SEXUAL MATURITY OF THE SPECKLED SWIMMING CRAB *ARENAEUS CRIBRARIUS* (LAMARCK, 1818) (DECAPODA, BRACHYURA, PORTUNIDAE), IN THE UBATUBA LITTORAL, SÃO PAULO STATE, BRAZIL

BY

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ABSTRACT

The sizes at morphological and physiological maturity of male and female *Arenaeus cribrarius* were estimated to determine if both events are synchronous. Animals were captured with otter-trawls at Ubatuba, Brazil. A total of 2 356 specimens, 977 males and 1 379 females, were obtained. The major carapace width without spines (CW), the propodus length of the major cheliped (PL) and the width of the 5th abdominal somite (AW) were measured with vernier calipers. Allometric relationships and gonadal development were analyzed to determine the maturity in both sexes. The size at the onset of male morphological maturity was estimated at CW 52 mm, smaller than the CW 63.4 mm physiological maturity size observed. For females, these events are synchronous since both estimates converged at CW 59.7 mm. The onset of functional sexual maturity in *A. cribrarius* at CW 63.4 and 59.7 mm in males and females, respectively, would indicate a minimum size of CW 64 mm for fishing purposes. Differences between allometric and gonadal estimates indicate the importance of considering both methods. A comparison of the present results with other available data in portunid crabs is provided.

RÉSUMÉ

Les tailles à la maturitè morphologique et physiologique du mâle et de la femelle d'*Arenaeus cribrarius* ont été estimées pour déterminer si les deux évènements sont synchrones. Des animaux ont été capturés au chalut à Ubatuba, Brésil. Au total, 2 356 spécimens, 977 mâles et 1 379 femelles, ont été obtenus. La plus grande largeur de carapace sans les épines (CW), la longueur du propode de grand chélipède (PL) et la largeur du 5ème somite de l'abdomen (AW) ont été mesurées au pied à coulisse à vernier. Les relations morphométriques et la maturité des gonades ont été analysées pour évaluer la maturité dans les deux sexes. Le début de la maturité morphologique des mâles (CW 52 mm) a précédé la maturité physiologique (CW 63,4 mm), alors qu'un synchronisme a été observé chez les femelles (CW 59,7 mm). La maturité fonctionnelle a été constatée à CW 63,4 mm pour les mâles à CW 59,7 mm pour les femelles. La taille minimale pour la préservation des stocks est de CW 64 mm.

Ces résultats montrent l'importance de l'étude macroscopique des gonades associée à la morphométrie pour mieux caractériser la maturité de l'espèce. Une comparaison avec d'autres crabes portunides est fournie.

INTRODUCTION

Estimates of size at the onset of sexual maturity, especially in the case of edible species, are among the most important information concerning biological populations. This information is required prior to the establishment of a fishery management program, which would preserve these natural stocks for future generations.

Most work on sexual maturity has been carried out on marine and freshwater fish species, but such studies have also been conducted on crustaceans, mainly commercially exploited species such as shrimps (Crocos & Kerr, 1983; Dailey & Ralston, 1986; Crocos, 1987; El Hady et al., 1990) and lobsters (Krouse, 1973; Grey, 1979; MacDiarmid, 1989). Due to an intensification of fishing activities and a growing consumption of crustaceans, there has been a remarkable increase of available information on this subject in recent years. This is the case for certain brachyurans, mainly portunids (Lewis, 1977; Choy, 1988; Prasad & Neelakantan, 1990; Haefner, 1990; Branco & Thives, 1991; Branco & Lunardón-Branco, 1993; Santos, 1994) and majids (Watson, 1970; Brown & Powell, 1972; Conan & Comeau, 1986).

The onset of sexual maturity, defined as a measure of size, can vary considerably at the inter- and intraspecific level (Fonteles-Filho, 1989). Therefore, the estimate of size at which at least 50% of a given species' population is sexually mature is important and often required.

Assessment of sexual maturity has been accomplished by associating the macroscopical development stage of gonads with the size of individuals. Carapace width is frequently used as a measure of size in brachyuran crabs, and gonadal maturation analysis provides an estimate of the physiological maturity (Campbell & Eagles, 1983; Conan & Comeau, 1986; Fonteles-Filho, 1989).

The ontogenetic growth of crustaceans is divided into phases, that often can be detected by external morphological examination. Allometric growth rates of certain somites are in many cases growth phase indicators. Sometimes the growth phase transition itself is marked by an abrupt allometric change of these structures (Hartnoll, 1974, 1978, 1982). Among the three described growth phases, i.e., larval, juvenile, and adult, the puberty moult, which separates the last juvenile and first adult instars, is the most important since the secondary sexual characters are fully developed.

