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Population biology of *Callinectes danae* and *Callinectes sapidus* (Crustacea: Brachyura: Portunidae) in the south-western Atlantic

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The capture of crabs of the genus Callinectes *is one of the oldest extractive activities practised by waterside communities, due to the abundance of brachyurans along the Brazilian coast. The present paper aimed to provide basic information on the population biology of* C. sapidus *and* C. danae *during the period of December 2003 to November 2004, in Babitonga Bay, Joinville, Santa Catarina. The size of the first maturation of* C. danae *was estimated as 7.1 cm in total carapace width for females, and as 8.6 cm for males. Fecundity of the 20 females of* C. danae *with carapace width from 7.0 to 11.0 cm varied from 618,667 to 811,267 eggs. Fecundity of* C. sapidus *was higher, with a median of 978,000 eggs per female, but carapace widths in this species were also larger, with the highest frequency of females attaining 19.01 cm on average. In both species, a tendency was observed for the egg mass to increase with size of females. The capture per unit of effort presented the lowest values in summer, while the largest values occurred from March, August and November. A total of 80 males and 117 females of* C. sapidus *were captured in the four collecting areas, with the largest abundances in Area III (45.18%), followed by Areas II, IV and I. The size of the first maturation of* C. sapidus *was estimated as 10.2 cm for females and as 9.0 cm for males. Fishing effort was in relative equilibrium for adult stock (males = 58.75% and females = 52.99%) and juveniles (males = 41.25% and females = 47.01%). The largest monthly rates of biomass of* C. sapidus *occurred from April to November, with a peak of capture in August, without significant differences in the participation of males and females.*

Keywords: fisheries biology, abundance, fecundity, maturation size, biomass, Brazil

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INTRODUCTION

A large part of the benthic fauna associated with estuarine waters is formed by brachyuran crustaceans, particularly Portunidae Rafinesque, 1815 (Severino-Rodrigues *et al.*, 2001). This dominance may have contributed to the popularization of swimming-crab fisheries (*Callinectes* Stimpson, 1860), making this one of the oldest fishing activities along the Brazilian coast. Presently several communities survive from the commercialization of these crabs (Barreto *et al.*, 2006). Besides contributing to the diet and economy of human river communities, these crabs are important biological indicators of distinct water masses and are used to delimit marine biogeographical regions (Taissoun, 1973).

The portunid fauna of the Americas consists of about 45 species, 13 of which belong to the genus *Callinectes* (Robles *et al.*, 2007). Another 3 species occur in the eastern Atlantic (Williams, 1974). Southern Brazil is characterized by the presence of three abundant species, *C. danae* Smith, 1869, *Callinectes sapidus* Rathbun, 1986, and *C. ornatus* Ordway, 1863 (Melo, 1996), and two less abundant species, *C. bocourti* A. Milne-Edwards, 1879, and *C. exasperatus* Gerstaecker, 1856.

The biology and fisheries of *C. sapidus* is well documented in North America, mainly in the pioneer papers of Churchill Jr. (1919) and Van Engel (1958, 1987, 1990), in Chesapeake Bay, USA, having been recently reviewed by Kennedy & Cronin (2007). In Brazil, most information is from Patos lagoon (Rio Grande do Sul), available in the form of dissertations and theses. The biology of *C. danae* was investigated in the country by Pereira-Barros (1980), Pita *et al.* (1985), Branco & Thives (1991), Branco & Avila (1992), Branco & Masunari (2000), Branco & Verani (1997), Baptista-Metri *et al.* (2005) and Barreto *et al.* (2006), while Severino-Rodrigues *et al.* (2001) studied its commercial importance and Weber *et al.* (2003) researched the genetic relations among four species of Portunidae. Fecundity and the reproductive cycle of *C. danae* was studied in Ubatuba Bay, São Paulo, by Costa & Negreiros-Fransozo (1996, 1998).

The estuarine complex of Babitonga Bay shelters the largest concentration of mangroves of the coast of Santa Catarina State, and represents the second largest formation of mixohaline waters in the south region of Brazil (IBAMA, 1998).

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In this region, the crabs *Callinectes danae* and *C. sapidus* are the most abundant species and represent an important food item and a significant income product for the local craft fishermen and their families.

The present paper provides information on the population biology of these species, contributing new information for the management of this resource in the south-western Atlantic.

MATERIALS AND METHODS

Babitonga Bay is located on the north coast of the State of Santa Catarina, among the municipalities of Joinville, Araquari, São Francisco do Sul, Barra do Sul, Itapoá and Garuva, with coordinates 26°02′–26°28′S and 48°28′–48°50′W, embracing many mangroves, beaches, rocky shores, and small islands (IBAMA, 1998). Sediments are of the types sandy, silty sand, and sandy silt, with low salinity stratification. Tides are the main water regulators, having a mixed regime and being predominantly semi-diurnal (IBAMA, 1998).

Swimming crabs were collected monthly in four traditional fishing areas located within the bay (Figure 1), during the morning, afternoon and night, in the period from December, 2003 to November, 2004. Ten traps (known locally as *jererés*) were used for the capture of specimens. These nets consisted of a metal arch (0.7 m × 0.45 m), attached to a nylon chord of 15 m. Pieces of fish were used as bait (Gamba, 1994). The traps were inspected every fifteen minutes, and remained immersed for three hours in each colleting area (Branco, 1996).

Samples of bottom water were obtained in parallel with a Nansen bottle, temperature (°C) and salinity being registered with an optic refractometer.

The identification and recognition of the sexes followed the protocol in Williams (1974). Maturation stages were established by the shape and degree of adherence of the abdomen to the thoracic sternites (Taissoun, 1969). Total carapace width (Wid) in centimetres was obtained with an ichthyometer, representing the distance between the lateral spines in complete specimens. Total weight (Wt) was obtained in grams with a digital scale (precision of 0.01 g).

