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Aquatic Invasions Records

First record of the non-indigenous portunid crab *Charybdis variegata* from the western Atlantic coast

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Abstract

Biological invasions are a present and growing environmental problem because non-indigenous organisms may affect the structure and functioning of native communities. In the marine environment there are records of invasive species in almost all phyla, including crustaceans, and the portunid crabs of the genus *Charybdis* are among the most widespread invasive groups. We report the first record of *Charybdis variegata* (Fabricius, 1798) from the western Atlantic coast. This species was collected on an intertidal rocky shore near Santos Harbor, São Paulo state, Brazil. Of 311 portunid crabs sampled, 309 individuals belonged to the non-indigenous *Charybdis hellerii* (A. Milne Edwards, 1867), one was a native *Cronius ruber* (Lamarck, 1818), and one was identified as the non-indigenous *Charybdis variegata*. This individual was a juvenile female measuring 27.5 mm in carapace width. The taxonomic traits used for species identification, as well as a morphological comparison between *C. hellerii* and *C. variegata* are presented. The introduction route and establishment status of this species are also discussed.

Key words: alien species, *Charybdis*, Atlantic waters, Crustacea

Introduction

Biological invasions are commonly a consequence of human activities related to globalization and/or accidental introductions. Non-indigenous species may alter the structure and functioning of ecosystems and may also threaten native biological diversity (Vitousek et al. 1997). Many crustacean species from the Pacific Ocean such as the grapsids *Hemigrapsus sanguineus* (de Haan, 1853) and *Eriocheir sinensis* (H. Milne Edwards, 1854), the xanthid *Pilumnoides perlatus* (Poepig, 1836), the majoid *Pyromaia tuberculata* (Lockinghton, 1877) (Melo 1996; Tavares and Mendonça 1996; Ferreira et al. 2009; Junqueira et al. 2009) and the portunids *Scylla serrata* (Forskål, 1775) and *Charybdis hellerii* (A. Milne Edwards, 1867) were introduced to the western Atlantic coast (Nepszy and Leach 1973; McDermott 1991; Lemaitre 1995; Melo et al. 2000; Tavares 2011).

In the family Portunidae, at least two species originating from the Indo-Pacific have successfully spread through the world: *Scylla serrata* (Eldredge and Smith 2001; Tavares 2011; Tavares and Mendonça 2011) and *Charybdis hellerii* (Galil 2000; Junqueira et al. 2009). This latter species is one of the most frequently recorded invasive species around the world. On the Atlantic coast of the Americas, this species was first recorded in Cuba in 1987 (Gómez and Martínez-Iglesias 1990). In the following years there were northern and southern range extensions of *C. hellerii* on eastern American coasts (Campos and Türkay 1989; Lemaitre 1995), including the Brazilian coast (Calado 1996; Carqueija and Gouvêa 1996; Negreiros-Fransozo 1996; Tavares and Mendonça 1996; Mantelatto and Dias 1999; Ferreira et al. 2001; Lima Junior et al. 2008).

Charybdis hellerii has biological traits that are helpful during invasion of new areas, such as

Figure 1. Location of the study area, Ponta da Praia Beach (white arrow) at the entrance of Santos Harbor, São Paulo State (black arrow), Brazil.

a high number of larval stages (Dineen et al. 2001), storage of sperm, and multiple spawning (unpublished data, B.S. Sant'Anna 2010), and an omnivorous and generalist diet (Dineen et al. 2001; personal communication, D. N. Oliveira, Unesp, São Vicente, São Paulo, Brazil). If these traits are present in the entire genus *Charybdis*, any new occurrence of one of its members around the world deserves attention because it suggests the possibility of a new invasion. At present, only *C. hellerii* is recorded as an invasive species of this genus on western Atlantic coasts (Tavares 2011); however, we now report the first occurrence of *Charybdis variegata* (Fabricius, 1798) in this region.

Materials and methods

In July of 2011, the rocky shores of Ponta da Praia (23°59′28.9″S; 46°18′17.0″W), located in Santos Bay, São Paulo State, Brazil (Figure 1) were visited during low tide on four days, to sample portunid crabs. During two hours per day, two people collected the crabs manually among the rocks, totaling 8 hours of capture effort. All crabs were carefully packed in plastic bags and taken to the laboratory for identification. The native crabs were identified according to Melo (1996). Non-native crabs of the genus *Charybdis* were identified by characteristics described by Wee and Ng (1995) and Padate et al. (2010). The single specimen of the non-native crab *C. variegata* found was measured for carapace width (including and excluding spines) with digital calipers (0.1 mm).