In some brachyuran male crabs, fully developed secondary sex characters include the release of abdominal somites and gonopods from the thoracic sternites (Guinot, 1979), the conspicuous growth of certain cheliped segments (mainly the propodus) (Hartnoll, 1982; Pinheiro & Fransozo, 1993), and colour pattern enhancement of cheliped propodus and dactylus (Hopkins, 1963; Ryan, 1967). In females, there is a positive allometric growth of certain abdominal somites, e.g., the 5^{th} and the 6^{th}, and in some species the gonopore openings are only noticeable when maturity is achieved.

Sexual maturity in crustaceans can also be estimated from external observations. In this procedure, biometrical relationships are analyzed in which dimensions of chelar propodus (in males) and abdominal somites (in females) are regarded as dependent variables. Since graphical inspection can only indicate the size interval in which the portunid puberty moult occurs, Somerton (1980) and Somerton & MacIntosh (1983) developed two FORTRAN computer softwares (MATURE 1 and MATURE 2) for a more precise estimate.

Synchronism between morphological and physiological maturity in crustaceans, such as in the functionally mature juvenile specimens, for reproductive purposes are not very clear. Although frequently focused on (Conan & Comeau, 1986; Ennis et al., 1988), the reproductive events related to these questions are not adequately understood.

Though being used as a fishery resource in many regions along the Brazilian coast, there is no information regarding the sexual maturity in *Arenaeus cribrarius* at present. Establishing a minimum capture size would help this species' management in the wild and contribute to keep available stocks for future generations. Therefore, this study aims to estimate the size at the onset of sexual maturity in the swimming crab *Arenaeus cribrarius* (Lamarck, 1818) in the Ubatuba region, SP, Brazil, comparing size at morphological and physiological maturity to verify a possible synchrony between them. Furthermore, a comparative analysis using information gathered on other portunid crabs is provided.

MATERIALS AND METHODS

Monthly crab samples were obtained during a 2-year period, from May 1991 to April 1993, with two otter-trawls with 10 mm mesh nets in the Ubatuba region (fig. 1). An additional 403 crabs (189 males and 214 females), sampled in November 1988 and October 1989 in Fortaleza Bay, Ubatuba, were included

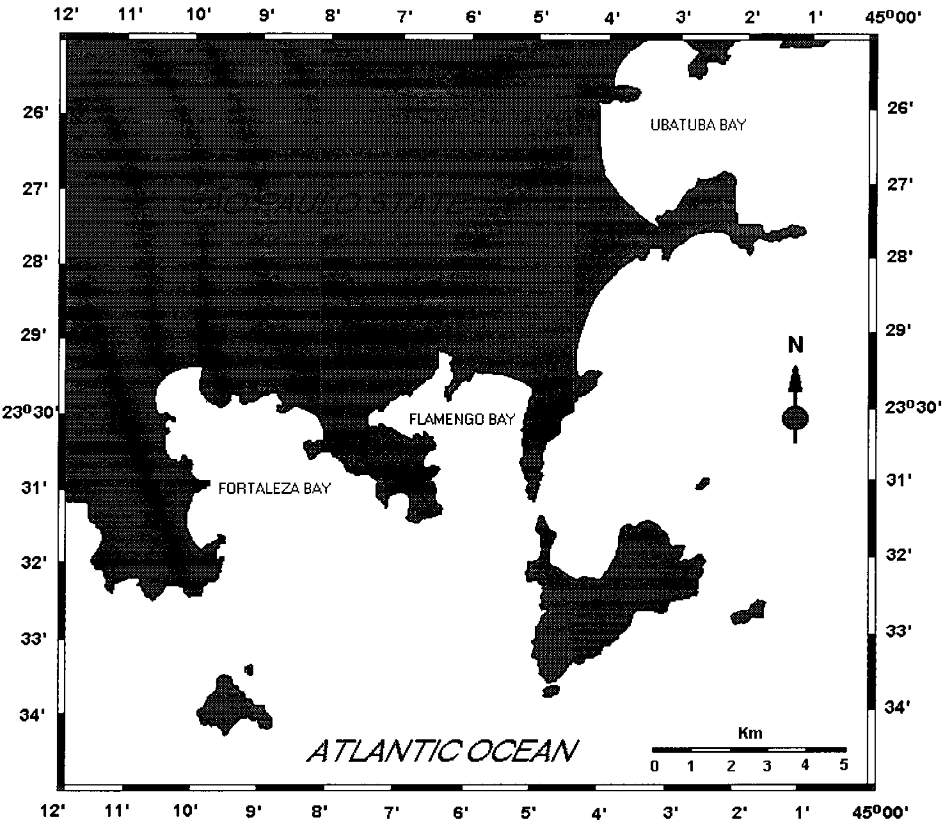

Fig. 1. Ubatuba region, São Paulo State, Brazil, where *Arenaeus cribrarius* (Lamarck, 1818) specimens were obtained.

in these analyses. After capture, the crabs were maintained in thermic boxes, placed in labeled plastic bags and frozen (−10°C) until processed.