To verify possible differences between the sexes, both monthly and by width class, the Chi-square test (χ^2) was used, with a significance level of 0.05 and (n-1) degrees of liberty. The relation of the carapace weight/width (Santos, 1978), and the size of the first morphological maturation stage (Taissoun, 1969), were calculated for each sex. Fecundity was estimated from the egg masses of 20 females that were initially weighed in a semi-analytic scale. Three subsamples of eggs of 0.01 g, from females with orange or yellow eggs, characterizing initial developmental stages (Costa & Negreiros-Fransozo, 1996), were removed from each female, placed in quadriculated Petri dishes with water, and the eggs were then counted under a stereomicroscope (Ogawa & Rocha, 1976).

Capture per unit of effort (CPUE) was calculated for each sampled area, representing the biomass of crabs sampled by the 10 traps during a period of three hours. The analysis of parametric variance (ANOVA) (Zar, 1999) was used to verify the existence of significant differences in the CPUE among areas and among stations of the year, being tested for homogeneity of variance (Bartlett test) and for normality of distribution (Kolmogorov–Smirnov proof). With significant differences, the contrast of media (Tukey–Kramer test) was applied to indicate which media were significantly different.

RESULTS

Water temperatures oscillated during the study period, with the highest values occurring in summer months (24.0 ± 1.7) and the lowest values occurring at the end of autumn and at the beginning of winter (22.5 ± 1.9) (Figure 2a). Significant

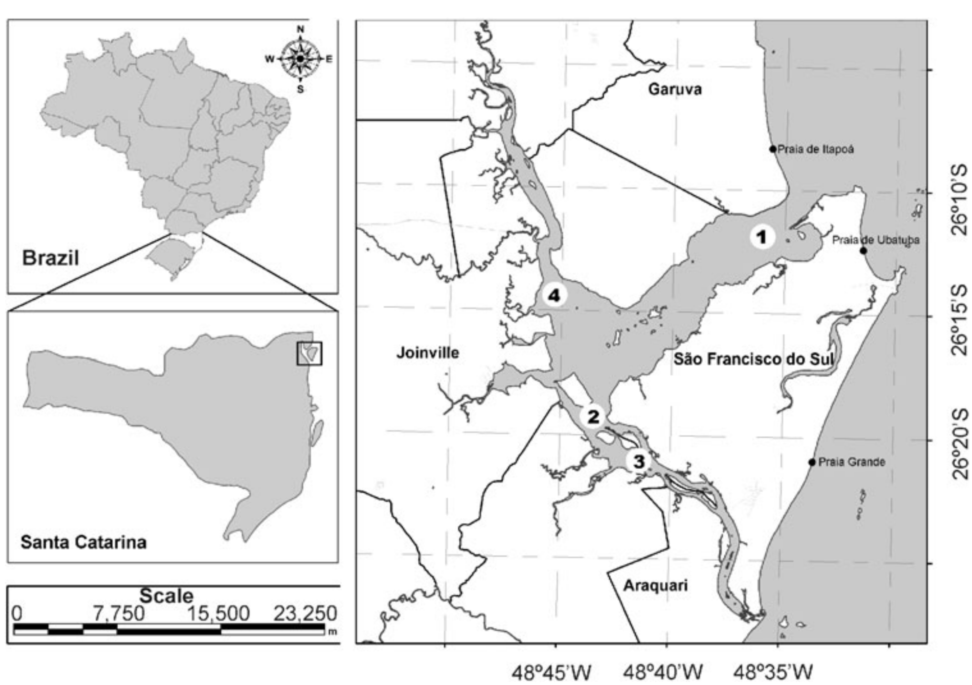

Fig. 1. Map of Babitonga Bay, indicating collecting areas.

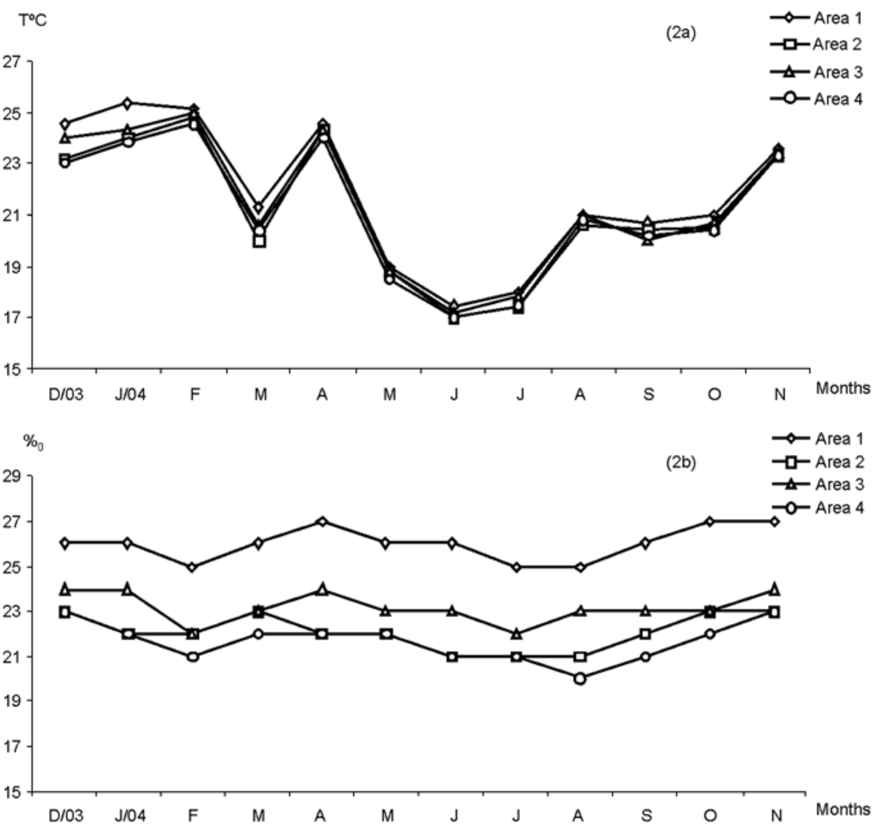

Fig. 2. Fluctuation in surface water temperature (a) and surface water salinity (b) of Areas 1, 2, 3 and 4.

differences were not observed among the temperatures of the sampled areas ($F_{3-44} = 0.152$; $P > 0.05$).

