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INVASION NOTE

The non-indigenous medusa *Blackfordia virginica* (Hydrozoa, Leptothecata) in tropical Brazil: 50 years of unnoticed presence

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Abstract *Blackfordia virginica*, a hydromedusa native to the Black Sea, has become established in a number of estuarine areas worldwide. In estuaries of northeastern Brazil, only a single published report, from the early 1960s, exists of the species and its establishment here has remained doubtful. On discovering specimens collected in the region at various times between 1987 and 2000, however, we hypothesized that this hydromedusa has long inhabited estuaries in the area while going unnoticed. The objective of this study was to investigate its occurrence in brackish waters of tropical northeastern Brazil over the past 50 years. In a search for specimens we found 1,759 individuals from estuaries of the Santa Cruz Channel (Itamaracá) and Capibaribe and Jiquiá rivers that had been collected between 1987 and 2000. In addition, an analysis of grey literature (Ph.D. theses) suggests that the species has been present in the Santa Cruz Channel for at least five decades. Results thus support the hypothesis that this non-indigenous species has been established in the region for several decades at least, and that it constitutes an exotic component of the community.

Keywords Cnidaria · Hydromedusa · Bioinvasion · Southwestern Atlantic Ocean

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Introduction

Discovery of invasive marine species in coastal and estuarine waters is by now a widespread phenomenon (Wonham and Carlton 2005). Amongst hydromedusae, some species are well-known for their their ability to colonize new habitats around the world. One of these, the leptomedusa *Blackfordia virginica* Mayer 1910, has been reported in estuarine ecosystems of both hemispheres (Chícharo et al. 2009).

Blackfordia virginica was originally described as the medusa stage from estuarine environments in Virginia (Hampton Roads and Norfolk Harbor) on the east coast of the USA by Mayer (1910). The species is now believed to be native to the Black Sea, and its

