Marine Biodiversity Records, page 1 of 8.
doi:10.1017/S1755267210000874; Vol. 3; e94; 2010 Published online

More common than reported: range extension, size–frequency and sex-ratio of *Uca (Minuca) victoriana* (Crustacea: Ocypodidae) in tropical mangroves, Brazil

DANIELA DA SILVA CASTIGLIONI[1], ALEXANDRE OLIVEIRA ALMEIDA[2] AND LUIS ERNESTO ARRUDA BEZERRA[3]

[1]Universidade Federal de Pernambuco, Centro Acadêmico de Vitória, Núcleo de Biologia, Rua Alto do Reservatório, s/n, Bairro Bela Vista, CEP 55608-680, Vitória de Santo Antão, Pernambuco, Brazil, [2]Universidade Estadual de Santa Cruz, Departamento de Ciências Biológicas, Rodovia Ilhéus-Itabuna, km 16, CEP 45662-900 Ilhéus, Bahia, Brazil, [3]Universidade Federal de Pernambuco, Departamento de Oceanografia, Programa de Pós-Graduação em Oceanografia, Avenida Arquitetura, s/n, Cidade Universitária, 50670-901, Recife, Pernambuco, Brazil

The fiddler crab Uca (Minuca) victoriana *von Hagen, 1987 has been reported, until recently, only from the type locality at Vitória, State of Espírito Santo, Brazil. We report here, for the first time, the occurrence of* U. (M.) victoriana *in estuaries of the States of Bahia and Pernambuco, north-eastern Brazil, extending its distribution; as well as some aspects of its population biology. For the population study, four sites were defined in mangroves of the Mamucabas and Ariquindá Rivers, Pernambuco, on different types of substrate, and sampled monthly during spring low tide from April 2008 through to March 2009. A total of 41 specimens were obtained in June 2008 in the Arinquindá River, of which 25 were males, 16 non-ovigerous females and 1 ovigerous female. In the Mamucabas River, 772 crabs were collected over the year, including 472 males, 300 non-ovigerous females and 2 ovigerous females. In both areas, the* U. (M.) victoriana *population showed a unimodal size–frequency distribution, with males and females (ovigerous and non-ovigerous) similar in size (7.46 ± 1.60 mm for males and 7.09 ± 1.45 mm for females; $t = -0.744$; $P > 0.05$). The overall sex-ratio (1:1.57) differed significantly from the expected 1:1 proportion1 ($\chi 2 = 38.32$; $P < 0.05$). Study of material deposited in Brazilian carcinological collections revealed several misidentified specimens, especially as* U. (M.) rapax *and* U. (M.) burgersi. *Some morphological characters to distinguish among these species are presented.*

Keywords: *Uca (Minuca) victoriana*, population biology, sex-ratio, first record, north-eastern Brazil, morphological characters

Submitted 10 May 2010; accepted 8 August 2010

INTRODUCTION

Fiddler crabs of the genus *Uca* Leach, 1814 are a diversified group, inhabiting intertidal areas of estuaries and mangrove forests of the Old and New Worlds (Crane, 1975). They are an important component of mangrove ecosystems and in transferring energy to both marine and terrestrial habitats, being consumed by a wide variety of fish, birds and invertebrates (Skov & Hartnoll, 2001; Skov *et al.*, 2002; Litulo, 2004); and promote turnover of nutrients because of their burrowing habits (Aveline, 1980). The evident sexual dimorphism in the chelipeds is one of the most remarkable characteristics of these crabs (Crane, 1975).

Nowadays, the genus *Uca* comprises 94 species (Beilinch & von Hagen, 2006), of which 10 are known from the Brazilian coast: *U. (Leptuca) cumulanta* Crane, 1943, *U. (L.) leptodactyla* Rathbun, 1898, *U. (L.) uruguayensis* Nobili, 1901, *Uca (Minuca) burgersi* Holthuis, 1967, *U. (M.) mordax* (Smith, 1870), *U. (M.) rapax* (Smith, 1870), *U. (M.) thayeri* Rathbun, 1900, *U. (M.) victoriana* von Hagen, 1987, *U. (M.) vocator* (Herbst, 1804) and *U. (Uca) maracoani* (Latreille, 1802) (Melo, 1996; Ng *et al.*, 2008).

Uca (M.) victoriana was until recently known only from the type locality at Vitória, State of Espírito Santo (von Hagen, 1987). Bedê *et al.* (2007) reported it from farther south in the State of Rio de Janeiro.

Several recent studies have treated *Uca* populations in Brazilian mangroves, including size–frequency distribution, sex-ratio, reproductive season, and density, etc. (Frith & Brunenmeister, 1980; Colpo & Negreiros-Fransozo, 2004; Costa & Negreiros-Fransozo, 2003; Castiglioni & Negreiros-Fransozo, 2005; Koch *et al.*, 2005; Bezerra *et al.*, 2006; Bezerra & Mathews-Cascon, 2006, 2007; Castiglioni *et al.*, 2006; Benetti *et al.*, 2007; Bedê *et al.*, 2008; Hirose & Negreiros-Fransozo, 2008; Costa & Soares-Gomes, 2009). The only study on population biology of *U. (M.) victoriana* was carried out by Bedê *et al.* (2008) in a tropical mangrove in the State of Rio de Janeiro. The scarcity of population studies on *U. (M.) victoriana* is due partly to difficulties in identifying this species.

Corresponding author:
L.E.A. Bezerra
Email: luiseab@gmail.com

Here we report, for the first time, *U. (M.) victoriana* in estuaries of north-eastern Brazil, extending its geographical range; and provide morphological characters to help distinguish it from similar species. We also investigated aspects of its population biology including the size–frequency distribution, body size, and sex-ratio.

MATERIALS AND METHODS

Taxonomy

We based our taxonomic study on the type series deposited in the Zoologisches Museum der Universität Hamburg, Hamburg, Germany, and additional material in Brazilian repositories: the Museu de Zoologia of the Universidade de São Paulo, São Paulo (MZUSP); Museu de Zoologia of the Universidade Estadual de Santa Cruz, Ilhéus (MZUESC); and Centro Acadêmico de Vitória, Universidade Federal de Pernambuco, Vitória de Santo Antão Campus, State of Pernambuco (CAV-UFPE). We made the drawings with the help of a stereomicroscope fitted with a drawing tube.