Results

Animal samples

A total of 311 portunid crabs were collected; 309 were individuals of the non-indigenous crab *C. hellerii* with carapace width ranging from 17.70 to 70.75 mm (without spines), one was the native crab *Cronius ruber* (Lamarck, 1818) with carapace width of 30.8 mm without spines, and one was a new, non-indigenous portunid crab. The specimen was a juvenile female of *Charybdis variegata,* with a carapace width of 24.0 mm (without spines) and 27.5 mm (with spines) (Figure 2 A).

Taxonomic traits

The genus and subgenus of the non-indigenous specimen were determined by the following specific characters (from Wee and Ng 1995): 1) extent of the frontal-orbital border distinctly less than greatest breadth of carapace; antero-lateral border of carapace oblique and arched, cut into six or seven teeth, Genus *Charybdis* (Figure 1, A); 2) posterior border of carapace forming a curve with postero-lateral border; merus of cheliped with distal spine on posterior border (Figure 1A); and 3) "antero-lateral border divided into six teeth of which at least five are large", Sub-genus *Charybdis* (Figure 1, A-I and 2, B-I).

The identification of *Charybdis (Charybdis) variegata* was based on Padate et al. (2010), considering: 1) transverse ridges on carapace posterior to the last antero-lateral tooth present

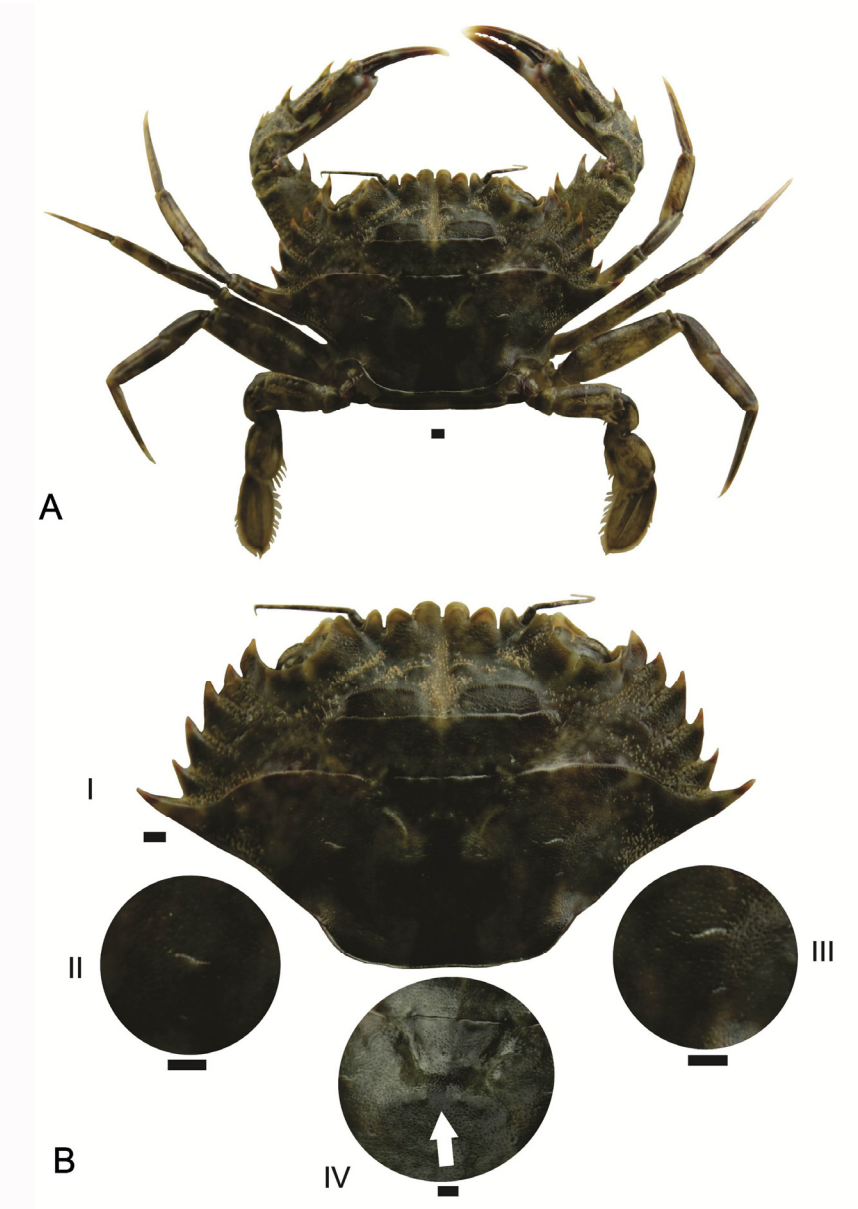

Figure 2. (**A**) Dorsal view of the juvenile female of *Charybdis variegata* collected in Santos Bay, São Paulo, Brazil. (**B**) Detail of taxonomic traits used for *C. variegata* identification: I, Dorsal view of carapace; II and III, pairs of ridges on both right and left mesobranchial area of carapace; and IV, interruption of the ridges in the cardiac area on the carapace (white arrow). Scale bar 1 mm. Photographs by Timóteo Tadashi Watanabe.

