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REPRODUCTIVE ASPECTS OF *Chasmagnathus granulata* DANA, 1851 (DECAPODA,GRAPSIDAE) IN THE PATOS LAGOON ESTUARY- BRAZIL.

RUFFINO, M.L.; TELLES, M.D. & F. D'INCAO

Universidade do Rio Grande, Departamento de Oceanografia, Caixa Postal 474, Rio Grande, RS, 96201-900 - Brazil.

ABSTRACT

Several biological features of the salt marsh crab *Chasmagnathus granulata*, such as the stage of ovarian development, fecundity, size of eggs and morphometry of the male and female chelae and abdomen have been examined for their reliability as criteria of maturity. The crabs were collected from a irregular salt marsh located on the west side of the access channel to the Patos Lagoon estuary during 1986, 1988 and 1989 spawning seasons. Mean carapace width of crabs studied for estimate fecundity was 19.13mm; mean fecundity was 19,205.5 eggs. Fecundity was significantly related to carapace width. The mean of 50% sexual maturity is 16.50mm of carapace width for females and the relationship between carapace width and abdomen width is linear and isometric for males, but is linear and alometric for females, showing that the abdomen width of females increase when the individuals reach about the mean size of first sexual maturity. Prepubertal and pubertal molts of males were inferred from changes in allometry of chelar propodal dimension.

Key words: *Chasmagnathus*, crab, fecundity, sexual maturity.

INTRODUCTION

The salt marsh crab *Chasmagnathus granulata* has a wide geographical distribution range on the Atlantic coast of South America, from Rio de Janeiro (22°S) to San Matias Gulf (41°S) (Boschi, 1964). The species is specially abundant in the Patos Lagoon estuary (Capitoli et al., 1978). Despite its biological importance as to enhance the erosive action of the organic material of the salt marshes that flow out to the estuary (D'Incao et al., 1990), large gaps persists in our knowledge on the population biology. In a recent species synopsis, D'Incao et al. (1992), dealt several items, including average abundance, burrow's role on lowering the temperature and salinity variations, and some aspects of the reproduction season. Nevertheless, there is no information available about reproductive effort or fecundity, as well as about maturity size. In this paper, we report observations of ovarian development of females fecundity (the number of eggs carried) and its relationship to the carapace width, total weight, time of year and their possible relationship to relative growth.

MATERIAL AND METHODS

During the spawning season of 1986, 1988 and 1989, we gathered, at random, 204 crabs by hand from a irregularly salt marsh located on the west side of the access channel to the Patos Lagoon estuary. The specimens were taken to the laboratory in plastic-covered buckets and maintained in an aquarium with local water prior to examination.

The following measurements were taken from each specimen: carapace width (CW), carapace length (CL), abdomen width of fourth segment (AW4), propodus length of the rigth chelipeds (PLR), all nearest to 0.1 mm. Fresh, entire, and intact crabs were weighed (WT) to the nearest 0.01 g.

The morphometric relationships between carapace width (CW) and abdomen width of the fourth segment (AW4) of 98 males and 60 females, and between carapace length (CL) and propodus length (PL) of 74 males and 54 females were determined from samples collected between September and December 1986.

Gonadal development of 103 females was analysed from samples collected in May-December 1989 and in April-October 1990. Five stages of gonadal development (immature; initial development; advanced development; mature and spawning) have been assigned to the species (Telles & Cousin, 1991). The average minimum size of maturity was determined according with to the procedures decribed by Vazzoler (1981).

Fecundity of 43 females was determined from samples collected during the spawning season of 1988-1989. Fecundity is defined in this study as the number of eggs carried per female per breeding season (October-April). The egg mass was removed from the pleopod structure by a solution of sodium hypochlorite 100% during about ten seconds and then washed out in current water (Sá, 1988). The eggs were placed in a becker with 300 ml of water, and five subsamples, with reposition, were obtained with a cylinder with known volume (2.9 ml) from the total sample. From each subsample the eggs were counted using a binocular stereomicroscope. The estimated fecundity of each crab was obtained multiplying the mean number of eggs counted by the total volume sample (300 ml) and dividing by the subsample volume (2.9 ml). The diameter of 25 eggs was determined by a calibrated binocular stereomicroscope, the largest distance was measured.

Statistical analysis as average, standard deviation, variance, regression and covariance analysis were performed with STATIGRAPHICS (Statistical Graphics System, Version 4.0, STC, Inc, 1989) program.

