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New records confirming the occurrence of the ghost shrimps *Biffarius biformis* (Biffar, 1970) and *B. fragilis* (Biffar, 1971) (Decapoda, Callianassidae) in Brazil and the southwestern Atlantic

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BOTTER-CARVALHO, M.L., CARVALHO, P.V.V.D.B.C. & SANTOS, P.J.P. **New records confirming the occurrence of the ghost shrimps *Biffarius biformis* (Biffar, 1970) and *B. fragilis* (Biffar, 1971) (Decapoda, Callianassidae) in Brazil and the southwestern Atlantic.** Biota Neotrop. 12(3): <http://www.biotaneotropica.org.br/v12n3/en/abstract?article+bn02012032012>

Abstract: Previous records of the callianassid ghost shrimps *Biffarius biformis* (Biffar, 1971) and *Biffarius fragilis* (Biffar, 1970) from Pernambuco, northeastern Brazil, were considered as doubtful, because their original record (Carvalho et al. 1997) in a conference abstract cannot be considered as a valid publication. The original material examined by Carvalho et al. (1997) combined with the more recently collected material of *B. biformis* and *B. fragilis*, confirm the presence of these two species in Brazil and the southwestern Atlantic. Taxonomic and ecological remarks, as well as illustrations, are provided for both species.

Keywords: Callianassidae, *Biffarius*, new records, Brazil, Atlantic Ocean.

BOTTER-CARVALHO, M.L., CARVALHO, P.V.V.D.B.C. & SANTOS, P.J.P. **Novos registros confirmam a ocorrência dos camarões fantasma *Biffarius biformis* (Biffar, 1970) e *B. fragilis* (Biffar, 1971) (Decapoda, Callianassidae) no Brasil e sudoeste do Atlântico.** Biota Neotrop. 12(3): <http://www.biotaneotropica.org.br/v12n3/pt/abstract?article+bn02012032012>

Resumo: A ocorrência dos camarões fantasma *Biffarius biformis* (Biffar 1971) e *Biffarius fragilis* (Biffar 1970) no nordeste do Brasil têm sido considerada duvidosa, porque o registro original (Carvalho et al. 1997) realizado em resumo durante uma conferência regional não pode ser considerado válido. Neste trabalho, o estudo dos espécimens examinados por Carvalho et al. (1997), combinados com o material coletado mais recentemente, confirma a presença dessas duas espécies na costa brasileira e no sudoeste do Atlântico. São fornecidas novas informações taxonômicas, ecológicas e ilustrações.

Palavras-chave: Callianassidae, *Biffarius*, novos registros, Brasil, Oceano Atlântico.

Introduction

Ghost-shrimps of the family Callianassidae (Axiidea) are among the most common burrowing crustaceans in coastal soft-bottom environments, with about 54% of all known species found in very shallow waters (0-2 m) (Dworschak 2004). About 155 callianassid species are known worldwide, 39 of them in the western Atlantic (Dworschak 2000); the majority of species are distributed in the Indo-West Pacific (Sakai 1999b, Dworschak 2000).

Seventeen species of callianassids have been reported for Brazil (Rodrigues 1971, Coelho & Ramos-Porto 1986, Manning & Felder 1991, Rodrigues & Manning 1992a, b, Manning & Lemaitre 1993, Botter-Carvalho et al. 1995, Coelho 1997, Melo 1999, Coelho et al. 2007). However, the actual species richness of these cryptic bioturbators may be heavily underestimated, which is partly due to sampling difficulties (see Garcia et al. 2003).

The genus *Biffarius* Manning and Felder, 1991 includes 11 small-sized species worldwide (Sakai 1999b, Tudge et al. 2000, Guzmán & Thatje 2003, Poore 2008), three in the Atlantic Ocean and eight in the Pacific Ocean. At present, three species of this genus are known from Brazil: *Biffarius delicatulus* Rodrigues & Manning, 1992, originally described from the coasts of São Paulo, and *B. biformis* (Biffar, 1971b) and *B. fragilis* (Biffar, 1970), both briefly reported from Pernambuco (Carvalho et al. 1997). However, only the description of *B. delicatulus* may be accepted as a valid record of *Biffarius* in Brazil. The records of the two northeastern congeners appeared in abstracts of a local conference (Carvalho et al. 1997), which was later merely cited by Coelho (1997) in his revision of the “Thalassinidea” (now Axiidea + Gebiidea). Coelho (1997) clearly stated that did not examine any specimens of *B. biformis* and *B. fragilis*. Melo (1999), in his major treatment of Anomura and “Thalassinidea”, also referred to Carvalho et al. (1997) as being the first record of these two species in Brazil. More recently, Coelho et al. (2007) included *B. biformis* and *B. fragilis* in their checklist of Brazilian decapod crustaceans, based on the same earlier listing in Coelho (1997). Applying Article 9 of the International Code of Zoological Nomenclature (1999) the original record of *B. biformis* and *B. fragilis* (Carvalho et al. 1997) is not a published study, making the Brazilian records of these two species doubtful.

