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Article

Morphological sexual maturity of the marine crab *Xanthodius parvulus* at the State Marine Park Laje de Santos, São Paulo, Brazil

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ABSTRACT. The marine crab *Xanthodius parvulus* (Fabricius, 1793) is naturally distributed in the Western Atlantic, being commonly found in the northeastern Brazilian coast. However, this species has been also recorded in the southeastern coast, especially in São Paulo State, on islands located close to harbors, which are becoming a place of occurrence for exotic species. This study aimed to estimate the morphological sexual maturity (relative growth) of *X. parvulus* the functional biological patterns of the species in a No-take marine reserve. The crabs were sampled at the Marine State Park of Laje de Santos, an important protected area from São Paulo that is located close to the largest Brazilian harbor, Santos, using an artificial substrate and active search methods (scuba diving). The morphological sexual maturity of females was estimated in 7.28 mm, according to the Abdomen Width *vs.* Carapace Width relationship, while for males this value was 8.83 mm based on the Gonopod Length *vs.* Carapace Width relationship, the females presented an increase in abdominal growth, even during the mature stage in order to achieve higher reproductive success, since the abdominal structure is used to protect the embryos. The Gonopod Length *vs.* Carapace Width relationship showed that males copulate with different sized females, since a non-exaggerated growth of the gonopods keeps them adequate to the size of the female genital pore, *i.e.*, juveniles exhibited negative allometry and adults presented isometry. Thus, estimating the size of the sexual maturity of a species requires the development of a model to acknowledge its biological and reproductive pattern, being an important tool to increase the knowledge about the behavior of this species and one of the parameters to evaluate its conservation status.

KEYWORDS. Continental Islands, relative growth, growth, reproduction, Brachyura.

RESUMO. Maturidade sexual morfológica do caranguejo marinho *Xanthodius parvulus* no Parque Estadual Marinho Laje de Santos, São Paulo, Brasil. O caranguejo marinho *Xanthodius parvulus* (Fabricius, 1793) tem distribuição natural ao longo do Atlântico Ocidental, comumente encontrado no litoral nordeste brasileiro. Contudo, essa espécie vem sendo amplamente registrada ao longo do litoral sudeste, especialmente na costa do estado de São Paulo, em ilhas próximas a regiões portuárias, (que são regiões recorrentes para introdução de espécies exóticas). O presente estudo tem como objetivo estimar a maturidade sexual morfológica (utilizando crescimento relativo) de *X. parvulus* para que seja possível compreender o funcionamento de padrões biológicos da mesma em uma área de preservação ambiental, subsidiando assim, possíveis intepretações para futuros estudos de conservação e manejo da espécie. Os caranguejos foram amostrados no Parque Estadual Marinho Laje de Santos, uma importante área de preservação do estado de São Paulo, utilizando substrato artificial de refúgio e captura ativa com mergulho autônomo como metodologia. A maturidade sexual morfológica das fêmeas foi estimada em 7,28 mm, considerando a relação da Largura do Abdome *vs.* Largura da Carapaça, enquanto para os machos, este valor foi de 8,83 mm baseando na relação Comprimento do Gonopódio *vs.* Largura da Carapaça, as fêmeas apresentaram um incremento no crescimento abdominal, mesmo durante os estágios mais maduros para alcançar um maior sucesso reprodutivo, uma vez que as estruturas abdominais são usadas na proteção dos embriões. A relação Comprimento do Gonopódio *vs.* Largura da Carapaça indicou que os machos, por sua vez, podem copular com fêmeas em diferentes tamanhos, uma vez que um crescimento não exagerado da estrutura mantém o gonopódio em tamanho adequado a todos os tamanhos de poros genitais das fêmeas, corroborado pelo crescimento alométrico negativo em juvenis e crescimento isométrico nos adultos. Sendo assim, estimando o tamanho da maturidade sexual das espécies, torna-se possível o desenvolvimento de um modelo para reconhecimento da biologia e padrões reprodutivos dos animais, sendo uma importante ferramenta no conhecimento comportamental e para registro de um dos parâmetros para se avaliar o *status* de conservação da espécie na área.

PALAVRAS-CHAVE. Ilhas continentais, crescimento relativo, crescimento, reprodução, Brachyura.

