – Comparison of the carapace width (mm) of *C. ornatus* from different regions.

Region	Authors	Males min/max	Females min/max
Santos (SP) Brazil	Pita *et al.* (1985)	28.6/83.9	25.9/100.9
Florianópolis (SC) Brazil	Branco *et al.* (1990)	20/90	25/85
Bermudas, USA	Haefner (1990a)	12.1/84.4	10.5/64.2
Ubatuba (SP) Brazil	present study	9.3/84.6	15/74.8

The possibility of habitat partitioning and salinity tolerance of *C. ornatus* must be considered. As assumed by Negreiros-Fransozo and Fransozo (1995), all sexual and maturation phase groups of *C. ornatus* are present in the Fortaleza bay, Ubatuba (SP), but there is an absence of males and juvenile males of *C. danae* in the same area.

In the case of *C. ornatus*, probably the juvenile habitat is different from the adult one, as it can be often found in the shallower sites, but this aspect has not yet been investigated in detail in the tropical and subtropical areas.

As shown by the comparison test used to analyze the swimming crab density at different depth strata, density decreases with increasing depth such that bellow 50 m there are very few specimens. This information confirms the current data are consistent for an appraisal on *C. ornatus* population biology.

According to Wenner *et al.* (1974), the percentage of ovigerous females can vary with the season and the reproductive cycle due to changes in temperature, food supply and/or other factors. However, in tropical or subtropical regions this is not verified. Compared to temperate regions, the oscillation of temperature arising out of the latitudinal gradient, is not so intense. This makes possible the continuity of the physiological processes of growth and reproduction throughout the year.

A diffrent spawning strategy by *C. ornatus* and *C. danae* was observed by Pita *et al.* (1985) in Santos region (São Paulo littoral) and by Negreiros-Fransozo and Fransozo (1995) during a previous period in a nearby area. The larval discharge by these species in different periods of the year could be a strategy to reduce competition and, consequently, adjust their reproductive cycles to a period of better developmental conditions. Nevertheless, a more detailed study must be accomplished in order to get a precise conclusion on the interaction of the reproductive biology in *Callinectes*.

ACKNOWLEDGEMENTS

This work was sponsored by “Fundação de Amparo à Pesquisa do Estado de São Paulo” - FAPESP (Proc. # 91/2326-0, # 91/4559-1 and # 94/0824-0). We are sincerely thankful to NEBECC members who helped us during the sampling and the laboratories activities. We also wish to thank Dr. Carlos Roberto Padovani for statistical advice.

REFERENCES

Abelló, P. – 1989. Reproduction and moulting in *Liocarcinus depurator* (Linnaeus, 1758) (Brachyura: Portunidae) in the Northwestern Mediterranean Sea. *Sci. Mar.,* 53(1): 127-134.

Abelló, P., R. Villanueva and J.M. Gili. – 1990. Epibiosis in deep-sea crab populations as indicator of biological and behavioral characteristics of the host. *J. Mar. Biol. Ass. U.K.,* 70: 687-695.

Buchanan, B.A. and A.W. Stoner. – 1988. Distributional patterns of blue crabs (*Callinectes* sp) in a tropical estuarine lagoon. *Estuaries*, 11(4):231-239.

Branco, J.O., A. Thives and E. Porto-Filho. – 1990. Estrutura das populações, abundância e distribuição dentro de espécies integrantes da família Portunidae (Crustacea, Decapoda), na lagoa da Conceição e área adjacente, Ilha de Santa Catarina, SC, Brasil. *II Simpósio de Ecossistemas da Costa Sul e Sudeste Brasileira: estrutura, função e manejo. ACIESP, São Paulo*, 71 (2): 294-300.

Díaz, H. and J.E. Conde. – 1989. Population dynamics and life history of the mangrove crab *Aratus pisonii* (Brachyura, Grapsidae) in a marine environment. *Bull. Mar. Sci*., 45 (1): 148-163.

Devries, M.C., C.E. Epifanio and A.I. Dittel. – 1983. Reproduction periodicity of tropical crab *Callinectes arcuatus* Ordway in Central America. *Est. Coast. Shelf Sci*., 17: 709-716.

DuPreez, H.H. and A. McLachlan. – 1984. Biology of three-spot swimming crab *Ovalipes punctatus* (De Haan). III Reproduction, fecundity and egg development. *Crustaceana,* 47 (3): 285-297.

Giesel, J.T. – 1972. Sex-ratio rate of evolution and environmental heterogeneity. *Amer. Natur*., 106: 380-387.

Gore, R.G. – 1977. Studies on Decapod Crustacea from the Indian River region of Florida. VII. A field character for rapid identification of the swimming crabs *Callinectes ornatus* Ordway, 1863 and *C. similis* Williams, 1966 (Brachyura: Portunidae). *Northeast Gulf Sci*., 1(2): 119-123.

Goodman, L.A. – 1964. Simultaneous confidence intervals for contrasts among multinomial proportions. *Ann. Math. Stat.,* 35(2): 716-725.

Goodman, L.A. – 1965. On simultaneous confidence intervals for multinomial proportions. *Technometrics,* 7(2): 247-254.

Haefner Jr, P.A. – 1990a. Morphometry and size at maturity of *Callinectes ornatus* (Brachyura, Portunidae) in Bermuda. *Bull. Mar. Sci*., 46(2): 274-286.