Each specimen was sexed and its morphology checked. In the later procedure, females with triangular and suboval-shaped abdomens were considered juvenile and adult crabs, respectively. In males, both juveniles and adult specimens have inverted "T" shaped abdomens, but in juvenile crabs the abdomen adheres to the thoracic sternites, a characteristic which became first known from *Callinectes* spp. (Van Engel, 1958; Taissoun, 1970).

Carapace width excluding lateral spines (CW) was used as a representative measure of body size (independent variable) (fig. 2). The propodus length of the major cheliped (PL) in males and 5^{th} abdominal somite width (AW) of females (regarded as dependent variables) were also measured. All measurements were made with vernier calipers to the nearest 0.05 mm. Damaged crabs or individuals with regenerating or otherwise anomalous limbs were discarded.

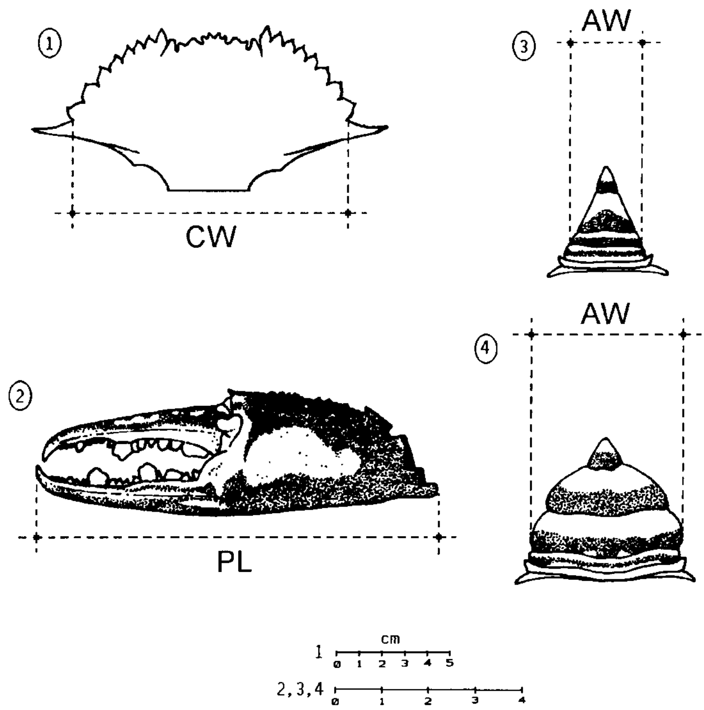

Fig. 2. *Arenaeus cribrarius* (Lamarck, 1818). Measurement specifications of: 1, carapace; 2, major chela; 3, abdomen of juvenile female; 4, abdomen of adult female. CW, carapace width; PL, propodus length; AW, abdomen width.

Morphological maturity in *A. cribrarius* was estimated from the biometric relationship between PL × CW in males and AW × CW in females (Pinheiro & Fransozo, 1993). The allometric equation ($y = \mathrm{a}\,x^{\mathrm{b}}$) was fitted to each growth phase to obtain the allometric growth constant "b", which is required to determine the growth pattern (see Somerton, 1980). Patterns of relative growth include cases in which growth phase lines present an overlap, making it difficult to determine the size at maturity by simple graphic inspection, and others in which allometric growth of the dependent dimension at the puberty moult leads to non-overlapping juvenile and adult growth lines. MATURE 1 software (Somerton, 1980) was developed to estimate the morphological maturity of species presenting overlapping growth phase lines, while MATURE 2 (Somerton & MacIntosh, 1983) should be used in the case of intercepting growth phase lines. If the data set is too extensive, its size can be reduced by means of pseudo-random generation of uniformly distributed numbers (Naylor et al., 1966; Wichmann & Hill, 1982), maintaining the lower and upper limits of each growth phase line.

TABLE I

Arenaeus cribrarius (Lamarck, 1818). Diagnosis of gonadal development stages and substages used in macroscopical analyses in both males and females (modified from Haefner, 1976 and Erdman & Blake, 1988)

Stage	Substage	Macroscopical features	
		Male	Female
Immature	I	Gonads can only be observed under an over 40× magnification.	Gonads can only be observed under an over 40× magnification.
	II	Filamentous colourless vas deferens. Only visible if magnified.	Filamentous ovary. Colourless to translucent. Only visible if magnified.
Developing	III	Vas deferens filament visible to the naked eye. Colourless to translucent.	Filamentous ovary but visible to the naked eye. Salmon to orange.
	IV	Gonad : hepatopancreas size ratio approximately 1 : 4. White.	Gonad : hepatopancreas size ratio approximately 1 : 2. Ovary is light orange.
Developed	V	Gonad and hepatopancreas with similar sizes. White.	Gonad and hepatopancreas with similar sizes. Ovary is dark orange.
	VI	The gonad is larger than the hepatopancreas, occupying all cephalothoracic cavity. White.	The ovary is larger than the hepatopancreas, occupying all cephalothoracic cavity. Ova are visible to the naked eye. Dark orange.