Among the marine crabs, *Xanthodius parvulus* (Fabricius, 1793) belongs to the Xanthidae family, which is one of the largest families of the Infraorder Brachyura (Ng *et al.*, 2008). As a specious group, the taxonomic *status* of the family is current discussed due to its polyphyletic nature (Ng *et al.*, 2008). Also, the classification of this species in the *Xanthodius* genus is also highly discussed and studied in the literature, with the larval characteristics indicating that in fact *X. parvulus* should be considered as a member of the *Cataleptodius* genus (Barros-Alves *et al.*, 2013). This taxonomic status is currently not accepted in the World Register of Marine Species platform (WORMS), revised by Peter D., where its taxonomic position remained as *Xanthodius parvulus* (WORMS, 2021).

Xanthodius parvulus is distributed throughout the Western Atlantic, being found in Bermuda, Florida, Gulf of Mexico, Bahamas, Caribbean Sea, Venezuela, and Brazil, where it has been recorded at Atol das Rocas, Fernando de Noronha, Rio Grande do Norte, Ceará, Bahia, and São Paulo (Melo, 1998; Barros-Alves *et al.*, 2013). In the São Paulo State, this species has been recorded at the continental northeastern islands such as Vitória Island, Ilhote das Cabras, and Rapada Island (Alves *et al.*, 2006, 2012) and now, it is recorded for the first time at the Laje de Santos Archipelago (continental islands), a "No-take marine reserve".

These islands are geographically close to the city of São Sebastião and to the Santos harbor and, therefore, become susceptible to the introduction of invasive species brought in the ballast water of ships docking at the port, one of the possible means by which *X. parvulus* is expanding its area of occurrence on the Brazilian coast (Alves *et al.*, 2012). Another possibility for this expansion may be the transportation of the larvae of this crab by the Current of Brazil and the Current of Malvinas (Falklands) (Boschi & Gavio, 2005; Araújo *et al.*, 2012). The introduction of a decapod species may result in ecological disturbances since this is the most diverse and abundant animal group in the marine environment (Mansur *et al.*, 2003; Alves *et al.*, 2006; Thayer & Stahlnecker, 2006; Costa *et al.*, 2007). Therefore, it is essential to analyze as many parameters as possible about the biology and behavior of these species.

Until now, few studies have been conducted on *X. parvulus*, addressing the presence of its larvae and its systematic position (Barros-Alves *et al.*, 2013), as well as some checklists of brachiurans carried out on the coast of the State of São Paulo, such as those that found *X. parvulus* inhabiting natural substrates at the Vitória Archipelago (Alves *et al.*, 2012) and artificial substrates at the Ilhote das Couves (S. de P. Barros-Alves, unpubl. data). Furthermore, this species is commonly found in rocky subtidal environments, presenting a wide distribution on the Brazilian coast, since individuals have been collected also in northeastern Brazil (Coelho *et al.*, 2008). Thus, the present study is the first that describes the reproductive parameters of *X. parvulus* in an important area like the Marine State Park of Laje de Santos (MSPLS), providing knowledge about the sexual maturity of this species, its reproductive interpretations, and the populational status of this species in the area.

The size at which a crab becomes capable of reproducing is an essential information for the knowledge about the biological dynamics of a species because, in this period of transition, individuals go through changes in their ecological (search for food, migration) and biological (gonads, body structure) roles performed in the population (Moura & Coelho, 2004). Therefore, this information is of great importance to determine the reproductive potential of a species and the role it plays in the community structure.

In brachiurans, the morphological sexual maturity is defined by the differentiated growth of certain body structures. The growth of the appendages follow different patterns compared to the growth of the body size of the animal. These differences may be related to the secondary sexual characteristics associated with the reproductive behavior, being indispensable for success in the reproduction (PInheiro & Fransozo, 1993). For example, the importance of abdomen in brachiuran females is well established on the literature as the most important structure for reproduction since it protects and incubates the embryos (Cobo & Fransozo, 1998), and the chelipeds in males are considered important tools in the dispute with other males, as a weapon, as a visual display, and to manipulate females (Pinheiro & Fransozo, 1993).

Considering the lack of information in the literature about the reproductive parameters of *X. parvulus*, and the importance of the area where the samples were taken for marine conservation, this study aimed to provide accurate criteria for the determination of the size of morphological sexual maturity of the marine crab *X. parvulus*, using statistical methods applied to the relative growth of this species.

MATERIAL AND METHODS

The sample local. The Marine State Park of Laje de Santos (24°19'S / 46°10'W) is considered the first marine conservation No-Take unit in the São Paulo State. It represents a continental island with 33 meters high, 550 meters long, 185 meters wide, and is located approximately 42 km from the city of Santos (Fig. 1).

The "No-take" status and the high conservation management conducted at the island makes this location a place with great biological diversity, since different marine species use it as a place for feeding, reproduction, and growth, in spite of making vast displacements along the Atlantic coast (Luiz *et al.*, 2008).

