Nauplius
The Journal of The Brazilian Crustacean Society

e-ISSN 2358-2936
www.scielo.br/nau
www.crustacea.org.br

Original Article

Some population aspects of *Charybdis* (*Charybdis*) *hellerii* (A. Milne-Edwards, 1867) (Decapoda, Portunidae) at Sergipe River Estuary, northeastern Brazilian coast

Leonardo Cruz da Rosa

Laboratório de Ecologia Bentônica, Departamento de Engenharia de Pesca e Aquicultura, Centro de Ciências Agrárias Aplicadas, Universidade Federal de Sergipe, São Cristóvão, Sergipe, Brasil.
LCR E-mail: leonardo.rosa@rocketmail.com

ZOOBANK: http://zoobank.org/urn:lsid:zoobank.org:pub:E1516833-D9A9-49EE-8772-2D5760994E9E

ABSTRACT

The present study provides some parameters of the population biology of *Charybdis (Charybdis) hellerii* (A. Milne-Edwards, 1867), an invasive swimming crab inhabiting the estuarine portion of the Sergipe River, northeastern Brazilian coast. Samplings were carried out monthly from July 2015 to June 2016 with baited traps. The species was the second most abundant caught organism and its relative abundance ranged over the time from 11 to 59%. Sex ratio was 1:1 and all individuals were morphologically mature. Males were bigger than females. Ovigerous females were observed year-round and the smallest one was 31.35 mm carapace width. These findings show that the population is well established on the Sergipe coast. The entire distribution, and possible impacts, of *C. (C.) hellerii* on local environments need to be evaluated in further studies.

KEYWORDS

Crabs, non-indigenous species, population biology, relative abundance, size structure

Editor-in-chief
Christopher Tudge

Associate Editor:
Ingo Wehrtmann

Corresponding Author
Leonardo Cruz da Rosa
leonardo.rosa@rocketmail.com

Submitted 05 August 2022
Accepted 08 March 2023
Published 22 September 2023

DOI 10.1590/2358-2936e2023019

All content of the journal, except where identified, is licensed under a Creative Commons attribution-type BY.

INTRODUCTION

The swimming crab *Charybdis (Charybdis) hellerii* (A. Milne-Edwards, 1867) is an invasive portunid crab native to the Indo-West Pacific, which by now has a worldwide distribution in warm waters (Tavares, 2011; Negri et al., 2018; Dessouassi et al., 2019). Its introduction along the American coast is strongly believed to have occurred via larvae transported in ballast water of ships from the Mediterranean (see Negri

et al., 2018). On the Brazilian coast, this species was recorded for the first time in four states simultaneously: Alagoas (Calado, 1996), Bahia (Carqueija and Gouvêia, 1996), Rio de Janeiro (Tavares and Mendonça-Jr, 1996) and São Paulo (Negreiros-Fransozo, 1996). Since then, many other records were added along the Brazilian coast. Nowadays, this species is distributed from Pará to Santa Catarina, except for the Paraiba coast (see Negri et al., 2018), with well-established reproductive populations (Sant'Anna et al., 2012).

The information about the impacts of *C. (C.) hellerii* introductions on native crab fauna is not clear. This species displays both an aggressive behavior (Morán and Atencio, 2006) and an omnivorous diet (Dineen et al., 2001), even feeding on native crabs (Sant'Anna et al., 2015), making this invasive crab a potential predator and/or competitor of native fauna (Mantelatto and Garcia, 2001). Indeed, declines in native crab populations were recorded and attributed to this interaction (Tavares, 2011; Sant'Anna et al., 2012).

Besides its wide distribution along Brazilian coasts and evidence of negative impacts on native crab fauna, studies about population biology of this invasive crab are scarce and restricted to the southeast (Mantelatto and Garcia, 2001; Sant'Anna et al., 2012) and south region of Brazil (Sant'Anna et al., 2015). On the Sergipe coast, northeastern Brazil, this species was recorded for the first time in 2013 based on an immature female caught in the intermediate estuarine zone of the Vaza-Barris River (Rosa, 2014). Recently, during a field experiment carried out to evaluate which factors could affect crab catchability at another estuary (Sergipe River Estuary), *C. (C.) hellerii* was the second most abundant crab species (Rosa et al., 2022).

In the present study some basic biological parameters (relative abundance, sex ratio, size structure) are provided for a population inhabiting the estuarine region of Sergipe River, state of Sergipe, northeastern Brazilian coast to contribute to better understanding about population dynamics of this invasive crab species. This information is useful to evaluate the current status of invasiveness in the local estuaries as well as to contribute to future studies regarding latitudinal influences on the population biology of this invasive crab species.

