

POPULATION PARAMETERS AND DISTRIBUTION OF *Arenaeus cribrarius* (CRUSTACEA, PORTUNOIDEA), IN SOUTHEASTERN BRAZILIAN COAST

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ABSTRACT

To test the hypothesis of differential occupation of depths by demographic groups of *A. cribrarius*, their population structure, spatial-temporal distribution and sex ratio were studied, taking environmental factors into consideration. The animals were collected monthly during one year in Ubatuba, southeastern coast of Brazil, at nine different depths. There was no deviation from the pattern 1:1 sex ratio, and also no significant difference in size between the sexes. Reproductive activity was continuous, but more intense in the summer. It was possible to verify that there is differential occupation of space by demographic groups of *A. cribrarius*. Juveniles occupy shallower regions, which probably provide them with protection of predation. Adult males are more often collected in regions near these juveniles, probably in order to maximize the chances of finding primiparous females. Finally, adult females were more associated to deeper regions, where larval dispersal is facilitated by the influence of the movement of water mass.

Key words: Brachyura; coastal monitoring; habitat partition; fishing resource.

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PARÂMETROS POPULACIONAIS E DISTRIBUIÇÃO DE *Arenaeus cribrarius* (CRUSTACEA, PORTUNOIDEA), NO LITORAL SUDESTE BRASILEIRO

RESUMO

Para testar a hipótese de ocupação diferencial de profundidade pelos grupos demográficos de *A. cribrarius*, a distribuição espaço-temporal, estrutura populacional e razão sexual foram estudadas, levando em consideração os fatores ambientais. Os animais foram coletados mensalmente durante um ano em Ubatuba, litoral sudeste brasileiro, em nove profundidades diferentes. Não houve desvio do padrão 1:1 para a razão sexual. Tampouco diferença significativa no tamanho entre os sexos. A atividade reprodutiva foi contínua, porém mais intensa no verão. Foi possível verificar que há ocupação diferencial do espaço pelos grupos demográficos de *A. cribrarius*. Juvenis ocuparam regiões mais rasas, que fornecem proteção contra a predação. Machos adultos foram mais frequentes em regiões próximas aos juvenis, o que, provavelmente, aumenta as chances de encontrar fêmeas primíparas. Finalmente, fêmeas adultas estiveram mais associadas às regiões mais profundas, onde a dispersão larval é facilitada pela influência do movimento das massas de água.

Palavras-chave: Brachyura; monitoramento costeiro; partição de habitat; recurso pesqueiro.

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INTRODUCTION

Speckled swimming crabs, *Arenaeus cribrarius* (Lamarck, 1818), are found West of the Atlantic Ocean, ranging from the coast of Massachusetts, USA, to La Paloma, Uruguay (MELO, 1996). This species has been recorded from intertidal zones on sandy beaches to depths of 70 m, although they are more abundant in shallow areas (AVILA and BRANCO, 1996; CARMONA-SUAREZ and CONDE, 2002; PINHEIRO *et al.*, 1996; DE LÉO and PIRES-VANIN, 2006). According to MELO (1996) this crab is rarely found in estuaries.

As seen in other decapods, the distribution patterns and abundance variation of *A. cribrarius* may be modulated by many environmental factors, which can determine the occupation or restriction of a species to a certain area (MANTELATTO *et al.*, 1995;

MANTELATTO and FRANSOZO, 1999a). Crabs in general have a very conspicuous bathymetric distribution pattern (BERTINI and FRANSOZO, 2004; SANTOS *et al.*, 2016), possibly associated with the distribution of biotic (e.g., organic matter in sediments) and abiotic factors (e.g., types of sediment, temperature and salinity) (PINHEIRO *et al.*, 1997). GUILLORY *et al.* (2001) defend the idea that crabs select their habitat based on the particular physiological needs of each stage of their life cycle, given that they may inhabit the planktonic, nektonic or benthic strata depending on their current stage. Therefore, the influence of these variables on marine organisms are important clues for understanding the distribution of these animals.

The complex interaction between environmental and biotic factors, together with the vastness of the ocean convolute the understanding of the distribution patterns of benthic communities (SHIRLEY *et al.*, 1990). For this reason, populational studies of small areas, such as bays or coves, may contribute to our understanding of those interactions (MANTELATTO *et al.*, 1995;). In addition, ANDRADE *et al.* (2014) studied the spatial-temporal distribution of demographic groups of *Callinectes ornatus* (Ordway, 1863) in 3 coves of southern Brazil, and observed that immature individuals and adult males were abundant in shallow areas, while adult females were abundant in deeper areas.