Gonads were examined to determine the size at which half of the population is physiologically mature ($CW_{50\%}$). Stage of gonadal development was assigned by gonad colour and the gonad/hepatopancreas size ratio (table I).

According to the methodology described by Vazzoler (1982) and Fonteles-Filho (1989), the crabs were grouped into 5 mm CW classes. Individuals with immature gonads were classified as juvenile while specimens with both developing and developed gonads were considered adults. The proportions of juvenile and adult crabs within each size class were calculated, and the percentages of adult crabs per class were adjusted to an $y = 1 - e^{-\mathrm{AZ}}$ sigmoid curve, where $\mathrm{Z} = x^{\mathrm{b}}$ and $\mathrm{A} = \ln \mathrm{a}$ of the linearized equation $\ln[-\ln(1-y)] = \ln \mathrm{a} + \mathrm{b} \ln x$. Estimates of the onset of sexual maturity were obtained from the equation $CW_{50\%} = e^{[\ln[-\ln(1-0.5)]-\ln \mathrm{A}]/\mathrm{b}}$ (Fonteles-Filho, 1989).

Functional maturity was regarded as the minimum size at which crabs of each sex are both morphologically and physiologically ready to reproduce. A quantitative assessment of the immature crab catch in a locally exploited commercial activity is provided.

RESULTS

From May 1991 to April 1993, a total of 1 953 crabs were obtained: 788 males (100 juveniles and 688 adults) and 1 165 females (253 juveniles and 912 adults). Including the crabs previously collected in the Fortaleza Bay, 2 356 individuals were analyzed.

Morphological maturity

A total of 685 males (100 juveniles and 585 adults) were included in the PL × CW analysis; the equations:

$$\ln \mathrm{PL} = -0.84 + 1.11 \ln \mathrm{CW} \quad (r^2 = 0.99; t = 105.52; P < 0.05) \quad \text{and}$$
$$\ln \mathrm{PL} = -1.53 + 1.28 \ln \mathrm{CW} \quad (r^2 = 0.98; t = 164.91; P < 0.05)$$

were obtained for juvenile and adult crabs, respectively. In the AW × CW analysis of 1 313 females (324 juveniles and 989 adults), we found, respectively:

$$\ln \mathrm{AW} = -2.40 + 1.27 \ln \mathrm{CW} \quad (r^2 = 0.98; t = 113.76; P < 0.05) \quad \text{and}$$
$$\ln \mathrm{AW} = -1.79 + 1.20 \ln \mathrm{CW} \quad (r^2 = 0.93; t = 114.68; P < 0.05)$$

for juvenile and adult crabs.

In males, the PL × CW scatterplot (fig. 3) resembles Somerton's (1980) "A" pattern, prompting the use of the MATURE 2 software in the analysis. Since the data size was within the software's capability range, the routines were executed without sample size reduction. Sizes of analyzed crabs ranged from 22.1 to 107.7 mm CW and a residual sum of squares (RSS) minimization at 52 mm CW, indicating the inflection point. In this analysis, the fit of two different regressions was better than the fit of a single one (F = 61.23; $P < 0.01$), and the expressions obtained were:

$$\text{juvenile males: } \ln \mathrm{PL} = -0.77 + 1.09 \ln \mathrm{CW} \quad (N = 75) \quad \text{and}$$
$$\text{adult males: } \ln \mathrm{PL} = -1.56 + 1.29 \ln \mathrm{CW} \quad (N = 610).$$

In females, the AW × CW scatterplot is similar to Somerton's (1980) "D" pattern, so MATURE 1 software was used. In this case, data size (1 313 females) was too large and 500 random points were used to obtain the relationships shown