Samples were conducted under ICMBio and COTEC-SP (260108 – 010.480/2014) licenses that authorized specifically the realization of scientific studies on crustaceans like the present study.

The sampling methods. Quarterly sampling was carried out from June 2015 to June 2016 using two-sampling methods: First, the active search with SCUBA dive during the daytime, which is a very common method used to sample the decapod fauna (Mantelatto *et al.*, 2004; Alves *et al.*, 2012; Moraes *et al.*, 2021). Two divers made a sampling effort of about two hours in each campaign, looking for animals between rocks and associated with other invertebrates such as coral and sponges.

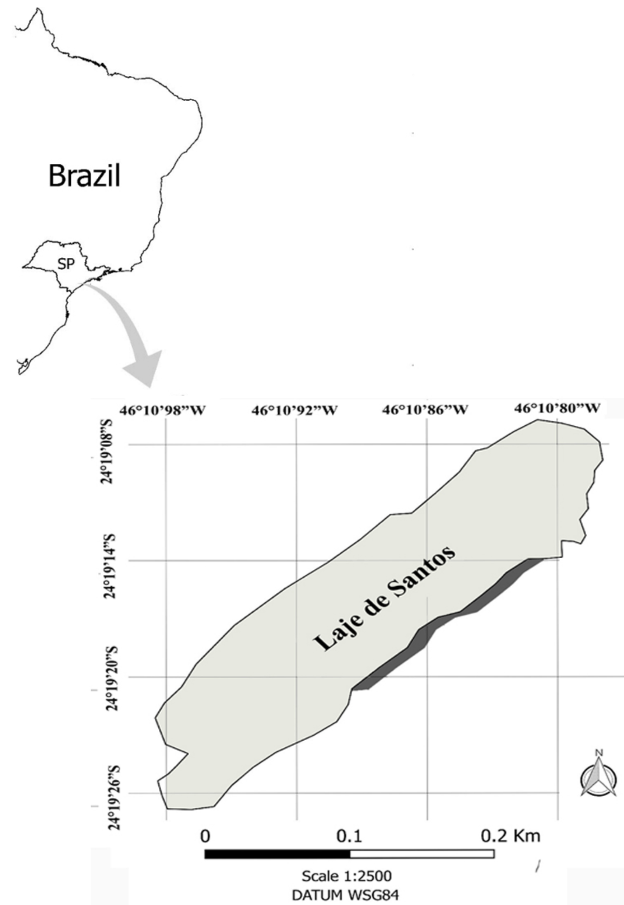


Fig. 1. Location of the sampling sites on the Brazilian coast. *SP: São Paulo State Coast. Marine State Park of Laje de Santos (MSPLS). 200 m bars indicates the extension and face of the island where all samples were randonly made (Both active and Passive captures). Depth in those 200 m vary between 6 and 20 m on rocky bottom.

The second method was the passive sampling using the Artificial Refuge Substrate (ARS), represented by a cube (25 x 25 cm) made from plastic canvas with 5.5 x 4.0 cm mesh. Twenty sets of three smooth conduit tubes were placed inside this structure, presenting the following dimensions: five sets of 12 x 1.5 cm; five sets of 12 x 2.0 cm, and ten sets of 12 x 2.5 cm. Also, six sets of three screen nets were placed, each measuring 25 x 25 cm. The substrates were identified utilizing a nº 10 (4.8 x 6.3 cm) type of fishing float and a centrifuge tube (15 ml) with an internal tag that identified the Project (as used by MORAES *et al.*, 2020; 2021 at Laje de Santos). This ARS was set along 200 m in the rocky subtidal zone and removed (and replaced by new) every three months. During the ARS removal, the structures were bagged underwater to guarantee that all specimens were sampled and kept inside the ARS, only then the bagged substrates were taken from between the rocks (Figs 2-4).

Both active and passive samples were conducted in a 200 m extension randomly area on the sheltered region of the island in all rocky bottom extension, in depth between 6 and 20 m, where most rocks and sessile invertebrates were disposed. All captured specimens were immediately individualized in plastic bags and kept frozen in a thermal icebox to preserve their morphological characteristics until their transfer to the laboratory.