This study tested the hypothesis of differential occupation of space (depth) of *A. cribarius* by demographic groups (young males and females, adult males and females and ovigerous females), through their spatial-temporal distribution, populational structure and sex ratio, taking into account the influence of environmental factors. We expected to find a pattern of differential spatial distribution among demographic groups, as has been observed for other species of swimming crabs (PINHEIRO *et al.*, 1996; CARMONA-SUÁREZ and CONDE 2002; ANDRADE *et al.*, 2014),

as well as influences of environmental factors such as temperature and mainly sediment features, as suggested by PINHEIRO *et al.* (1997). In addition, this study covered offshore regions in its sample area, unlike the aforementioned studies.

METHODS

Sampling of animals and environmental factors

The crabs were collected from January to December 2000, in Ubatuba on the northern coast of São Paulo state. Four sampling points were determined in the internal area of the bay (2, 5, 10, and 15 m in average depth), and 5 in the outer area (offshore) with average depths of 20, 25, 30, 35, and 40 m (Figure 1). Each sampling point was sampled using a shrimping boat equipped with two nets (double-rig), consisting of a main net body with a 20mm mesh and a terminal cod with 15mm mesh. The distance covered in each site was approximately 2 km, for 30 minutes, covering a total area of 18,000m².

The swimming crabs were identified according to MELO (1996), separated by sex through the abdominal morphology and number of pleopods. They were measured with a caliper (0.01 mm) at its greatest carapace width (CW), but excluding the last spike of the anterolateral margin. All individuals were classified into demographic groups, differentiating young (immature) and adult (mature) in accordance with the format and adherence to the thoracic abdominal sternite (HAEFNER JUNIOR, 1990). The following demographic groups was considered: JM = juvenile males, AM = adult males, JF = juvenile females, AF = adult females, and OF = ovigerous females.

At each sample point, temperature (bottom and surface) and salinity measurements were registered. The values of organic

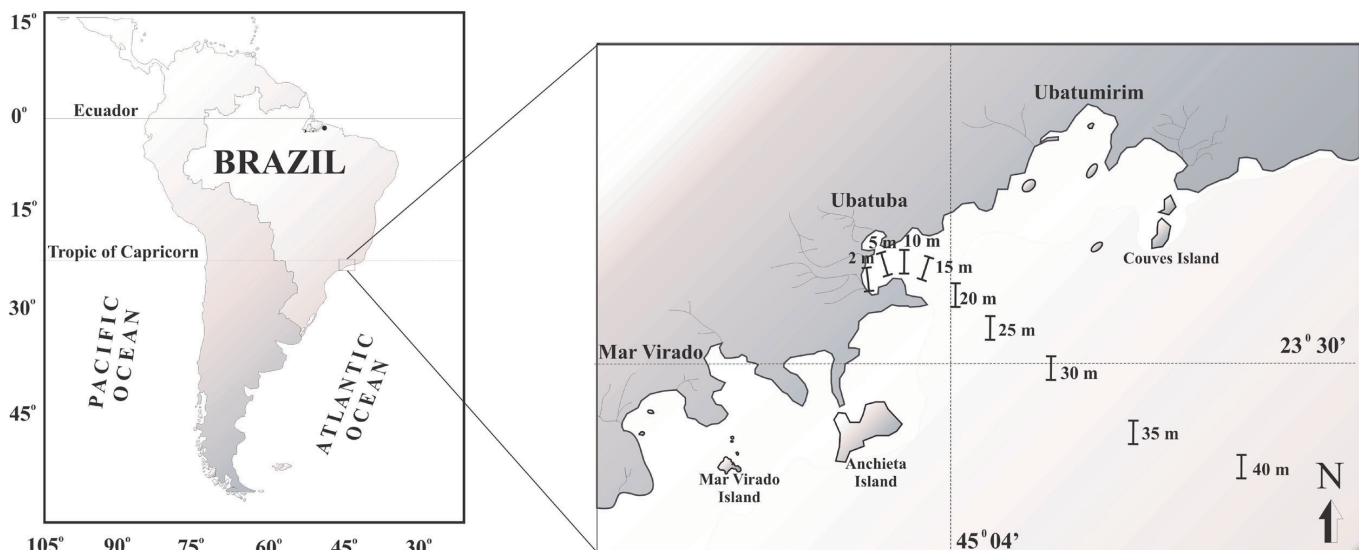


Figure 1. Map of the Ubatuba (SP) region, with studied sample points.

