Snapping shrimps of the genus *Alpheus* Fabricius, 1798 from Brazil (Caridea: Alpheidae): updated checklist and key for identification

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Abstract - We provide an updated checklist of the snapping shrimps of the genus *Alpheus* Fabricius, 1798 (Crustacea: Alpheidae) from the Brazilian coast, as well as a key for their identification. The checklist was based on an exhaustive analysis of the literature published up to now, supported by analysis of material of 24 of the 33 species presently recorded from Brazil. Illustrations of the main diagnostic characters are provided to facilitate the identification process, as well as color photographs of 16 species collected by the authors, to facilitate the identification of fresh specimens. For each species, we provide information on the distribution and a list of previous records for the Brazilian coast. Comments on dubious records or taxonomic remarks are provided when appropriate. Finally, the zoogeography of the species is briefly discussed.

Key words: Alpheid, Brazilian coast, Crustacea, Decapoda, diversity

Introduction

Snapping shrimps of the genus *Alpheus* Fabricius, 1798 live from the intertidal zone to great depths, occurring especially in coastal tropical and subtropical ecosystems such as estuaries, mangroves and coral reefs (Chace, 1988; Anker *et al.*, 2006). These shrimp inhabit a wide variety of microhabitats, from soft to hard bottoms (Chace, 1988; Anker *et al.*, 2006). Although they are more abundant in marine and estuarine environments, the genus includes at least one true freshwater species, *A. cyanoteles* Yeo and Ng, 1996, from Malaysia (Yeo and Ng, 1996). Species of *Alpheus* are also frequently found in association with other organisms such as sponges (Anker *et al.*, 2008a, 2008d), corals (Patton, 1966; Castro, 1971), sea anemones (Knowlton and Keller, 1983, 1985), bryozoans (Anker *et al.*, 2008a, 2008c), echiuran worms (Anker *et al.*, 2007a), polychaetes (Anker *et al.*, 2007b, 2008a, 2008d), echinoderms (Criales, 1984) and goby fish (Karplus, 1987). The association of these shrimps with other crustaceans is also documented, such as with upogebiid (Schembri and Jaccarini, 1978) and xanthoid crabs (Vannini, 1985; Silliman *et al.*, 2003), and with other alpheids such as *Alpheopsis chilensis* Coutière, 1897 which is a commensal of burrows of *Alpheus inca* Wicksten and Méndez, 1981 (Boltaña and Thiel, 2001). Many species exhibit social monogamy, which consists in forming stable heterosexual pairs (Mathews, 2002; Rahman *et al.*, 2003).

The genus *Alpheus* includes 296 valid species worldwide (De Grave and Fransen, 2011; Anker, 2012; Anker and De Grave, 2012; Almeida *et al.*, 2013; Anker and Pachelle, 2013), the most of any genus of caridean shrimps. However, this number represents an underestimate of the actual diversity of the taxon. Empirical evidence and molecular studies point to the existence of cryptic diversity in *Alpheus* (Anker *et al.*, 2006;

Mathews, 2006; Mathews and Anker, 2009). Indeed, studies with a multidisciplinary approach, involving not only the morphology but also genetics, analysis of color pattern, and ecological data, have revealed the existence of cryptic lineages in a number of species that were previously considered to be widely distributed (Anker, 2001; Anker *et al.*, 2007b, 2008a, 2008b, 2008c, 2009; Mathews and Anker, 2009).

A total of 52 species of *Alpheus* have been recorded in the western Atlantic (Anker, 2012; Almeida *et al.*, 2013), and most of them have been reported for the Brazilian coast. However, some of the Brazilian records need to be confirmed because many taxa belong to species complexes as mentioned above, but also because some records were published in general lists of species from certain localities and regions, without morphological descriptions and illustrations of diagnostic characters or color patterns [e.g., *A. armatus* Rathbun, 1901, *A. belli* Coutière, 1898, *A. candei* Guérin-Méneville, 1855 and *A. macrocheles* (Hailstone, 1835) (Coelho *et al.*, 1983; Guterres *et al.*, 2005; Coelho Filho, 2006; Alves *et al.*, 2008)]. Confirmation of some doubtful records is difficult because in some cases the reported material was not deposited in any carcinological collection or is no longer available (damaged). Other species are indeed rare, and it is difficult to obtain new samples for analysis.