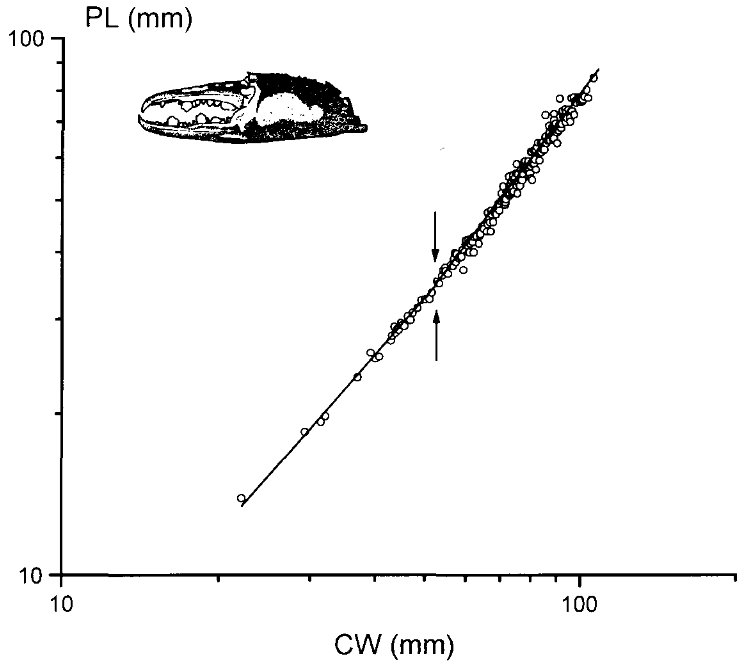

Fig. 3. *Arenaeus cribrarius* (Lamarck, 1818). Chelar propodus length (PL) versus carapace width (CW) scatterplot in males (N = 685).

in fig. 4. Size ranged from 28.4 mm to 92.8 mm CW and growth phase lines overlap within the 45-75 mm size interval. The relationships obtained were:

$$\text{juvenile females: } \ln \text{AW} = -2.41 + 1.28 \ln \text{CW} \quad (N = 120) \quad \text{and}$$
$$\text{adult females: } \ln \text{AW} = -1.83 + 1.20 \ln \text{CW} \quad (N = 380).$$

Parameter estimates when fitting the logistic function, $y = 1/(1 + \mathrm{A}\, e^{\mathrm{B}x})$ to the size class frequency of mature females data resulted in the constants A = 847.11×10^5 and B = -305.62×10^{-3}. Therefore, the onset of morphological maturity ($CW_{50\%}$) is estimated at 59.7 mm. Of the 500 specimens analyzed, mature female size ranged from 51.9 mm to 72.4 mm CW.

Physiological maturity

The size frequency distributions of 952 males and 1369 females in each gonadal development stage are shown in table II. In males, the maturity curve constants obtained were A = 2.51×10^{-16} and b = 8.57. Thus, the onset of physiological maturity in males was estimated at $CW_{50\%}$ = 63.4 mm as shown in fig. 5. Crabs larger than 85.7 mm were invariably mature. In females, the "A" and "b" constants were estimated at 8.06×10^{-18} and 9.54, respectively. As

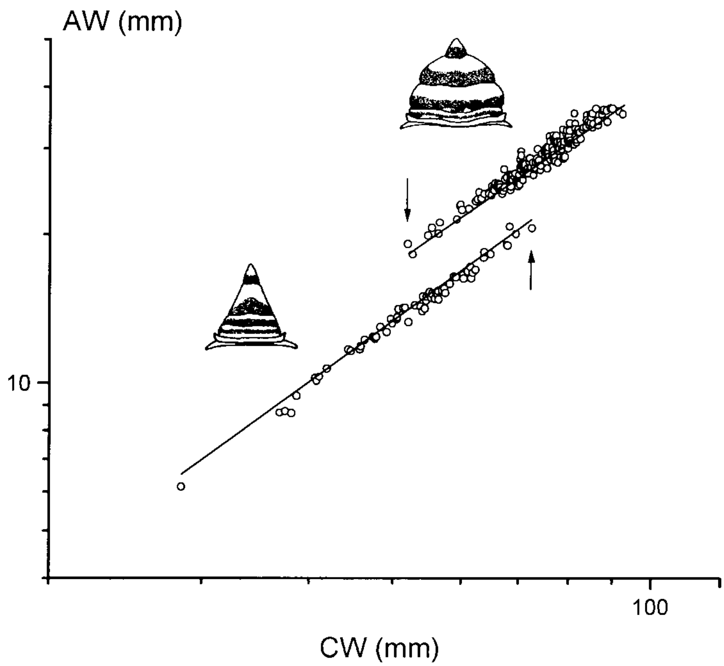

Fig. 4. *Arenaeus cribrarius* (Lamarck, 1818). Abdomen width (AW) versus carapace width (CW) scatterplot in females ($N = 500$).

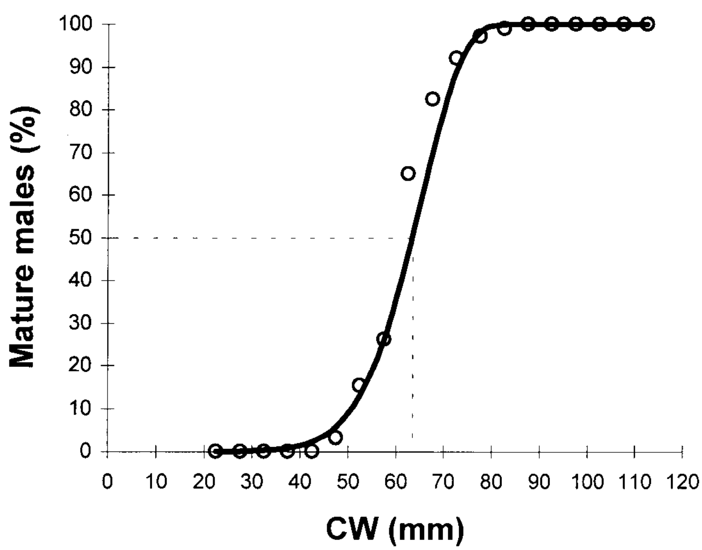

Fig. 5. *Arenaeus cribrarius* (Lamarck, 1818). Physiological maturity curve in males ($N = 952$).