Salinity presented the same tendency to fluctuate in the study area, with larger variations in spring (24.0 ± 1.7), followed by autumn (23.2 ± 2.5), summer (23.1 ± 1.7) and winter (22.5 ± 1.9) (Figure 2b). Significant differences in salinity were observed among collecting areas ($F_{3-44} = 73.860$; $P < 0.05$), being attributed by the Tukey–Kramer test to the highest values registered in Area I (Figure 2b).

The relative participation of the biomass of captured crabs in Babitonga Bay was as follows: *C. danae* represented 85.4% of the total, followed by *C. sapidus* (12.6%), *C. bocourti* (1.5%), *C. exasperatus* (0.3%) and *C. ornatus* (0.2%) (Figure 3). We provide data for the two most abundant species.

Callinectes danae

The relative frequencies between sexes within populations differed from 1:1 (except in March 2004). This tendency became evident with the application of the χ^2 test by collecting month, indicating significant differences in favour of males, except in March, and of egg-bearing females in January, March and May (Figure 4).

The distributions of frequencies of males and females by classes of carapace width presented an amplitude of 3.0 to 13.0 cm (males) and between 5.0 and 11.0 cm (females), with a significant domain (χ^2, $P < 0.05$) of males in classes from 8.0 to 12.0 cm and an inversion in favour of females from 5.0 to 6.0 cm. In the class of 7.0 cm no significant differences occurred between the sexes (Figure 5).

The carapace width of the first maturation of *C. danae* was estimated as 7.1 cm (females) and 8.6 cm (males) and, beginning at 8.0 and 10.0 cm, respectively, all specimens captured were mature (Figure 6). The fishing effort in Babitonga Bay influenced the adult stock (males = 86.39% and females = 56.42%) and, to a smaller degree, the juvenile stock (males = 13.61% and females = 43.58%) (Figure 7).

The distributions of carapace widths indicate that stratifications did not occur in the sizes of males. Peak captures for male carapace widths reached between 9.0 and 11.0 cm (Figure 7). In Area I, females were represented mainly by adults, with the highest frequencies in the classes of 9.0 cm. In the remaining areas juveniles alternated with adults, with most captures ranging in the classes of 6.0 and 9.0 cm (Figure 7).

The seasonal distribution of carapace widths presented a tendency of unimodality in males, with amplitudes oscillating between 3.0 and 13.0 cm (Figure 8). In spring the highest frequencies occurred between 10.0 and 11.0 cm, while in summer

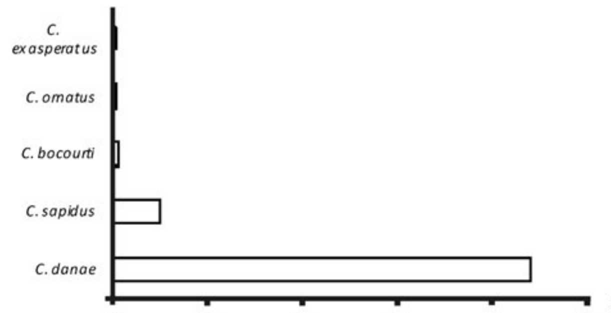

Fig. 3. Relative contribution of biomass in *Callinectes* captured in Babitonga Bay.

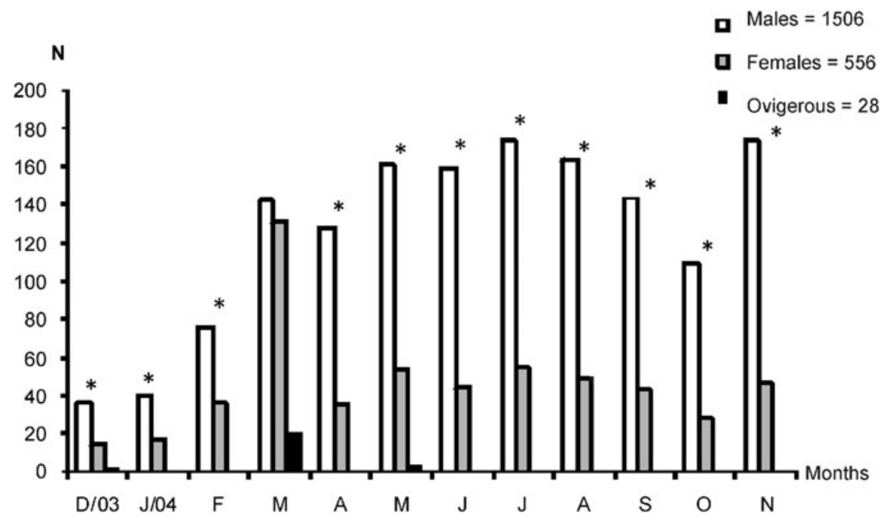

Fig. 4. Monthly distribution of frequencies of males, females and egg-bearing females of *Callinectes danae* in Babitonga Bay (*, significant difference in favour of one sex, χ^2, $P = 0.05$).

the recruitment of juveniles incremented the classes of smaller sizes. The peak of 10.0 cm was maintained until autumn, returning to 11.0 cm in the winter months (Figure 8). Females presented a multimodal tendency, with an amplitude between 5.0 and 11.0 cm. The largest captures occurred between classes of 6.0 and 9.0 cm, independently of the station of the year (Figure 8).

The amplitude of carapace widths in egg-bearing females in *C. danae* was between 7.0 and 11.0 cm, with the largest frequencies in classes from 9.1 to 10.0 cm (Table 1). Fecundity oscillated from 618,667 to 811,267 eggs, with a medium of 755,357.250 eggs per female, and a tendency to increment the mass of eggs with the size of the female (Table 1).

The values of the relation weight/width of the carapace were corroborated by the adherence of empirical points to the coefficient of determination curve (Table 2). The species presented a negative allometric growth. In males, the width varied between 3.0 and 13.6 cm, and the weight between 0.32 and 202.9 g. In females, width varied from 5.1 to 11.6 cm and weight varied from 8.12 to 122.5 g (Table 2).