MATERIAL AND METHODS

The study was carried out next to the old pier of Atalaia Nova, municipality of Barra dos Coqueiros, situated at Sergipe River estuary (Fig. 1). Samples were taken monthly from July 2015 to June 2016 using cylindrical traps (50 cm diameter and 20 cm height) covered by 20 mm cod end mesh. Five traps were baited with fish fragments and randomly distributed around the pier; they remained submerged for three hours during the night low tide. During each sampling, water temperature and salinity were measured with a glass thermometer and a portable refractometer, respectively.

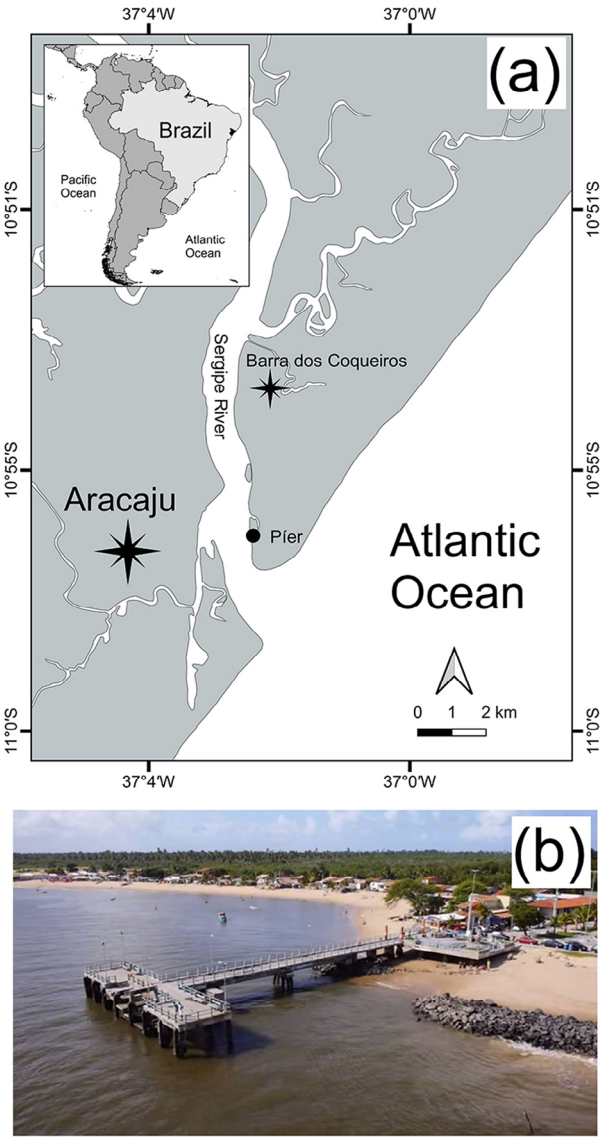

Figure 1. Map of the collection locality (**A**) and aerial view (**B**) of the old pier on the Atalaia Nova, Barra dos Coqueiros, Sergipe, northeastern Brazilian coast.

All collected individuals were kept in ice and sent to the laboratory for identification. The specimens were identified according to Melo (1996; 1999) and Tavares & Mendonça-Jr (2011). All individuals of *C. (C.) hellerii* was measured for carapace width (CW, without spines) with a digital caliper (0.01 mm). The sex was checked by inspection of abdominal morphology and/or by presence of eggs, while morphological maturity stage was determined according to adherence of abdomen to thoracic sternites (adhered abdomen for immature individuals and not adhered for mature ones) (Watanabe et al., 2015).

The relationship between *C. (C.) hellerii* abundance and both water temperature and salinity were accessed by a Pearson Correlation test, while a Chi-square test was applied to test whether the overall sex ratio significantly deviated from the expected 1:1 proportion. Differences between male and female sizes were assessed by a Mann-Whitney U test (Zar, 2009).

RESULTS

A total of the 230 individuals comprising seven species of brachyuran crabs and two of spiny lobster were collected during the study period (Table 1). The swimming crab *Callinectes exasperatus* (Gerstaecker, 1856) was the most abundant species, corresponding to 37.8% of the total of the collected individuals, followed by the invasive crab *Charybdis (Charybdis) hellerii* (35.7%). The relative abundance of *C. (C.) hellerii* varied over time from 11% (September 2015) to 59% (April 2016) (Fig. 2).