At the laboratory, the specimens were kept in 70% alcohol and identified using a taxonomic key (MELO, 1996). The individuals were separated by sex based on the morphology of the abdomen, such as the presence of pleopods in females and of gonopods in males. Then, under a stereomicroscope, coupled to an image capture system, equipped with a camera and the Axio Visio program (vers.4.8), the following structures were measured: Carapace Width (CW) (Fig. 5); Carapace Length (CL) (Fig. 5); Right and Left Propod Length (RPL and LPL) (Fig. 5); Right and Left Propod Width (RPW and LPW) (Fig. 5); Right and Left Propod Height (RPH and LPH) (Fig. 5); Abdomen Width (AW) (Fig. 6); just for males, Gonopod Length (GL) (Fig. 7).

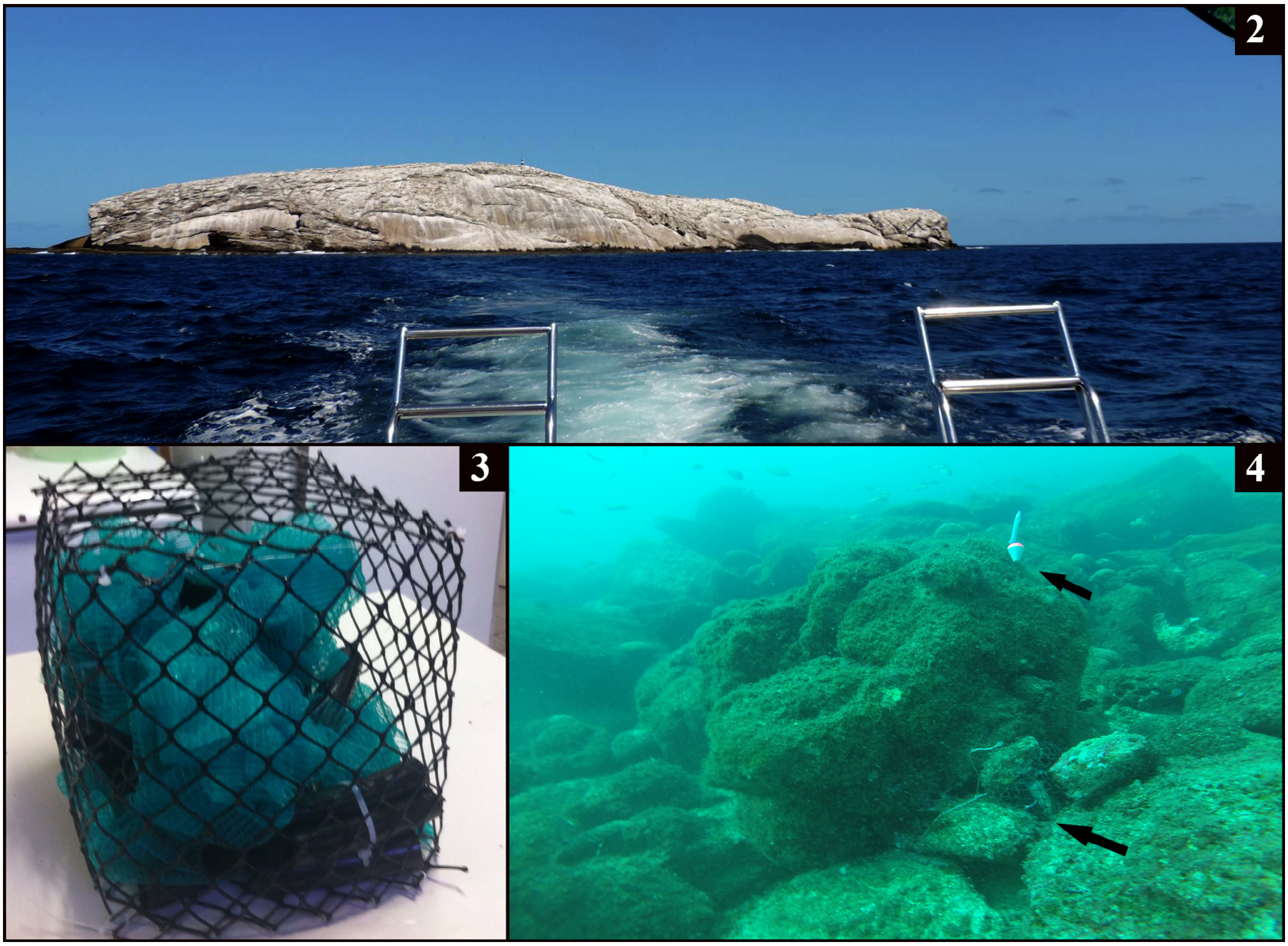
Data analysis. Based on the allometric methods applied in morphometry, the Carapace Width (CW) measurement was used as the independent variable (x) for the relative growth analysis. The other morphometric measurements aforementioned were considered as dependent variables (y). Each set of ordered pairs was adjusted by the allometric equation ($y = ax^b$), used as a linearized equation ($\log y = \log a + b \log x$), where y is the dependent variable or the dimension studied, x is the independent variable, a is the elevation of the line, and b is the allometric coefficient of the analyzed structure (HARTNOLL, 1982).