Site description

In Pernambuco, we collected specimens of *U. (M.) victoriana* in mud sediments in areas with *Lagungularia racemosa* and *Avicennia* sp. In the Arinquindá River, we found it together with the congeners *U.* (*M.*) *burgersi, U. (M.) thayeri* and *U. (L.) cumulanta*; and in the Mamucabas River, with *U.* (*M.*) *burgersi, U. (M.) thayeri*, *U. (L.) cumulanta* and *U. (L.) leptodactyla*, in salinities from 2 to 30 practical salinity units (psu).

In southern Bahia, in the Almada River basin, we collected *U.* (*M.*) *victoriana* at both tidal and non-tidal stations. One of the stations was in freshwater, on a sandy substratum, with *Armases rubripes* (Rathbun, 1897), *Cardisoma guanhumi* Latreille, 1825, *Ucides cordatus* (Linnaeus, 1763) and *U.* (*M.*) *mordax*, known to establish larger populations in low-salinity areas (Melo, 1996). In the Jucuruçu River, we collected it in the transition zone between mangrove and restinga forest, with *U. (L.) leptodactyla*, *A. rubripes*, *A. angustipes* (Dana, 1852) and *Sesarma rectum* Randall, 1840, on mud and sand sediments covered by shrub vegetation. At Barra do Cahy we collected it on a sand–mud sediment covered by shrub vegetation (probably family Poaceae), adjacent to the mouth of the Cahy River, with *U.* (*M.*) *rapax*, *U.* (*M.*) *thayeri*, *Goniopsis cruentata* (Latreille, 1803), *A. angustipes* and *S. rectum*. In the Patipe River, we found specimens on mud near the river bank. In Bahia, we collected it in salinities of 7 (Jucuruçu River), 9 (Patipe River), 15 (Barra do Cahy) and 25 psu (Itanhém River).

Population biology

Over one year, four sites with different types of substrate were sampled monthly from April 2008 through to March 2009 in mangroves of the Ariquindá River (8°46′43.69″S and 35°06′25.87″W) and the Mamucabas River (8°41′28.48″S and 35°06′09.32″W), both in the municipality of Tamandaré, Pernambuco. At each location, one person captured crabs during 30 minutes, at low spring tide. All crabs obtained were bagged, labelled and preserved in 70% ethanol until further analysis. Because we collected only a few individuals of *U. (M.) victoriana* at Ariquindá, the size–frequency distribution, body size of males and females, and sex-ratio were analysed only for the population from the Mamucabas River mangrove.

In the laboratory, specimens were identified, sexed, and checked for the presence of eggs on female pleopods. The carapace width (CW) was measured using a digital caliper ($\pm$0.01 mm). We recorded the number of crabs from each mangrove.

The population size structure was analysed from the size–frequency distribution of all individuals collected. Specimens were grouped in 0.5 mm size-class intervals from 4.0 to 12.0 mm CW. The number of classes was obtained by Sturges's formula (Conde *et al.*, 1986): $K = 1 + 3.22\log N$, where K = class number and N = number of crabs.

The mean size of males and females (ovigerous and non-ovigerous) was compared using Student's *t*-test ($\alpha = 0.05$). The overall size–frequency distribution was tested for normality using the Shapiro–Wilk test ($\alpha = 0.05$) (Zar, 1996).

The sex-ratio was analysed for each month and size-class. A Chi-square (χ^2) test for goodness of fit was used to evaluate whether the sex-ratio in each month, each size-class, and for the entire year differed significantly from 1:1 ($\alpha = 0.05$) (Zar, 1996).

Abbreviations used: f = female (s); m = male (s); ovf = ovigerous female; CW = carapace width.

RESULTS

TAXONOMY
Superfamily OCYPODOIDEA Rafinesque, 1815
Family OCYPODIDAE Rafinesque, 1815
Subfamily UCINAE Dana, 1851
Uca (Minuca) victoriana von Hagen, 1987
Figures 1–3

Uca victoriana von Hagen, 1987: p. 81, pl. 1–4; Coelho, 1995: p. 140; Melo, 1996: p. 495, figure 1; Melo, 1998: p. 505; Bedê *et al.*, 2007: p. 799, figure 1; Bedê *et al.*, 2008: p. 602; *Uca rapax*—Almeida *et al.*, 2006: p. 16 (in part); *Uca mordax*—Almeida *et al.*, 2006: p. 16 (in part); *Uca (Minuca) victoriana*—Beinlich & von Hagen, 2006: p. 27; Ng *et al.*, 2008: p. 241.

Type-series

Brazil: Espírito Santo, Vitória. Holotype (ZMH-K 28887, 1 m); allotype (ZMH-K 28887, 1 f); paratype (ZMH-K

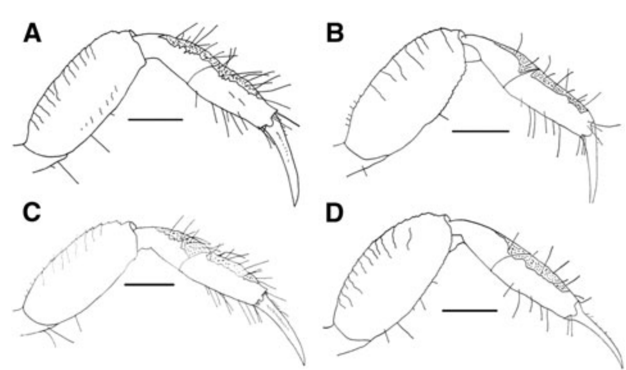


Fig. 1. Second and third pereiopods of *Uca (Minuca) burgersi* Holthuis (A, C) and *Uca (Minuca) victoriana* von Hagen (B, D). (A, B) Female second pereiopod; (C, D) female third pereiopod. (A, C) São Paulo, Ubatuba, MZUSP 14515; (B, D) Espírito Santo, Vitória, MZUSP 18571. Scale bars = 0.2 mm.