Studies of the species of *Alpheus* from Brazil began in the mid-19th century. Dana (1852), describing *A. malleator* based on material collected by the U.S. Exploring Expedition, mentioned that the type material was probably from Rio de Janeiro. Spence Bate (1888) described *A. intrinsecus* from off Salvador, based on a specimen collected during the Challenger Expedition. Pocock (1890) and Coutière (1898) described *A. ridleyi* Pocock, 1890 (a junior synonym of *A. websteri* Kingsley, 1880) and *A. belli* Coutière, 1898 [possible junior synonym of *A. malleator* (see Anker and Pachelle, 2013)], respectively, from Fernando de Noronha Archipelago. Rathbun (1900), studying the material obtained by the Branner-Agassiz Expedition in northeastern Brazil, attributed the new name *A. cristulifrons* to material from Fernando de Noronha reported by Pocock (1890) as *Alpheus obeso-manus* Dana, 1852. Christoffersen (1979) studied the taxonomy of the Alpheoidea collected during the Calypso Expedition, which carried out sampling along the Brazilian coast in 1961, and also included other material from the western Atlantic in his analyses. His study included 11 species of *Alpheus* from Brazil, and descriptions of the new taxa *A. maxilliplanus* Christoffersen, 1979, *A. pouang* Christoffersen, 1979 and *A. puabeba* Christoffersen, 1979; the type localities of the first two are on the coasts of Sergipe and São Paulo, respectively. Christoffersen (1984), revising a group of species morphologically similar to *A. heterochaelis* Say, 1818, described *A. estuariensis* Christoffersen, 1984 (type locality: estuary of the Potengi River, Rio Grande do Norte), and considered *A. maxilliplanus* a junior synonym of *A. chacei* Carvacho, 1979. Besides these major taxonomic works, species of *Alpheus* from Brazil have been recorded in several lists of species (e.g., Coelho and Ramos, 1972; Fausto Filho, 1974; Christoffersen, 1998; Coelho *et al.*, 2006; Coelho Filho, 2006; Santos *et al.*, 2012), some of them of great historical importance (e.g., Smith, 1869; Moreira, 1901; Luederwaldt, 1919). A few ecological and biological studies (Mossolin *et al.*, 2006; Pavanelli *et al.*, 2008, 2010; Rodrigues *et al.*, 2009) or larval descriptions (Pires *et al.*, 2008) have been published.

In recent years, several new species were described from the western Atlantic, some of which have been reported from the Brazilian coast, such as *A. brasileiro* Anker, 2012 (type locality: Fortaleza area and Camocim, Ceará), *A. carlae* Anker, 2012, *A. christofferseni* Anker, Hurt and Knowlton, 2007 (type locality: Cemitério Island, Atol das Rocas) and *A. rudolphi* Almeida and Anker, 2011 (type locality: off Alagoas) (Anker *et al.*, 2007a, 2009; Almeida and Anker, 2011; Anker, 2012). Some recent descriptions of new taxa are the product of taxonomic revisions of complexes of cryptic species (Anker *et al.*,

2007a, 2009; Anker, 2012; Almeida *et al.*, 2013). *Alpheus vanderbilti* Boone, 1930, which until recently was believed to be a junior synonym of *A. cylindricus* Kingsley, 1878a, was resurrected after revision (Anker *et al.*, 2008d). *Alpheus cylindricus* is currently restricted to the eastern Pacific, and the previous records of this species from Brazil (e.g., Coelho and Ramos, 1972; Christoffersen, 1998) correspond to *A. vanderbilti* (Anker *et al.*, 2008d). On the other hand, *A. agilis* Anker, Hurt and Knowlton, 2009 and *A. buckupi* Almeida, Terossi, Araújo-Silva and Mantelatto, 2013 (type locality: Timbó River, Pernambuco) were recognized as new species of amphi-Atlantic distribution. Finally, species that have long been recorded along the Brazilian coast, such as *A. heterochaelis* and *A. armillatus* H. Milne Edwards, 1837 (see Christoffersen, 1984), may not occur in Brazil. New evidence suggests that *A. heterochaelis* is a species complex (A.O. Almeida, under study). The *A. armillatus* complex was recently revised, and the occurrence of the *sensu stricto* form was not confirmed in Brazil (see Anker, 2012).

The process of identifying species of *Alpheus* is difficult, not only because it is a taxonomically complex group, including several cryptic lineages as mentioned above, but also because of the scarcity of keys for identification and illustrations of the diagnostic characters for regional faunas. Therefore, our present objective is to provide an updated list of members of the shrimp genus *Alpheus* from Brazil, including all recent changes regarding species composition, as well as a key for their identification, with illustrations of the main characters of taxonomic significance and photographs of color patterns of some species.

Material and Methods

The Brazilian coast is about 8,500 km long (Lavrado, 2007). The checklist contains species recorded from coastal areas extending from Cape Orange, northern Amapá State (04°17'N / 51°32'W) to the mouth of Chuí Stream, southern Rio Grande do Sul State (33°45'S / 53°23'W) (Fig. 1). Oceanic areas include: (1) the seamounts of the North Chain (= seamounts off Ceará) (01°00'–04°00'S / 37°00'–39°00'W) (Coelho Filho, 2006); (2) the Atol das Rocas (03°45'–03°56'S / 33°37'–33°56'W), 260 km east of Natal, Rio Grande do Norte State (Kikuchi, 2000); (3) the Fernando de Noronha Archipelago (03°45'–03°57'S / 32°19'–32°41'W), located 345 km east off the coast of Rio Grande do Norte (Leão and Dominguez, 2000); and (4) the seamounts of the Vitória-Trindade Chain, which extends over about 1,000 km (approx. 20–21°S / 28–38°W) off the coast of Espírito Santo State, southeastern Brazil (Ferrari and Riccomini, 1999). The eastern limits of this chain are Trindade Island (20°28'–20°32' / 29°17'–29°20'W) and the Martin Vaz Archipelago (20°30'–20°31' / 28°51'–29°20'W), located about 1,100 and 1,145 km off the Espírito Santo coast, respectively (Castro and Antonello, 2006) (Fig. 1).