RESULTS

The spawning season of *C. granulata* was inferred from relative monthly occurrence of gonadal stages of females (Fig. 1). Lower percentage of immature females occurred in June, August and October/89 and October/90. The initial and advanced development stages were observed almost all months, with the main occurrence in May, comprising about 46% of the samples. Mature females were present nearly in every month, showing high percentages during spring (October, November and December) with 42%, 47% and 50%, respectivelly. The spawning stages were observed from November to August, with higher percentages in May (26%), June, August and November (23%) and December (20%). In May and June 1990 they comprised 51% and 66%, respectivelly.

Estimated mean size of first sexual maturity ($CW_{50\%}$) was 16.5 mm carapace width for females (Fig. 2).

The relationship between carapace width (CW) and abdomen width of the fourth segment (AW4) was linear and isometric to males (Fig. 3), but linear and alometric to females (Fig. 4). Covariance analysis showed a significative difference between male and females and between females abdomen (Table 1). Conspicuous difference between males and females also occurred in the propodus length, which was linear and isometric to females (Fig. 5), but linear and alometric to males (Fig. 6). Covariance analysis showed a significative difference between male and females, and between propodus length males (Table 1).

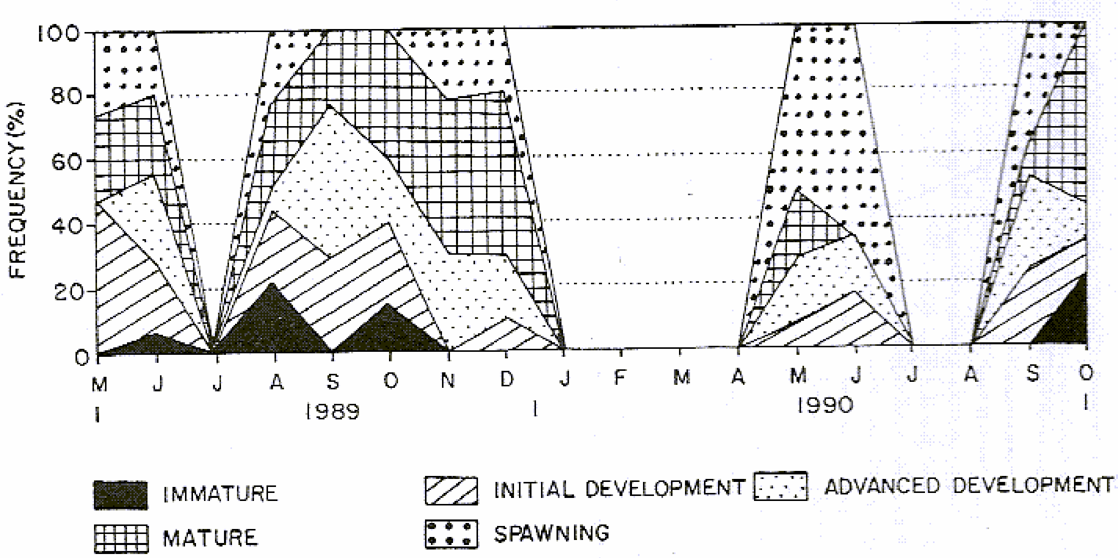

Figure 1. Gonadal development of females *Chasmagnathus granulata* relative to time.

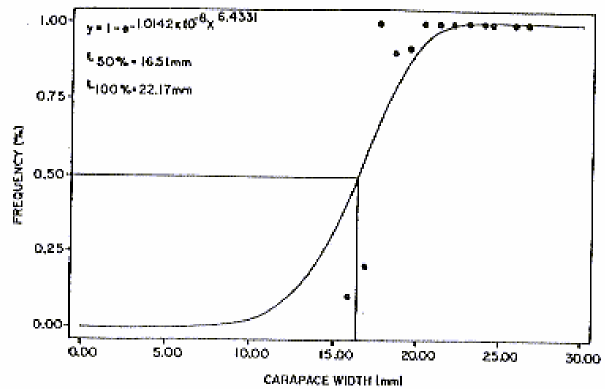

Figure 2. The mean carapace width at first maturity of females of *Chasmagnathus granulata*. (It is fit to a logistic curve).