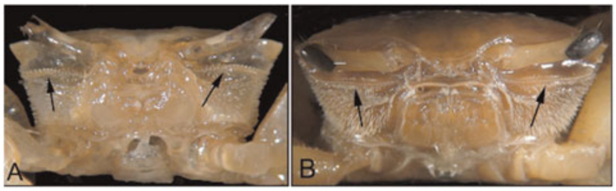


Fig. 2. Suborbital margin (arrows) of *U. (Minuca) victoriana* von Hagen (A) and *U. (Minuca) rapax* Smith (B). (A) Holotype, CW = 11.0 mm, ZMH-K 28887; (B) male, CW = 18.3 mm, United States, Florida, Brevard County, USNM 170173.

28887, 5 m, 9 f). Zoologisches Museum, Universität Hamburg, Hamburg.

Other material

597 males, 334 females (4 ovigerous). Brazil: State of Pernambuco—Tamandaré, Ariquindá River (CAV-UFPE 100, 25 m, 16 f, 1 ovf); Tamandaré, Mamucabas River (CAV-UFPE 101, 472 m, 298 f, 2 ovf); State of Bahia—Ilhéus, Parque Municipal Boa Esperança (MZUESC 124, 3 m, 2 f); Ilhéus, Acuípe River (MZUESC 1198, 2 m); Ilhéus, Almada River (MZUESC 1199, 2 m, 2 f; MZUESC 391, 2 m, 2 f; MZUESC 255, 4 m, 4 f); Prado, Barra do Cahy (MZUESC 1200, 4 m, 3 f); Prado, Jucuruçu River (MZUESC 1201, 2 m, 3 f); Alcobaça, Itanhém River (MZUESC 1037, 2 m); Mucuri (MZUSP 18641, 4 m). State of Espírito Santo—Serra, Lagoa do Baú (MZUSP 18640, 6 m); Vitória (MZUSP 18642, 2 m; MZUSP 16292, 16 m); Anchieta, Benevente River (MZUSP 18571, 49 m, 4 f, 1 ovf; MZUSP 18568, 2 m).

Distribution

Western Atlantic—Brazil: States of Pernambuco, Bahia, Espírito Santo and Rio de Janeiro (Figure 4).

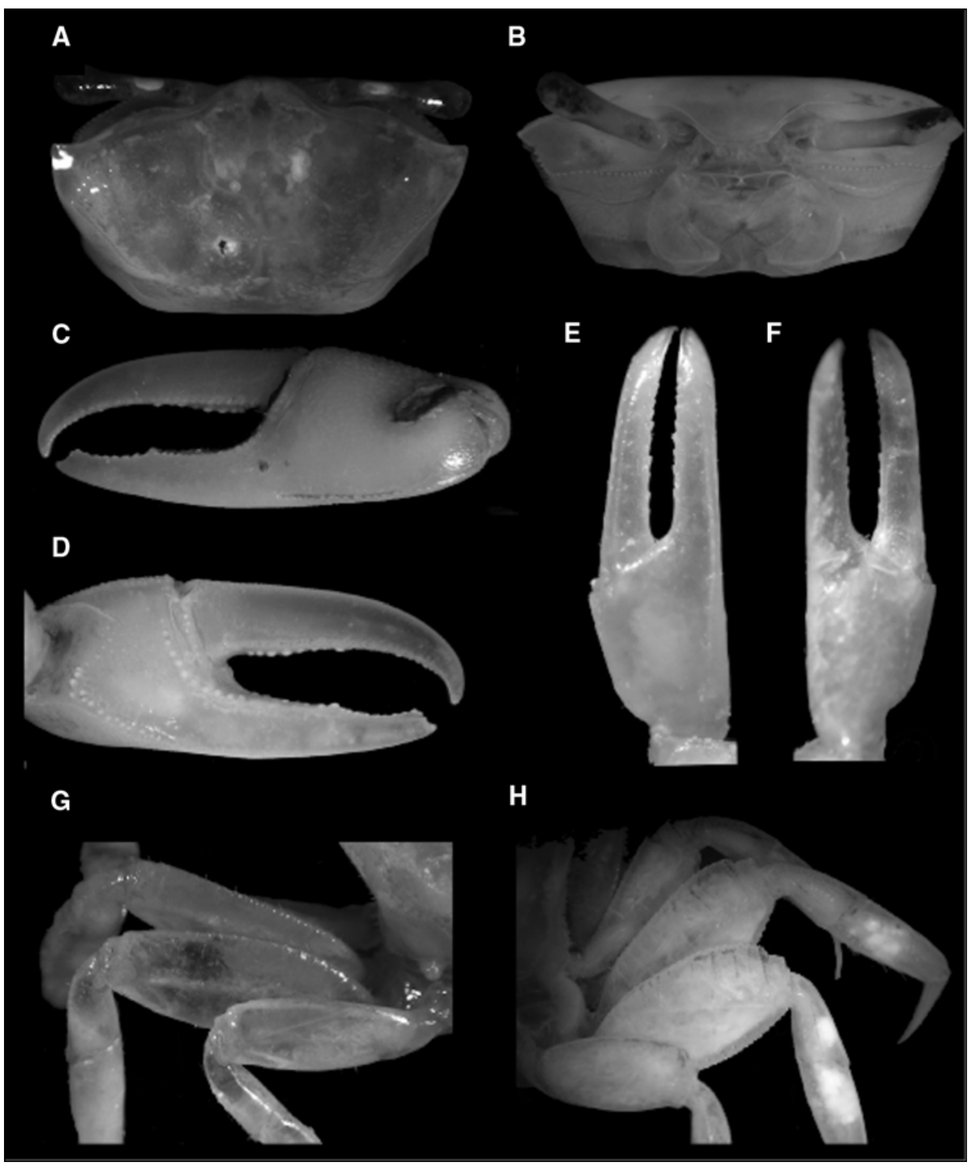


Fig. 3. *Uca (Minuca) victoriana* von Hagen. (A) Dorsal margin of carapace; (B) frontal view; (C) outer major manus; (D) inner surface of major palm; (E) outer minor manus; (F) inner surface of minor palm; (G) ambulatory legs of males; (H) ambulatory legs of females. (A–G) Holotype, ZMH-K 28887; CW = 11 mm; H, paratype, ZMH-K 28887; CW = 10 mm.