Significant differences were not observed ($F_{3-44} = 1.273$; $P > 0.05$) between the CPUE and collecting areas. However, when the data were analysed by month, independently of area, moderate differences occurred ($F_{11-36} = 3.057$; $P < 0.05$). The Tukey–Kramer test attributed these differences to the smallest rates of capture in the months of December 2003, January and February 2004, and to the highest rates registered in March, August and November (Figure 9).

Callinectes sapidus

A total of 80 males and 117 females were captured, with larger abundances in Area III (45.18%), followed by II, IV and I (Table 3). Females dominated significantly (χ^2, $P = 0.05$) in January, May, June, September and October 2004, while in December 2003, March and August 2004, males were not captured (Figure 10).

The distribution of frequencies of carapace widths presented an amplitude oscillating between 5.0 and 16.0 cm, with a significant dominance of males (χ^2, $P = 0.05$) in the classes from 6.0 to 15.0 cm, and of females from 9.0 and 11.0 to 13.0 cm (Figure 11). In the 20 egg-bearing females captured, the width varied from 10.0 to 15.0 cm, with the highest frequencies in the class of 12.0 cm (Table 1).

The size of the first maturation of *C. sapidus* was estimated as 10.2 cm of carapace width for females and 8.9 cm for males. Above 12.0 cm all captured specimens were adults (Figure 12). As a function of these sizes and of the frequencies of carapace widths, it may be verified that the fishing effort in Babitonga Bay is acting in relative equilibrium between the adult stock

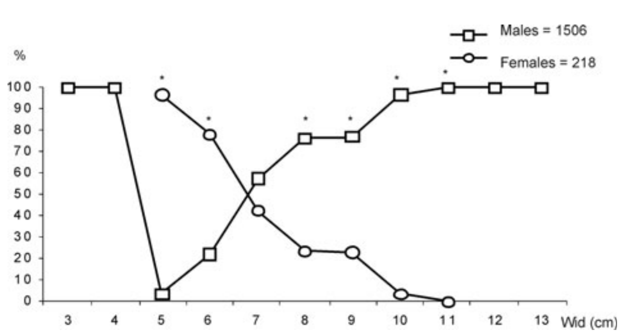

Fig. 5. Monthly distribution of percentage per length-class (%) of males and females of *Callinectes danae* (*, significant difference, χ^2, $P = 0.05$).

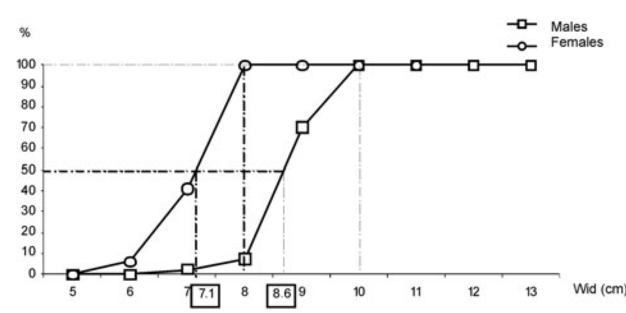

Fig. 6. Distribution of accumulated frequencies of males and females of *Callinectes danae* by classes of total length. Males $Wid_{PM} = 8.6$ cm; females $Wid_{PM} = 7.1$ cm.