Table 1. Number of individuals per species caught throughout the year at Sergipe River estuary, state of Sergipe, Brazil. RA (%) refers to relative abundance of species in relation to total of individuals caught.

Species	2015						2016						RA (%)
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	
Callinectes danae Smith, 1869	6	6				1		2			1		7.0
Callinectes exasperatus (Gerstaecker, 1856)	5	5	10	5	6	10	9	14	8	9	3	3	37.8
Callinectes marginatus (A. Milne-Edwards, 1861)		1	3	2						2			3.5
Callinectes ornatus Ordway, 1863	1	1	2	1	2			2		3	2	2	7.0
Charybdis (Charybdis) hellerii (A. Milne-Edwards, 1867)	5	2	2	9	10	6	12	7	7	4	13	5	35.7
Hepatus pudibundus (Herbst, 1758)	2				5	3				1	3		6.1
Menippe nodifrons Stimpson, 1859			1						1	1			1.3
Panulirus argus (Latreille, 1804)							1						0.4
Panulirus laevicauda (Latreille, 1817)					2		1						1.3
Total	**19**	**15**	**18**	**17**	**25**	**20**	**23**	**25**	**16**	**20**	**22**	**10**	

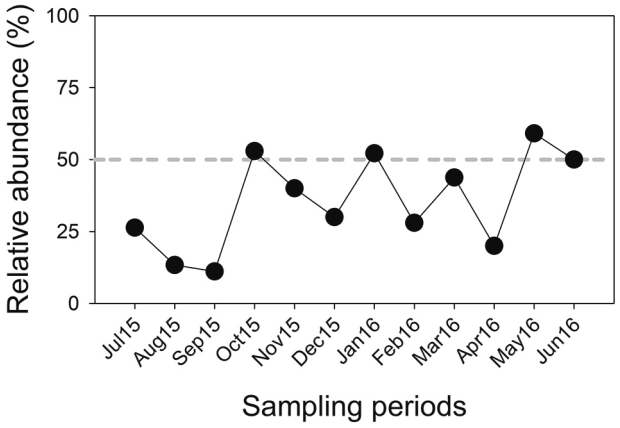

Figure 2. Relative abundance of *Charybdis (Charybdis) hellerii* (A. Milne-Edwards, 1867) over the sampling periods at the Sergipe River Estuary, northeastern Brazilian coast.

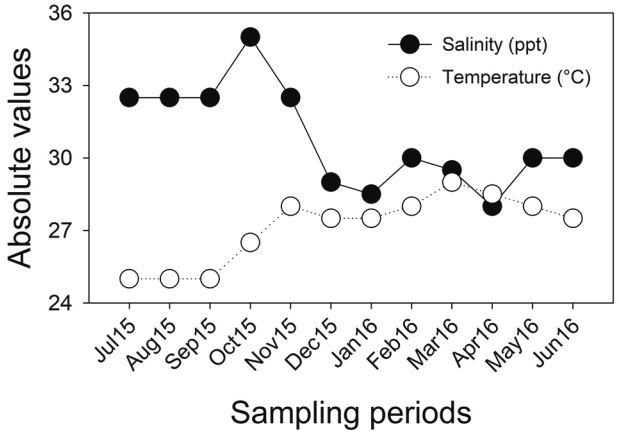

Figure 3. Absolute values of the water temperature and salinity over the sampling periods at the Sergipe River Estuary, northeastern Brazilian coast.

The water temperature and salinity ranged from 25 (June-August 2015) to 29 °C (March 2016) and from 28 (April 2016) to 35 ppt (October 2015), respectively (Fig. 3). There was no significant relationship between the abundance of the invasive crab and both water temperature (r = 0.514; p = 0.087) and salinity (r = -0.136; p = 0.674).

Of the 82 individuals of *C. (C.) hellerii* caught, 43 (52%) were males, 26 (32%) were non-ovigerous females and 13 (16%) were ovigerous females. All of them were mature specimens. The overall sex ratio (1M:0.9F) of the population did not differ from the expected 1:1 proportion (χ^2 = 0.11; p = 0.66).

Male crabs (54.99 ± 6.44 mm CW) were significantly larger than females (50.31 ± 8.16 mm CW; U = 497.00; p = 0.002). The size of males ranged from 44.76 to 67.42 mm CW, and most of them were in the 50-55 mm size class, while non-ovigerous females ranged in size from 42.03 to 75.20 mm CW with a peak of individuals in the 45-50 mm size class (Fig. 4). Ovigerous females were caught almost year-round (two individuals in July 2015, one in November 2015, two in January 2016, one in February, two in March, three in May, and two in June 2016). The smallest ovigerous female measured 31.35 mm CW, while the mean size of egg-bearing females was 47.21 ± 6.89 mm CW.