The allometric condition b for each structure was analyzed ($b = 1$: isometry; $b < 1$: negative allometry; $b > 1$: positive allometry) testing the null hypothesis (H_0: $b = 1$) using the Student's t-test ($\alpha = 0.05$) (ZAR, 1996).

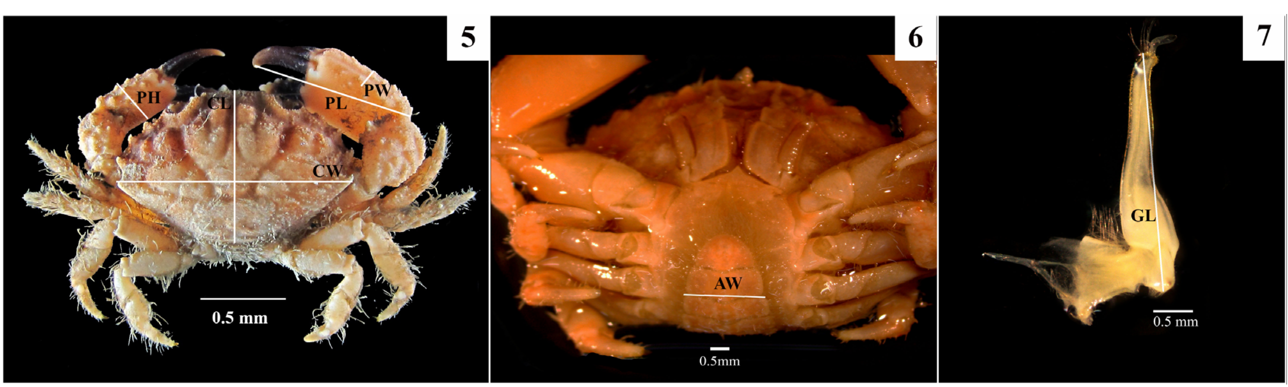
A non-hierarchical *K*-means clustering analysis was performed and the data were plotted in scatter plots and adjusted using the coefficient of determination (R^2) for each relation (PINHEIRO & FRANSOZO, 1993; SAMPEDRO *et al.*, 1999).

The Analysis of Covariance (ANCOVA) was applied to test differences in the angular (b) and linear (a) coefficients for each body ratio and covariate group (juvenile *vs.* adult). This analysis determined whether the data for each body ratio were best represented by a single straight line or by different linear equations in the same way used by HERRERA *et al.*, 2013.

The cutoff point between the groups identified in the significant ($p < 0.05$) biometric relationships that best defined the reproductive strategies of this species, that is, those structures that are considered secondary sexual characters, being considered as the onset of the morphological sexual maturity (DAVANSO *et al.*, 2016; HERRERA *et al.*, 2018). The size of the smallest individual classified as an adult was used as the value at which the species reaches the morphological sexual maturity. This statistical methodology was based on the work of SAMPEDRO *et al.* (1999).



Figs 2-4. Sample site and artificial substrate: 2, Laje de Santos view from the face where the samples were taken; 3, Artificial Substrate of Refuge (ASR) ready for installation; 4, ASR installed between rocks at the consolidated substrate of Laje de Santos (arrows point to the ASR and the floater with the centrifuge tube with the identification of the Project).



Figs 5-7. *Xanthodius parvulus* (Fabricius, 1793), dimensions used in the morphometric analysis of each structure: 5, Carapace Width (CW); Carapace Length (CL); Propod Length (PL); Propod Width (PW); Propod Height (PH); 6, Abdomen Width (AW); 7, Gonopod Length (GL).

RESULTS

Among all the sampled specimens, a total of 77 crabs belonged to the studied species: 44 females with a CW ranging from 4.55 to 15.53 mm, nine of which were ovigerous females with a CW varying between 8.08 and 15.53 mm; and 33 males with a CW varying between 4.45 and 16.07 mm.

The straight lines obtained at the different stages (juvenile and adult) were best fitted to the data separately, with exception of the CL *vs.* CW, RPL *vs.* CW, and RPH *vs.* CW for females, (ANCOVA, $p > 0.05$) (Tab. I).