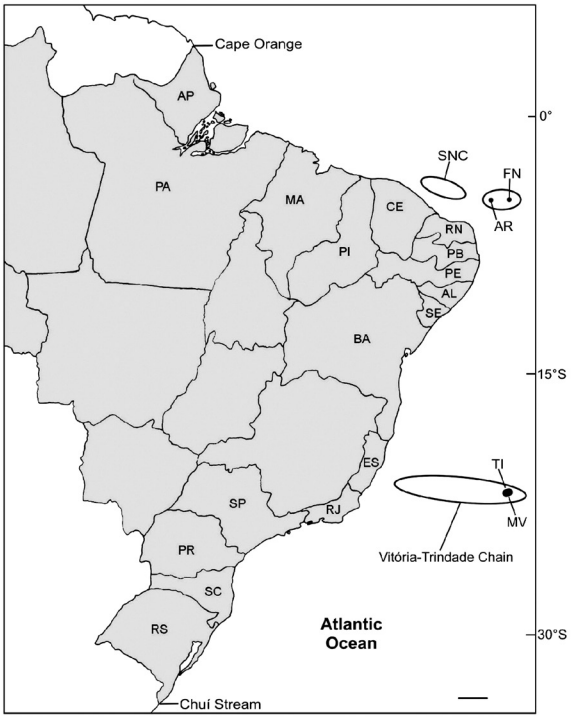

Figure 1. Coastal states and oceanic areas of Brazil. (AL) Alagoas, (AP) Amapá, (AR) Atol das Rocas, (BA) Bahia, (CE) Ceará, (ES) Espírito Santo, (FN) Fernando de Noronha Archipelago, (MA) Maranhão, (MV) Martin Vaz Archipelago, (PA) Pará, (PB) Paraíba, (PE) Pernambuco, (PI) Piauí, (PR) Paraná, (RJ) Rio de Janeiro, (RN) Rio Grande do Norte, (RS) Rio Grande do Sul, (SC) Santa Catarina, (SE) Sergipe, (SP) São Paulo, (SNC) seamounts of the North Chain, (TI) Trindade Island. Scale bar = 185 km.

The checklist presented herein was based on an exhaustive analysis of the literature published up to 2013. Sources with restricted access such as monographs, theses, and congress communications were not used in the checklist. The list is supported by the analysis of material of 24 of the 33 species recorded from Brazil. This material consists largely of specimens deposited in the Crustacean Collection of the Universidade Estadual de Santa Cruz, Ilhéus, Bahia, Brazil. Other material analyzed is deposited at the carcinological collections of the Universidade de São Paulo, São Paulo State, Brazil (Museu de Zoologia – MZUSP and Departamento de Biologia, Faculdade de Filosofia, Ciências e Letras de Ribeirão Preto - CCDB).

The key for identification was developed taking as a starting point the adaptation of the keys proposed by Chace (1972) for species of *Alpheus* from the Caribbean Sea, by Christoffersen (1984) for species related