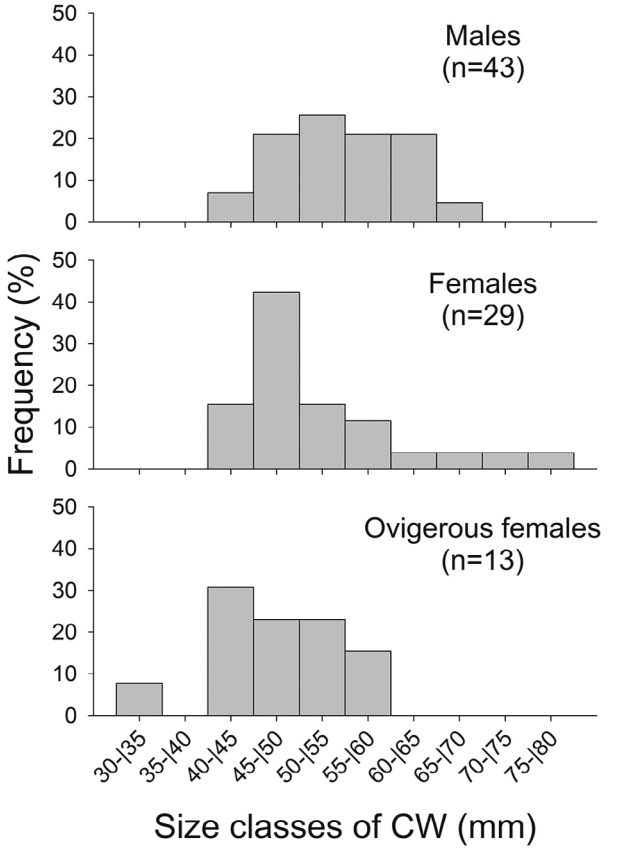

Figure 4. Size-frequency distribution (CW, carapace width in millimeters) of *Charybdis (Charybdis) hellerii* (A. Milne-Edwards, 1867) collected in the Sergipe River Estuary, northeastern Brazilian coast.

DISCUSSION

The population of *Charybdis (Charybdis) hellerii* inhabiting the estuarine region of the Sergipe River, northeastern Brazilian coast, showed very similar population traits as other populations along its non-native range in the western Atlantic. In our study, this invasive crab was the second most abundant collected species and, its relative abundance was often up to 50%. A similar pattern was observed in the southeast region by Sant'Anna et al. (2012), and the decline of the native crab *Cronius ruber* (Lamarck, 1818) abundance was reported as a consequence of the high abundance of *C. (C.) helleri*. This was associated with its aggressive behavior (Sant'Anna et al., 2012).

On the Sergipe coast, the sex ratio did not differ from the expected 1:1 proportion. This 1:1 proportion was also recorded from a population in the USA (Dineen et al., 2001) and the coast of Venezuela (Bolaños et al., 2012). Contrastingly, a male-biased sex ratio has been recorded from populations inhabiting the coast of south-southeast Brazil (Mantelatto and Garcia, 2001; Sant'Anna et al., 2012; 2015) and the Caribbean coast (Ferry et al., 2017). As mentioned by Sant'Anna et al. (2012), a skewed sex ratio, however, may be due to a sampling artifact.

All collected individuals were mature. According to Mantelatto and Garcia (2001), sexual maturity of *C. (C.) hellerii* is attained at 35 mm CW in the southeast region of Brazil. Indeed, from all caught individuals obtained in this study, only one was below this size, which was an ovigerous female, reinforcing that just the mature proportion of this population was analyzed. The low frequency, or complete absence, of small-sized and immature individuals was also reported from other regions (Bolaños et al., 2012; Sant'Anna et al., 2012; 2015). According to these authors, immature individuals could prefer different microhabitats than rocky structures. For instance, the first record of *C. (C.) hellerii* from the Sergipe coast was based on one immature female of 26.8 mm CW collected in a tidal creek bordered by mangroves (Rosa, 2014), which could support the hypothesis that the species occupies different habitats during its ontogenetic development.