Haefner Jr, P.A. – 1990b. Natural diet of *Callinectes ornatus* (Brachyura: Portunidae) in Bermuda. *J. Crus. Biol*., 10(2): 236-246.

Haefner Jr, P.A. and C.N. Shuster. – 1964. Length increment during terminal moult of female blue crab, *Callinectes sapidus* in different salinity environments. *Chesapeake Sci*., 5: 114-118.

Hartnoll, R.G. and A.D. Bryant. – 1990. Size-frequency distribution in decapod crustacea - the quick, the dead, and the cast-offs. *J. Crust. Biol*., 10 (1): 14-19.

Hines, A.H., R.N. Lipcius and A.M. Haddon. – 1987. Population dynamics and habitat partitioning by size, sex, and molt stage of blue crabs *Callinectes sapidus* in a subestuary of central Chesapeake bay. *Mar. Ecol. Progr. Ser*., 36: 55-64.

Kretz, J. and W. Bücherl. – 1940. Contribuição aos estudos da anatomia e fisiologia do gênero *Callinectes* (Crustacea, Decapoda, fam. Portunidae). Arquivos de Zoologia do Estado de São Paulo, vol. 1 (Tomo XXIV) *Rev. Mus. Paulista,* 1: 153-217.

Lipcius, R.N. and W.A. Van Engel. – 1990. Blue crab population dynamics in Chesapeake bay: variation in abundance (York River, 1972-1988) and stock-recruit functions. *Bull. Mar. Sci*., 6(1): 180-194.

Melo, G.A.S. de. – 1985. *Taxonomia e padrões distribucionais e ecológicos dos Brachyura (Crustacea, Decapodda) do litoral sudeste do Brasil.* Thesis Universidade de São Paulo, 215p.

Mori, M. and P. Zunino. – 1987. Aspects of the biology of *Liocarcinus depurator* (L.) in the Ligurian Sea. *Invest. Pesq*., 51(1): 135-145.

Negreiros-Fransozo, M.L. and A. Fransozo. – 1993. Avaliação preliminar da biologia de *Callinectes ornatus* Ordway, 1963 and *Callinectes danae* Smith, 1969 (Crustacea, Decapoda, Portunidae) na região de Ubatuba (SP), Brazil. *Anais do III Simpósio de Ecossistemas da Costa Brasileira*, ACIESP, 87-I: 122-125.

Negreiros-Fransozo, M.L. and A. Fransozo. – 1995. On the distribution of *Callinectes ornatus* Ordway, 1863 and *Callinectes danae* Smith, 1869 (Brachyura, Portunidae) in Fortaleza bay, Ubatuba (SP), Brazil. *Iheringia*, Porto Alegre (RS), (79): 13-29.

Negreiros-Fransozo, M.L. and J. M. NAKAGAKI. – 1998. Differential benthic occupation by crabs in the Ubatuba bay, São Paulo, Brazil. *J. Shellfish Res.,* 17(1): 293-297.

Perry , H.M. and R. F. Malone (eds.). – 1985. *National Symposium on the soft-shelled blue crab fishery*. Gulf Coast Research Laboratory, 128 p.

Pires-Vanin, A.M.S. – 1989. *Estrutura e dinâmica da megafauna bêntica na plataforma continental dar região Norte do Estado de São Paulo, Brasil*. Thesis Universidade de São Paulo, 172p.

Pita, J.B., E.S. Rodrigues, R. Graça-Lopes and J.A.P. Coelho. – 1985. Levantamento da família Portunidae (Crustacea, Decapoda, Brachyura) no complexo Baía-Estuário de Santos, São Paulo, Brasil. *Bo. Inst. Pesca*, 12(3): 153-162.

Román-Contreras, R. – 1986. Análisis da la población de *Callinectes* spp (Decapoda: Portunidae) en el sector Occidental de la Laguna de Terminos, Campeche, México. I. *Ann. Inst. Cienc. Mar Limnol.,* Universidad Nacional Autónoma de Mexico, 13(1): 315-322.

Swartz, R. C. – 1976. Sex-ratio as a function of size in the xanthid crab, *Neopanope sayi*. *Amer. Natur.,* 110: 898-900.

Van Engel, W.A. – 1958. The blue crab and its fishery in Chesapeake bay. Part 1. Reproduction, early development, growth, and migration. *Comm. Fish. Rev*., 20(6): 6-17.

Van Engel, W.A. – 1990. Development of the reproductively functional form in the male blue crab, *Callinectes sapidus. Bull. Mar. Sci*., 46(1): 13-22.

Wenner, A.M. – 1972. Sex-ratio as a function of size in marine Crustacea. *Amer. Natur.,* 106: 321-350.

Wenner, A.M., C. Fusaro and A. Oaten. – 1974. Size at onset of sexual maturity and growth rate in crustacean populations. *Can. J. Zool*., 32(9): 1095-1106.

Williams, A.B. – 1966. The Western Atlantic swimming crabs *Callinectes ornatus, C. danae* and a new related species (Decapoda, Portunidae). *Tulane Stud. Zool*., 13(3): 83-93.

Williams, A.B. – 1974. The swimming crabs of the genus *Callinectes* (Decapoda: Portunidae). *Fish. Bull*., 72(3): 685-798.

Scient. ed.: P. Abelló