TABLE II

Arenaeus cribrarius (Lamarck, 1818). Size frequency distributions of males and females in each gonadal development stage (I = immature; D = developing; De = developed)

Size classes (mm)	Males			Females		
	I	D	De	I	D	De
20-25	3	–	–	–	–	–
25-30	4	–	–	3	–	–
30-35	6	–	–	8	–	–
35-40	13	–	–	11	–	–
40-45	37	–	–	44	1	–
45-50	30	1	–	53	6	–
50-55	33	6	–	74	14	–
55-60	48	15	2	65	46	7
60-65	23	38	4	37	54	26
65-70	15	48	22	17	133	76
70-75	11	65	63	7	135	96
75-80	3	35	68	–	126	100
80-85	1	24	69	–	82	70
85-90	–	37	89	–	36	30
90-95	–	21	66	–	5	7
95-100	–	9	23	–	–	–
100-105	–	4	12	–	–	–
105-110	–	2	1	–	–	–
110-115	–	–	1	–	–	–
Total	227	305	420	319	638	412

shown in fig. 6, the maturity curve indicates the onset of physiological maturity at $CW_{50\%} = 59.6$ mm. All individuals larger than 78.2 mm were mature.

Functional maturity

Considering the values obtained from morphological and physiological data (fig. 7), the onset of functional maturity in males and females is estimated at 63.4 mm and 59.7 mm CW, respectively. Hence, the catch of immature crabs, 266 males and 329 females, corresponded to 25.5% of all crabs collected ($N = 2\,337$).

DISCUSSION

Size at the onset of sexual maturity and number of instars following the puberty moult are important information on the reproductive biology of brachyuran crabs. This knowledge is required in the management of commercially exploited

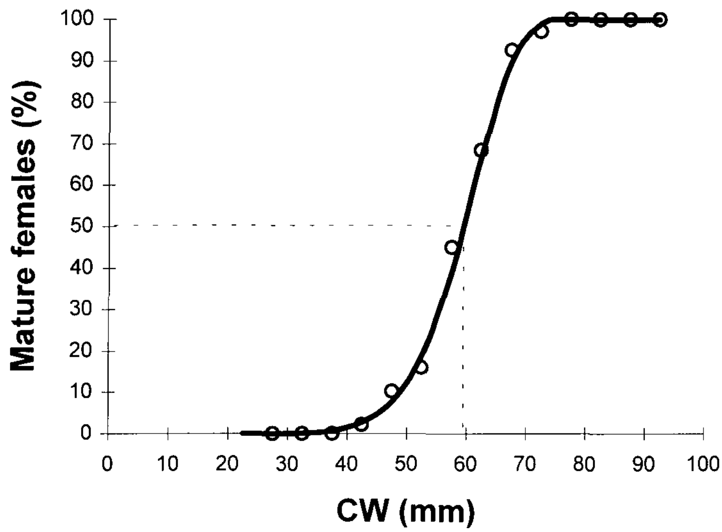

Fig. 6. *Arenaeus cribrarius* (Lamarck, 1818). Physiological maturity curve in females ($N = 1\,369$).

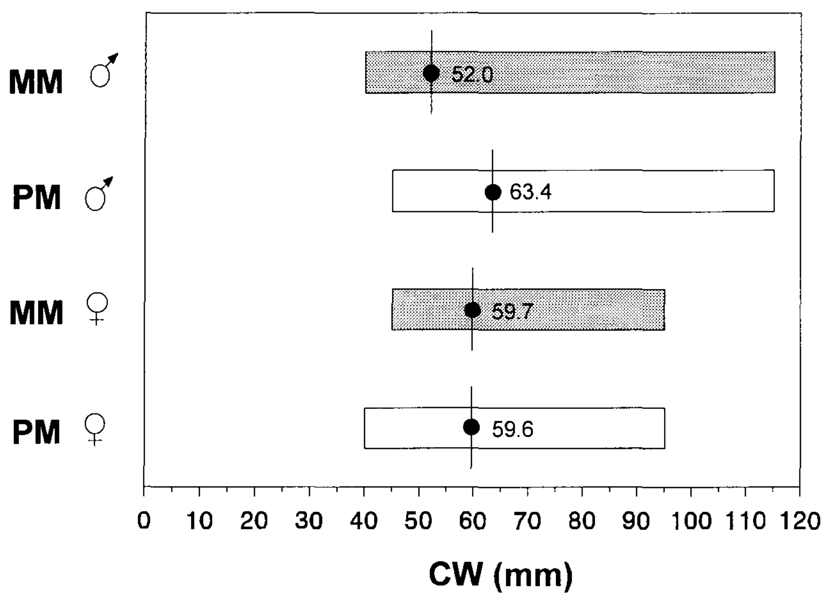

Fig. 7. *Arenaeus cribrarius* (Lamarck, 1818). Comparative scheme showing morphological (MM) and physiological maturity (PM) in males and females and size range of mature specimens.