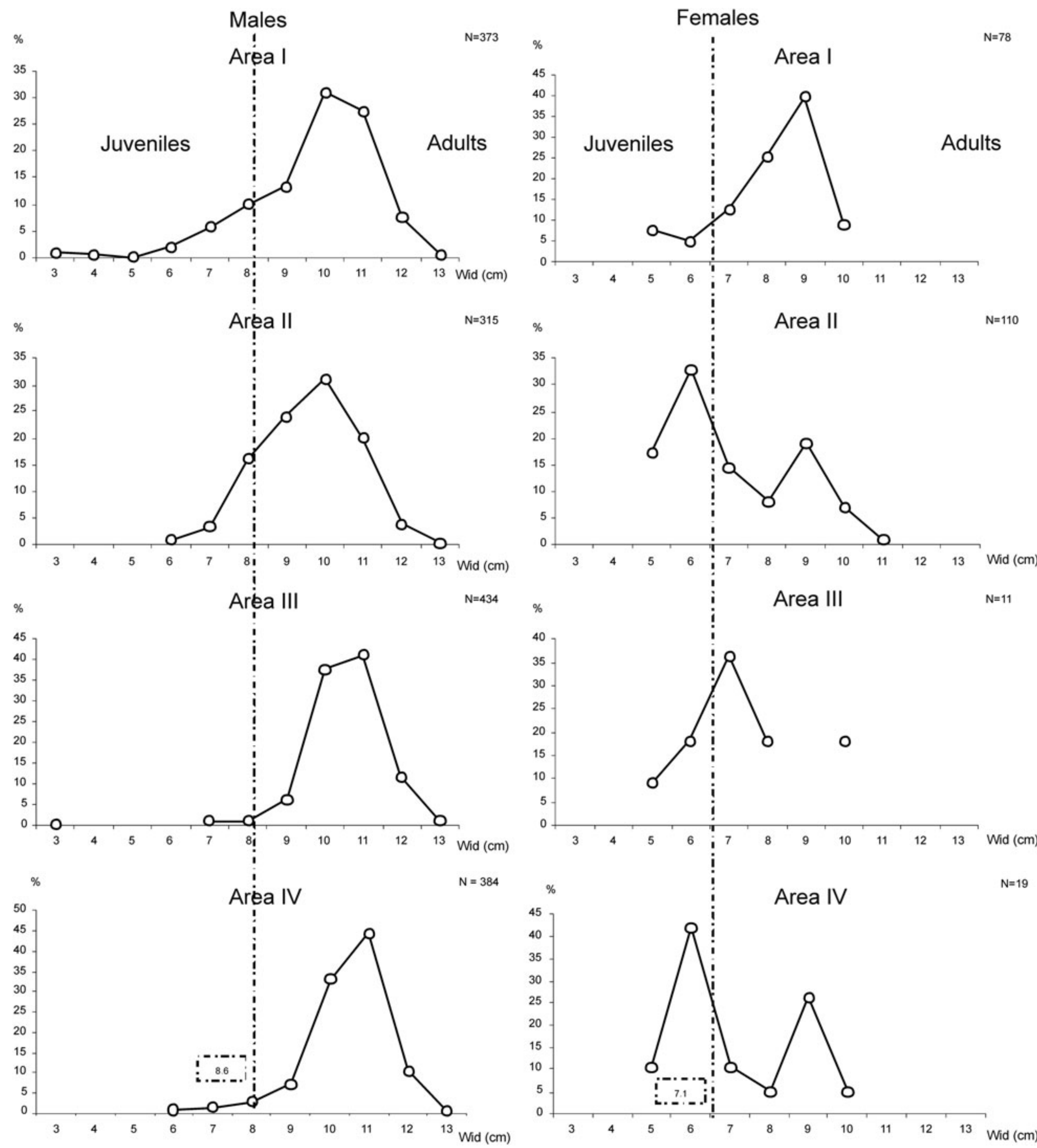

Fig. 7. Distribution of frequencies of total length in males and females of *Callinectes danae* by collecting area.

(males = 58.75% and females = 52.99%) and the juvenile stock (males = 41.25% and females = 47.01%) (Figure 13).

The seasonal distributions of carapace widths alternate between unimodal, in the majority of stations, and polymodal, in autumn (males) and winter (females). In summer the smallest specimens were collected (N = 6), indicating that recruitment possibly occurs between the months of summer and autumn (Figure 14).

The values of the relation weight/width of the carapace were corroborated by the adherence of empirical points to the curve and by the determination coefficients (Table 2). *Callinectes sapidus* presented negative allometric growth. In males, width varied between 6.5 and 16.2 cm, and weight varied from 18.97 to 343.18 g. In females, width varied between 5.5 and 15.3 cm, and weight varied from 10.92 to 192.81 g (Table 2).

The amplitude of the carapace width in egg-bearing females of *C. sapidus* was between 10.0 and 15.0 cm, with highest frequencies in the classes of 12.0 to 13.0 cm (Table 1). Fecundity oscillated between 651,241.196 and 1,704,300.443 eggs, with average of 978,109.000 eggs per female and a tendency to increase the median number and the weight of the egg mass with the size of the female (Table 1).

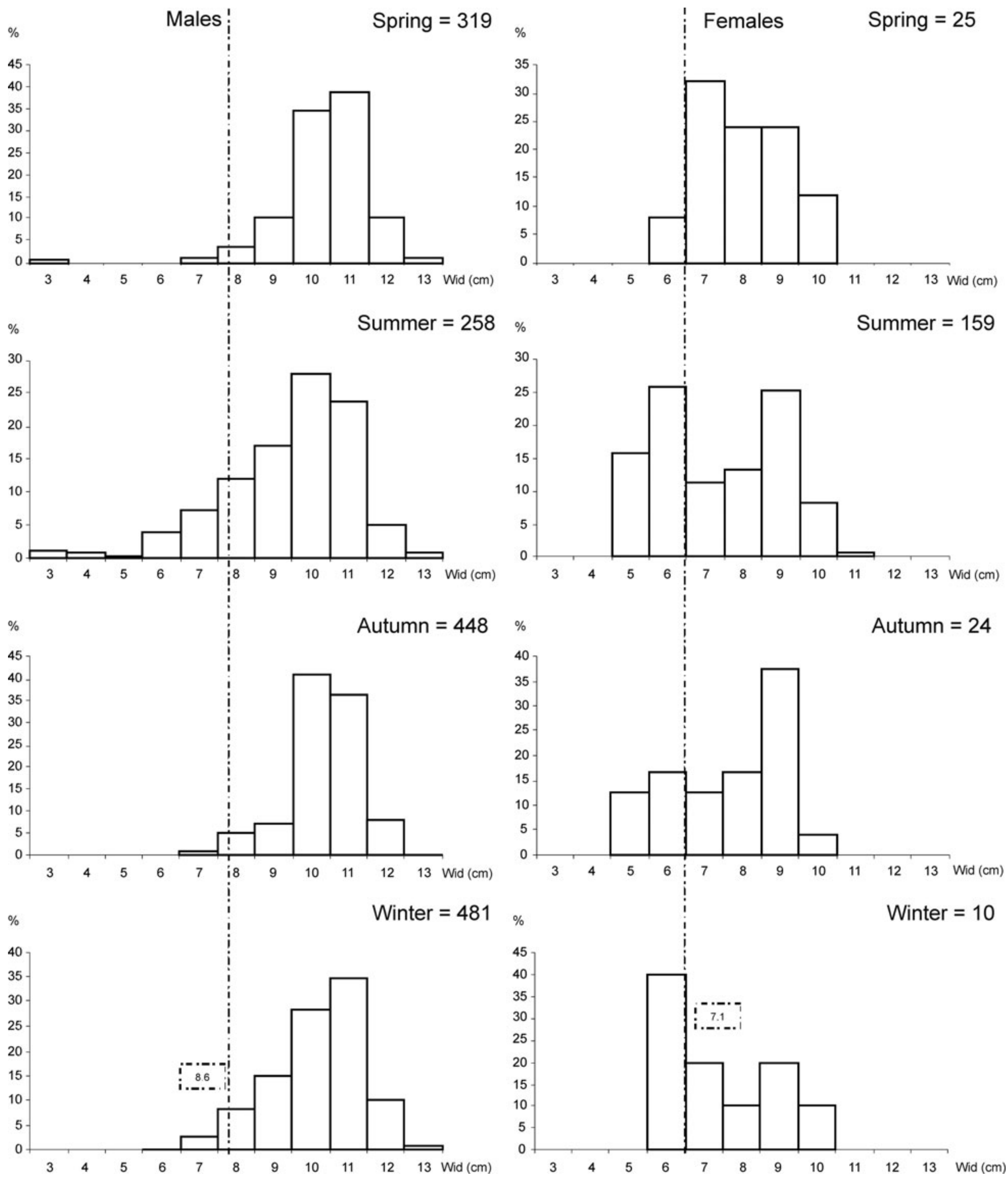

Fig. 8. Seasonal distribution of frequencies of total length of males and females of *Callinectes danae* in Babitonga Bay.