Fig. 4. Known range of *Uca (Minuca) victoriana* von Hagen.

DIAGNOSIS

Male: front wider; orbits oblique; carapace strongly arched, but not semi-cylindrical; no pile or granulations on dorsal margin of carapace; antero-lateral margins short, straight, better defined on major side where they merge moderately sharply with dorso-lateral margins; on minor side, antero-lateral margins merge gently with dorso-lateral margins; eyebrow broad, lower margin slightly beaded; suborbital crenelations well defined and well separated throughout, enlarging toward outer orbital margins; setae in rows above and below crenelations sparse, almost absent; upper postero-lateral stria long. Fingers of minor cheliped long, with tiny serrations on inner margin, hairs on tip sparse. Antero-dorsal margins of major merus straight, oblique, arched on distal end which has small serrations. Upper margin of outer major manus covered by moderate granulation, decreasing in size toward ventral margin, a shorter straight depression filled with pile near ventral margin, near base of pollex; oblique tuberculate ridge on palm high at apex, smaller toward distal end; pollex as long as manus, with an enlarged tooth halfway to its tip; dactyl longer than manus, oblique, tip strongly curved downwards, below pollex tip; gap narrow, pile present. Merus of ambulatories moderately broad; pile present on dorsal margins of carpus and manus of first 3 ambulatories; no setae on ambulatories. Abdominal segments not fused.

Female: dorsal margin of carapace with minute granulations near antero-lateral margins, which merge roundly into dorso-lateral margins (as on the minor side in males); orbits slightly oblique, almost straight. Merus of ambulatories enlarged, both dorsal and ventral margins armed with few serrations; pile on dorsal margin of carpus and manus; setae absent on all ambulatories. Gonopore slightly raised without tubercles.

REMARKS

Uca (M.) victoriana is morphologically very similar to *U. (M.) rapax* and *U. (M.) burgersi*, resulting in confusion among these species. By comparing the type series and the additional material collected in Pernambuco and Bahia, we found some morphological differences among these fiddlers that we believe to be useful in avoiding misidentification of preserved specimens.

Uca (M.) victoriana can be distinguished from *U. (M.) burgersi* by the more slender ambulatory merus (Figure 1) and by the semicircular divergence of the proximal tuberculate predactylar ridge on the major palm. *Uca (M.) victoriana* is more difficult to distinguish from *U. (M.) rapax*, but can be segregated by the suborbital crenellations, which are sinuous in *U. (M.) victoriana* and straight in *U. (M.) rapax* (Figure 2). Males of *U. (M.) victoriana* are readily distinguished from all other Brazilian species by the presence of pubescence on the outer major manus, near the base of the pollex.

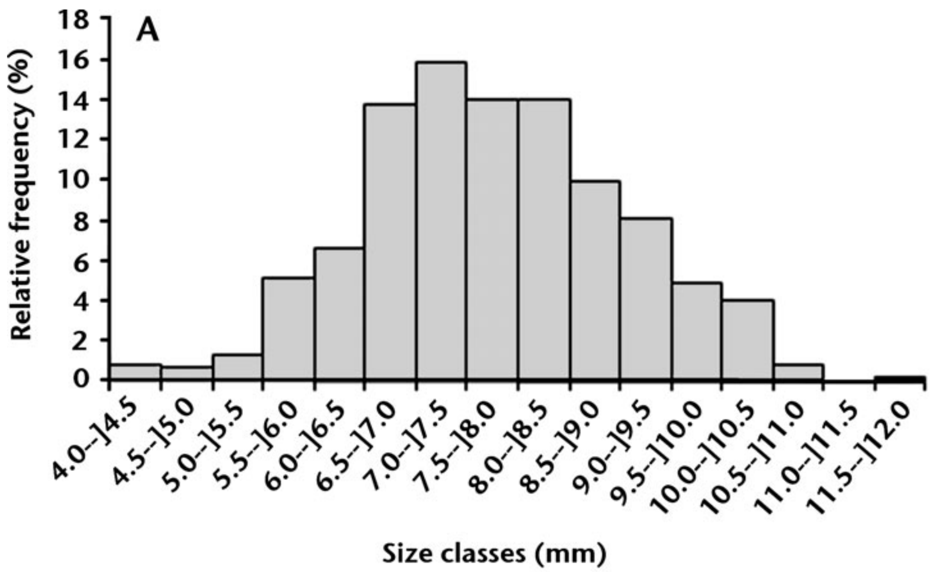
POPULATION BIOLOGY

A total of 814 crabs were collected during the study period: 41 in the Arinquindá River, of which 25 were males, 16 non-ovigerous females, and 1 ovigerous female, all in June 2008; and 772 in the Mamucabas River, including 472 males, 298 non-ovigerous females, and 2 ovigerous females. The number of males and females (ovigerous and non-ovigerous) collected in the Mamucabas River is given in Table 1. Males ranged from 4.12 to 11.54 mm CW (mean $\pm$ SD: 7.46 $\pm$ 1.60 mm), and females (ovigerous and non-ovigerous) from 4.44 to 11.15 mm CW (mean $\pm$ SD: 7.09 $\pm$ 1.45 mm), not differing significantly in size ($t = -0.7445$; $P > 0.05$).

Figure 5 shows the yearly size–frequency distribution for males and for non-ovigerous and ovigerous females. Both sexes showed unimodal distributions, with a normal distribution for both males ($W = 0.98283$, $P < 0.05$) and females ($W = 0.98509$; $P < 0.05$). Males and non-ovigerous and

Table 1. Number of specimens of *Uca (Minuca) victoriana* von Hagen collected at Mamucabas River mangrove, State of Pernambuco, north-eastern Brazil from April 2008 to March 2009.