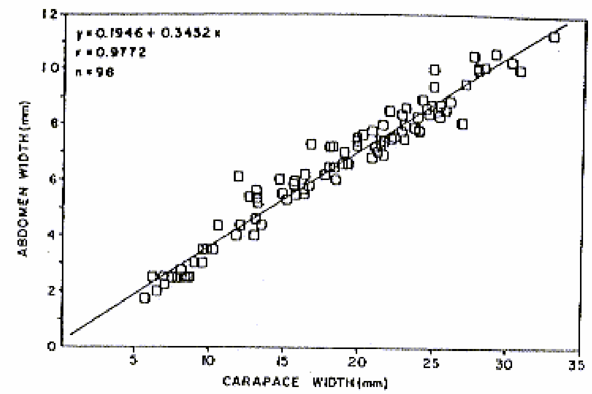

Figure 3. Male *Chasmagnathus granulata*. Relationship of carapace width (CW) to abdomen width (AW).

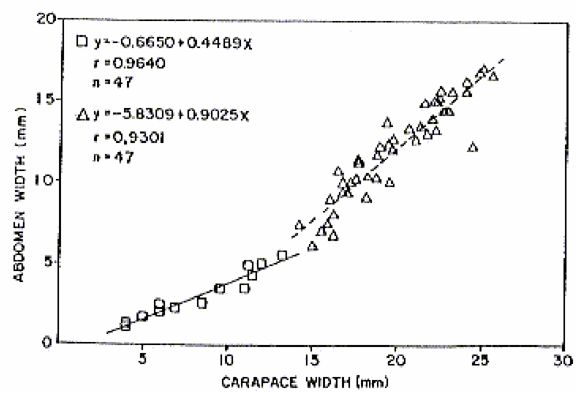

Figure 4. Female *Chasmagnathus granulata*. Relationship of carapace width (CW) to abdomen width (AW). □ Relationship isometric, Δ relationship alometric.

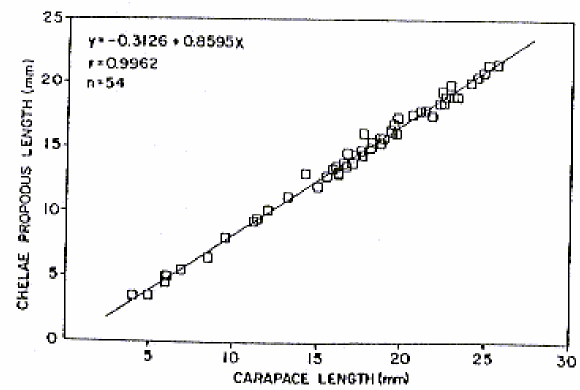

Figure 5. Female *Chasmagnathus granulata*. Relationship of carapace length (CL) to chelae propodus length (CPL).

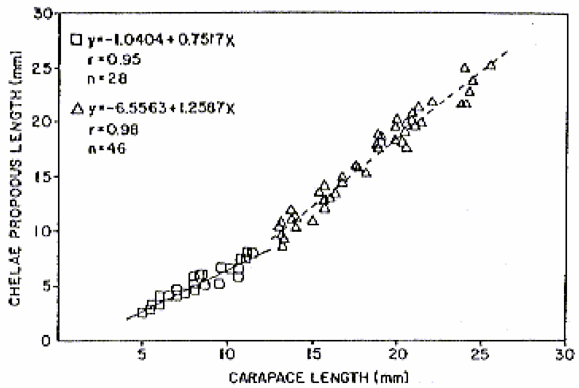

Figure 6. Male *Chasmagnathus granulata*. Relationship of carapace length (CL) to chelae propodus length (CPL). □ Relationship isomeric, △ relationship allometric.

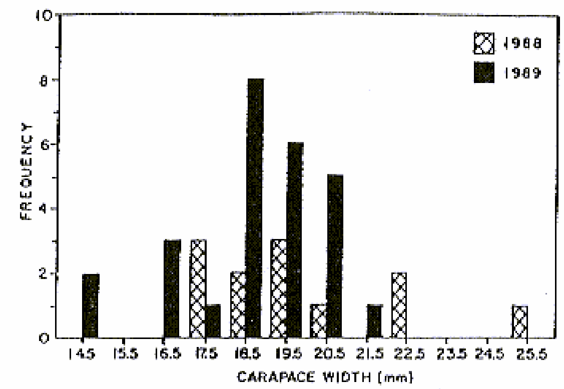

Figure 7. Frequency distribution of carapace width (mm) of 43 ovigerous specimes of Chasmagnathus granulata taken from The Patos Lagoon estuary in 1988 and 1989.