The present study is the first formal confirmation of the presence of *B. biformis* and *B. fragilis* in Brazil and the southwestern Atlantic, based on the material originally examined by Carvalho et al. (1997), as well as more recently (2003) collected material. The Brazilian material is illustrated and some taxonomic and ecological notes are provided.

Materials and Methods

All specimens of *Biffarius biformis* and *B. fragilis* were collected in the intertidal habitats of Pernambuco, northeastern Brazil (Figure 1). The northern sampling site (Site 1 - 7° 48' 44" S and 34° 48' 48" W) is located at Itamaracá Island next to the mouth of Santa Cruz Channel, which connects a large estuarine complex composed of several small rivers (Figure 1). At this site, the ghost shrimps were collected in the intertidal zone of a sandy beach (Praia do Forte Orange). The superficial layer of sediment consists of well-sorted coarse sand and the depth of the redox potential discontinuity layer is approximately 10 cm. The anoxic layer consists of fine sand and mud sediments with abundant biogenic detritus. Salinity range during low tide is 31.0-34.5‰. The southern sampling sites (Site 2 and 3) are located in a southern area of Praia da Casa Caiada (7° 59' 42" S, 34° 49' 48" W and 7° 58' 15" S and 34° 49' 49" W, respectively), an urban beach polluted by domestic sewage (Figure 1). The beach is semi-enclosed by a groyne and a series of seven seawalls, which favour

the deposition of fine sediments and increased water temperature and salinity mainly during summer (Pereira et al. 1996). Site 2 is located approximately 100 m outward from the shoreline, and is characterized by a depositional environment formed by an inshore gravel bank adjacent to the seawall. Site 3 is located in the intertidal zone of Praia da Casa Caiada (Figure 1). The sediment (muddy sand) here is poorly oxygenated, superficially covered by conspicuous microphytobenthic patches, and has a dense population of the snail *Neritina virginea* (L.). Pereira et al. (1996) reported the range of salinity and water temperature of 36.3-30.0‰ and 31.3-28.0 °C during summer and winter, respectively. Site 2 is characterized by moderate to poorly sorted quartz sand and 95% biogenic debris (Pereira et al. 1996); the sub-surface layer is characterized by well-sorted fine sand.

Sampling took place during low tide, in the intertidal zone, using a bait suction (“yabby”) pump, modified from that of Hailstone & Stephenson (1961). The pumped water (with sediments) was sieved through a 0.3 mm mesh to retain callianassids and other gallery-associated infauna. All samples were fixed in 4% buffered seawater-formaldehyde solution and 24 hours later transferred into 70% ethanol. Biometric measurements were made using a digital caliper (0.1 mm) or a micrometric eyepiece, following Biffar (1971a) for morphometric standards. Drawings were made with the aid of a stereomicroscope equipped with a camera lucida.

At site 1, the density of ghost shrimp burrows was estimated as the mean number of burrow openings per m² along five transects. At sites 2 and 3, this estimation was not possible due to co-occurrence of other infaunal, burrowing organisms, such as polychaetes and stomatopods.

The following abbreviations are used in the text: CL, carapace length (mm); TL, total length (mm); MZUSP, Museu de Zoologia da Universidade de São Paulo.

Taxonomic Section

Biffarius biformis (Biffar, 1971b)

Callianassa biformis Biffar 1971b: 225, Figure 1. – Rabalais et al. 1981: 101.

Biffarius biformis – Manning & Felder 1991: 769.

Material examined: Brazil, Pernambuco: Itamaracá Island, Praia do Forte Orange, Site 1, 1 ♂ (4.17 mm CL), 23.XI.1995 (MZUSP 19074); Itamaracá Island, Praia do Forte Orange, Site 1, 1 ovigerous ♀ (5.20 mm CL, 24.1 mm TL), 23.XI.1995 (MZUSP 19072); Olinda, Praia da Casa Caiada, Site 2, 1 ♀ (4.73 mm CL), 23.XII.2003 (MZUSP 19073).