matter content in the sediment and grain diameter were obtained as the methodology described by BERTINI and FRANSOZO (2004). Water samples were collected with a Nansen bottle and the values of temperature and salinity were obtained with a thermometer and an optical refractometer, respectively. The depth was measured with an ecobathymeter coupled to a GPS. Sediment samples were collected with a Van Veen bottom gripper.

To determine the content of organic matter in the sediment, three subsamples (10 g each) were placed in porcelain crucibles and incinerated in a furnace at 500°C during 3 hours. Thus, the percentage of organic matter content (%OM) of the sediment was obtained by the ash-free dry weight.

The sediment for granulometric analysis was separated into two subsamples of 50 g each, and then 250 ml of a NaOH (0.2 N) solution was added to the silt and clay suspension. Soon after, the subsamples were rinsed in a sieve with a mesh of 0,063 mm, passing only the silt and clay. The remaining pellet was dried and subjected to a graded sieving, following the WENTWORTH (1922) scale. The procedures for analysis of sediment followed HAKANSON and JANSSON (1983) and TUCKER (1988), and they were used by BERTINI *et al.* (2001), COSTA and FRANSOZO (2004), and COSTA *et al.* (2007) for determining the values of *Phi* by the formula $\phi = -\log_2 d$, where “*d*” is the grain diameter (mm).

Data analysis

Prior analyzes, the data were log transformed and tested for their univariate and multivariate normality, respectively, by Shapiro-Wilk test (SHAPIRO and WILK, 1965), and symmetry and multivariate kurtosis (MARDIA, 1970, 1980) (with modifications proposed by DOORNIK and HANSEN, 2008 - omnibus test). To test the homogeneity of variances we performed a Brown-Forsythe test (BROWN and FORSYTHE, 1974).

The spatial distribution patterns of *A. cribarius* were analyzed by sampling points by variance analyzes (ANOVA) followed by Tukey's test. The abundance of demographic groups in different sampled depths was compared through a correspondence analysis (CA). During this analysis the associations of both variables (demographic group and sample point) were summarized by the frequency of each table cell, and then positioned in a geometric dimensional space, consistent with the associations of the table. Statistical significance of the eigen values was obtained using the X^2 test with simulated p-value, based on 2000 randomizations (NENADIC and GREENACRE, 2007).

To analyze the temporal distribution a multinomial proportion test was performed (GOODMAN, 1964), verifying possible differences in the proportion of demographic groups into the season and between seasons.

The correlation of the abundance of the demographic groups with the environmental variables was verified by a redundancy analysis (RDA) (PERES-NETO *et al.*, 2005). In addition, an adjustment of the environmental variables was performed using

the function “*envfit*,” a routine that draws the maximum correlation of environmental variables with the data of a sorted order.

The size (CW) between males and females was compared by the t test. The population structure was evaluated based on the frequency distribution of individuals in size classes and checked by the modal peaks. The sex ratio was compared by binomial test (WILSON and HARDY, 2002) to see if there was deviation from 1:1 pattern.

In all analyzes, the significance level was $\alpha = 0.05$ (ZAR, 1996). Excel (Microsoft Corporation) software was used for the multinomial proportions test, and Peakfit software Version 4.12 (Sea Solve Software Inc.) was used to verify the existence of modal peaks of the distribution by size classes. Other statistical analyzes were performed using R v3.2.0 (R Development Core Team) software, with the CA and performed by the package “*ca*” (NENADIC and GREENACRE, 2007) and “*vegan*” (OKSANEN *et al.*, 2013) for the RDA and *envfit* routines.