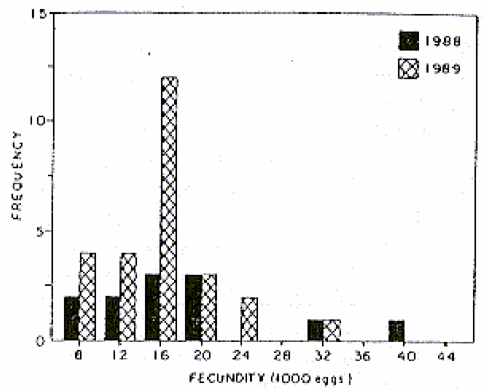

Figure 8. Frequency distribution of fecundity (number of eggs per individual) of 43 mature females specimes of *Chasmagnathus granulata* from the atos Lagoon estuary.

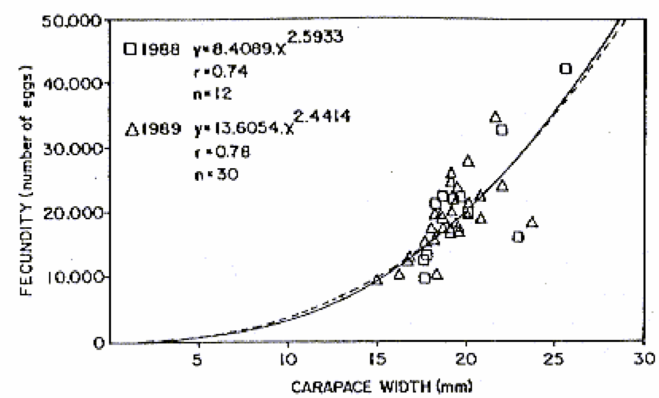

Figure 9. Relationship of carapace width to fecundity in 43 ovigerous specimes of *Chasmagnathus granulata* from The Patos Lagoon estuary.

The mean carapace width of all crabs, collected for fecundity studies, was 19.13 mm (maximum = 25.6 mm and minimum = 14.5 mm); the estimated standard deviation of width was 2.03 mm. The smallest carapace width of ovigerous females found in this area measured 12.2 mm, although this specimen is not included in the material examined in this study. The distribution of carapace width appears approximately normal (Fig. 7). The mean fecundity of all crabs was 19,250.5 eggs, the estimated standard deviation of fecundity was 6,816.3 eggs. The diameter of eggs was nearly constant, for all stages of development considered together, ranging between 0.29 mm and 0.50 mm. The mean diameter of all eggs examined was 0.36 mm and the estimated standard deviation was 0.05 mm. The frequency distribution of fecundity appears approximately normal under log transformation (Fig. 8). Detailed univariate statistics are given in Table 2. As show in figure 9, fecundity is correlated with carapace width. Nevertheless, a covariance analysis did not show significative difference between 1988 and 1989 (Table 1).

DISCUSSION

The gonadal development of the crabs does not show an interruption in the winter months. Females in advanced stage of maturation were observed in all winter months. According to D'Incao et al. (1988) ovigerous females are present during October to April. The analysis of the gonadal maturation showed that females are not mature in September-October which characterizes these months as the begining of the breeding season. During the others months it can be observed some females in spawning stage, mainly in May and June, which are the months immediately after the reproduction season. We can infer that the species would be ready to spawn throughout the year, however, this does not occur probably because of the adverse conditions of the environment. According to D'Incao et al. (1992) the temperature plays an important role in the species' behavior. During four years of field work, only one ovigerous female was captured in August/1989. This could support our hypothesis.

Our estimate of fecundity, based on counts of number of eggs, was lower (average fecundity = 20,897 eggs in 1988 and 18,489 eggs in 1989) than those verified by Botto & Irigoyen (1979) (average fecundity = 64,400 eggs) in Argentina. However, the mean carapace width of females analysed in their paper was 25.8 mm and the maximum and minimum number of eggs were 47,000 and 79,000 eggs per female, respectively. Our data show that the mean of CW of females was 19.13 and the maximum and minimum number of eggs were between 8,751 and 42,206 eggs per female. This number being estimated using the relationship carapace width/fecundity (Fig. 9). The number of eggs of a female with 25.8 mm is about 38,502 eggs (1988) and 38,022 eggs (1989). The largest female analysed in this study measured 25.6 mm CW and 42,200 eggs, showing a good fitness with the values. The difference of estimates between years may be due primarily to the different size of the crabs examined; it can be also due to variations in the biotic or abiotic environmental factors affecting fecundity directly or indirectly. Another possible reason for the differences on the number of eggs due to abrasion while the animal moves around or when it ventilates, and the volumetric expansion of the eggs due to imbibition of water at the initial and terminal periods of incubation. The fact that crustaceans egg imbibes water and increase its volume by several-fold is well known (Herring, 1974; Wear, 1974). The eggs loss in Decapoda, which carry the eggs fully exposed on pleopods is about 43% (Balasundaran & Pandian, 1982).