	Male	Female
April 2008	9	18
May 2008	23	16
June 2008	22	9
July 2008	87	39
August 2008	41	17
September 2008	25	29
October 2008	24	16
November 2008	21	19
December 2008	57	45
January 2009	51	28
February 2009	52	23
March 2009	60	41
Total	472	300



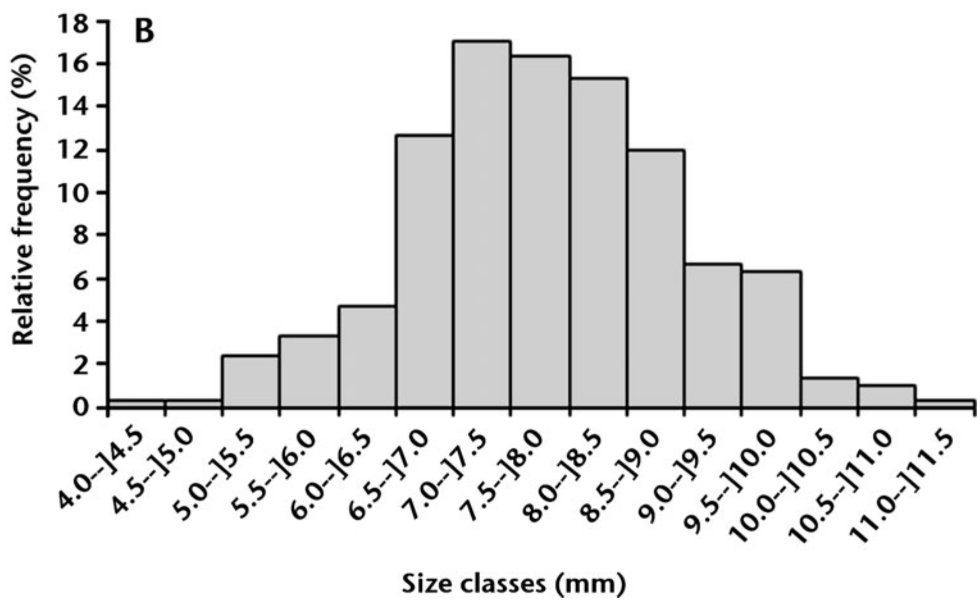


Fig. 5. Size–frequency distribution of *Uca (Minuca) victoriana* von Hagen collected from the Mamucabas River mangrove, State of Pernambuco, north-eastern Brazil, from April 2008 through to March 2009. (A) Males; (B) females (ovigerous and non-ovigerous).

ovigerous females were all most abundant in the medium size-classes (7.0–7.5 mm).

The overall sex-ratio was 1:1.57 (males:females) and differed significantly from the expected 1:1 proportion ($\chi^2 = 38.32$; $P < 0.05$); males were slightly more abundant than females. The monthly sex-ratio did not differ from the Mendelian proportion ($P < 0.05$), except in June, July, and August 2008, and January and February 2009, when males were more abundant (Figure 6). Males were more frequent than females in the larger size-classes (10.0–10.5 mm, $\chi^2 = 9.78$; 10.5–11.0 mm, $\chi^2 = 4.57$; 11.0–11.5 mm, $\chi^2 = 4.50$ and 11.5–12.0 mm, $\chi^2 = 4.00$; $P < 0.05$).

DISCUSSION

The finding of *U. (M.) victoriana* in Pernambuco and Bahia considerably extends its geographical range on the Brazilian coast. Bedê *et al.* (2007) recently reported it from the State of Rio de Janeiro, extending its southern distribution. According to these authors, the small size of *U. (M.) victoriana* has contributed to limiting the number of records in Brazil, because of difficulties in collecting and identifying. We believe that the similar morphology with *U. (M.) burgersi* and *U. (M.) rapax*, as reflected in the large number of misidentified specimens found in Brazilian collections, was the main factor in the scarcity of records of *U. (M.) victoriana*. This species may occur along the coast of Central America and the Caribbean, and could be present (but misidentified) in other carcinological collections.

In the present study, we found specimens of *U. (M.) victoriana* mainly on muddy sediments, with its congeners *U. (L.) cumulanta*, *U. (L.) leptodactyla*, *U.* (*M.*) *burgersi*, and *U.* (*M.*) *thayeri*, and other crab species including *Armases rubripes*, *Cardisoma guanhumi* and *Ucides cordatus*. Von Hagen (1987) and Bedê *et al.* (2007) also found *U. (M.)*

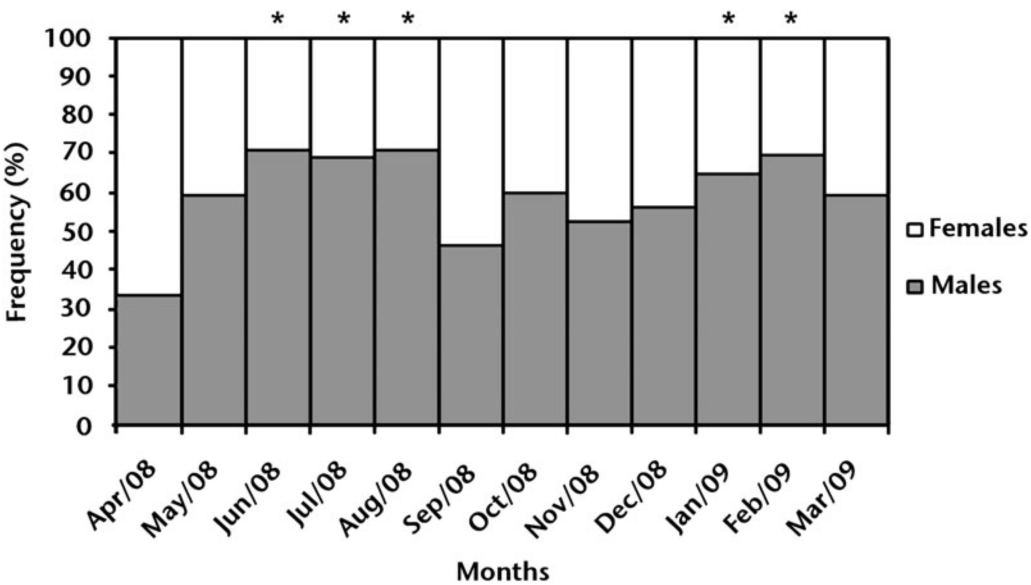


Fig. 6. Sex-ratio of *Uca (Minuca) victoriana* von Hagen collected from the Mamucabas River mangrove, State of Pernambuco, north-eastern Brazil, from April 2008 through to March 2009. *, significant difference between number of males and females (ovigerous and non-ovigerous) (χ^2; $P < 0.05$).

victoriana in muddy sediments, with *U. (L.) leptodactyla*, *U.* (*M.*) *burgersi* and *U.* (*M.*) *thayeri*; and with *U. (L.) cumulanta* and *U.* (*M.*) *thayeri*, respectively.

