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Short Communication

Occurrence of ovigerous females of *Callinectes bocourti* A. Milne-Edwards, 1879 (Decapoda: Portunidae) on the Amazon Continental Shelf

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ABSTRACT

The family Portunidae comprises a diverse group of crabs, with 336 described species. Although they are easily collected and widely distributed in coastal regions, the life history of *Callinectes bocourti* remains poorly understood. This species is abundant in Amazon estuaries; however, ovigerous females have never been found throughout the various studies carried out in the region, which compromises the understanding of its reproductive cycle. We investigated the presence of *C. bocourti* ovigerous females in the Amazon Continental Shelf (ACS), Brazil, to confirm the migration of these females to areas outside the oligohaline estuary where the population is abundant. The specimens were captured as bycatch during industrial shrimp fishing on the Brazilian North Coast between February and March 2016. Twelve individuals of *C. bocourti* were found: three males, five adult females, and three ovigerous females, which is the first record of their occurrence on the ACS. This information can help manage this resource, as the species is exploited for commercial and subsistence means in estuarine fishing communities in the Amazon coastal zone.

KEYWORDS

Ecology, Migration, Portunidae, Reproduction, Swimming crab

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The swimming crabs (family Portunidae) comprise a group of 336 species distributed worldwide, of which 21 occur on the Brazilian coast (Poore and Ahyong, 2023). Among the 40 genera of portunid crabs (De Grave, 2009), the 14 species of genus *Callinectes* Stimpson, 1860 (Norse, 1977; Melo, 1996) are commonly found in coastal areas of tropical and subtropical regions (Willians, 1974; Carmona-Suárez and Conde, 2002; Das Nevis et al., 2009). An example is *Callinectes bocourti* A. Milne-Edwards, 1879, a species that occurs throughout the Western Atlantic from Florida (USA) to Rio Grande do Sul (Brazil) (Santos et al., 2000).

The swimming crab *C. bocourti* tolerates low salinity (brackish water) and is found in estuaries, river mouths, and polluted waters (Melo, 1996). In the northern coastal zone of Brazil, this species is abundant and economically important for the local human population, especially in the oligohaline estuary of Ilha de Mosqueiro (Pará, Brazil) where the species is commercialized (D.T.H., personal observation). Swimming crabs have been extensively studied around the world because of their abundance, ease of collection, and ecological and economic importance, especially species with the highest commercial value. Although there are many publications on the Portunidae (Mantelatto and Fransozo, 1997; 1999; Mantelatto, 2000; Pinheiro and Fransozo, 2002; Doi et al., 2008; Watanabe et al., 2014; Kobayashi and Vazquez-Archdale, 2018), *C. bocourti*, on the other hand, lacks information when compared to congeners, especially reproductive data such as reproductive period, fecundity, and the occurrence of ovigerous females.

In general, young female specimens of estuarine *Callinectes* grow and develop in the interior of the estuaries and migrate to saline waters for gonadal maturation and spawning, where the environment is more suitable for larval development, returning to brackish waters as juveniles to complete the cycle (Barreto et al., 2006; Fernandes et al., 2006; Severino-Rodrigues et al., 2009; 2012; Lima et al., 2022). The larval cycle description for *C. bocourti* is incomplete (Lima and Martinelli-Lemos, 2019), given that only the zoea I phase has been described (Lopes et al., 2000; Mantelatto et al., 2014).

To this date, there are no records of ovigerous females from the Brazilian North Coast, and no other work mentions the occurrence of ovigerous females or the larval stages of this species in a natural environment. The occurrence of ovigerous females is an important indicator of the reproductive season of the species and constitutes one of the bases for establishing its management. This study aims to investigate the presence of ovigerous females of *C. bocourti* in the Amazon Continental Shelf (ACS) to confirm the migration pattern of ovigerous females to the sea, since only juveniles and adults (except ovigerous females) occur at high density in oligohaline waters of the Amazon coastal region.