Warner (1977) mentioned that the size of a new-laid egg is very small; they are generally slightly oval in stage with a maximum diameter of between 0.25 and 0.35 mm. The maximum diameter of eggs found by Botto & Irigoyen (1979) of *C. granulata* varied between 0.36 and 0.42 mm. Our data agree with the results of the authors cited above.

Morphometric analysis revealed that a transition in the abdominal width and cheliped data series of *C. granulata*. It is often inferred that such transiction are related to pre-pubertal and pubertal changes associated with gonadal development and the onset of sexual maturity (Hartnoll, 1982; Gore & Scotto, 1983). This study presents evidence that supports such inferences.

The observed allometric patterns for the male chela are comparable to those reported for other Brachyura (Hartnoll, 1974, 1982). Male chelae normally have a high positive allometry as juveniles and a large increase in relative size at puberty. Moreover, the level of allometry in females is generally near unity in all phases, so that growth is essentially isometric throughout. In males and females of *C. granulata* the chelae grow with a positive allometry that is equal to both sexes during the juvenile phase. Moreover, the male chelae increase in relative size at the pubertal molt than that of females. As it is known, the chelae are widely used by males in territorial defence, combat, display and courtship.

Table 1. Covariance analyses of data sets for male and female *Chasmagnathus granulata*. Significance of F ratios determined at 0.005 (*) level. (CL= carapace length; CW= carapace width; AW4= abdomen width of fourth segment; PLR= propodus length of rigth chelipods; M=male and F=female).

Independent variable	Dependent variable	Sex	F var.	df	F reg.	df	F intercept	df
CL	AW4	M	1.53	96.11	5.44*	1.107	0.08	1.108
CL	AW4	F	7.18	41.11	19.55*	1.56	0.09	1.57
CW	PLR	F	0.81	50.26	15.64*	1.76	59.56*	1.77
CW	PLR<12.5	M	3.77	44.26	33.31*	1.70	1.50	1.71
CW	Fecundity	F	0.91	28.9	1.62	1.37	0.009	1.38

In the females crabs of *C. granulata*, the single allometric change in the abdomen width series occurs near 15 mm CW, when about 50% of individuals are mature. These transition may reflect the physiological changes that accompany reproductive development at the pre-pubertal and maturation molts.

The role of the abdomen in Brachyura is very different in the two sexes. In males it serves only to cover and support the first two pairs of pleopods which act as intromittent organs during copulation; then the growth of the male abdomen is expected to be approximately isometric throughout. In females, the abdomen encloses a chamber that facilitates the fixation of the eggs to the pleopods and the protection to the eggs during incubation. Thus, as with the male chelae, it shows a conspicuous positive allometry in the juvenile phase and a large increase in size at the puberty molt, which bring it to a functional size when, but not before, it is required (Hartnoll, 1982).

The growth of the male abdomen of most Brachyura is expected to be isometric throughout the life span (Hartnoll, 1982). Such is the case for *C. granulata*. However, a marked positive allometry is characteristic for the abdomen of female Brachyura, and that allometry should increase significantly at the pubertal molt (Hartnoll, 1982). Females of *C. granulata* bracket the juvenile phase of growth and reveal a slight change in allometry in the fourth abdominal segment.

D'Incao et al. (1993) studied the growth of *Chasmagnathus granulata* on the same study area and suggested that environmental conditions such as temperature, salinity and food supply can play an important role on growth. We believe that the conditions cited above can also influence the size of sexual

Table 2. Summary statistics on carapace width (mm), total weigth (g) and fecundity (number of eggs) of 43 salt marsh crabs of the Patos Lagoon estuary.