The size–frequency distribution of *U. (M.) victoriana* in the Mamucabas River mangrove was consistently unimodal, indicating a stable population with continuous recruitment and a constant mortality rate through different life phases (Díaz & Conde, 1989). This is a common pattern in tropical fiddler crab populations (Litulo, 2005a, b; Bezerra & Matthews-Cascon, 2006; Castiglioni *et al.*, 2006). Bedê *et al.* (2008) also reported a unimodal population for *U. (M.) victoriana* in a tropical mangrove in Rio de Janeiro. Temperate and subtropical *Uca* populations generally have a bimodal size–frequency distribution (Spivak *et al.*, 1991; Mounton & Felder, 1995; Yamaguchi, 2001). However, Bezerra & Matthews-Cascon (2007) found a bimodal size–frequency distribution with a seasonal breeding season in a tropical population of *U. (M.) thayeri* in the Pacoti River, State of Ceará, north-eastern Brazil. Bimodality or polymodality may result from slow growth during the immature or mature stages, recruitment pulses, migration, mortality, or differential behaviour (Díaz & Conde, 1989).

The difference between male and female carapace widths was not large in this population, the females being slightly smaller than males. In several *Uca* populations, males are larger than females (Colpo & Negreiros-Fransozo, 2004; Castiglioni & Negreiros-Fransozo, 2005; Castiglioni *et al.*, 2006; Bedê *et al.*, 2008; Hirose & Negreiros-Fransozo, 2008). This may occur because females concentrate their energy budget on gonad development (Díaz & Conde, 1989; Johnson, 2003; Hartnoll, 2006), whereas males reach a larger size because larger males have better chances of obtaining females for copulation, and win more intra-specific fights (Christy & Salmon, 1984). Bedê *et al.* (2008) found a population of *U. (M.) victoriana* in Rio de Janeiro with females larger than males, but did not discuss the possible causes.

The mean carapace width found by Bedê *et al.* (2008) for males and females was smaller than that in the population examined here. According to Campbell & Eagles (1983), environmental factors such as photoperiod, rainy season and food availability could be responsible for phenotypic differences among *Uca* populations. Differences in the mean body size of males and females between different populations in tropical mangroves were also observed by Colpo & Negreiros-Fransozo (2004) in *U. (M.) vocator*, by Castiglioni & Negreiros-Fransozo (2005) in *U. (M.) rapax* and by Benetti *et al.* (2007) in *U. (M.) burgersi*. These authors attributed the size differences to different levels of food resources, especially the substrate organic matter content.

The overall sex-ratio in the present population was skewed toward males. Fiddler crab populations commonly deviate significantly from the 1:1 proportion (Genoni, 1985), and several *Uca* populations with similarly biased sex-ratios have been recorded (Spivak *et al.*, 1991; Castiglioni & Negreiros-Fransozo, 2005; Litulo, 2005a, b; Masunari & Dissenha, 2005; Hirose & Negreiros-Fransozo, 2008; Costa & Soares-Gomes, 2009). According to Johnson (2003), deviations from the 1:1 ratio might result from sex differences in the spatial–temporal distribution and mortality rates. Sampling methods (Montague, 1980) and differential predation on males and females (Wolf *et al.*, 1975) could also be responsible for biased sex-ratios.

Bedê *et al.* (2008) also found a deviated sex-ratio in a *U. (M.) victoriana* population in Rio de Janeiro, but with more females than males. According to Valiela *et al.* (1974) and Emmerson (1994), male fiddler crabs are more easily found because they feed for longer periods on the surface. The deviations from the normal proportion of sexes appear to be related to the reproductive system, because males spend more time moving their major cheliped, holding and disputing territory to attract females, and feeding over long periods to compensate for the presence of a single cheliped which is used in food capture; and consequently they are easily caught (Valiela *et al.*, 1974; Montague, 1980; Emmerson, 1994).

We could not determine the reproductive season of *U. (M.) victoriana* because of the few ovigerous females collected. Aciole *et al.* (2000) and Bezerra & Matthews-Cascon (2006), studying ecological aspects of *U. (L.) leptodactyla* in two mangroves of north-eastern Brazil, also found few ovigerous females in a one-year period. This may be because ovigerous females of broad-fronted fiddler crabs such as *U. (M.) victoriana* can incubate their eggs underground to protect them from extreme environmental conditions. Christy & Salmon (1984), Murai *et al.* (1987) and Henmi (2003) observed similar behaviour in *U. (L.) pugilator* (Bosc, 1802), *U. (Paraleptuca) lactea* (De Haan, 1875) and *U. (P.) perplexa* (H. Milne-Edwards, 1837), respectively. The ovigerous females had large broods, remained in their burrows throughout the incubation period, and did not feed during this phase. Bedê *et al.* (2008) did not report the number of ovigerous females of *U. (M.) victoriana* collected.

ACKNOWLEDGEMENTS

The authors are grateful to the Fundação de Amparo à Ciência e Tecnologia do Estado de Pernambuco (FACEPE), for financial support for fieldwork to D.S.C. (APQ: 0108-2.04/07), and to CNPq for a fellowship to D.S.C.; to Dr Petrônio Alves Coelho (UFPE) for his usual support; to the Universidade Estadual de Santa Cruz for financing the projects 'Inventariamento da Fauna de Crustáceos Decápodos do Município de Ilhéus, Bahia' (00220.1100.347) and 'Diversidade de Crustáceos do Sudeste e Sul da Bahia, Brasil: I. Ambientes Costeiros' (00220.1100.590). Special thanks to Dr Marcos Tavares for providing facilities for the revision of *Uca* species in the collection at the MZUSP, São Paulo and to T. Chad Walter (National Museum of Natural History/USNM) for providing the type series from the Zoologisches Museum Universität Hamburg, Hamburg, Germany; and to Dr Janet W. Reid for assistance with the English text. All sampling in this study was conducted in compliance with current applicable state and federal laws (ICMBio 14340-1).