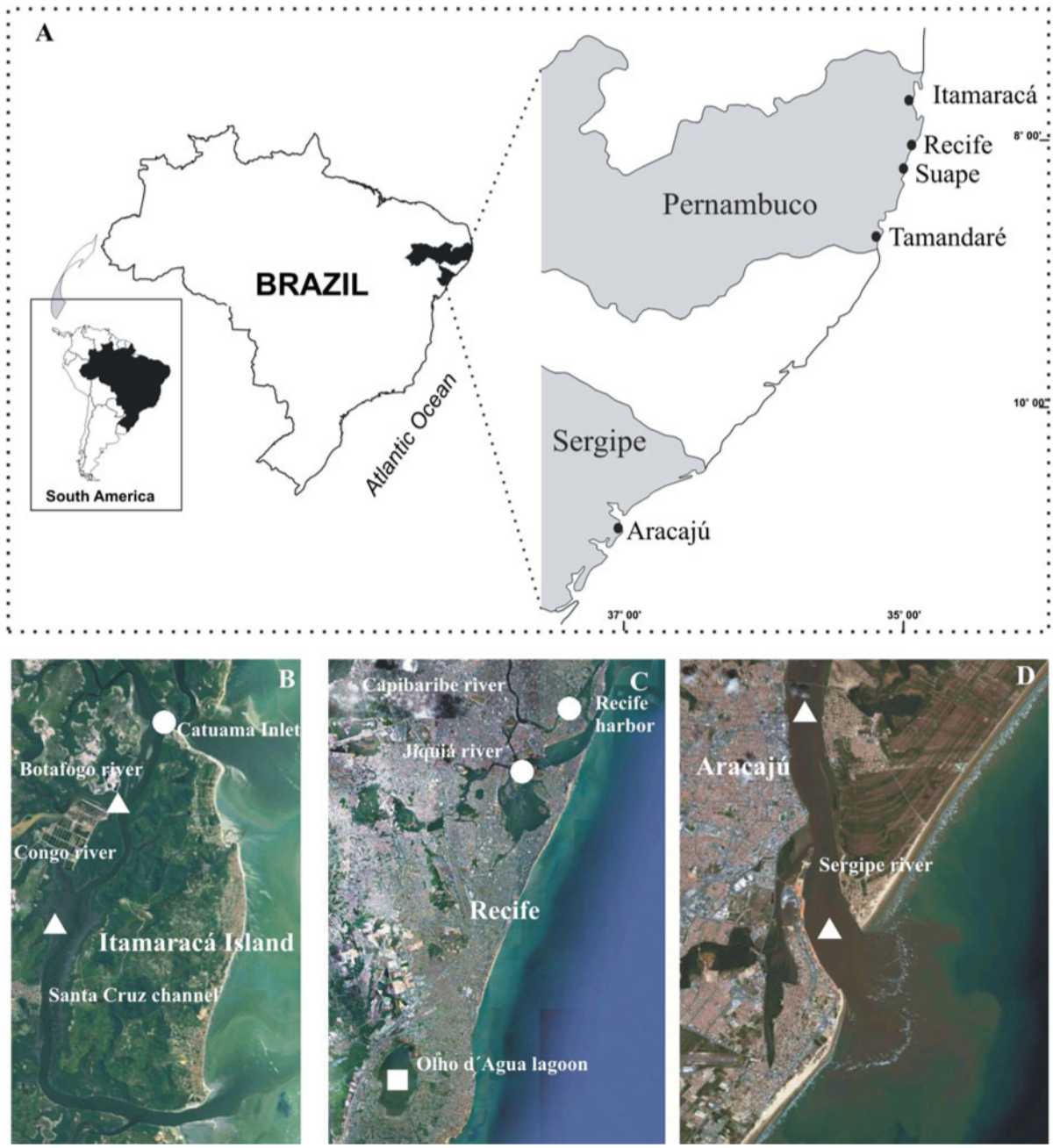

Fig. 1 **a** Sites of samples in the different tropical Brazilian states (PE: Pernambuco; SE: Sergipe); **b–d** sites where *Blackfordia virginica* medusae were found. *Circle* this study; *square* Paranaguá 1963; *triangle* grey literature. Modified from satellite images from Google Earth

widespread dispersal has likely been due to shipping (Thiel 1935; Mills and Sommer 1995; Grigorovich et al. 2003). It has subsequently been recorded from lagoons connected to the sea, and from estuarine systems, on both Pacific and Atlantic coasts of the USA and Mexico, from the southwestern Atlantic Ocean, and from the east coast of South Africa, as well as from Portugal, France, the Baltic Sea, the Caspian Sea, India, and China (Buecher et al. 2005; Bardi and Marques 2009, and references therein, Mills and Rees

2000). Such a widespread distribution of an estuarine species highlights its invasive character.

The medusa stage of *B. virginica* was first reported in the southwestern Atlantic Ocean by Paranaguá (1963) from a mixohaline area in northeastern Brazil (Lagoa Olho dÁgua, Recife, Pernambuco state; 08°12′S–34°56′W; Paranaguá 1963). Almost four decades later, this hydromedusa was reported from the south coast of Brazil coast in the Antonina Bay (Paraná State), Cananéia Channel (São Paulo State), Babitonga Bay (Santa Catarina State) (between 25°21 and 26°22′S and 48°38–48°26′W; Nogueira and Oliveira 2006; Bardi and Marques 2009; Nogueira 2012), and in the estuarine area of the La Plata River, Argentina (36°15′S–56°30′W; Genzano et al. 2006).

The record of *B. virginica* in northeastern Brazil (Paranaguá 1963), considered unique for the region (Bardi and Marques 2009 and references therein), is based on only three specimens. However, the species was observed in plankton surveys conducted by the Department of Oceanography, Universidade Federal de Pernambuco, in the 1970s (Neumann-Leitão, personal observation). Later, nearly 1,500 specimens were collected in the same area during February 2000. Thus, it seemed possible that this non-native hydromedusa has long dwelt in estuarine areas of Pernambuco but has remained unnoticed or not properly disclosed. To test this hypothesis, the present study was undertaken to document presence of *B. virginica* in different estuaries of northeastern Brazil over the past 50 years.

Results and discussion

A total of 412 plankton samples, collected in estuaries of Pernambuco state (northeast Brazil) between 1980 and 2000 by the Department of Oceanography, Universidade Federal de Pernambuco—DOCEAN—UFPE, were examined. *B. virginica* was discovered in 11 samples (2.7 % of the total) (Fig. 1a; Table 1). From 1987 to 2000, 1,749 medusae of *B. virginica* were found in Catuama Inlet (Santa Cruz Channel, Itamaracá Island), Jiquiá River, and Capibaribe River (Recife Harbor Basin) (Fig. 1b, c; Table 2). The latter samples represent the first record of the species in this estuarine region. All specimens have characters that corroborate previous descriptions of the species (see Bardi and Marques 2009).

Technical reports and theses (master's and doctoral) on plankton communities of estuaries in northeastern Brazil were reviewed to check for records of this hydromedusa in grey literature not readily accessible through primary bibliographic sources. The species was reported between 1975 and 1977 in the estuary of Santa Cruz Channel (Congo River and Botafogo River), as well as in another estuarine area in the Sergipe River to the south (Fig. 1b, d; Table 3).