Tab. I. *Xanthodius parvulus* (Fabricius, 1793). Results of analysis of covariance (ANCOVA) between males and females for each relationship (CW, Carapace Width; CL, Carapace Lenght; RPW, Right Propodus Width; RPL, Right Propodus Length; RPH, Right Propodus Height; LPW, Left Propodus Width; LPH, Left Propodus Height; LPL, Left Propodus Length; AW, Abdomen Width; GL, Gonopod Length; J, juveniles; A, adults; *, p < 0,05.

Relationship	Factor (group)	Par. (Log)	F	*p*
CL *vs.* CW	Female J *vs.* A	*a*	0.056	0.893
		b	0.018	0.813
	Male J *vs.* A	*a*	4.756	0.037*
		b	0.065	0.799
RPL *vs.* CW	Female J *vs.* A	*a*	1.522	0.225
		b	1.905	0.176
	Male J *vs.* A	*a*	12.796	0.001*
		b	0.369	0.549
RPW *vs.* CW	Female J *vs.* A	*a*	8.157	0.007*
		b	0.762	0.388
	Male J *vs.* A	*a*	8.905	0.005*
		b	0.214	0.647
RPH *vs.* CW	Female J *vs.* A	*a*	0.125	0.725
		b	0.150	0.700
	Male J *vs.* A	*a*	7.840	0.009*
		b	0.110	0.742
LPL *vs.* CW	Female J *vs.* A	*a*	5.238	0.028*
		b	8.824	0.095
	Male J *vs.* A	*a*	–	–
		b	5.775	0.023*
LPW *vs.* CW	Female J *vs.* A	*a*	14.666	0.000*
		b	2.167	0.148
	Male J *vs.* A	*a*	8.584	0.006*
		b	0.356	0.555
LPH *vs.* CW	Female J *vs.* A	*a*	9.039	0.004*
		b	2.091	0.156
	Male J *vs.* A	*a*	16.843	0.000*
		b	1.091	0.305
AW *vs.* CW	Female J *vs.* A	*a*	21.704	0.000*
		b	0.333	0.566
	Male J *vs.* A	*a*	35.139	0.000*
		b	3.666	0.065
GL *vs.* CW	Male J *vs.* A	*a*	–	–
		b	11.681	0.001*

A detailed description of each of the relationships analyzed can be seen in Tab. II. The RPL *vs* CW relationship showed isometric growth for juveniles and adults, in both males and females. The AW *vs* CW relationship showed negative allometry for juveniles and adults males. When the AW *vs* CW relationship was analyzed for females an isometric pattern in the transition to the adult stage, with the growth pattern of adults remaining the same as the one observed in the juveniles. The GL *vs* CW relationship showed a negative allometry for the growth pattern of the juveniles, which changed to an isometric pattern in the adults in males.

The morphological sexual maturity of females was estimated at 7.28 mm, based on the AW *vs.* CW relationship (Fig. 8). In males, this value was 8.83 mm, based on the GL *vs.* CW relationship (Fig. 9).

DISCUSSION

Crustaceans exhibit changes in their growth pattern during their life cycle (Hartnoll, 1974), which result from the switch in the amount of energy used for body growth to an investment in reproduction when these individuals reach sexual maturity (Taylor & Gabriel, 1992).

Tab. II. *Xanthodius parvulus* (Fabricius, 1793). Regression analyzes morphometric data using Carapace Width (CW) as the independent variable (JF, juvenile female; AF, adult female; JM, juvenile male; AM, adult male; 0, isometry; -, negative allometry; R^2, coefficient of determination; CW, carapace width; CL, Carapace Lenght; RPW, Right Propodus Width; RPL, Right Propodus Length; RPH, Right Propodus Height; LPW, Left Propodus Width; LPH, Left Propodus Height; LPL, Left Propodus Length; AW, Abdomen Width; GL, Gonopod Length).