REFERENCES

Aciole S.D.G., Sousa E.C. and Calado T.C.S. (2000) Aspectos bioecológicos de *Uca cumulanta* Crane, 1943 e *Uca leptodactyla* Rathbun, 1898 (Crustacea: Decapoda: Ocypodidae) do complexo estuarino–lagunar Mundaú/Manguaba–Maceió, Estado de Alagoas. *Boletim de Estudos de Ciências do Mar* 79, 79–100.

Almeida A.O., Coelho P.A., Santos J.T.A. and Ferraz N.R. (2006) Crustáceos decápodos estuarinos de Ilhéus, Bahia, Brasil. *Biota Neotropica* 6, http://www.biotaneotropica.org.br/v6n2/pt/abstract?inventory+bn03406022006

Aveline L.C. (1980) Fauna dos manguezais brasileiros. *Revista Brasileira de Geografia* 42, 786–821.

Bedê L.M., Oshiro L.M.Y. and Melo G.A.S. (2007) Observation on the occurrence of *Uca victoriana* von Hagen (Decapoda, Brachyura, Ocypodidae) on the coast of Rio de Janeiro, Brazil. *Brazilian Journal of Biology* 67, 799–800.

Bedê L.M., Oshiro L.M.Y., Mendes L.M.D. and Silva A.A. (2008) Comparação da estrutura populacional das espécies de *Uca* (Crustacea: Decapoda: Ocypodidae) no manguezal de Itacuruça, Rio de Janeiro, Brasil. *Revista Brasileira de Zoologia* 25, 601–607.

Beinlich B. and von Hagen H.O. (2006) Materials for a more stable subdivision of the genus *Uca* Leach. *Zoologische Mededelingen* 80, 9–32.

Benetti A.S., Negreiros-Fransozo M.L. and Costa T.M. (2007) Population and reproductive biology of the crab *Uca burgersi* (Crustacea: Ocypodidae) in three subtropical mangrove forests. *Revista de Biología Tropical* 55 (Supplement 1), 55–70.

Bezerra L.E.A., Dias C.B., Santana G.X. and Matthews-Cascon H. (2006) Spatial distribution of fiddler crabs (genus *Uca*) in a tropical mangrove of northeast Brazil. *Scientia Marina* 70, 759–766.

Bezerra L.E.A. and Matthews-Cascon H. (2006) Population structure of the fiddler crab *Uca leptodactyla* Rathbun, 1898 (Brachyura: Ocypodidae) in a tropical mangrove of north-eastern Brazil. *Thalassas* 22, 65–74.

Bezerra L.E.A. and Matthews-Cascon H. (2007) Population and reproductive biology of the fiddler crab *Uca thayeri* Rathbun, 1900 (Crustacea: Ocypodidae) in a tropical mangrove from northeast Brazil. *Acta Oecologica* 31, 251–258.

Campbell A. and Eagles M.D. (1983) Size maturity and fecundity of rock crabs, *Cancer irroratus*, from the Bay of Fundy and south-western Nova Scotia. *Fishery Bulletin* 8, 357–36.

Castiglioni D.S. and Negreiros-Fransozo M.L. (2005) Comparative population biology of *Uca rapax* (Smith, 1870) (Brachyura, Ocypodidae) from two subtropical mangrove habitats on the Brazilian coast. *Journal of Natural History* 39, 1627–1640.

Castiglioni D.S., Negreiros-Fransozo M.L. and Mortari R.C. (2006) Biologia populacional do caranguejo violinista *Uca rapax* (Smith, 1870) (Brachyura, Ocypodoidea) proveniente de uma área de manguezal degradado em Paraty, RJ, Brasil. *Atlântica* 28, 73–86.

Christy J.H. and Salmon M. (1984) Ecology and evolution of mating system of fiddler crabs (genus *Uca*). *Biological Reviews* 59, 483–509.

Coelho P.A. (1995) Sinopse dos crustáceos decápodos brasileiros (família Ocypodidae). *Trabalhos Oceanográficos da Universidade Federal de Pernambuco, UFPE* 23, 135–142.

Colpo K.D. and Negreiros-Fransozo M.L. (2004) Comparison of the population structure of the fiddler crab *Uca vocator* (Herbst, 1804) from three subtropical mangrove forest. *Scientia Marina* 68, 139–146.

Conde J.E., Rull V. and Vegas T. (1986) Análisis exploratório de datos ecológicos y biométricos: gráficos stem-and-leaf (talo-y-roja) y boxplot (cajás gráficas). *Enseñanza de las Ciencias* 4, 153–162.

Costa T.M. and Negreiros-Fransozo M.L. (2003) Population biology of *Uca thayeri* Rathbun, 1900 (Brachyura, Ocypodidae) in a subtropical South American mangrove area: results from transect and catch-per-unit-effort techniques. *Crustaceana* 75, 1201–1218.

Costa T. and Soares-Gomes A. (2009) Population structure and reproductive biology of *Uca rapax* (Decapoda: Ocypodidae) in a tropical coastal lagoon, southeast Brazil. *Zoologia* 26, 647–657.

Crane J. (1975) *Fiddler crabs of the world: Ocypodidae: genus* Uca. Princeton, NJ: Princeton University Press.

Díaz H. and Conde J.E. (1989) Population dynamics and life history of the mangrove crab *Aratus pisonii* (Brachyura, Grapsidae) in a marine environment. *Bulletin of Marine Science* 45, 149–163.

Emmerson W.D. (1994) Seasonal breeding cycles and sex ratios of eight species of crabs from Mgazana, a mangrove estuary in Transkei, southern Africa. *Journal of Crustacean Biology* 14, 568–578.

