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

DANIELA DA SILVA CASTIGLIONI¹, ALEXANDRE OLIVEIRA ALMEIDA² AND LUIS ERNESTO ARRUDA BEZERRA³

¹Universidade 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, ²Universidade Estadual de Santa Cruz, Departamento de Ciências Biológicas, Rodovia Ilhéus-Itabuna, km 16, CEP 45662-900 Ilhéus, Bahia, Brazil, ³Universidade 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 Aririúndã 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 Aririúndã 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 proportion (χ² = 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).


*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-Franozo, 2004; Costa & Negreiros-Franozo, 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-Franozo, 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.
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 Zoológia of the Universidade do São Paulo, São Paulo (MZUSP); Museu de Zoológia of the Universidade Estadual de Santa Cruz, Ilhéus (MZUESC); and Centro Académico 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 *Lagunularia racemosa* and *Avicennia* sp. In the Arinquiriá 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. At Barra do Cahy we collected it on a sand–mud sediment covered by shrub vegetation. At Barra do Cahy we collected it on a sand–mud sediment covered by shrub vegetation. At Barra do Cahy we collected it on a sand–mud sediment covered by shrub vegetation. At Barra do Cahy we collected it on a sand–mud sediment covered by shrub vegetation. At Barra do Cahy we collected it on a sand–mud sediment covered by shrub vegetation.

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 (± 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 $K = \text{class number}$ and $N = \text{number of crabs}$.

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 ($\chi^2$) 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: $f = \text{female} (s)$; $m = \text{male} (s)$; $ovf = \text{ovigerous female}$; $\text{CW} = \text{carapace width}$.

**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 f); allotype (ZMH-K 28887, 1 f); paratype (ZMH-K 28887, 24 f).
Data from ZMH-K 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 119, 3 m, 2 f); Ilhéus, Acupe 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); Alcobaca, Itanhezm River (MZUESC 1037, 2 m); Mucuri (MZUSP 18641, 4 m). State of Espírito Santo—Serra, Lagoa do Bau (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. 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.

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.
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 crenellations well defined and well separated throughout, enlarging toward outer orbital margins; setae in rows above and below crenellations 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 pre-dactylar 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 Arinquinda 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 ± SD: 7.46 ± 1.60 mm), and females (ovigerous and non-ovigerous) from 4.44 to 11.15 mm CW (mean ± SD: 7.09 ± 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 ovigerous females 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 ovigerous females 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 ovigerous females showed unimodal distributions, with a normal distribution for both males (W = 0.98283, P < 0.05) and females (W = 0.98509; P < 0.05).

<table>
<thead>
<tr>
<th>Month</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>April 2008</td>
<td>9</td>
<td>18</td>
</tr>
<tr>
<td>May 2008</td>
<td>23</td>
<td>16</td>
</tr>
<tr>
<td>June 2008</td>
<td>22</td>
<td>9</td>
</tr>
<tr>
<td>July 2008</td>
<td>87</td>
<td>39</td>
</tr>
<tr>
<td>August 2008</td>
<td>41</td>
<td>17</td>
</tr>
<tr>
<td>September 2008</td>
<td>25</td>
<td>29</td>
</tr>
<tr>
<td>October 2008</td>
<td>24</td>
<td>16</td>
</tr>
<tr>
<td>November 2008</td>
<td>21</td>
<td>19</td>
</tr>
<tr>
<td>December 2008</td>
<td>57</td>
<td>45</td>
</tr>
<tr>
<td>January 2009</td>
<td>51</td>
<td>28</td>
</tr>
<tr>
<td>February 2009</td>
<td>52</td>
<td>23</td>
</tr>
<tr>
<td>March 2009</td>
<td>60</td>
<td>41</td>
</tr>
<tr>
<td>Total</td>
<td>472</td>
<td>300</td>
</tr>
</tbody>
</table>

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.
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. 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).
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.) burgeri. 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 Henri (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 Petronio 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 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 Sudoeste 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**


and


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