Our data reveals sexual dimorphism, with males being larger than females. This pattern is in agreement with the results of other studies with the same species (Mantelatto and Dias, 1999; Mantelatto and Garcia, 2001; Dineen et al., 2001; Morán and Atencio, 2006; Bolaños et al., 2012; Sant'Anna et al., 2012; 2015; Ferry et al., 2017) and it is a typical pattern for crabs, associated with higher success in mating and protecting females during the reproductive period (Williams, 1974; Hartnoll, 2006).

The year-round presence of ovigerous females, but at a low frequency of occurrence, were also recorded from populations inhabiting the Venezuelan (Bolaños et al., 2012) and southeast Brazilian coasts (Sant'Anna et al., 2012), suggesting that these populations have continuous reproduction but with very low intensity (Bolaños et al., 2012). The smallest ovigerous female (31.35 mm CW) recorded at Sergipe coast fitted into the size range recorded for specimens along the western Atlantic: from a minimum of 27.03 mm CW recorded at Martinique, French Lesser Antilles (Ferry et al., 2017) to a maximum of 58.80 mm CW on the Venezuelan coast (Morán and Atencio, 2006).

Despite the limitations imposed due to low spatial coverage of this study (only one sampling area), the presence of a mature and reproductive population indicates that this invasive species is well established on the Sergipe coast. *Charybdis (Charybdis) hellerii* occurs in a variety of habitats from intertidal to beyond 30 m depth, including soft bottoms, algal mats, seagrass beds, mangroves roots, coral reefs, rocky shores, and breakwaters (Dineen et al., 2001; Morán and Atencio, 2006; Bolaños et al., 2012; Sant'Anna et al., 2012; Ferry et al., 2017; Searles et al., 2019). However, a clear preference for rocky shores, over subtidal soft bottoms, was observed on the southeast Brazilian coast, where the impact of this invasive crab changed according to habitat use (Sant'Anna et al., 2012). Therefore, additional studies are needed to determine the entire distribution of this invasive species along the different sets of habitats in the region as well as to evaluate its possible impacts as a predator and/or competitor of the native crab fauna.

ACKNOWLEDGEMENTS

I thank Wellington Luis Silva Júnior and Rafael Barbosa dos Santos for their help with data collection. This manuscript was improved by suggestions from Dr. Ingo Wehrtmann and two anonymous reviewers.

REFERENCES

Bolaños JÁ, Baeza JA, Hernandez JE, Lira C and López R 2012. Population dynamics and reproductive output of the non-indigenous crab *Charybdis hellerii* in the south-eastern Caribbean Sea. *Journal of the Marine Biological Association of the United Kingdom*, 92: 469–474. https://doi.org/10.1017/S002531541100052X

Calado TC 1996. Registro de *Charybdis hellerii* (Milne Edwards, 1867) em águas do litoral brasileiro (Decapoda: Portunidae). *Boletim de Estudos de Ciências do Mar*, 9: 175–180.

Carqueija CRG and Gouvêia EP 1996. A ocorrência, na costa brasileira, de um Portunidae (Crustacea, Decapoda), originário do Indo-Pacífico e Mediterrâneo. *Nauplius*, 4: 105–112.

Dessouassi CE, Lalèyè PA and D'Acoz CD 2019. First record of the globally invasive crab, *Charybdis hellerii* (A. Milne-Edwards, 1867), in Benin, with notes on its taxonomy (Crustacea, Decapoda, Brachyura, Portunidae). *Zootaxa*, 4576 (2): 201–238. https://doi.org/10.11646/zootaxa.4576.2.1

Dineen JF, Clark PF, Hines AH, Reed SA and Walton HP 2001. Life history, larval description, and natural history of *Charybdis hellerii* (Decapoda, Brachyura, Portunidae), an invasive crab in the western Atlantic. *Journal of Crustacean Biology*, 21: 774–805. https://doi.org/10.1163/20021975-99990173

Ferry R, Buske Y, Poupin J and Smith-Ravin J 2017. First record of the invasive swimming crab *Charybdis hellerii* (A. Milne Edwards, 1867) (Crustacea, Portunidae) off Martinique, French Lesser Antilles. *BioInvasions Records*, 6: 239–247. https://doi.org/10.3391/bir.2017.6.3.09

Hartnoll RG 2006. Reproductive investment in Brachyura. *Hydrobiologia*, 557:31–40. https://doi.org/10.1007/s10750-005-9305-6

Mantelatto FLM and Dias LL 1999. Extension of the known distribution of *Charybdis hellerii* (A. Milne Edwards, 1867) (Decapoda, Portunidae) along the western tropical South Atlantic. *Crustaceana*, 72(6): 617–620.