Relationship	Sex	N	*a*	*b*	R^2	T (b=1)	*p*	Allometry
CL *vs.* CW	JF/AF	44	0.108	0.921	0.987	4.548	<0.001	–
	JM	11	0.129	0.941	0.970	1.017	<0.001	0
	AM	22	0.098	0.925	0.967	1.858	<0.001	–
RPL *vs.* CW	JF/AF	39	0.201	1.059	0.852	-0.933	<0.001	0
	JM	15	0.071	0.919	0.759	0.595	<0.001	0
	AM	14	0.122	1.040	0.833	-0.338	<0.001	0
RPW *vs.* CW	JF	16	0.273	0.495	0.164	2.066	<0.001	0
	AF	23	0.405	0.766	0.538	1.580	<0.001	0
	JM	13	0.607	0.939	0.638	0.335	<0.001	0
	AM	17	0.634	1.051	0.849	-0.510	<0.001	0
RPH *vs.* CW	JF/AF	39	0.643	1.132	0.719	-1.520	<0.001	0
	JM	4	0.700	1.102	0.762	-0.296	<0.001	0
	AM	26	0.672	1.221	0.746	-2.149	<0.001	0
LPL *vs.* CW	JF	24	-0.222	1.021	0.928	-14.706	<0.001	0
	AF	19	0.406	0.435	0.223	-1.312	<0.001	–
	JM/AM	31	- 0.246	1.074	0.933	-1.400	<0.001	0
LPW *vs.* CW	JF	20	0.473	0.661	0.650	2.432	<0.001	–
	AF	23	0.027	0.274	0.060	3.430	<0.001	0
	JM	10	0.242	0.450	0.429	2.059	<0.001	–
	AM	22	0.300	0.618	0.365	2.146	<0.001	–
LPH *vs.* CW	JF/AF	43	- 0.676	1.028	0.869	-0.448	<0.001	
	JM	14	0.504	0.833	0.863	1.560	<0.001	0
	AM	18	0.122	0.574	0.285	2.0135	<0.001	–
AW *vs.* CW	JF	16	0.747	0.838	0.332	0.740	<0.001	0
	AF	28	0.702	1.062	0.483	-0.438	<0.001	0
	JM	14	0.387	0.317	0.264	2.759	<0.001	–
	AM	19	0.702	0.627	0.622	1.995	<0.001	–
GL *vs.* CW	JM	10	0.039	0.350	0.370	2.318	<0.001	–
	AM	22	0.466	0.870	0.861	1.554	<0.001	0

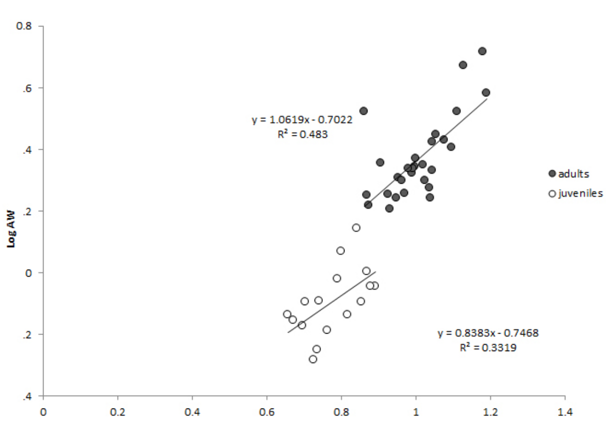


Fig. 8. *Xanthodius parvulus* (Fabricius, 1793). Estimated size at the morphological sexual maturity for females. The estimated size refers to the smallest individual after the inflection point of the equations for juveniles and adults [CW, Carapace Width (mm); AW, Abdomen Width (mm)].

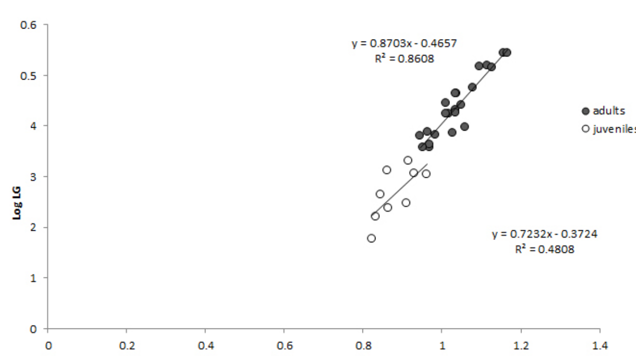


Fig. 9. *Xanthodius parvulus* (Fabricius, 1793). Estimated size at morphological sexual maturity for males. The estimated size refers to the smallest individual after the inflection point of the equations for juveniles and adults [CW, Carapace Width (mm); LG, Gonopod Length (mm)].

Brachiuran females exhibit increased abdominal growth, even during the mature stage in order to obtain higher reproductive success, since this structure acts as an "incubatory chamber", protecting externalized embryos (HARTNOLL, 1974). However, *X. parvulus* showed isometric abdomen growth in juvenile and adult phases. Abdomen growth in female is essential, because this structure provides protection for eggs (PESCINELLI *et al.*, 2015). Considering the largest females sampled, those characteristics suggests the importance of the development of this structure for reproduction compared to the smaller females.