RESULTS

Environmental variables

The highest mean bottom temperature occurred in January ($25.3 \pm 3.8^\circ\text{C}$) and the lowest was observed in September ($19.2 \pm 0.7^\circ\text{C}$). For the surface temperature, the highest ($27.8 \pm 1.2^\circ\text{C}$) and the lowest means ($19.5 \pm 0.4^\circ\text{C}$) occurred in the months of January and July, respectively. It was possible to verify that the difference between the mean bottom and surface temperature was higher in the months of January to April. The highest salinity average occurred in July (37.6 ± 0.5) and lowest in October (31.7 ± 1.4).

The mean value of *phi* ranged from 3 ± 1.1 to 5.4 ± 0.5 at 20 m and 5 m, respectively. The lowest values of this variable occurred at external area depths (20 to 40 m). The percentage of organic matter in the sediment ranged from $2.4 \pm 2.4\%$ at 20m to $6.2 \pm 0.5\%$ at 10m. The lowest values for %OM also occurred up to 20 m in all seasons, except during the spring, where this site showed the highest.

Demographic distribution

The animals were found only in areas of 2-20 m depth, with no specimens registered up to 20 m depths. In total 162 individuals were collected, with the greatest abundance (N = 77) occurring in the sample point of 2 m, whose mean differed significantly from that occurred at the point of 20 m, where the lowest number of individuals (N = 11) was collected (ANOVA, F = 3.31, p = 0.01). Supplementing these results, it was possible to observe by the Correspondence Analysis that the adult males (Figure 2a) predominate, with greater proportion in all points, with the exception at 2 m, were observed the higher proportions of juveniles (both sexes), in similar proportions of adult males (Figure 2b). Adult females occupied most transects in similar proportions, with ovigerous females occurred mainly at 10 m (Figure 2a, 2b).

The test of multinomial proportions indicated no significant differences for the temporal distribution of demographic groups between seasons and even within the same season ($p > 0.05$).

The first two RDA axes explained 92.3% of the correlations in demographic groups of *A. cribrarius* (Table 1). According to the obtained correlation values, salinity and *phi* were the most important in explaining the variability in the distribution of demographic groups. Juveniles were negatively associated with salinity (see axis 1 in Table 1), while adults showed positive relationship with the *phi* values. The distribution of ovigerous females was positively correlated with the bottom temperature (axis 2) and salinity (axis 1).

Population structure

In total 84 males (29 juveniles and 55 adults) and 78 females (29 juveniles and 49 adults, among which 11 were ovigerous) were collected. There was no significant deviation from the pattern 1:1 sex ratio for males:females (Binomial test of total sample = 0.52, $p = 0.63$).

Adult males had carapace width (CW) varying from 42.0 to 99.3 mm (63.0 ± 18.63 mm) with no significant difference in relation to adult female size (t test, $p = 0.67$), that varied from 53.8 to 91.2 mm (60.0 ± 13.0 mm). The analysis of frequency distribution by size classes revealed the polymodal pattern, independent of the sexes ($P_k = Gauss\ amp$, males = 5 modes, females = 4 modes). The highest peak occurred in 65.02 mm (Peakfit: $r^2=0.78$, $F=0.25$) for males and 64.34mm (Peakfit: $r^2=0.83$, $F=0.44$) for females. There was no significant deviation from the pattern 1:1, in anyone size class (Binomial test, $p > 0.05$), however comparing sampling points, there was deviation in favor to females at 10 m (Binomial test, $p < 0.01$).

Juveniles were collected throughout the year, but the smaller occurred during the summer, taking the first two size classes. Juvenile females showed sizes varying from 32.6 to 60.7 mm, while juvenile males vary from 22.0 to 55.1. The season with the fewest juveniles was the autumn and it was the only one in which no ovigerous females were found (Figure 3).

Table 1. *Arenaeus cribrarius* (Lamarck, 1818). Results of the Redundancy Analysis (RDA) for each demographic group and the environmental variables sampled in the study.

	RDA1	RDA2
Axis value	1.0185	0.8033
Proportion explained	51.61%	40.70%
Accumulated proportion	0.5161	0.9231
<i>Demographic group</i>		
JM	-0.3131	0.9422
JF	-0.6184	0.3615
AM	-1.0818	-0.4181
AF	-0.1279	-0.214
OF	0.2504	0.4987
<i>Environmental variables</i>		
BT	0.14036	0.6237
BS*	0.62397	-0.7683
<i>Phi</i> *	-0.34632	-0.1181
%OM	0.02562	0.5775

JM – juvenile males, JF – juvenile females, AM – adult males, AF – adult females, OF – ovigerous females, BT – bottom temperature, BS – bottom salinity, %OM – organic matter percentage. *significant variables ($p < 0.05$) by *envifit* function.