Ecology: *Biffarius biformis* was collected in the lower intertidal only. Burrow openings were very sparse (<0.1 m⁻²), small (1-2 mm diameter) and rather inconspicuous, without mound-like accumulation of sediments. No commensals were observed in sieved sediments. The lower intertidal was largely dominated by the callianassid *Neocallichirus maryae* Karasawa, 2004, with some specimens of *Callichirus major* (Say 1818), and, in muddy patches near the low-tide level, *Sergio guassutunga* (Rodrigues 1971). Galleries of these ghost shrimps were inhabited by the pinnotherid crabs *Austinxia aidaea* (Righi 1967) and *Pinnixa* sp.; small reddish polyclads were found only in galleries of *S. guassutunga*.

Biffarius biformis was previously recorded from both intertidal and subtidal habitats, burrowing in fine sand or mud bottoms (Biffar 1971b, Dörge 1972, Holland & Polgar 1976, Rabalais et al. 1981, Prezant et al. 2002). Rabalais et al. (1981) stated that *B. biformis* is

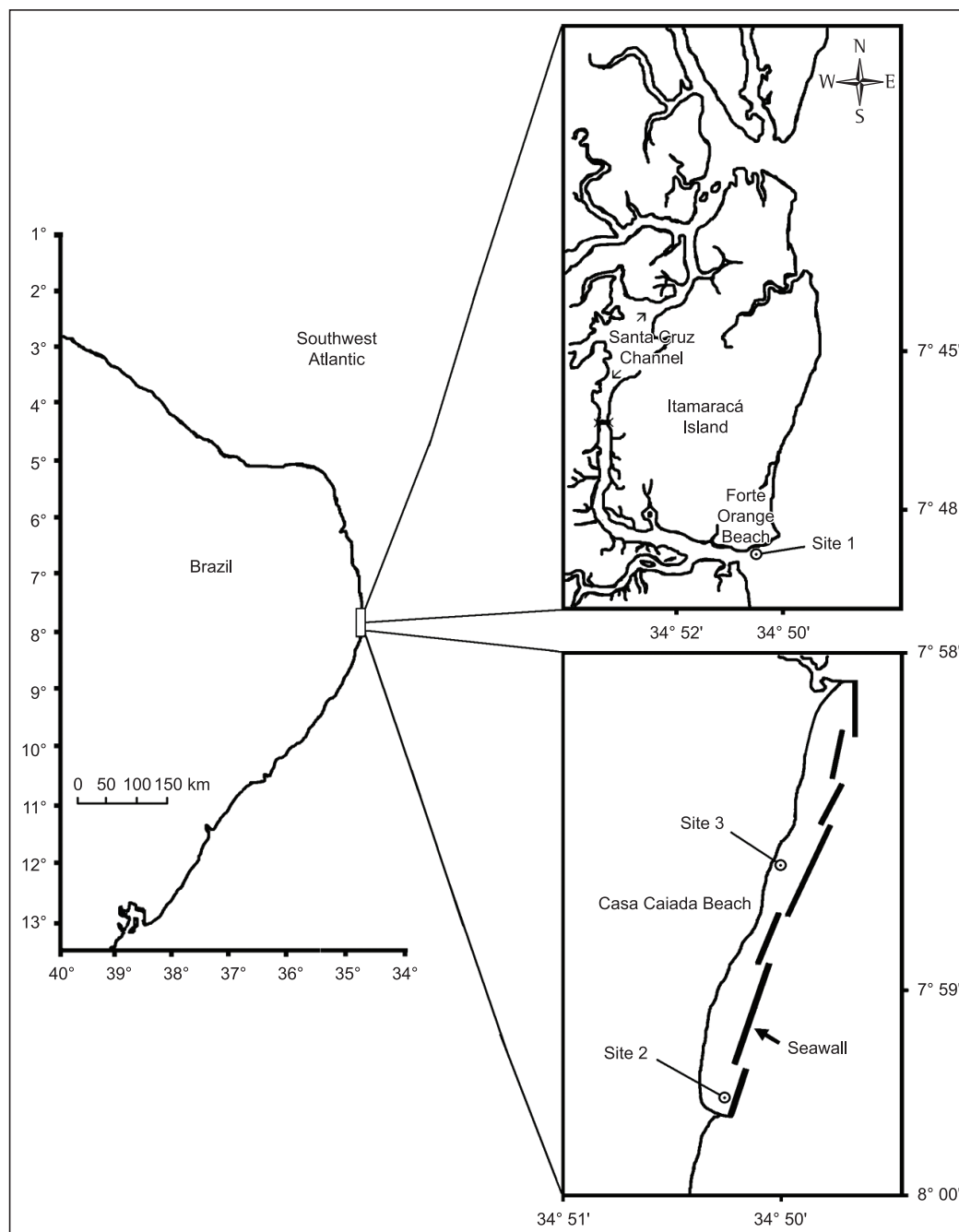


Figure 1. Map of the northeastern Brazilian coast showing localities of sampling sites.