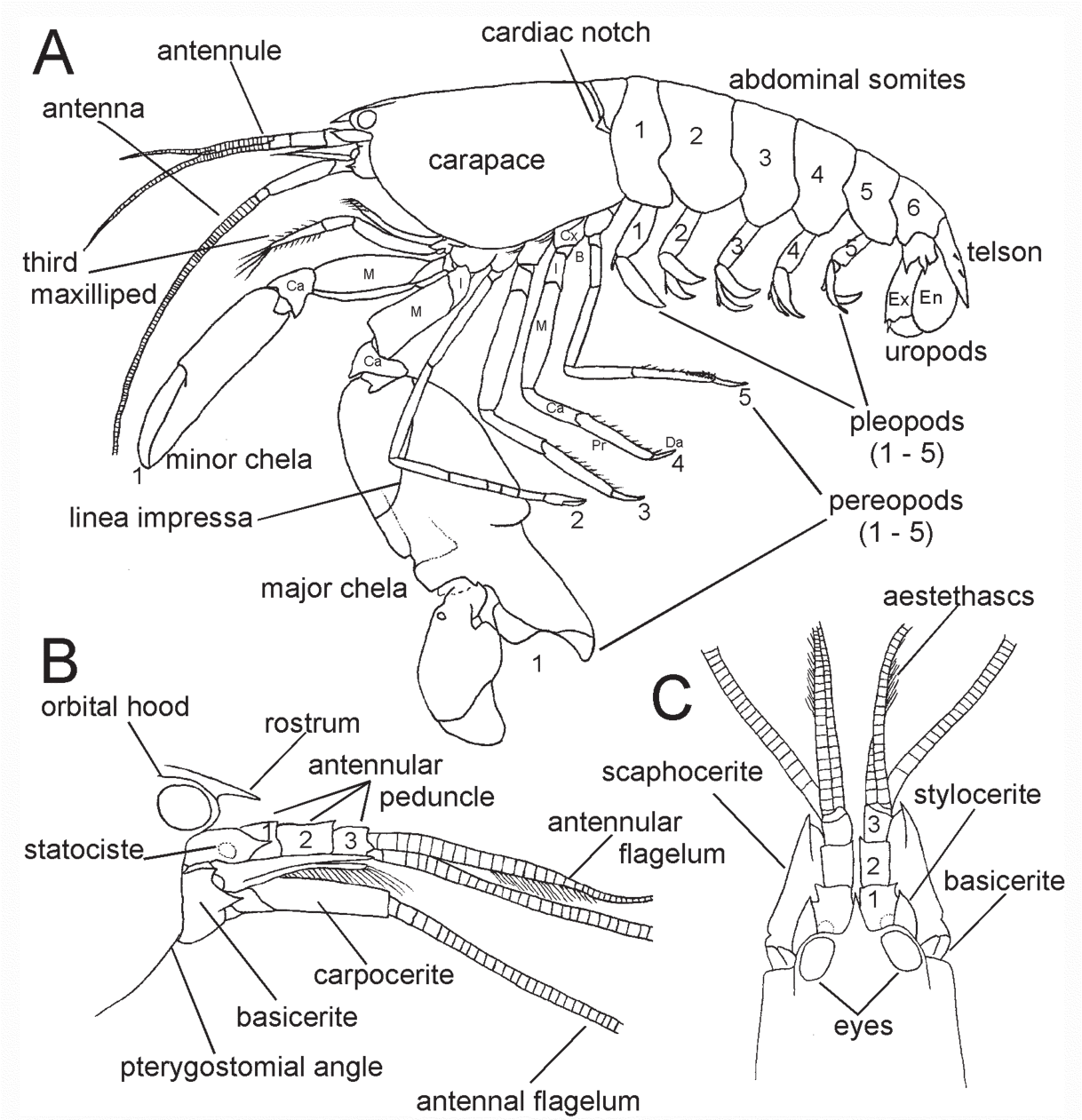

Figure 2. Morphology of snapping shrimp of the genus *Alpheus* Fabricius, 1798: (A) entire body, lateral view; (B) head and cephalic appendages, lateral view; (C) same, dorsal view. (B) basis, (Ca) carpus, (Cx) coxa, (Da) dactylus, (En) endopod, (Ex) exopod, (I) ischium, (M) merus, (Pr) propodus. In (B) and (C) the numbers 1 – 3 indicate the segments of the antennular peduncle. (A) Redrawn from Kim and Abele (1988).

to *A. heterochaelis,* and by Anker (2012) for the *A. armillatus* complex. Morphological characteristics of each taxon were also obtained through examination of the available material, complemented with descriptions of the species obtained in the literature. Illustrations of the main diagnostic characters are provided to facilitate the identification process (Figs. 2, 3). Color photographs of 16 species collected by the authors on the coast of Bahia are also provided to facilitate the identification of fresh specimens, since some taxa listed in this study