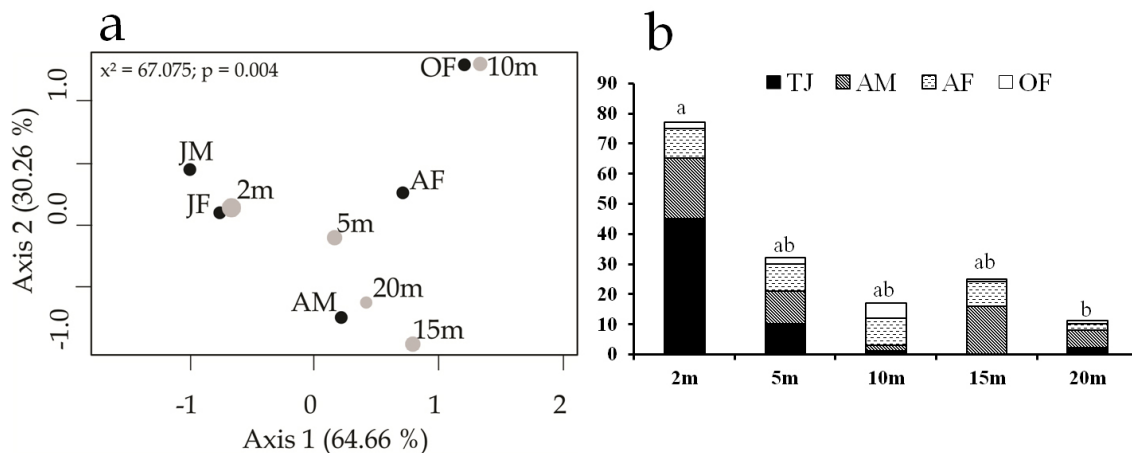


Figure 2. *Arenaeus cribrarius* (Lamarck, 1818). (a) Correspondence analysis (CA) with the abundance of the demographic groups related to depth, where point diameter is proportional to registered total abundance. (b) Abundance of the demographic groups related to the depth and the results of the *a posteriori* Tukey's test (ANOVA, $F = 3.01$, $p < 0.05$), where columns with the same letters represents absence of statistical difference ($p > 0.05$). TJ = total juveniles; JM = juvenile males; JF = juvenile females; AM = adult males; AF = adult females; OF = ovigerous females.