Blackfordia virginica is a euryhaline species that has been widely reported in estuarine areas of temperate and tropical regions with salinity levels ranging from 2 to 35 (Moore 1987). In our samples, this hydromedusa was found in salinities from 2.2 to 36 and temperature from 26.8 to 29.5 °C (Table 2). Its

Table 1 Sites and number of samples (N) studied in Pernambuco estuaries (northeast Brazil)

Site	Coordinates	Date	N	Presence of *B. virginica*
Catuama inlet	7°41′S–34°50′W	Monthly between January and December, 1980	40	–
		Monthly between March and December, 1981	41	–
		March, April and May, 1996	8	+
		April and May, 1998	3	+
		February, 2000	1	+
Jiquiá river	8° 01′S–34° 48′W	Monthly between November, 1985 and December, 1986	27	–
		Monthly between May 1989 and May, 1991	35	+
Capibaribe river	8° 05′S–34° 51′W	Seasonally between 1987 and 1991	93	+
		July 1991	7	–
Ipojuca river	8° 25′S–34° 55′W	Spring, 1987 and summer 1988	81	–
Formoso river	8° 39′S–35° 09′W	Monthly between July 1989 and July, 1990	76	–

Table 2 Sites where the medusae *Blackfordia virginica* were sampled in Pernambuco estuaries (northeast Brazil)

Site and date	n	Percentage of mature specimens (sexes)	Range umbrella diameter (Average), cm	T (°C)	S Min–max
Catuama inlet					
April 09, 1996	84	90.04 % (♂♀)	1–11 (6.48)	27.5	21.0–36.0
May 03, 1996	130	81.74 % (♂♀)	2–11 (5.03)	26.8	17.0–26.9
May 08,1996	21	57.14 % (♂♀)	4–10 (8.0)	26.8	17.2–27.0
April 04, 1998	12	All juveniles	5–11 (8.75)	27.6	17.4–35.8
February, 2000	1,500	55 % (♂♀)	5–11 (8.90)	28.0	20.5–36.0
Jiquiá river					
September 29,1989	2	50 % (♂)	3.5–8 (6.0)	27.5	10.5–26.5
October 26, 1989	5	40 % (♂♀)	2–6 (3.8)	28.3	12.0–28.0
September 14,1990	1	100 % (♂)	6	28.0	11.0–27.0
Capibaribe river					
September 08,1987	1	100 % (♂)	7 (7.0)	28.4	9.2–27.5
May 03, 1988	1	Juvenile	2	29.5	3.5–31.0
May 16, 1988	2	100 % (♂)	1–2 (1.5)	29.1	2.2–26.0
Total	1,759				

Table 3 Sites in northeastern Brazil where the medusa *Blackfordia virginica* was mentioned in grey literature

Site	Latitude–Longitude	Sample data and observation	Temperature	Salinity	Unpublished data
Congo river and Botafogo river, Santa Cruz channel, Pernambuco state	07°45′S–34°53′W	Numerous specimens were collected in July–August, 1977; June, July, 1976 and May to August, 1977. Same specimens sampled in two silver mullet fish farms	25–29.5 °C	7.56–20	Macedo 1978 (Doctoral Thesis, DOCEAN-UFPE)
Botafogo river, Santa Cruz channel, Pernambuco state	07°43′S–34°52′W	Numerous specimens were collected in August, 1975	26.9 °C	11.1	Nascimento 1980 (Master Dissertation, DOCEAN-UFPE)
Sergipe river, Aracajú, Sergipe state	Between 10°45′ to 10°57′S and 37°01′ to 37°09′W	336 specimens collected between September, 1977 and June, 1978	26.1–29.9 °C	8.6–18	Pereira 1980 (Master Dissertation, DOCEAN-UFPE)

broad salinity tolerances have facilitated its successful invasion of estuaries worldwide.

This hydromedusa has been introduced in several coastal ecosystems worldwide by shipping, probably in ballast water (Cohen 1998). Early detection of introduced species is only possible when proper baseline information is available, such as data and collections from long-term monitoring programs. Unfortunately, long-term monitoring of oceanic waters is rare (Genzano et al. 2006) and most invasions may pass unnoticed for a long time. According to our results, this medusa has inhabited estuarine areas of northeastern Brazil (Santa Cruz Channel) for at least five decades, and its population seems well-established. Collection of both males and females of different sizes, as well as very small juveniles (a large amount in some samples) suggests local reproduction, corroborating successful establishment (Table 2).

Our results suggest that this non-indigenous hydromedusa is well-established in certain estuaries of tropical northeast Brazil, forming an exotic component of the community. There is no information on the impact of *B. virginica* on the local community, but in the Guadiana estuary of SE Portugal–SW Spain it has reduced densities of all zooplanktonic organisms including eggs of anchovy (Chícharo et al. 2009). In our study, we found large concentrations of medusae in nurseries for mullets (*Mugil curema* and *Mugil liza*) at the Fish Culture Base of Itamaraca-PE; abundances were so great that inflow of water to these nurseries was impeded by the gelatinous masses (Macedo 1978). These data together with new records of *B. virginica* in others estuarine areas such as Recife Harbor Basin, Santa Cruz Channel, and the Botafogo and Sergipe rivers (Fig. 1b–d; Tables 2, 3), point to the need for additional monitoring programs in northeastern estuarine complexes.

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