Mantelatto FLM and Garcia RB 2001. Biological aspects of the nonindigenous portunid crab *Charybdis hellerii* in the western tropical south Atlantic. *Bulletin of Marine Science*, 68: 469–477.

Melo GAS 1996. Manual de identificação dos Brachyura (caranguejos e siris) do litoral brasileiro. São Paulo, Editora Plêiade. 603p.

Melo GAS 1999. Manual de identificação dos Crustacea Decapoda do litoral brasileiro: Anomura, Thalassinidea, Palinuridea, Astacidae. Editora Plêiade, São Paulo. 551p.

Morán R and Atencio M 2006. *Charybdis hellerii* (Crustacea: Decapoda: Portunidae), especie invasora en la Península de Paraguaná, estado Falcón, Venezuela. *Multiciencias*, 6: 202–209.

Negreiros-Fransozo ML 1996. The zoea I of *Charybdis hellerii* (A. Milne-Eswards, 1867) (Decapoda, Portunidae) obtained in laboratory. *Nauplius*, 4: 165–168.

Negri M, Schubart CD and Mantelatto FL 2018. Tracing the introduction history of the invasive swimming crab *Charybdis hellerii* (A. Milne-Edwards, 1867) in the Western Atlantic: evidences of high genetic diversity and multiple introductions. *Biological Invasions*, 20: 1771–1798. http://doi.org/10.1007/s10530-018-1660-0

Rosa LC 2014. New records of portunid crabs (Decapoda: Brachyura: Portunidae) from Sergipe, NE Brazil. *Check List*, 10: 445–447. http://doi.org/10.15560/10.2.445

Rosa LC, Silva-Junior WL and Santos RB 2022. Quais fatores influenciam a captura de crustáceos braquiúros? Um experimento de campo no Estuário de Rio Sergipe. *Boletim do Laboratório de Hidrobiologia*, 32(1): 37–45. http://doi.org/10.18764/1981-6421e2022.3

Sant'Anna BS, Branco JO, de Oliveira MM, Boos H and Turra A 2015. Diet and population biology of the invasive crab *Charybdis hellerii* in southwestern Atlantic waters. *Marine Biology Research*, 11: 814–823. http://doi.org/10.1080/17451000.2015.1024134

Sant'Anna BS, Watanabe TT, Turra A and Zara FJ 2012. Relative abundance and population biology of the non-indigenous crab *Charybdis hellerii* (Crustacea: Brachyura: Portunidae) in a southwestern Atlantic estuary-bay complex. *Aquatic Invasions*, 7: 347–356. http://doi.org/10.3391/ai.2012.7.3.006

Searles AR, Gipson EE and Cook GS 2019. Notes on the discovery of an invasive marine decapod, *Charybdis hellerii*, in Mosquito Lagoon, Florida. *Florida Scientist*, 82: 40–46.

Tavares M 2011. Alien decapod crustaceans in the southwestern Atlantic Ocean. p. 251–268. In: BS Galil; PF Clark and JT Carlton (eds), In the Wrong Place - Alien Marine Crustaceans: Distribution, Biology and Impacts. Springer Netherlands, Dordrecht. http://doi.org/10.1007/978-94-007-0591-3_7

Tavares MD and Mendonça-Jr JB 1996. *Charybdis hellerii* (A. Milne Edwards, 1867) (Brachyura: Portunidae), eight nonindigenous marine decapods recorded from Brazil. *Crustacean Research*, 25: 151–157.

Tavares MD and Mendonça-Jr JB 2011. The occurrence of the Indo-Pacific swimming crab *Scylla serrata* (Forskal, 1775) in the Southwestern Atlantic (Crustacea: Brachyura: Portunidae). *Aquatic Invasions*, 6: 49–51. http://doi.org/10.3391/ai.2011.6.S1.011

Watanabe TT; Zara FJ; Hattori GY; Turra A and Sant'Anna BS 2015. Biological associations of color variation in the Indo-Pacific swimming crab *Charybdis hellerii*. *Anais da Academia Brasileira de Ciências*, 87: 219–232. http://doi.org/10.1590/0001-3765201520130388

Williams AB 1974. The swimming crabs of the genus *Callinectes* (Decapoda: Portunidae). *Fishery Bulletin*, 72: 685–798.

Zar JH 2009. *Biostatistical analysis*. Prentice-Hall, New Jersey.

ADDITIONAL INFORMATION AND DECLARATIONS

Competing interests

The author(s) declare(s) no competing interest.

Data availability

All study data are included in the article.

Funding and grant disclosures

There were no external funding sources for this study.