populations (Knudsen, 1960; Kwei, 1978; Campbell & Eagles, 1983). These reproductive features, among others, such as number of spawns in a single instar and reproductive seasonality, present high interspecific variability in brachyuran crabs which, compared to other crustaceans, show a relatively large array of reproductive strategies (Hartnoll & Gould, 1988).

According to Hartnoll (1969), mating in portunid crabs generally involves intermoult males and recently moulted females. Males should be sexually mature for a successful spermatophore transfer while morphological maturity, instead of gonadal maturity stage, is the main requirement in mating females (Hartnoll, 1978; González-Gurriarán, 1985). This fact was verified in *Arenaeus cribrarius*, in which 98.8% of recently mated females (with full spermathecae) showed immature or developing gonads (Pinheiro, 1995).

Some morphological changes take place during brachyuran ontogeny. Of those, the most conspicuous ones are related to sexual maturity and the moult of puberty (Pérez, 1928). At this moult, portunid males undergo a marked growth of certain cheliped segments (mainly the propodus), thereby increasing individual shape, and establish dominant hierarchical castes (Warner, 1977). In some portunids, these castes are differentiated by the colour pattern of the inner side of the chelae (propodus and dactylus), as verified by Ryan (1967) for *Portunus pelagicus* (L., 1758). In male *A. cribrarius* there is an intensification of the yellowish colour pattern of the inner chelar surface, which is displayed during mating (Pinheiro, 1995). This is similar to what Hopkins (1963) observed in *Callinectes sapidus* Rathbun, 1896.

Brachyuran males use their chelae in a wide variety of ritualized exhibitions related to the reproductive process, including agonistic interactions with other males while contending for mates and during female handling in pre- and post-copulatory events (Wright, 1968; Hartnoll, 1968, 1974, 1978; Lewis, 1977; Conan & Comeau, 1986; Vaninni & Gherardi, 1988). Therefore, larger males provided with larger chelipeds have an advantage in mate selection and in related intraspecific competition events. In the case of portunid females, the abdomen is released from the thoracic sternite, pleopod setae are developed and the abdominal somites widen. These changes, which provide protection to gonopores and egg mass, occur after the puberty moult (Finney & Abele, 1981; Hartnoll, 1982). In *A. cribrarius* the opening of the gonopore occurs at this stage, a process that takes place before this critical moult in some *Callinectes* species (Negreiros-Fransozo, pers. comm.).

The morphometrical analyses in this study provide accurate estimates of size at the onset of sexual maturity. Similar meaningful results were obtained by other authors (Watson, 1970; Brown & Powell, 1972; Wenner et al., 1974; Haefner, 1985; Conan & Comeau, 1986; Choy, 1988; Felder & Lovett, 1989; Haefner, 1990) justifying its wide use in carcinology.

According to Hartnoll (1963), the puberty moult in oxyrhynchous crabs (e.g., Majidae, Hymenosomatidae, Parthenopidae) is the terminal moult, while cancrid crabs and some representatives of the family Portunidae can moult once, twice, or several times after attaining the puberty moult. Although uncommon, moulting activity after sexual maturity was confirmed in *A. cribrarius* (cf. Pinheiro, 1995), since 11 adult females (near 1% of all adult females collected) were captured in the pre-moult stage, indicating that they may moult at least once after the puberty moult. Similar results were obtained in *P. sanguinolentus* (Herbst, 1796) and *Necora puber* (L., 1767) by Ryan (1967) and Drach (1933), respectively.

Despite the close association between development of secondary sexual characters and physiological maturity, in some species these events are not synchronous (table III). Asynchrony, in which physiological maturity precedes morphological maturity, was verified in *A. cribrarius* males. Other portunids demonstrating asynchrony are *Liocarcinus holsatus* (Fabricius, 1798) and *N. puber* (L., 1767) as found by Choy (1988), *Scylla serrata* (Forskål, 1775) by Prasad & Neelakantan (1990), and *Necora puber* (L., 1767) by González-Gurriarán & Freire (1994) (see table III). These events are simultaneous in *A. cribrarius* females, as also reported for other portunids like *Callinectes danae* Smith, 1869 by Pita et al. (1985), *Ovalipes catharus* (White, 1843) by Armstrong (1988), and *Portunus spinimanus* Latreille, 1819 by Santos (1994).