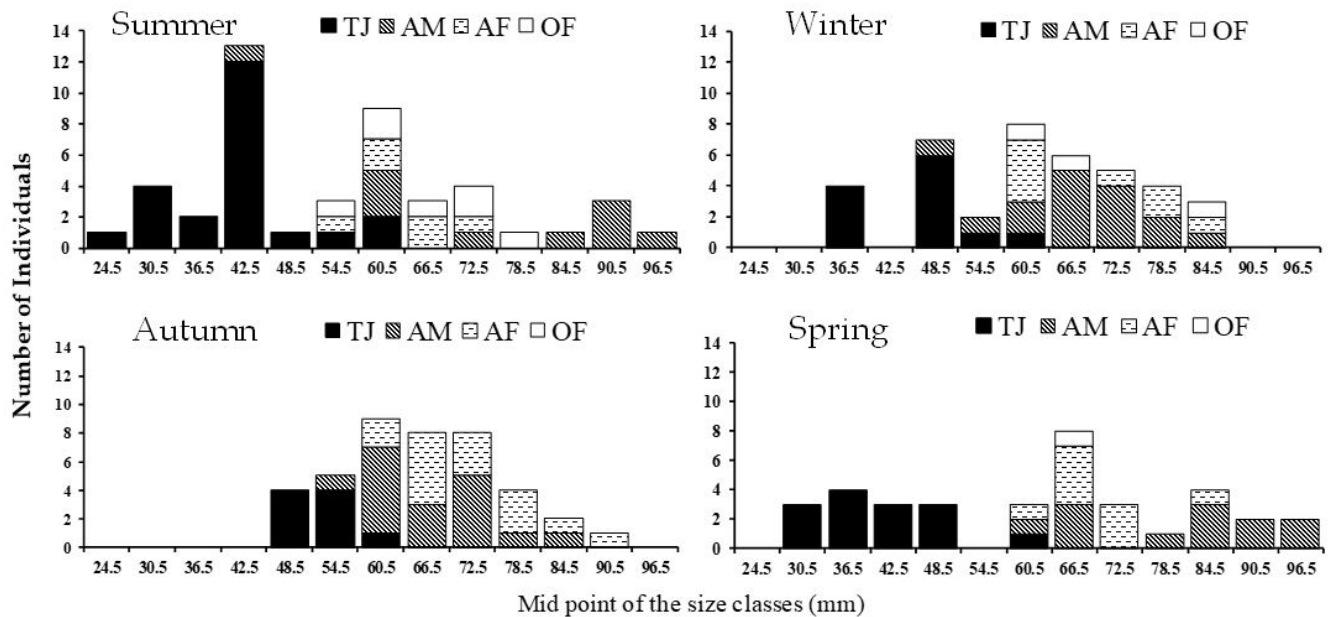


Figure 3. *Arenaeus cribrarius* (Lamarck, 1818). Frequency distribution by size classes of the demographic groups in each season. Where: TJ = total juveniles, AM = adult males, AF = adult females and OF = ovigerous females.

DISCUSSION

Ecological distribution

Although most demographic groups were more abundant in shallow areas (2 and 5 m depth), we observed that the pattern for bathymetric distribution was a high frequency of juveniles in those areas, with rare occurrences deeper than 10 m. In turn, adults occurred in a larger distribution range, up to 20 m. These data confirm the distribution pattern previously recorded by PINHEIRO *et al.* (1996), CARMONA-SUÁREZ and CONDE (2002) and DA SILVA *et al.* (2017). This behavior may be driven by the negative correlation with ϕ values, which are directly proportional to depth, since the thinner sediment in the study area was found in shallow places, contrary to what was found in the offshore region.

Mean size of sediment particles in certain areas reflect the local hydrodynamics and geological history, which dictates the stratification of the sediment. As a rule, the finer particles (silt and clay) accumulate in sheltered areas, while the sand particles indicate a more hydrodynamic environment (PIRES, 1992). According to ANDRADE *et al.* (2014), this can explain the high abundance of juveniles in shallow areas, where the high concentration of organic matter and the amount of silt and clay provide better food availability for them.

Portunids have a well-known habit of burrowing in the sediment (BELLWOOD, 2002), especially *A. cribrarius*, with whom this behavior is intimately linked with reproduction (PINHEIRO and FRANZOZO, 1999). This reinforces the importance of this environmental variable for these crustaceans. Bottoms of fine sand or smaller particle size fractions, with reduced organic matter,

characteristics of shallow regions, would be more advantageous for these animals to bury themselves in (CARMONA-SUÁREZ and CONDE, 2002). Therefore, the opposite should happen in areas with larger (consequently heavier) particles where this behavior is limited, mainly for smaller individuals, but not for large ones. This aspect may represent a strategy of ontogenetic niche segregation, in the way it reduces intraspecific competition (in this case, foraging spaces) between juveniles and adults, making larger individuals occupy niches where smaller ones could be disadvantaged (ANDRADE *et al.*, 2014).

GUERRA-CASTRO *et al.* (2007) also observed that juveniles of *A. cribrarius* prefer shallow areas, notably regions with higher wave energy, on sandy beaches. The same authors connected this distribution pattern to the fact that these are refuge areas to the juveniles, especially when there are no other shelter options (e.g. protective algal patches, seagrass meadows or rocky bottoms). In addition, according to PINHEIRO *et al.* (1996), those areas are ideal to the establishment of a fauna of filter feeders, commonly preyed by *A. cribrarius*.

The evolutionary process selected behavioral, morphological and physiological traits for *A. cribrarius* that gives it advantage in habitats with intense hydrodynamics, such as the splash zones. Dense setae cover, mainly on the maxillipeds and on the gill cavity opening, helps to prevent sediment particles from entering the buccal and respiratory cavities of *A. cribrarius* (PEARSE *et al.*, 1942). Also, this species has a large respiratory surface, which allows them to sustain activities with high energy expenditure, such as burrowing and moving in places with high hydrodynamics (GRAY, 1957).