Frith D.W. and Brunenmeister S. (1980) Ecological and population studies of fiddler crabs (Ocypodidae, genus *Uca*) on a mangrove shore at Phuket Island, western peninsular Thailand. *Crustaceana*, 39, 157–183.

Genoni G.P. (1985) Food limitation in salt marsh fiddler crab *Uca rapax* (Smith) (Decapoda, Ocypodidae). *Journal of Experimental Marine Biology and Ecology* 87, 97–110.

Hartnoll R.G. (2006) Reproductive investment in Brachyura. *Hydrobiologia* 557, 31–40.

Henmi Y. (2003) Trade-off between brood size and brood interval and the evolution of underground incubation in three fiddler crabs (*Uca perplexa, U. vocans* and *U. dussumieri*). *Journal of Crustacean Biology* 23, 46–54.

Hirose G. and Negreiros-Fransozo M.L. (2008) Population biology of *Uca maracoani* Latreille 1802–1803 (Crustacea, Brachyura, Ocypodidae) on the south-eastern coast of Brazil. *Pan-American Journal of Aquatic Sciences* 3, 373–383.

Johnson P.T.J. (2003) Biased sex ratios in fidler crabs (Brachyura, Ocypodidae): a review and evaluation of the influence of sampling method, size class, and sex specific mortality. *Crustaceana* 76, 559–580.

Koch V., Wolff M. and Diele K. (2005) Comparative population dynamics of four fiddler crabs (Ocypodidae, genus *Uca*) from a north Brazilian mangrove ecosystem. *Marine Ecology Progress Series* 291, 177–188.

Litulo C. (2004) Reproductive aspects of a tropical population of the fiddler crab *Uca annulipes* (H. Milne-Edwards, 1837) (Brachyura: Ocypodidae) at Costa do Sol Mangrove, Maputo Bay, southern Mozambique. *Hydrobiologia* 525, 167–173.

Litulo C. (2005a) Population biology of the fiddler crab *Uca annulipes* (Brachyura: Ocypodidae) in a tropical East Africa mangrove (Mozambique). *Estuarine, Coastal and Shelf Science* 62, 283–290.

Litulo C. (2005b) Population structure and reproductive biology of the fiddler crab *Uca inversa* (Hoffman, 1874) (Brachyura: Ocypodidae). *Acta Oecologica* 27, 135–141.

Masunari S. and Dissenha N. (2005) Alometria no crescimento de *Uca mordax* (Smith) (Crustacea, Decapoda, Ocypodidae) na Baia de Guaratuba, Paraná, Brasil. *Revista Brasileira de Zoologia* 22, 984–990.

Melo G.A.S. (1996) *Manual de identificação dos Brachyura (caranguejos e siris) do litoral brasileiro*. São Paulo: Plêiade, 604 pp.

Melo G.A.S. (1998) Malacostraca—Eucarida. Brachyura, Oxyrhyncha and Brachyrhyncha. In Young P.S. (ed.) *Catalogue of Crustacea of Brazil*. Rio de Janeiro: Museu Nacional, pp. 455–717.

Montague C.L. (1980) A natural history of temperate western Atlantic fiddler crabs. *Contributions in Marine Science* 23, 25–55.

Mounton E.C. and Felder D.L. (1995) Reproduction of the fiddler crabs *Uca longisignalis* and *Uca spinicarpa* in a Gulf of Mexico salt marsh. *Estuaries* 18, 469–481.

Murai M., Goshima S. and Henmi Y. (1987) Analysis of the mating system of the fiddler crab, *Uca lactea*. *Animal Behavior* 35, 1334–1342.

Ng P.K.L., Guinot D. and Davie P.J.F. (2008) *Systema brachyurorum*: Part I. An annotated checklist of extant brachyuran crabs of the world. *Raffles Bulletin of Zoology* 17, 1–286.

Skov M.W. and Hartnoll R.G. (2001) Comparative suitability of binocular observation, burrow counting and excavation of the mangrove fiddler crab *Uca annulipes* (H. Milne-Edwards). *Hydrobiologia* 449, 201–212.

Skov M.W., Vannini M., Shunula J.P., Hartnoll R.G. and Cannicci S. (2002) Quantifying the density of mangrove crabs: Ocypodidae and Grapsidae. *Marine Biology* 141, 725–732.

Spivak E.D., Gavio M.A. and Navarro C. (1991) Life history and structure of the world's southernmost *Uca* population: *Uca uruguayensis* (Crustacea, Brachyura) in Mar Chiquita Lagoon (Argentina). *Bulletin of Marine Science* 43, 679–688.

Valiela I., Babiec D.F., Atherton W., Seitzinger S. and Krebs C. (1974) Some consequences of sexual dimorphism: feeding in male and female fiddler crabs, *Uca pugnax* (Smith). *Biological Bulletin. Marine Biological Laboratory, Woods Hole* 147, 652–660.

von Hagen H.O. (1987) Morphologie und Winkbalz einer neuen *Uca*—Art (Crustacea, Brachyura) aus dem Staat Espirito Santo (Brasilien). *Mitteilungen aus dem Hamburgischen Zoologischen Museum und Institut* 84, 81–94.

Wolf P.L., Shanholtzer S.F. and Reimold R.J. (1975) Population estimates for *Uca pugnax* (Smith, 1870) on the Duplin estuary marsh, Georgia, U.S.A. (Decapoda, Brachyura, Ocypodidae). *Crustaceana* 29, 79–91.

Yamaguchi T. (2001) Breeding period of the fiddler crab *Uca lactea* (Decapoda, Brachyura, Ocypodidae) in Japan. *Crustaceana* 74, 285–293.

and

Zar J.H. (1996) *Biostatistical analysis*. 3rd edition. Upper Saddle River, NJ: Prentice-Hall, 662 pp.

Correspondence should be addressed to:
L.E.A. Bezerra
Universidade Federal de Pernambuco
Departamento de Oceanografia
Programa de Pós-Graduação em Oceanografia
Avenida Arquitetura, s/n, Cidade Universitária
50670-901 Recife, Pernambuco, Brazil
email: luiseab@gmail.com