the second most abundant “thalassinidean” on the outer continental shelf in the northwestern Gulf of Mexico (off southern Texas).

Distribution: Western Atlantic. USA: Atlantic coast from Massachusetts to Florida and Gulf of Mexico coast from Florida to Texas (Biffar 1971a, Rabalais et al. 1981, Williams 1984, Prezant et al. 2002, Heard et al. 2007); Brazil: Pernambuco (present study).

Remarks: The Brazilian specimens agree with the majority of the diagnostic features of *B. biformis* (as *Callianassa biformis*) given by Biffar (1971b). The major cheliped of Brazilian male individuals resembles the “strong” cheliped described by Biffar (1971b), differing from it only in the absence of fine elongate setae on the dorsal and ventral margins of the ischium and ventral margins of the merus,

carpus and palm (Figure 2). On the other hand, the median spine on the telson mentioned as a diagnostic feature of *B. biformis* by Sakai (1999b), was not observed in the Brazilian material, which agrees with the description of Biffar (1971b). The paired lateral spiniform setae at each posterolateral corner of the telson described in the holotype by Biffar (1971b) are rather inconspicuous in the Brazilian material. Finally, in the Brazilian specimens, the distal margin of the telson is straight (Figure 2), whereas in the holotype of *B. biformis*, it was illustrated as slightly convex (Biffar 1971b). Generally, the tail fan of the Brazilian specimens matches more the drawing of individuals from the western Gulf of Mexico (Texas) provided by Rabalais et al. (1981).

Rodrigues & Manning (1992a) compared the main diagnostic features of *B. biformis* and *B. delicatulus* from southeastern Brazil and concluded that the two species are morphologically very close. However, the specimens examined here and identified as *B. biformis* clearly differ from *B. delicatulus*, for instance, in the armed ischium of the larger male cheliped, the eyestalks bearing a small rounded denticle on the dorsomesial surface, and the lateral margins of the telson being convergent and approximately of the same length as the uropodal endopod (Figure 2).

***Biffarius fragilis* (Biffar, 1970)**

Callianassa fragilis Biffar 1970: 45, Figure 3 – Biffar 1971b: 667.

Callianassa fragilis – Sakai 1999b: 27.

Biffarius fragilis – Manning & Felder 1991: 769. – Tudge et al. 2000: 133.

Biffarius cf. *fragilis* – Heard et al. 2007: 21.

Material examined: Brazil, Pernambuco: Itamaracá Island, Praia do Forte Orange, Site 1, 1 ♀ (6.91 mm CL), 23.XII.1995 (MZUSP 19068); Olinda, Praia da Casa Caiada, Site 2, 1 ovigerous ♀

(4.95 mm CL), 06.III.1996 (MZUSP 19069); Itamaracá Island, Praia do Forte Orange, Site 1, 1 ♂ (5.08 mm CL, 23.5 mm TL), 22.III.1996 (MZUSP 19066); Itamaracá Island, Praia do Forte Orange, Site 1, 1 ♂ (4.29 mm CL), 21.IV.1999 (MZUSP 19067); Olinda, Praia da Casa Caiada, Site 3, 1 ♂ (4.91 mm CL), 23.XII. 2003. (MZUSP 19071); Olinda, Praia da Casa Caiada, Site 3, 1 ovigerous ♀ (3.52 mm CL), 23.XII.2003 (MZUSP 19070).

Ecology: At all sampling sites, burrow openings of *B. fragilis* were very scarce, small (~1 mm in diameter), and without mounds. At Site 3, the sympatric fauna included callianassids *Neocallichirus maryae*, *Callichirus major* and *Lepidophthalmus siriboia* Felder and Rodrigues, 1993. As for the previous species, no commensals were observed in galleries of *B. biformis*. Elsewhere, *B. fragilis* was also collected mainly on near-shore sandy habitats (Biffar 1971a, Manning & Felder 1991).