Collection sample number	Carapace mean	Width st. dev.	Total mean	Weight st. dev.	Fecundity		Sample size
					Mean	std. dev.	
1	18.45	1.20	4.08	0.76	17,244.0	6,656.7	2
2	20.93	3.31	5.71	1.85	21,740.2	12,281.4	6
3	19.48	1.57	4.87	1.38	21,516.8	7,224.7	5
4	18.88	1.39	4.14	0.82	19,528.1	5,349.8	8
5	19.09	0.82	4.29	0.54	17,443.9	3,607.1	7
6	18.26	1.14	4.19	0.57	17,180.4	4,428.3	5
7	18.03	2.93	3.91	1.73	16,851.2	9,407.3	6
8	21.08	2.17	5.59	1.27	22,337.5	3,152.4	4

maturity and fecundity. New reproductive studies comparing different populations of different habitats would contribute to a better knowledge of the ecology of this species.

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REFERENCES

BALSUNDARAN, C. & T.J. PANDIAN. 1982. Egg loss during incubation in *Macrobrachium nobilii* (Henderson & Mathias). J.exp.mar. Biol.Ecol., Amsterdam, 59(2,3):289-299.

BOSCHI, E.E. 1964. Los crustaceos decapodos Brachyura del litoral bonarense (Republica Argentina). Boln Inst.Biol.mar., Mar del Plata, 6:1-76.

CAPITOLI, R.R.; BENVENUTI,C.E. & N.M. GIANUCA. 1978. Estudos de ecologia bentônica na região estuarial da Lagoa dos Patos. I- As comunidades bentônicas. Atlântica, Rio Grande, 3:5-22.

D'INCAO, F.; RUFFINO,M.L. & K.G. Silva. 1988. Notas preliminares sobre a ecologia de *Chasmagnathus granulata* Dana, 1851, na Barra de Rio Grande, RS (Decapoda, Grapsidae). In; XV° Congresso Brasileiro de Zoologia, Curitiba, Resumos p.92.

D'INCAO, F.; SILVA,K.G.; RUFFINO,M.L. & A.C. BRAGA. 1990. Hábito alimentar do caranguejo *Chasmagnathus granulata* Dana, 1851 na Barra de Rio Grande, RS (Decapoda, Grapsidae). Atlântica, Rio Grande, 12(2):85-93.

D'INCAO, F.; RUFFINO,M.L.; SILVA,K.G. & A.C. BRAGA. 1992. Responses of *Chasmagnathus granulata* Dana, 1851 (Decapoda, Grapsidae) to salt marsh environmental variations. J.exp.mar.Biol.Ecol., Amsterdam, 161:179-188.

D'INCAO, F.; RUFFINO,M.L.; SILVA,K.G.; BRAGA,A.C. & L.H.C. MARQUES. 1993. Crescimento de *Chasmagnathus granulata* Dana,1851, em um marisma do estuário da Lagoa dos Patos, RS (Decapoda: Grapsidae). Revta bras.Biol., Rio de Janeiro, 53(4):637-643.

GORE, R.H. & L.E. SCOTTO. 1983. Studies on decapod Crustacea from the Indian River region of Florida. XXV. Carapacial and abdominal allometry in five species of subtropical parthenopid crabs (Brachyura, Parthenopidae). Crustaceana, Leiden, 44:1-22.

HARTNOLL, R.G. 1974. Variations in growth pattern between some secondary sexual characters in crabs (Decapoda, Brachyura). Crustaceana, Leiden, 27:131-136.

HARTNOLL, R.G. 1982. Growth. *In* Bliss,D.E., The biology of Crustacea, New York, Academic Press, v.2,p.111-196.

HERRING,P.J. 1974. Observations on the embrionic development of some deep-living decapod crustaceans with particular reference to species of *Acanthephyra*. Mar.Biol.Berlin, Berlin, 25:25-33.

SÁ, H.S. 1988. Método rápido para dissociação de ovas de crustáceos e peixes. In: XV° Congresso Brasileiro de Zoologia, Curitiba, Resumos, p.414.

TELLES, M.D. & J.C.B. COUSIN. 1991. Desenvolvimento gonadal de *Chasmagnathus granulata* Dana, 1851 (Crustacea: Decapoda: Grapsidae). XVIII° Congresso Brasileiro de Zoologia, Salvador, Resumos, p.86.

VAZOLLER, A.E.A.M. 1981. Manual de métodos para estudos biológicos de populações de peixes; reprodução e crescimento. Brasília, CNPq. Programa Nacional de Zoologia. 108pp.

WARNER, G.F. 1977. The Biology of Crabs. New York, Van Nostrand Reinhold Company, Paul Eleck (Scientific Books) Ltd. London, 202pp.

WEAR, R.G. 1974. Incubation in British decapod crustacea and the effect of temperature on the rate and success of embryonic development. J.mar.biol.Ass.U.K., Plymouth, 54:745-762.