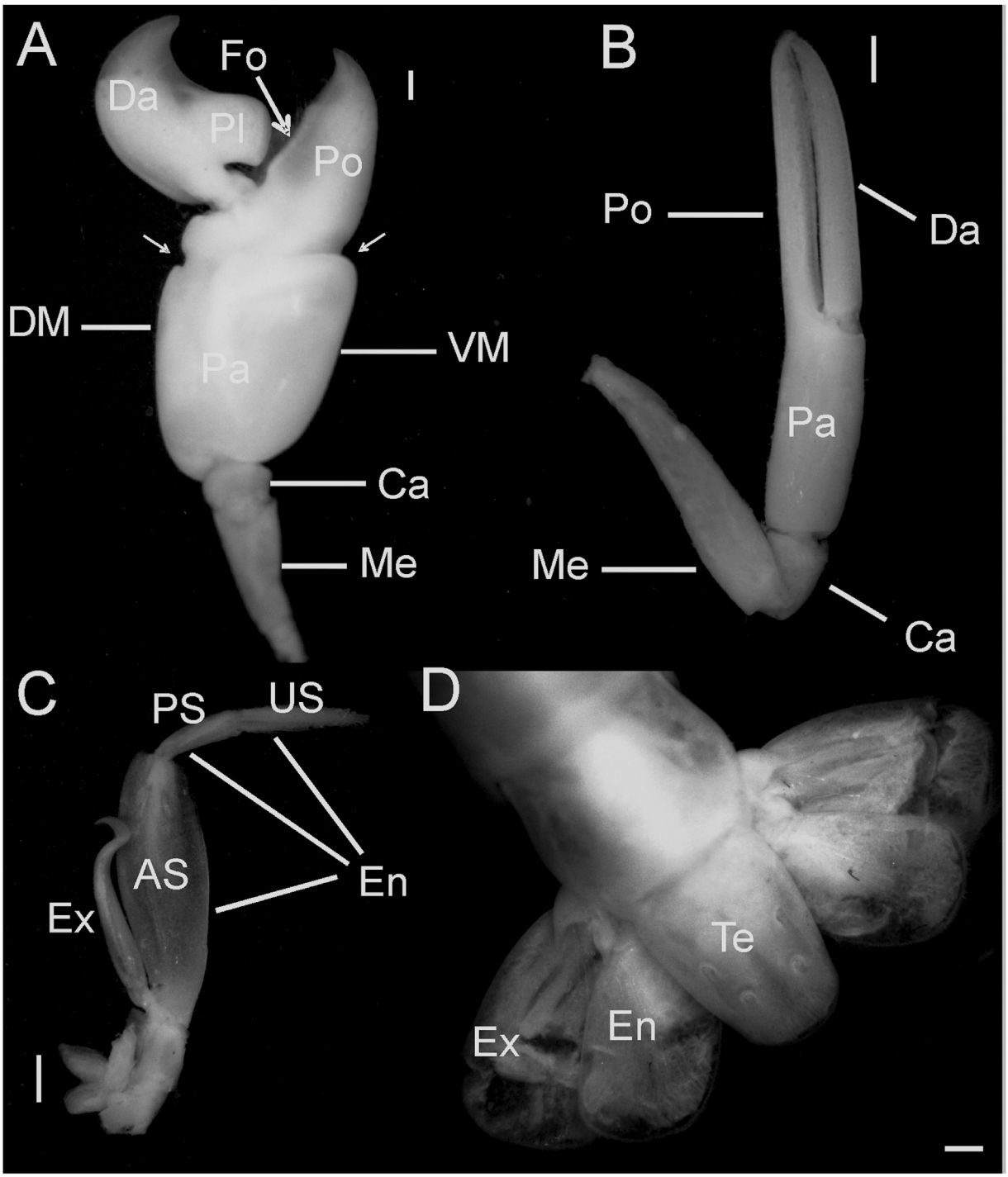

Figure 3. Morphology of snapping shrimp of the genus *Alpheus* Fabricius, 1798: (A) major cheliped, lateral view; (B) minor cheliped, lateral view; (C) third maxilliped, ventral view; (D) last abdominal segments, telson and uropods, dorsal view. (AS) antepenultimate segment, (Ca) carpus, (Da) dactylus, (DM) dorsal margin, (En) endopod, (Ex) exopod, (Fo) fossa, (Me) merus, (Pa) palm, (Pl) plunger, (Po) pollex, (PS) penultimate segment, (Te) telson, (US) ultimate segment, (VM) ventral margin. Arrows indicate dorsal and ventral chela notches. Scale bars = 1 mm.

can only be distinguished by analysis of their coloration in life. For each species, we provide the reference to the original description and the distribution, as well as a list of previous records for the Brazilian coast. Comments on dubious records or taxonomic remarks are provided. The existence of illustrations based on Brazilian material, when available, is also mentioned. The species marked with an asterisk had material examined in this study. We used the status cf. (e.g., *Alpheus* cf. *floridanus* Kingsley, 1878a) to designate a taxon belonging to a species complex which has not been taxonomically revised and the identity of the Brazilian material remains unknown.

The longitudinal and latitudinal distribution patterns (see discussion) were classified based on the proposal of Melo (1985). In the western Atlantic, the species are treated as having disjunct distributions where the gap in their range corresponds at least to the Guyana region (Guyanas, Amapá, and Pará) (Coelho and Ramos, 1972).

Results

Family Alpheidae Rafinesque, 1815

Genus *Alpheus* Fabricius, 1798

Alpheus agilis Anker, Hurt and Knowlton, 2009

Alpheus agilis Anker, Hurt and Knowlton, 2009: 12, figs. 4-5F.

Distribution: Western Atlantic - Brazil (Atol das Rocas). Eastern Atlantic - São Tomé and Cape Verde (Anker *et al*., 2009).

Previous records: Atol das Rocas (Anker *et al*., 2009).

Remarks: In the western Atlantic, *A. agilis* is presently known only from Atol da Rocas (Anker *et al*., 2009).

Alpheus amblyonyx Chace, 1972

Alpheus amblyonyx Chace, 1972: 59, fig. 16.

Distribution: Western Atlantic - Gulf of Mexico, Yucatan Peninsula, Caribbean Sea, and Brazil (Seamounts of the North Chain, Atol das Rocas, Fernando de Noronha, Ceará to Espírito Santo) (Christoffersen, 1979, 1998; Coelho Filho, 2006).

Previous records: Seamounts of the North Chain (Coelho Filho, 2006), Atol das Rocas (Christoffersen, 1979, 1998; Coelho *et al*., 2002; Paiva *et al*., 2007; Souza *et al*., 2011), Fernando de Noronha (Coelho Filho, 2006; Paiva *et al*., 2007; Souza *et al*., 2011), Ceará (Coelho *et al*., 2006; Coelho Filho, 2006), Paraíba (Christoffersen, 1979, 1998; Coelho *et al*., 2006), Bahia (Christoffersen, 1979, 1998; Coelho *et al*., 2006; Serejo *et al*., 2006, 2007; Almeida *et al*., 2012), Espírito Santo (Christoffersen, 1979, 1998; Serejo *et al*., 2006, 2007), Vitória-Trindade Chain and Trindade Island and Martin Vaz Archipelago (Serejo *et al*., 2007). Locality not provided: Coelho and Ramos-Porto (1995).

Remarks: Due to their similarity, part of the western Atlantic records of *A. macrocheles* (Hailstone, 1835) may refer to *A. amblyonyx* (see also remarks on *A. macrocheles*). The only published illustrations of the Brazilian material were provided by Christoffersen (1979; Bahia: fig. 1).

Alpheus angulosus McClure, 2002 * (Fig. 4A)

Alpheus angulosus McClure, 2002: 368.

Distribution: Western Atlantic - North Carolina to Florida, Gulf of Mexico, Caribbean Sea, French Guyana, and Brazil (Atol das Rocas, Fernando de Noronha, Ceará, Paraíba, Bahia, Rio de Janeiro, São Paulo, Santa Catarina, and Rio Grande do Sul) (Anker, 2012).

Previous records: Atol das Rocas (Mathews and Anker, 2009, as *A.* cf. *angulosus* A2), Ceará (Anker, 2012), Paraíba (Rodrigues *et al*., 2009, as *A.* cf. *angulosus*, see Anker, 2012), Bahia (Almeida *et al*., 2012, as *A.* cf. *armillatus*, in part; Anker, 2012), Rio de Janeiro and São Paulo (Anker, 2012), Santa Catarina (Anker, 2012; Boos *et al*., 2012) and Rio Grande do Sul (Anker, 2012).