(Figure 2B I); 2) for small-sized specimens, mesobranchial region of carapace with two pairs of transverse ridges (Figure 2B II-III); 3) transverse ridge on cardiac region not interrupted (Figure 2B IV); 4) second antero-lateral tooth as large as the first tooth (Figure 2B I), not attached to the posterior margin of the latter (Figure 2B I); 5) sixth antero-lateral tooth largest, spiniform and laterally projected (Figure 2BI); and 6) all frontal teeth acuminate at tip.

The juvenile female collected provided several taxonomic traits typical of *C. variegata* (as described by Leene 1937): 1) the second antero-lateral tooth is only slightly smaller than the first tooth; 2) the last antero-lateral spine is much longer than the fifth tooth, especially in the female; 3) the inner lobule of the outer part of the lower orbital border is sharply dentiform; and 4) whereas the hands of the chelipeds are unequal in size and shape in the male, in the female they are nearly the same, as is shown in Figure 2.

Finally, to facilitate distinguishing between *Charybdis variegata* and *C. hellerii*, even by

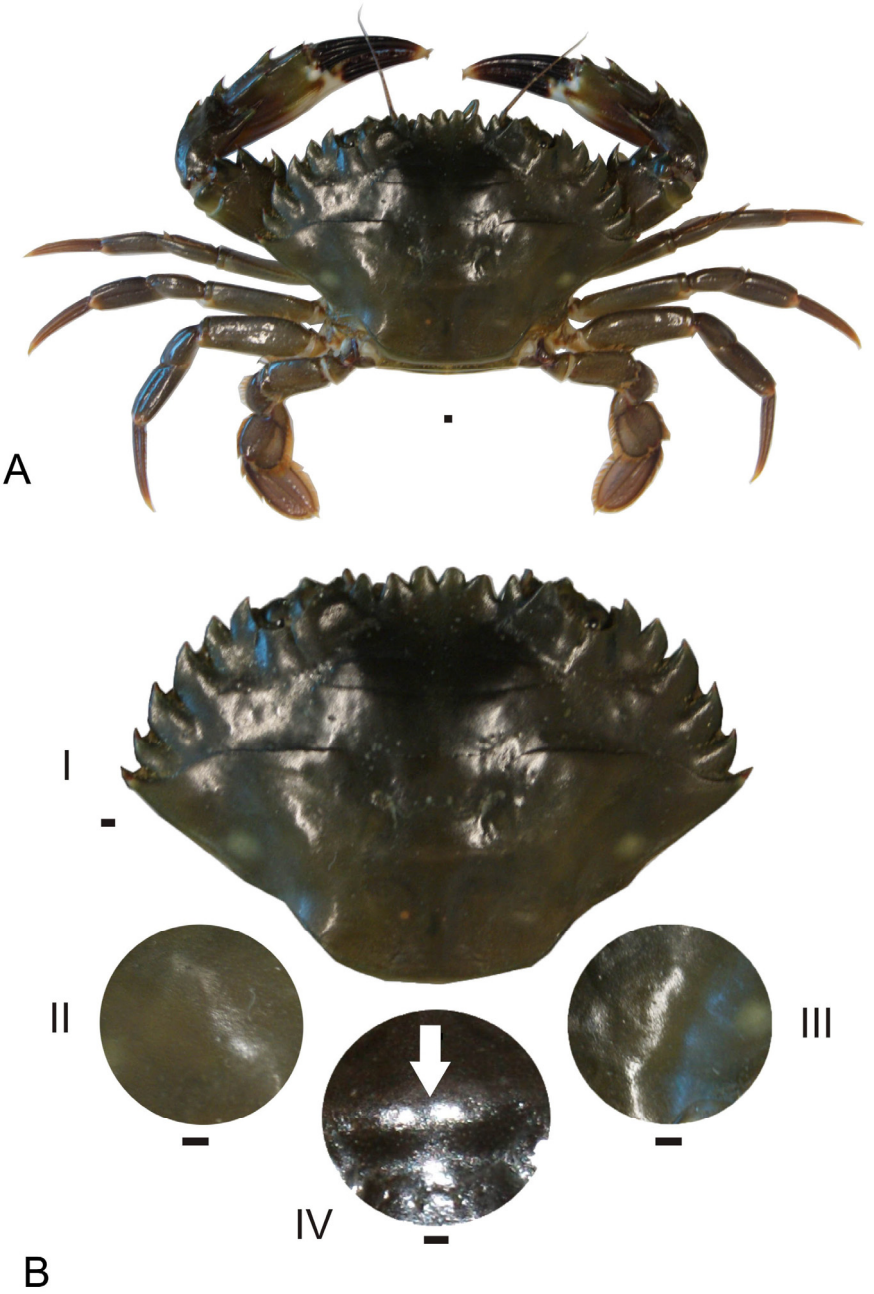

Figure 3. (**A**) Dorsal view of a juvenile female of *Charybdis hellerii* collected in Santos Bay, São Paulo, Brazil. (**B**) Detail of taxonomic traits used to separate *C. hellerii* from *C. variegata*: I, Dorsal view of carapace; II and III, absence of paired ridges on both right and left sides of mesobranchial area of carapace; and IV Continuous ridges of cardiac area on carapace (with arrow). Scale bar 1 mm. Photographs by Timóteo Tadashi Watanabe.

non-specialists, at least three taxonomic traits should be checked on the dorsal carapace (Figures 2 and 3), as follows: 1) absence of the pair of transverse ridges that are present on both sides of the mesobranchial region of the carapace in *C. hellerii* (Figure 3B II and III); 2) interruption of the transverse ridge on the cardiac zone (Figure 2B IV) in *C. variegata*; and 3) the sixth antero-lateral tooth in *C. variegata* is larger, spiniform and directed more laterally in relation to the corresponding tooth in *C. hellerii*. This specimen was deposited in the Crustacean Collection of the Museum of Zoology, University of São Paulo (MZUSP#24446).

Discussion

The species *Charybdis variegata* was first described as *Portunus variegatus* by Fabricius in 1798, and transferred to *Charybdis variegatus* by

De Hann in 1850. The taxonomic status of *Charybdis variegata* was updated in 1935 by Chopra (Leene 1937). The biology of *C. variegata* is poorly studied. Chandran (1968) showed that *C. variegata* has a biannual breeding cycle based on the hepatosomatic and gonadosomatic indices, which are directly influenced by environmental factors.