Another idiosyncratic trait of *A. cribrarius*, previously noted by PINHEIRO *et al.* (1996), CARMONA-SUÁREZ and CONDE (2002), is the association of the abundances of adult males and young individuals along the bathymetric gradient, with prevalence of these groups in shallow areas. This peculiarity may be associated with the mating habits of this species, in which large males pair with smaller females (PINHEIRO and FRANSOZO, 1999). Thus, the positioning of adult males near young females facilitate the pairings of mating partners soon after the pubertal molt.

ANDRADE *et al.* (2014) studied the differential occupation of the habitat as a reproductive strategy of *C. ornatos*, and observed that females with reproductive potential were more abundant in deeper areas, while the others (non-reproductive) occurred mainly in areas sheltered from wave action. The results also reinforce the idea that, after mating, adult females migrate to areas that are deeper and more susceptible to the movement of water masses (PINHEIRO *et al.*, 1996; PINHEIRO and PARDAL-SOUZA, 2016), thus providing a more efficient larval dispersion. At the same time, ovigerous females probably select areas with more heterogeneous sediment as a spawning ground, possibly due to the fact that this morsel of granulometric fractions facilitates oxygenation of the egg mass (PINHEIRO *et al.*, 1996).

Although the abundance of individuals was also correlated with bottom water salinity, this result was possibly influenced by its association with *phi* values and depth of the study region. The reason is that shallow cove areas receive greater influence from inland waters. This decreases the salinity, but not to the point of inhibiting the presence of this species, which does not occur in salinities lower than 29 (PINHEIRO *et al.*, 1996; CARMONA-SUÁREZ and CONDE, 2002; GUERRA-CASTRO *et al.*, 2007).

A study by ANDRADE *et al.* (2015a) tested the effect of latitudinal gradient on recruitment and population structure of *A. cribrarius*, and they observed the highest abundances of the crab during the summer at a latitude similar to the one this study sampled from, something also found by PINHEIRO and PARDAL-SOUZA (2016). It is important to point out that the region of this study is under the influence of the South Atlantic Central Water ($T < 20^{\circ}\text{C}$ and salinity < 36) during the summer (DE LÉO and PIRES-VANIN, 2006). Although this water mass does not directly affect depths < 20 m, the shallower regions are indirectly influenced by this water inflow due to the rich nutrients it carries (CASTRO-FILHO *et al.*, 1987; AIDAR *et al.*, 1993), which consequently increases the abundance of this species for that particular season.

Population structure

In a natural population, the sex ratio between males and females tends to be near 1:1 after birth. All through ontogeny, several factors, such as longevity and differential growth between genders, may affect this ratio (WENNER, 1972; HARTNOLL, 1982). In this study, the absence of deviations for this parameter suggests that these factors do not affect the sex ratio of individuals of this species. AVILA and BRANCO (1996), PINHEIRO *et al.* (1996) and PINHEIRO and PARDAL-SOUZA (2016) also found a similar result for this species, with a ratio close to 1:1, considering the total abundance. ANDRADE *et al.* (2015a) showed that the sex

ratio was slightly favorable to females in the same study region, highlighting the fact that the latter used a sample size six times as large as that used in this study. This characteristic shows an unusual pattern for *A. cribrarius* compared to those obtained for other species of crabs, that normally show a deviation from the 1:1 pattern at least after they reach maturity. This is a common occurrence for *Callinectes* spp., *C. ornatus* (BRANCO and FRACASSO, 2004), *C. danae* (Smith, 1869) and *C. sapidus* (PEREIRA *et al.*, 2009); as well as for *Achelous spinimanus* (= *Portunus spinimanus*) (BRANCO and LUNARDON-BRANCO, 2002; RIPOLI *et al.*, 2007). Those authors noted that the isolated (or collective) action of the differential growth between genders, human impact and differential occupation of the area by the demographic groups can be the cause of those deviations to the sex ratio pattern.

This study confirmed the above when it showed the sex ratio between collection points, indicating that the 10-m depth may be the preferred spot by adult females. PINHEIRO and PARDAL SOUZA (2016) also found a sex ratio favorable to females, with a significant deviation in only one sampling point, Fortaleza cove, which is also in Ubatuba. The average depth of this sampling point is also around 10 m, which suggests that the females of *A. cribrarius* prefer these areas. Still, emphasizing, CARMONA-SUÁREZ and CONDE (2002) found a deviation in the sex ratio that favors males and most of their collections took place in shallow waters, near the surf zone. Thus, the sex ratio of this species may vary depending on the bathymetric gradient.