Remarks: Records of *A. armillatus* (e.g., Coelho and Ramos, 1972; Christoffersen and Ramos, 1988; Christoffersen, 1998; Coelho *et al*., 2006 and many others) from Brazil may represent, at least in part, *A. angulosus*. On the other hand, material from Bahia reported as *A.* cf. *armillatus* (Almeida *et al*., 2012) corresponds, in part, to *A. angulosus* (G.O.

Soledade and A.O. Almeida, pers. obs.). Illustrations of the Brazilian material were provided by Anker (2012; Atol das Rocas: figs. 19, 20; Ceará: figs. 26A, 68E, F; Bahia: fig. 26B). Anker (2012) reported the occurrence of the species in Fernando de Noronha, but did not mention material or provide a reference from there.

Alpheus armatus Rathbun, 1901

Alpheus armatus Rathbun, 1901: 108, fig. 20.

Distribution: Western Atlantic – Florida, Yucatan Peninsula, Bahamas, Caribbean, and Brazil (Alagoas) (Chace, 1972; Rodríguez, 1980, Coelho *et al.*, 1983; Martínez-Iglesias *et al.*, 1997).

Previous records: Alagoas (Coelho *et al.*, 1983, 1990, 2006).

Remarks: Material reported by Coelho *et al.* (1983) and subsequently by Coelho *et al.* (1990, 2006) may correspond to *A. rudolphi* (see Almeida and Anker, 2011). For this reason, the occurrence of *A. armatus* in Brazil remains to be confirmed.

Alpheus bouvieri A. Milne-Edwards, 1878 * (Fig. 4B)

Alpheus bouvieri A. Milne-Edwards, 1878: 231.

Distribution: Western Atlantic – Bermuda, Florida, West Indies, Panama, and Brazil (Atol da Rocas, Fernando de Noronha, and Ceará to Rio Grande do Sul). Central Atlantic - Ascension Island. Eastern Atlantic - Cape Verde, Senegal to Gulf of Guinea and Congo (Crosnier and Forest, 1966; Chace, 1972; Christoffersen, 1979, 1998; Manning and Chace, 1990; Anker *et al.*, 2009).

Previous records: Atol da Rocas (Fausto Filho, 1980; Christoffersen, 1998; Paiva *et al.*, 2007; Anker *et al.*, 2009; Souza *et al.*, 2011), Fernando de Noronha [Pocock, 1890, as *A. edwardsii* (Audouin, 1826), in part, see Coutière, 1898 and Crosnier and Forest, 1966; Coutière, 1898; Crosnier and Forest, 1966; Fausto Filho, 1974; Christoffersen, 1998; Coelho *et al.*, 2002; Alves *et al.*, 2008; Souza *et al.*, 2011], Ceará (Fausto Filho and Furtado, 1970; Coelho *et al.*, 2006), Rio Grande do Norte (Christoffersen, 1979; Coelho *et al.*, 1986, 2006; Ferreira and Sankarankutty, 2002), Paraíba (Rathbun, 1900, as *A. heterochaelis*, in part, see Christoffersen, 1979; Christoffersen, 1979; Coelho *et al.*, 2006; Riul *et al.*, 2008), Pernambuco (Rathbun, 1900, as *A. heterochaelis*, see Christoffersen, 1979; Christoffersen, 1979; Calado, 1996; Coelho-Santos and Coelho, 1998; Coelho *et al.*, 2002, 2006; Nascimento and Torres, 2007; Almeida *et al.*, 2008; Anker *et al.*, 2009), Alagoas (Sousa and Calado, 1998; Calado and Sousa, 2003; Coelho *et al.*, 2006), Bahia (Christoffersen, 1979; Almeida *et al.*, 2006, 2012; Coelho *et al.*, 2006; Santos *et al.*, 2012), Espírito Santo (Christoffersen, 1979), Rio de Janeiro (Christoffersen, 1979; Anker *et al.*, 2009); São Paulo (Luederwaldt, 1919, as *A. heterochaelis*, in part, see Christoffersen, 1984; Christoffersen, 1979; Costa *et al.*, 2000; Mossolin *et al.*, 2006; Amaral *et al.*, 2010), Paraná (Christoffersen, 1979; Masunari and Dubiaski-Silva, 1998; Masunari *et al.*, 1998), Santa Catarina (Christoffersen, 1979; Boos *et al.*, 2012), Rio Grande do Sul (Christoffersen, 1979). Locality not provided: Coelho and Ramos-Porto (1995), Christoffersen (1998).

Remarks: Illustrations of the Brazilian material were provided by Christoffersen (1979) [São Paulo: figs. 2-5, in part reproduced by Coelho-Santos and Coelho (1998, figs. 12-13)], Calado and Sousa (2003) (Alagoas, 1 fig., unnumbered, impossible to verify species identity), Almeida *et al.* (2012; Bahia, fig. 2a) and Santos *et al.* (2012; Bahia, fig. 3b).

Alpheus brasileiro Anker, 2012 * (Fig. 4C)

Alpheus brasileiro Anker, 2012: 74, figs. 54-56, 64I, 65J, 66J, 67H, 68C.