Distribution. Western Atlantic. Southern Florida; Caribbean Sea: Puerto Rico, Antigua, Venezuela (Biffar 1970, 1971b; Manning & Felder 1991); Brazil: Pernambuco (present study). Eastern Pacific. Galapagos and Costa Rica (Biffar 1972; Vargas & Cortes 1999) [eastern Pacific records require both morphological and genetic confirmation].

Remarks: The Brazilian material of *B. fragilis* generally agrees with the descriptions of *B. fragilis* (as *Callianassa fragilis*) in Biffar (1970, 1971a), except for some subtle differences. The Brazilian

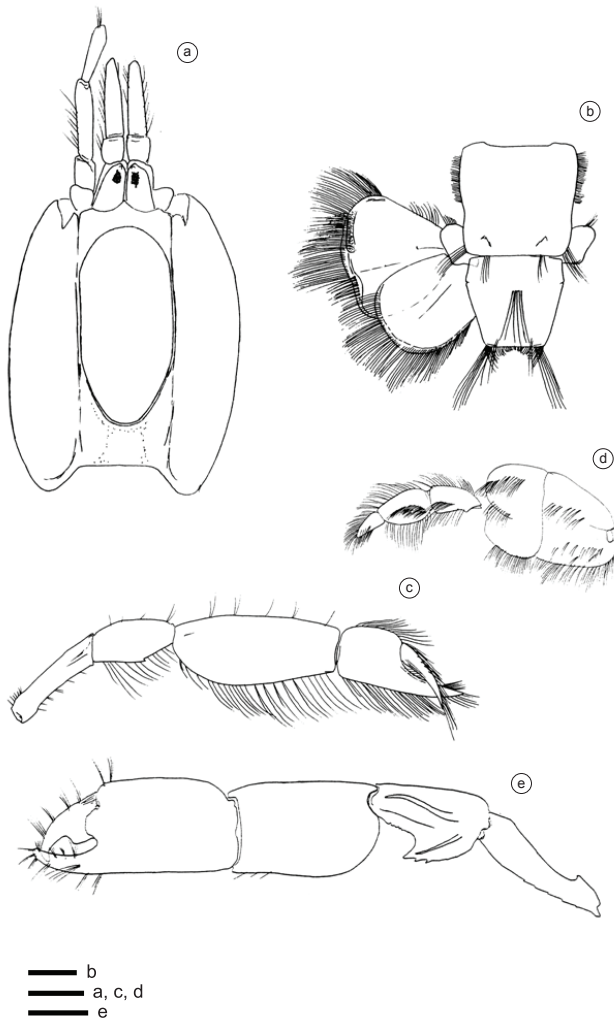


Figure 2. *Biffarius biformis* (Biffar, 1971): a) carapace and anterior appendages (dorsal view); b) sixth abdominal somite, telson and uropods (dorsal view); c) male minor cheliped (mesial view); d) third maxilliped (mesial view); e) male major cheliped (lateral view). Scale bars = 1 mm.