The *C. bocourti* specimens were collected as bycatch fauna of the brown shrimp *Penaeus subtilis* Pérez Farfante, 1967 fishery, as part of the project "Biodiversity and its implications in the Brazilian Blue Amazon", idealized by the Grupo de Pesquisa em Ecologia de Crustáceos da Amazônia [Amazon Crustacean Ecology Research Group] (GPECA-NEAP/UFPA) in partnership with the Centro Nacional de Pesquisa e Conservação da Biodiversidade Marinha do Norte [Research and Conservation National Center of Northern Marine Biodiversity (CEPNOR/ICMBio). Fishing was carried out in the ACS (between 0.85º and 1.01ºN latitudes and 47.74º and 47.97ºW longitudes) (Fig. 1), which covers two Brazilian states (Amapá and Pará) and presents a turbulent and physically challenging marine system due to a combination of geophysical factors with the outflow of the Pará, Tocantins-Araguaia, and Amazonas rivers (Silva et al., 2005).

The fishery took place bimonthly between June 2015 and May 2017 (rainy season) using medium-sized industrial fleet vessels with two double-rig bottom trawls measuring 1.8 m × 22 m, with an opening of 8 m. The mesh size decreases with increasing distance from the net opening (proximal portion with 13 mm mesh size decreasing to 5 mm in the cod-end). Abiotic data were recorded in situ with a refractometer for salinity and a mercury thermometer for temperature. Bycatch specimens were collected by an on-board sampler and frozen until laboratory processing. The swimming crabs were measured with a vernier caliper to determine the carapace width (CW) and length (CL) to the nearest 0.01 cm; and weighed to obtain