Distribution: Western Atlantic - Brazil (Pará, Ceará, Rio Grande do Norte, Alagoas, Bahia, Rio de Janeiro, São Paulo, and Santa Catarina) (Anker, 2012).

Previous records: Pará, Ceará, Rio Grande do Norte, Alagoas, Bahia, Rio de Janeiro, São Paulo, and Santa Catarina (Anker, 2012).

Remarks: Records of *A. armillatus* (e.g., Coelho and Ramos, 1972; Christoffersen,

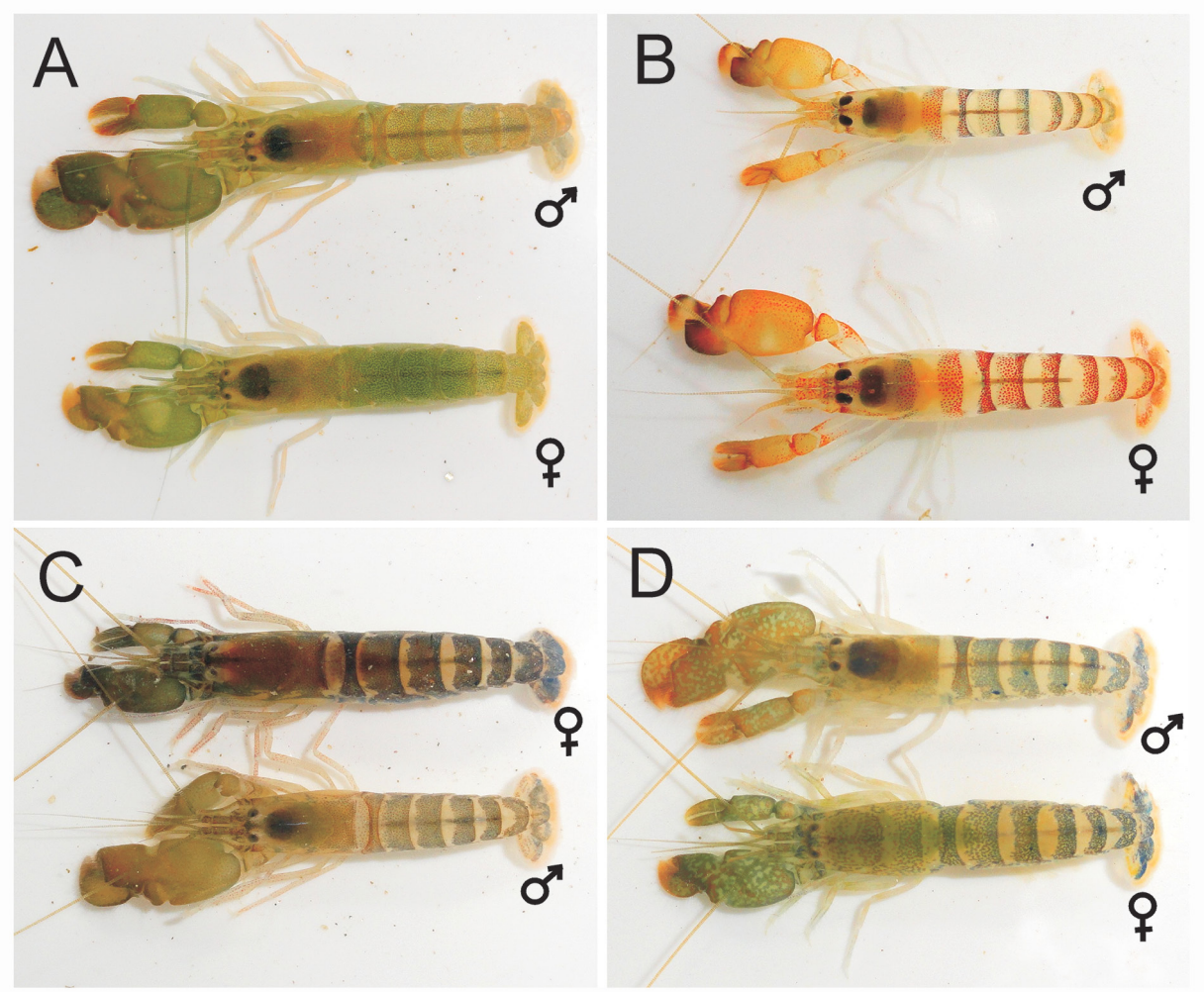

Figure 4. Color pattern of some snapping shrimps of the genus *Alpheus* Fabricius, 1798 from Brazil: (A) *Alpheus angulosus* McClure, 2002; (B) *Alpheus bouvieri* A. Milne-Edwards, 1878; (C) *Alpheus brasileiro* Anker, 2012; (D) *Alpheus carlae* Anker, 2012.

1998; Coelho *et al.*, 2006) from Brazil may represent, at least in part, *A. brasileiro*. Illustrations of the type material, from Ceará, were provided by Anker (2012, figs. 54-56, 68C).

Alpheus buckupi Almeida, Terossi, Araújo-Silva and Mantelatto, 2013 *

Alpheus buckupi Almeida, Terossi, Araújo-Silva and Mantelatto, 2013: 440, figs. 1-4.