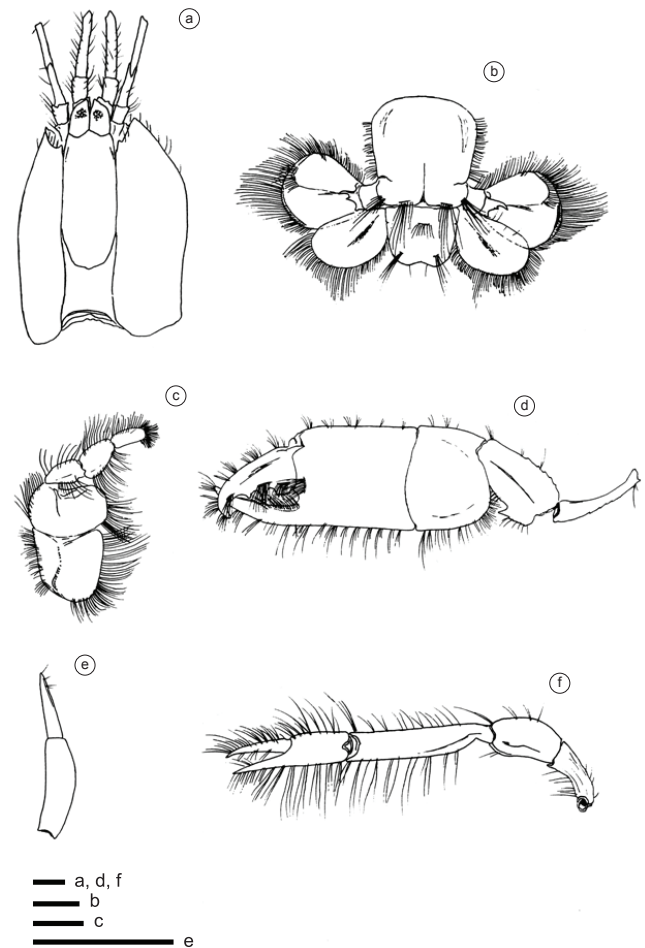


Figure 3. *Biffarius fragilis* (Biffar, 1970): a) carapace and anterior appendages (dorsal view); b) sixth abdominal somite, telson and uropods (dorsal view); c) third maxilliped (mesial view); d) male major cheliped (lateral view); e) male first pleopod; f) male minor cheliped (mesial view). Scale bars = 1 mm.

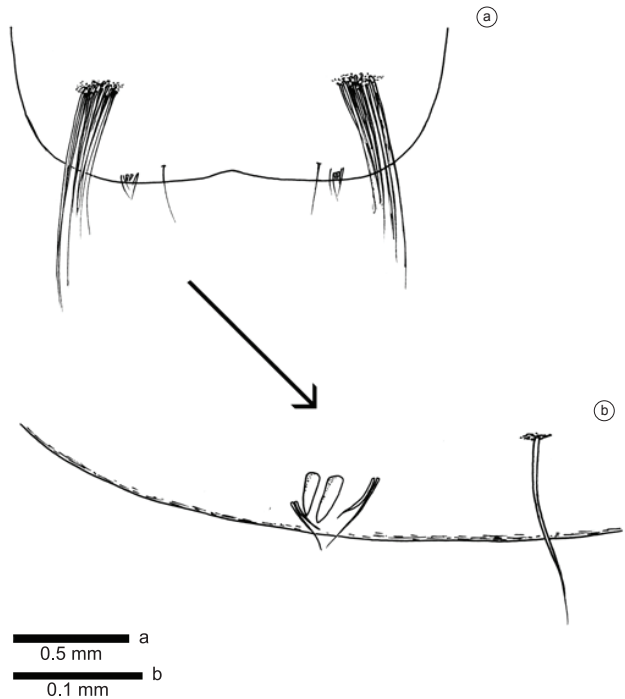


Figure 4. *Biffarius fragilis* (Biffar, 1970): a) posterior margin of telson; b) detail of spiniform setae near posterior margin.

specimens have 4–6 serrations on the ventral “hook” of the merus of the male major cheliped, as opposed to 3–4 as described by Biffar (1971a); the ventral margin itself has 10–13 denticles compared to the consistent 11 observed by Biffar (1971a). In the present material, the ischium of the third maxilliped bears 16–19 weak denticles on the mesial surface, whereas Biffar (1971a) observed 16–18 denticles. A pair of small spiniform setae on each posterolateral corner of the telson was observed in the Pernambuco material (Figure 4), but not mentioned or illustrated by Biffar (1970, 1971a). The Brazilian material partially agrees with the description in Heard et al. (2007), who mentioned the presence of only one spiniform setae in the material of *B. fragilis* from South Carolina. Therefore, our observations support the suggestion of Heard et al. (2007) that this character may be variable.

Discussion

The family Callianassidae has been revised first by Manning & Felder (1991), and then by Sakai (1999b). Manning & Felder (1991) erected the genus *Biffarius* for *Callianassa biformis* and *C. fragilis*, the former being its type species. Sakai (1999b, 2005) treated *Biffarius* along several other genera established by Manning & Felder (1991) again under *Callianassa* Leach 1814. However, a preliminary phylogenetic analysis of the Callianassidae (Tudge et al. 2000), did not support *Callianassa sensu lato* = *sensu* Sakai (1999b). *Callianassa* was also recovered as possibly polyphyletic group in a recent DNA-based analysis (Robles et al. 2009). Therefore, in the present study, both species were retained in the genus *Biffarius sensu* Manning & Felder (1991).

The present records from Pernambuco extend considerably the geographic ranges of *B. biformis* and *B. fragilis* from the Caribbean/Florida region south to Brazil. These two species now have the widest north-south ranges among the species of *Biffarius*. Their apparent disjunctive distribution may be simply due to the paucity of sampling along the northern and eastern coast of Brazil.

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