The reduced occurrence of *C. sapidus*, mainly in Areas I and IV (Table 3), made comparisons among capture rates unfeasible. However, when data were analysed by month, independently of area, moderate differences occurred ($F_{11-24} = 3.120$; <0.05). These differences are attributable to the larger rates of capture in the months of April and November 2004, and to smaller rates of capture in December 2003, March 2004, May and August (Figure 14).

DISCUSSION

Temperature of the surface water in Babitonga Bay maintained the expected seasonal pattern for the region (Matsuura, 1986). Salinity fluctuated during the year, as a function of river discharges and tidal regimes. The hydrographic complex of this bay receives the input of several rivers and streams, the most important regarding water

Table 1. Medium fecundity and carapace weight of *Callinectes danae* and *Callinectes sapidus*, by class of carapace width (Wid = carapace width, Wt = body weight, dp = standard deviation).

Species	Wid (cm)	N	Medium Wt of egg masses of females	dp	Medium number of eggs per female	dp
C. danae	7.0–8.0	5	3.73	0.95	811,267.000	141284.299
	8.1–9.0	5	5.50	0.82	781,733.000	124458.980
	9.1–10.0	7	7.35	0.51	809,762.000	149510.525
	10.1–11.0	3	8.48	0.56	618,667.000	142372.618
C. sapidus	10.0–11.0	3	11.52	0.14	693,939.219	112491.346
	11.1–12.0	5	12.51	3.09	651,241.196	130243.340
	12.1–13.0	8	19.01	2.21	962,960.521	161527.272
	13.1–14.0	3	27.75	5.37	1,704,300.443	539058.132
	14.1–15.0	1	22.23	–	1,422,720.000	–

volume are rivers Cubatão do Norte, Palmital, Cachoeira and Parati. These salinity oscillations probably contributed to the stratification of sizes in captured *Callinectes*, with a predominance of adult females mainly in areas of higher salinity. Besides this movement, characteristic of swimming crabs in the different age strata, salinity, water temperature, food, depth, wind, time of year and place of capture influence in fishing regarding relative participation of species, and in number and size of specimens (Taissoun, 1969; Severino-Rodrigues *et al.*, 2001).

The distribution and availability of species during fisheries in the interior of the bay may also be affected by the capacity of adult swimming crabs of chasing away smaller or less abundant species in the collecting areas (Williams, 1974).

The sexual proportion of species of *Callinectes* is related to the reproductive behaviour, seasonal variations and the salinity gradient (Van Engel, 1958; Tagatz, 1965). Males of *C. danae* dominated the collecting areas, probably due to the migration of adult females to waters of higher salinity, where they release their larvae (Branco & Masunari, 2000). This tendency of males to predominate over females was maintained in the littoral of Santa Catarina State (Branco & Masunari, 2000), in Ubatuba, São Paulo State (Mantelatto & Fransozo, 1999), in Pontal do Paraná, Paraná State (Baptista-Metri *et al.*, 2005), and in Matinhos, Paraná State (Branco & Lunardon-Branco, 1993).

Table 2. Weight/width relationship of carapace of males and females of *Callinectes danae* and *Callinectes sapidus*, during the study period.

Species	Sex	Equation	r^2
C. danae	Males	$Wt = 0.0087\ Wid^{2,858}$	0.919
	Females	$Wt = 0.0850\ Wid^{2,844}$	0.950
C. sapidus	Males	$Wt = 0.0805\ Wid^{2,954}$	0.924
	Females	$Wt = 0.1752\ Wid^{2,568}$	0.926

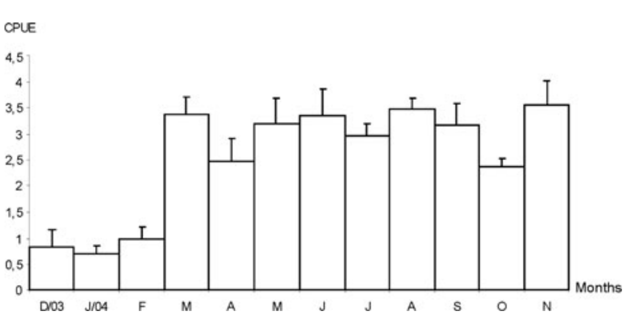

Fig. 9. Medium monthly variation of CPUE (capture per unit of effort) (kg) of *Callinectes danae* (vertical bar indicates standard error).

Usually, the highest abundances of *C. sapidus* were obtained in estuarine waters, mainly in the proximity of river mouths and mangrove areas (Melo, 1996). A similar pattern was obtained for Babitonga Bay, with females dominating in most samples, while in the bay of Santos, São Paulo State, males dominated in samples (Severino-Rodrigues *et al.*, 2001).

In swimming crabs, males always attain a larger final size than females (Williams, 1974), by investing metabolic energy in somatic growth, while females give precedence for the production of eggs (Hartnoll, 1982). Captured specimens of both species presented negative allometric growth and 'b' values similar for both sexes, following the expected pattern for brachyuran crustaceans (Hartnoll, 1982). The relation weight/width of the carapace has been largely used to facilitate the prediction of the weight of a specimen from its width and to determine the type of growth of the species.

In the present study, males of *C. danae* presented a tendency for the width of the carapace to be unimodal. Juveniles of this species tended to dominate in the summer months, without stratification of size by area. Females were mostly represented by juveniles, with a tendency to be multimodal by areas of sampling, except in Area I, located near the entrance to the bay, where adults predominated. Probably this is the site of highest concentration of egg-bearing females in the bay, which migrate through the connecting channel to the adjacent sea, where the eclosion of larvae occurs (Branco & Masunari, 2000).