In almost all studied portunid species except *P. pelagicus* (cf. Batoy et al., 1987; Ingles & Braum, 1989), females attain sexual maturity at smaller sizes than males (table III). This fact can be particularly advantageous in *A. cribrarius*, since in mating pairs males are 20 to 40% larger than females (Pinheiro, 1995), thus, soft-shelled female protection after mating is probably assured.

In some cases, population structure analyses involving, e.g., the size of the smallest ovigerous females, the abdominal dimorphism, and the size range in which the sealed-abdomen condition is observed, are useful in establishing size at sexual maturity. Some authors have investigated the size at maturity of certain crustacean species based on the smallest ovigerous females recorded in size frequency distribution analyses (Aguilar & Espina, 1988; Jayakody, 1989; Sardá, 1991).

Specimens of *A. cribrarius* larger than 64 mm CW can be regarded as mature. This value should only apply to Ubatuba, since an inverse relationship between latitude and size at maturity is known (Berrill, 1982; Hines, 1989). Among the environmental factors capable of influencing size at maturity, water temperature (Kinne, 1964; Leffler, 1972; Somerton, 1981) or its effect combined with certain photoperiod conditions (Hines, 1989) are noteworthy.

TABLE III

Size at the onset of sexual maturity in previously studied portunid species (MM = morphological maturity; PM = physiological maturity; CW = carapace width)

Species	Author	CW (mm)			
		Males		Females	
		MM	PM	MM	PM
Arenaeus cribrarius	This study[2)]	52	63.4	59.7	59.6
Callinectes danae	Pita et al. (1985)[1)]	67	–	55-60	55
	Costa (1995)[2)]	68.1	67.6	53.1	53.9
	Gaspar (1981)[1)]	–	86.3	–	69.8
	Branco & Thives (1991)[1)]	98.5	–	88.8	–
Callinectes ornatus	Haefner (1990)[2)]	51.3	51.3-58.3	40.8	50-65
	Branco & Lunardón-Branco (1993)[1)]	–	67	–	61
	Mantelatto (1995)[2)]	–	50	–	43
Callinectes sapidus	Gray & Newcombe (1938)[1)]	89	–	–	–
	Van Engel (1990)[1)]	107	82	–	–
Charybdis natator	Sumpton (1990)[3)]	–	–	80-95	–
Liocarcinus depurator	Mori & Zunino (1987)[1)]	30	–	24	–
Liocarcinus holsatus	Choy (1988)[1)]	18.5	28.5	17	25
Macropipus tuberculatus	Mori (1987)[1)]	28-33	–	25-32	–
Necora puber	Choy (1988)[1)]	42	54	38	48
	González-Gurriarán (1985)[2)]	57	56	53	–
	González-Gurriarán & Freire (1994)[3)]	53.3	54.8	52.3	49.8
Ovalipes catharus	Armstrong (1988)[2)]	–	60-65	55	55-60
Ovalipes stephensoni	Haefner (1985)[1)]	61	31-50	51	61-70
Portunus pelagicus	Batoy et al. (1987)[3)]	–	37	–	39
	Ingles & Braum (1989)[3)]	96.4	–	106	–
Portunus spinimanus	Santos (1994)[2)]	48	47	46.5	46
Scylla serrata	Prasad & Neelakantan (1990)[1)]	81-90	97	81-90	91-100

[1)] = carapace width including lateral spines; [2)] = carapace width excluding lateral spines; [3)] = no information available regarding carapace width measurements.

The number of instars preceding sexual maturity in swimming crabs varies considerably. In *Callinectes danae* sexual maturity is attained after 18 months since larval release, corresponding to the 27th instar (Fischler, 1965), while the blue crab *Callinectes sapidus* attains maturity at approximately the 18th to 20th instar (Van Engel, 1958). There is no information available on the somatic growth of *A. cribrarius*, limiting further estimates on this species' chronological age at maturity.

In the study region, otter trawl nets as those used in the present study are the main fishing gear used in the penaeid shrimp catch. Local fishermen are not particularly interested in *A. cribrarius* and most crabs captured are returned to the sea. However, it is alarming that 25% of the total catch is composed by immature specimens. Inasmuch as a commercial exploitative activity on this species is likely to occur, it is important to establish a minimum catch size to avoid overexploitation, possible (local) extinction, and consequently damage to the benthic environment.

According to González-Gurriarán (1985), it is necessary to compare size at sexual maturity values from different methodologies in order to achieve more reliable estimates. His point is confirmed in the present study. So, it can be concluded that accurate size at sexual maturity estimates should include allometric studies of secondary sexual characters and micro- or macroscopic gonad examination since these values are often different.

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