The specimen collected in Brazilian waters differs from the key to the genus *Charybdis* of Padate et al. (2010) in one characteristic. In the description of Padate et al. (2010), all frontal teeth are acuminate at the tip, but in the juvenile female caught in Santos Bay, the two median and two sub-median frontal teeth were blunt. However, this specimen conforms to the description provided by Leene (1937). This author compared the type species of *Portunus variegatus* Fabricius, 1798 from the Copenhagen Museum with specimens of *Charybdis variegatus* in the Leiden Museum (three males and one female) collected in Amoy (China), and found several differences, among them the less acute frontal teeth.

Charybdis variegata is a portunid crab originally from the Indo-Pacific Ocean, and was recorded in India (Chandran 1968), Malaysia and Singapore (Wee and Ng 1995), China (Chou et al. 1999), Japan (Yamochi and Oda 2002), and Australia (Stephenson et al. 1957), among other countries. The invasive potential of *C. variegata* was first reported by Williams et al. (1988). These authors analyzed the species composition of the ballast tanks of cargo vessels (water and sediment) between Japan and Australia, and found two specimens of *C. variegata,* among other invertebrate species, in the sediment. In the present study, only one individual of *C. variegata* was found among 311 portunid crabs collected in the vicinity of the largest Latin American port, the Port of Santos. The amount of sampling effort and the record of only one individual of *C. variegata* suggests that the introduction of this species may be recent and probably occurred in ballast water, as suggested for *C. hellerii* in the mid-1990s in Brazil (Calado 1996; Carqueja and Gouvea 1996; Mantelatto and Garcia 2001; Junqueira et al. 2009; Ferreira et al. 2009).

After more than 20 years of introduction, dispersal and establishment of *C. hellerii* in Atlantic waters (Gómez and Martínez-Iglesias 1990; Lemaitre 1995; Tavares 2011), little is known about its biology and environmental impacts. The present record of another portunid crab of the genus *Charybdis* confirms the prediction by Ferreira et al. (2009), that "(we) do not disregard the possibility of new occurrences as prospective alien species". This new find provides evidence that biological invasions are still occurring in the study area, and that more attention from the Brazilian maritime authorities is advisable. Brazil is engaged in the Global Ballast Water Management Program (GloBallast), and needs to increase the routine of inspection and control of ballast water, as highlighted by Ferreira et al. (2009).

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