The lack of size difference between sexes of *A. cribrarius* also differs from most results reported for other portunids, including this species (PINHEIRO and PARDAL-SOUZA, 2016). Generally, several studies on portunids indicate that in larger size classes the males have a clear predominance over females (MANTELATTO and FRANSOZO, 1999b; BRANCO *et al.*, 2002; BRANCO and FRACASSO 2004; RIPOLI *et al.*, 2007; PEREIRA *et al.*, 2009; ARAÚJO *et al.*, 2012). The reason for that is because males invest more energy in their somatic growth than females do, who in turn direct it towards reproduction (HARTNOLL, 1982), since the production of oocytes requires more energy than the production of spermatozoa (HARTNOLL, 2006).

There are indications that, within the population sampled in this study, males may have a higher growth rate than females, because they had more modes in the frequency distribution in size classes. PINHEIRO and PARDAL-SOUZA (2016) also observed that males of *A. cribrarius* have more modal peaks (6 for males and 3 for females) and attributed this to the fact that males had a more intense growth rate and, thus, with more age groups within a population. This has already been proven by PINHEIRO and HATTORI (2006), who obtained $k = 1.8$ and 1.6 for males and females, respectively.

A polymodal pattern of frequency distribution in size classes normally signals many age groups within a population, as a result of mortality and/or differential behavior among the demographic group (DÍAZ and CONDE, 1989). This fact is supported in this study by the presence of young individuals in all seasons, as well as by the absence of ovigerous females only during the fall, indicating continuous recruitment and reproductive pulses

throughout the year. The absence of ovigerous females during the fall may have occurred because it is when mating occurs, as proposed by PINHEIRO and FRANSOZO (2002). These authors found a higher number of post-molt females, with full spermathecae and developed gonads during that season.

Recruitment and reproduction patterns similar to those in this study have been previously reported for *A. cribrarius* (PINHEIRO *et al.*, 1996; PINHEIRO and FRANSOZO, 2002; ANDRADE *et al.*, 2015a). Despite young individuals getting captured throughout the entire year, the peak in the summer coincided with the intrusion of the SACW (South Atlantic Central Waters). ANDRADE *et al.* (2015a) observed that the juvenile recruitment of this species significantly intensified in zones affected by the resurgence of the SACW. Many investigators have reported the influence of this water mass on recruitment and reproduction patterns of many decapod species, for instance: *C. ornatus* (MANTELATTO and FRANSOZO, 1999a), *Mithraculus forceps* (MANTELATTO *et al.*, 2003), *Libinia spinosa* (BRAGA *et al.*, 2007), *Persephona mediterranea* (BERTINI *et al.*, 2010b) and *Nematopalaemon schmitti* (ALMEIDA *et al.*, 2011).

CASTRO-FILHO *et al.* (1987) and AIDAR *et al.* (1993) stated that the water mass brings an enrichment of nutrients to the coast, which sets off primary production and boosts food availability for larvae. VEGA-PÉREZ (1993) validates this when mentioning that the temporal variation of planktonic productivity is essential to the reproduction of crustaceans because of its intimate relationship with food (phytoplankton) availability for larvae.

Recruitment patterns are associated with the reproductive activity. ANDRADE *et al.* (2015b) noted that the reproduction of *A. cribrarius* is not only connected to temporal variations in temperature and other environmental factors (salinity and sediment features), but also to an adaptive synchrony between an intensified period of larval dispersion and food availability in the water column. Additionally, according to the same study, this reproductive plasticity reflects in changes in the size of sexual maturity, modulated by exogenous factors and probably by human actions, such as fishing and introduction of exotic species.

CONCLUSION

The hypothesis of differential occupation by demographic groups of *A. cribrarius* cannot be rejected. This species presents distinct spatial distribution patterns for juveniles, adult males and adult females. Juveniles occupied shallower areas, generally with adult males, aiming more protection and food, while adult females are associated to deeper areas, favoring larval dispersion by more water masses movement.

The sex ration can vary along bathymetric gradient, so we recommend that population studies for *A. cribrarius* be realized in a depth amplitude that cover all local distribution of the species.

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