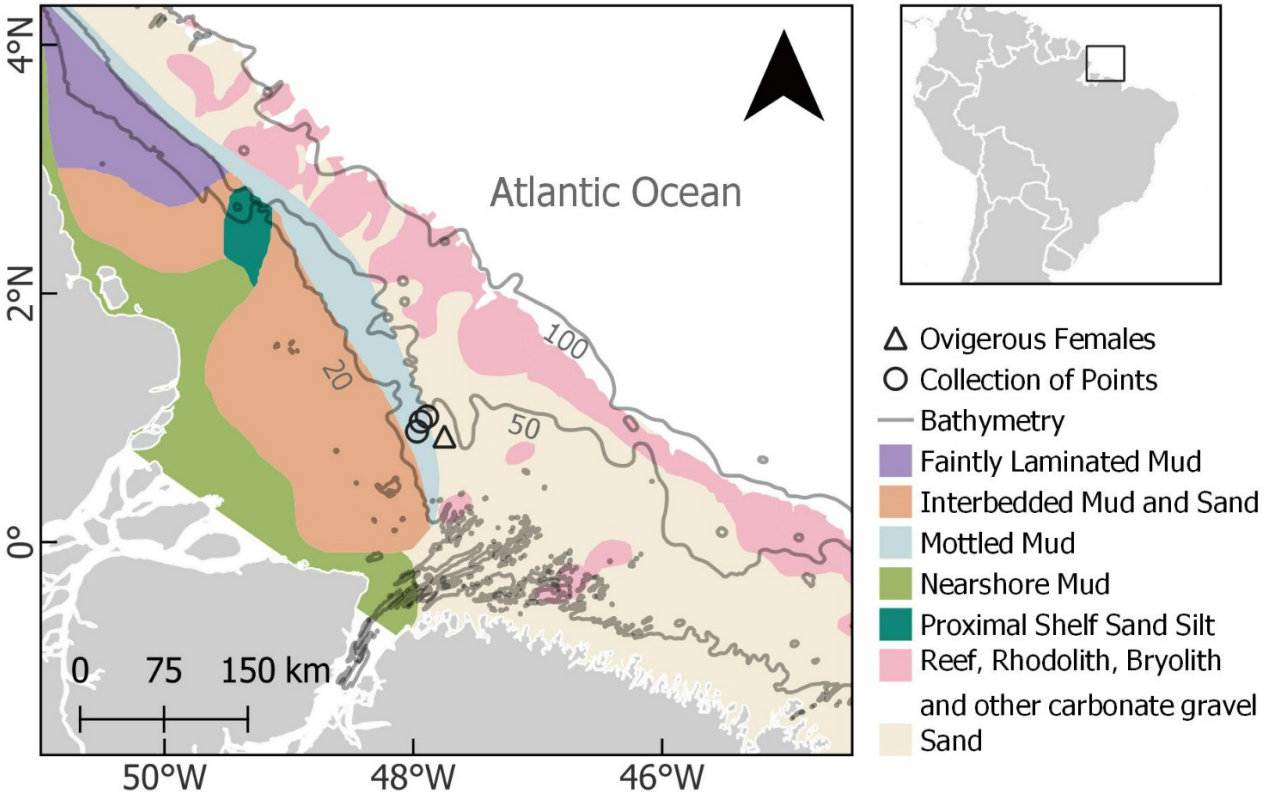

Figure 1. Occurrence map of ovigerous females of *Callinectes bocourti* collected at the Amazon Continental Shelf between February and March 2016 (Shapefile: Araújo et al., 2021)

the total body mass with (TW) and without egg mass (EGLW) in grams. The egg masses of each female were fixed in Bouin's solution and then diluted in 200 mL of alcohol (70%) for later analysis.

The eggs were placed in an oven at 60 °C until dried, and three subsamples of each dried egg mass was weighed on a precision scale and counted on a grid Petri dish under a Zeiss optical stereomicroscope (Discovery V.12 Zeiss®). For each sample, a comparison of the egg number in the subsample with the total sample weight was used to estimate fecundity.

A total of 12 individuals of *C. bocourti* (three males, five females, and four ovigerous females) were captured in February and March 2016. The ovigerous females were collected in muddy substrate (Fig. 1) at a depth of 40 m, and with stable values of temperature (mean 28.9 ± 0.15 °C) and salinity (28 ± 1.64) for the collection period. Ovigerous females had similar measurements and weights (Tab. 1), and the mean number of eggs per female was 571,100 (± 53,669). Only one female did not have estimated fecundity because it was in the final stage of egg development and had few eggs attached to the pleopods.

We concluded that the presence of ovigerous females in marine fishing spots only indicates their displacement to oceanic areas where larval hatching probably occurs. The presence of ovigerous *C. bocourti* has already been mentioned in the Brazilian subtropical estuary (Iguape Estuarine-Lagoon Complex, Ilha Comprida and Cananéia, São Paulo), where hundreds (973) of ovigerous females from four different *Callinectes* species (*Callinectes danae* Smith, 1869 - 936; *Callinectes sapidus* Rathbun, 1896 - 24; *Callinectes ornatus* Ordway, 1863 - 9; and *C. bocourti* - 4) were collected only in high salinity (euryhaline) areas (mean salinity 31) (Severino-Rodrigues et al., 2009). In contrast, this hypothesis becomes more evident in studies on *C. bocourti* carried out inside different Brazilian estuaries that present a significant abundance of individuals, but no record of ovigerous

Table 1. Morphometric data (CL: Carapace Length; CW: Carapace Width; TW: Total Weight; EGLW: EggLess Weight; EW: Egg Weight) and fecundity (number of eggs) of three ovigerous females of *Callinectes bocourti* captured as bycatch in the brown shrimp fishery on the Amazon Continental Shelf between February and March 2016.

Ovigerous females	1	2	3	Mean values (± SD)
Fecundity	600,500	617,000	495,800	571,100 (±53,669)
CL (mm)	107	104	120	110.3 (±6.9)
CW (mm)	51	50	57	52.67 (±3.1)
TW (g)	87.49	90.25	109.87	95.87 (±9.9)
EGLW (g)	66.02	65.26	87.99	73 (±10.5)
EW(g)	21.47	24.99	21.88	22.78 (±1.5)

females, such as the subtropical estuaries of Iguape (86 females) (Severino-Rodrigues et al., 2009), Santos and São Vicente - São Paulo State (426 specimens, 13 females) (Scalco et al., 2014); and the tropical estuaries in Curuçá (168 individuals, 94 males, 67 females, and 7 juveniles) (Das Nevis et al., 2009); Bragança, Salinópolis, and Vigia (742 specimens, 419 males and 323 females) (Oliveira, 2017), and Guajará Bay (133 specimens) (Cavalcante et al., 2012). These are all in Pará State, but with no record of any ovigerous females.