In addition, concerning other brachyurans, since we are dealing with very tiny and cryptic organisms, a differentiated growth of the abdomen compared to the carapace would not be morphologically viable for the organism, making it difficult to storage the fertilized eggs or their locomotion (FINNEY & ABELE, 1981). On the other hand, the negative allometry found in males in the abdomen growth shows that the structure is only involved in the protection of its pair of gonopods.

Several studies carried out with brachyurans showed that in males the significant relationship in the relative growth patterns is observed the growth of the chelipeds, since this structure is widely used by these individuals to perform the court, holding and guiding the female at the time of reproduction (HERRERA *et al.*, 2013; PESCINELLI et al., 2015; DAVANSO *et al.*, 2016).

Although, in this study, the growth of the chelipeds (mainly for males), represented by the relationships of the right propod (in terms of length, width and height), did not show differences in growth between the juvenile and adult phases or a negative allometry for the left propod for adults, this demonstrates that these structures are not directly related to reproduction in the specie. A similar case has been observed for males of *Homarus americanus* H. Milne Edwards, 1837 and *Menippe frontalis* A. Milne-Edwards, 1879 where sexual morphometric maturity was not detected in their chelipeds (CONAN *et al.*, 2001; ZAMBRANO & RAMOS, 2020).

Considering the fact that the gonopods are involved in the transfer of spermatophores to the female in the act of copulation, this structure becomes indispensable for the reproductive success of crabs and was used to estimate the morphological sexual maturity in males (PESCINELLI *et al.*, 2015). The significant relationship observed was the gonopod length, this may be related to the reproductive behavior of this species, in which males do not use the chelipeds to guide the female, characterizing the absence of an expressive copulation process, very common for other species of this Infraorder, especially in cryptic and small animals (HARTNOLL, 1969). However, in order to prove this hypothesis, the reproductive behavior of *X. parvulus* should be registered since there is no information about it.

Thus, for males, the negative allometry observed in juveniles and the isometric pattern found in the adults regarding the gonopod growth guarantees that they copulate with females of different sizes, since a non-exaggerated growth of the gonopods still makes them adequate to the size of the female genital pore (HARTNOLL, 1974). This characteristic was observed for other crabs such as *Goniopsis cruentata* (LATREILLE, 1803) (COBO & FRANSOZO, 1998) and *Menippe nodifrons* (STIMPSON, 1859) (BERTINI *et al.*, 2007).

The larger maturity size estimated for males compared to females is probably related to the fact that this size enables them to reproduce with females of different sizes, as previously mentioned. This characteristic was also observed for other crabs of this Infraorder, such as *Arenaeus cribrarius* (Lamarck, 1818) (PINHEIRO & FRANSOZO, 1998), *M. nodifrons* (BERTINI *et al.*, 2007), and *Aratus pisonii* (H. Milne Edwards, 1837) (PESCINELLI *et al.*, 2015).

Based on the data presented in this study, the relative growth analysis proved to be an efficient estimate of the morphological sexual maturity of *X. parvulus* based on reproductive structures related. Although the growth of the abdomen is isometric in both stages, it increases with the arrival of puberty, being related to the ability to carry and incubate the embryos until they are hatched (AHAMED & OHTOMI, 2014). This phenomenon is observed in several other brachiurans (BOND & BUCKUP, 1982; BARROS & FONTOURA, 1996; HERRERA *et al.*, 2018).

Finally, despite being considered an exotic species for the region, *X. parvulus* already occurs in expressive numbers in the area, according to the samplings, presenting individuals from all the demographic categories in the MSPLS. Thus, estimating the size at which the individuals attain sexual maturity is important to evaluate the functional biological patterns of the species to be possible to support interpretations in future studies of conservation and management of the species in an environmental preserved area. This is an extremely relevant information since *X. parvulus* plays an important role in the food web, feeding on organisms from the lower trophic level and transferring this energy to other major predators, being a relevant species in continental islands (WENNER & BOESCH, 1979)

Hypotheses of the specie arise regarding the occurrence in the study area through the ballast water of ships that dock mainly at the harbor of Santos since there are no studies on the migratory movement of the species and it was not found in other localities of the Brazilian coast, except for those cited by MELO (1988) and BARROS-ALVES *et al.* (2013). Thus, the knowledge about the reproductive parameters of *X. parvulus* is one of the possible works that can be done with species of conservation areas, like distribution, populational biology, ecological interactions, and all biological parameters of many species as possible that will be very representative and useful at the time of the elaboration of a potential management plan for these individuals to avoid environmental disturbances, especially in the case of a conservation "No-take" area.

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