The size of the first sexual maturation stage is an important parameter to be estimated, when the population is subject to

Table 3. Variation in carapace width (Wid cm) of males and females of *Callinectes sapidus* in collecting areas in Babitonga Bay (<, smallest value; >, largest value; media ± dp, medium ± standard deviation).

Areas	Males				Females			
	Wid (cm)			N	Wid (cm)			N
	<	>	media ± dp		<	>	media ± dp	
I	11.0	14.3	12.95 ± 1.49	4	11.4	12.4	11.88 ± 0.46	6
II	7.4	14.8	11.05 ± 2.27	18	8.8	15.3	12.28 ± 1.34	51
III	6.5	15.5	9.66 ± 2.21	50	5.8	13.6	9.37 ± 1.74	39
IV	11.5	16.2	13.40 ± 1.69	8	7.0	13.0	9.56 ± 1.89	21

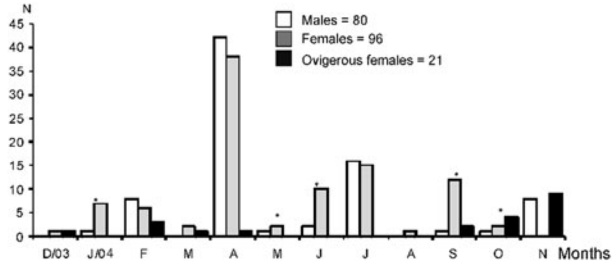

Fig. 10. Monthly distribution of frequency of males, females and egg-bearing females of *Callinectes sapidus* in Babitonga Bay (*, significant difference, $P < 0.05$).

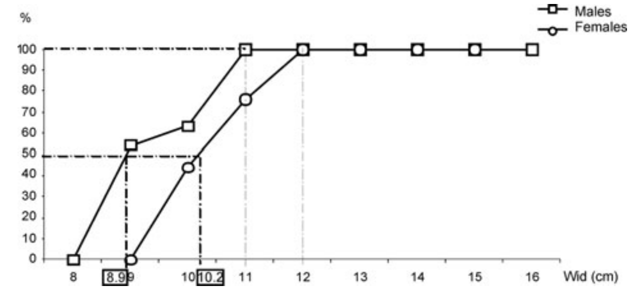

Fig. 12. Distribution of accumulated frequencies of males and females of *Callinectes sapidus*, by class of total length. Males $Wid_{PM} = 8.9$ cm; females $Wid_{PM} = 10.2$ cm.

commercialization. This parameter furnishes background on how the exploratory activity is affecting reproductive individuals (Campbell & Fielder, 1986; Vazzoler, 1996). This size varies considerably among populations of *C. danae* from the Brazilian littoral, oscillating between 6.1 and 6.3 cm in the region of Itamaracá, Pernambuco State (Barreto *et al.*, 2006), measuring 6.4 cm in Sepetiba Bay, Rio de Janeiro State (Medeiros & Oshiro, 1992), 5.5 cm in the Santos Bay-Estuary complex, São Paulo State (Pita *et al.*, 1985), varying between 5.2 and 6.0 cm in the Shangri-lá bathing resourt, Paraná State (Baptista-Metri *et al.*, 2005), and, in Florianópolis, Santa Catarina State, attaining 8.8 cm in the Itacorubi mangrove (Branco & Thives, 1991) and 8.4 cm in Conceição Lake (Branco & Masunari, 2000). In the present study, females of *C. danae* attained sexual maturity at 7.1 cm and males at 8.6 cm. Maturity is related to the morphological or physiological stage of crabs rather than to latitude. These comparisons illustrate that life cycle variations in *C. danae* are a function of available food and fishing pressure.

The international literature referring to *C. sapidus* is very abundant (see Kennedy & Cronin, 2007), dealing with different aspects of the biology, ecology and fishing of this group. Nevertheless, studies along the Brazilian littoral are rare. The size of the first maturation estimated for Babitonga Bay was below that registered in Chesapeake Bay (EUA), where a mean of 11.2 cm for males and females was obtained (Van Engel, 1958).

The knowledge on fecundity, associated to egg diameter, provide important subsidies for the estimation of the reproductive potential of species, which serves as a parameter for the protection of the site of eclosion of larvae (Branco & Avila, 1992).

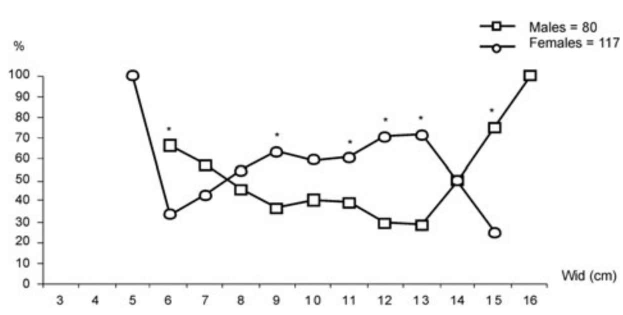

Fig. 11. Distribution of frequencies of total length of males and females of *Callinectes sapidus* in Babitonga Bay.

The estimated fecundity of *C. danae* in Babitonga Bay was lower than that obtained by Branco & Avila (1992) in Conceição Lake, where the number of eggs carried by females varied between 111,549 and 1,292,190, and by Santos (1990) in Vitória Bay, Espírito Santo State, which varied from 229,200 to 1,064,000 eggs per female. However, it was higher than that registered by Baptista-Metri *et al.* (2005), which oscillated between 25,127 and 246,676 eggs per female. The obtained differences may be attributed to the methods of quantification of eggs, to differences between numbers of eggs during first and second postures, to time and stages of development of embryos during estimations (Branco & Avila, 1992) and to genetic characteristics of populations in the studied habitats (Weber *et al.*, 2003).

The estimated fecundity for *C. sapidus* was relatively smaller, when compared with studies conducted in Chesapeake Bay, where from 700,000 to 4,500,000 eggs per female were obtained (Truitt, 1939; Tressler & Lemon, 1951; Prager *et al.*, 1990). In general, the fecundity of genus *Callinectes* also tends to increase with the size of females (Branco & Avila, 1992; Santos, 1990; Baptista-Metri *et al.*, 2005). This is corroborated by results from Babitonga Bay.