Two distinct migration phases can be described for *Callinectes* species: in phase 1, females start moving from mating sites inside estuaries to the lower estuary, while, in phase 2, late-stage ovigerous females migrate seaward by swimming near the surface, mostly at night, to use local currents in an Ebb-Tide Transport (ETT) (Tankersley et al., 1998). Migration to euryhaline areas for spawning has been observed for *C. sapidus* in the United States (Tankersley et al., 1998; Carr et al., 2004; 2005; Aguilar et al., 2005; Carr et al., 2005), Italy (Cilenti et al., 2015), and Brazil (Severino-Rodrigues et al., 2013) and for *C. danae* in Brazil (Costa and Negreiros-Fransozo, 1998; Sant'Anna et al., 2012; Severino-Rodrigues et al., 2012).

The seaward migration of females for spawning results in a significant difference in the sex ratio of swimming crab species depending on the environment: mid and upper estuaries usually present a higher number of males while euryhaline regions are dominated by females (Branco and Lunardon-Branco, 1993; Severino-Rodrigues et al., 2009), which can explain a higher number of females (nine of the twelve collected individuals) in this study. In more estuarine areas, male predominance is higher (4.6 M:1 F for *C. danae* and 12.8 M:1 F for *C. sapidus*) than the female prevalence in more oceanic waters (3.6 F:1 M for *C. danae* and 2 F:1 M for *C. sapidus*) (Severino-Rodrigues et al., 2009).

Fecundity is an important indicator of the reproductive potential of a species (Gonçalves and Reigada, 2012) and refers to the number of eggs produced by a female during the spawning season (Rodrigues et al., 2011). Like other *Callinectes* species females, a high number of eggs was observed (571,100 ± 53,669) for *C. bocourti*. For *C. danae*, fecundity can vary from 25,127 eggs (Shangri-lá, Paraná State) to 826,638 (Ubatuba, São Paulo State) (Costa and Negreiros-Fransozo, 1998; Baptista-Metri et al., 2005; Gonçalves and Reigada, 2012). For *C. ornatus* collected in Ubatuba (São Paulo State, subtropical region) fecundity ranged from 94,634 to 171,570 eggs, for females of the same length (Mantelatto and Fransozo, 1997). In contrast, *C. sapidus* has a higher fecundity, estimated between 152,799 and 2,573,576 (Rodrigues et al., 2011).

This study shows that, despite being low, the presence of ovigerous females of *C. bocourti* in the Amazon Continental Shelf indicates a reproductive behavior similar to that of its congeners, in which the migration to saline waters allows the success of larval development. Further studies are still needed to understand which abiotic factors interfere with larval development and physiology of females that migrate to high salinity sites. The improvement and application of mechanisms to monitor the brown shrimp trawling bycatch in the northern coast of Brazil in recommended, as the region is a habitat for many species, especially crustaceans, acting as an important breeding site.

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ADDITIONAL INFORMATION AND DECLARATIONS

Author Contributions

Conceptualization and Design: JMML. Performed research: ACSB and PSVN. Acquisition of data: ACSB, PSVN, and DTH. Analysis and interpretation of data: ACSB, DTH, JMML. Preparation of figures/tables/maps: DTH. Writing - original draft: ACSB and JMML. Writing - critical review & editing: DTH, JMML.

Consent for publication

All authors declare that they have reviewed the content of the manuscript and have provided their consent to submit the document.

Competing interests

The authors declare no competing interests.

Data availability

All study data are included in the article and/or supplementary material.

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All experiments conducted in this study complied with the current Brazilian federal legislation.