The CPUE, in biomass or number of specimens, may be considered the most adequate index of abundance for the monitoring of the fishing potential of a species of crustacean. In the present study, differences in capture rates among areas were not observed, but moderate differences may be attributed to monthly fluctuations in abundance along the year. For *C. sapidus*, the largest biomasses occurred between April and November 2004, with similar contributions of males and females and of adults and juveniles. This confirms previous knowledge for many north-western localities, but represents relevant new information for community structure in the south-western Atlantic. Fluctuations in the salinity and temperature gradients are determinant factors in the life cycle of *Callinectes* (Van Engel, 1958; Williams, 1974). Pronounced oscillations in the abiotic parameters in Babitonga Bay may have favoured the establishment of dominant species, such as *C. danae* and *C. sapidus*. However, to understand the population dynamics, it becomes necessary to monitor reproductive events, establishing migration routes and recruitment periods in the bay and mouths of the tributary rivers, as well as to conduct temporal studies of capture rates. This monitoring may, in the future, contribute to the increment of the fisheries of swimming crabs, to the maintenance of local fishermen, and to the conservation of Babitonga Bay.

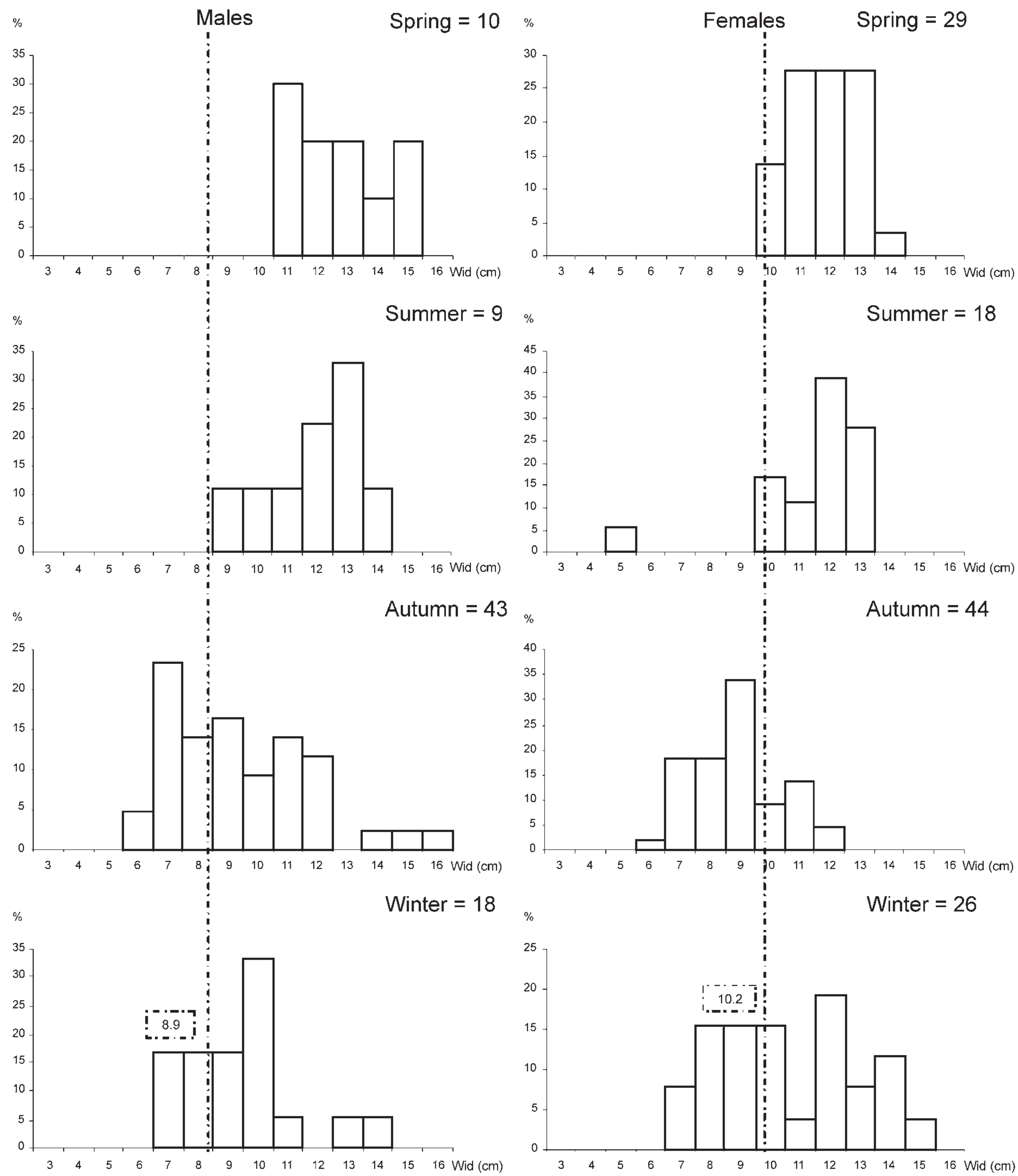

Fig. 13. Seasonal distribution of frequencies of total lengths in males and females of *Callinectes sapidus* in Babitonga Bay.

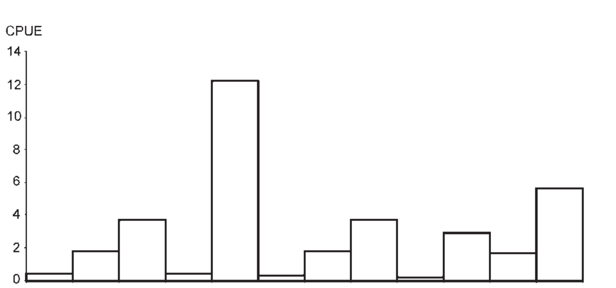

Fig. 14. Monthly variation in capture rates of *Callinectes sapidus* in Babitonga Bay.

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