Distribution: Western Atlantic – Venezuela (Orinoco Delta) and Brazil (Ceará, Rio Grande do Norte, Pernambuco, Alagoas, Bahia and São Paulo). Eastern Atlantic – São Tomé and Príncipe (Almeida *et al.*, 2013).

Previous records: Ceará, Rio Grande do Norte, Pernambuco, Alagoas, Bahia and São Paulo (Almeida *et al.*, 2013).

Remarks: Alpheus buckupi (type locality: Timbó River, Pernambuco), distributed in the western and eastern Atlantic, was recently recognized as new based on morphological and molecular data. The resemblance between that species and members of the *A. lobidens* De Haan, 1850 complex indicated they are cryptic taxa (Almeida *et al.*, 2013). Illustrations, including drawings and colour photographs, from Brazilian material were provided by Almeida *et al.* (2013; Pernambuco, holotype and paratypes, figs 1-3, 4B; Bahia: figs 4A, C-E).

Alpheus candei Guérin-Méneville, 1855

Alpheus candei Guérin-Méneville, 1855 [in Guérin-Méneville, 1855-1856]: xix; pl. 2, figs. 9-9a.

Distribution: Western Atlantic – Florida (Dry Tortugas), Cuba, Dominica?, Colombia, and Brazil (Seamounts of the North Chain) (Chace, 1972; Martínez-Iglesias *et al.*, 1997; Coelho Filho, 2006).

Previous records: Seamounts of the North Chain (Coelho Filho, 2006).

Remarks: Alpheus candei has only been recorded from Brazil in listings (Coelho and Ramos, 1972; Coelho Filho, 2006). Actually, the record of Coelho and Ramos (1972) from Rio de Janeiro consists of a misidentification (= *A. puapeba*, see Christoffesersen, 1979). For this reason, Christoffersen (1998) did not include the species in his list of Brazilian species of *Alpheus*. A new record of *A. candei* was provided by Coelho Filho (2006) from the seamounts of the North Chain, although with no reference to morphological characters or illustrations.

Alpheus carlae Anker, 2012 * (Fig. 4D)

Alpheus carlae Anker, 2012, 61, figs. 41-48, 64H, 65H, 67G, 68D.

Distribution: Western Atlantic - southern Florida, Puerto Rico, Jamaica, Belize, Panama, Venezuela, French Guyana, and Brazil (Ceará to São Paulo) (Anker, 2012).

Previous records: Ceará, Pernambuco, and Alagoas (Anker, 2012), Bahia (Almeida *et al.*, 2006, as *A. armillatus*, in part; 2007a, as *A.* cf. *armillatus*, in part; 2012, as *A.* cf. *armillatus*, in part; Anker, 2012; Santos *et al.*, 2012), Rio de Janeiro (Anker, 2012), São Paulo (Holthuis, 1956, as *A. armillatus*, see Anker, 2012; Mossolin *et al.*, 2006, as *A. armillatus*, see Anker, 2012; Pavanelli *et al.*, 2008, as *A. armillatus*, see Anker, 2012; Anker, 2012).

Remarks: Other records of *A. armillatus* (e.g., Coelho and Ramos, 1972; Christoffersen and Ramos, 1988; Christoffersen, 1998; Coelho *et al.*, 2006, and many others) from Brazil may represent, at least in part, *A. carlae*. Material from Bahia (Almeida *et al.*, 2006, 2007a, 2012) refers in part to *A. carlae* (G.O. Soledade and A.O. Almeida, pers. obs.). Based on the description of the color pattern, material referred to as "*A. armillatus sensu stricto*" by Rodrigues *et al.* (2009) is possibly *A. carlae* (see Anker, 2012). Information on population structure and on egg production for a population from northern São Paulo was published by Mossolin *et al.* (2006) and Pavanelli *et al.* (2008) (both as *A. armillatus*, see Anker, 2012). Illustrations of the Brazilian material were provided by Anker (2012; Pernambuco: figs. 43H-J; Ceará: figs. 43K, L, M-O, 68D; Bahia: 47D, E) and Santos *et al.* (2012; Bahia: fig. 3C).

Alpheus chacei Carvacho, 1979 * (Fig. 5A)

Alpheus chacei Carvacho, 1979: 455, figs. 4-6.

Distribution: Western Atlantic - French Antilles (Guadeloupe) and Brazil (Pará and Paraíba to São Paulo) (Christoffersen, 1979, as *A. maxilliplanus*; 1984; 1998; Barros and Pimentel, 2001).

Previous records: Pará (Barros and Pimentel, 2001), Paraíba (Christoffersen, 1979, as *A. maxilliplanus*; 1984, 1998; Coelho *et al.*, 2006), Pernambuco (Coelho *et al.*, 2006; Souza *et al.*, 2011), Sergipe (Christoffersen, 1979, as *A. maxilliplanus*; 1998; Melo *et al.*, 2003; Coelho *et al.* 2006), Bahia (Almeida *et al.*, 2007a; 2012), Rio de Janeiro (Christoffersen, 1979, as A. maxilliplanus; 1998) and São Paulo (Christoffersen, 1979, as A. maxilliplanus; 1998; Wakabara et al., 1996). Locality not provided: Coelho and Ramos-Porto (1995).

Remarks: The only illustrations of this species from Brazil were provided by Christoffersen (1979, figs. 11-13), when describing *A. maxilliplanus*, a junior synonym of *A. chacei* (see Christoffersen, 1984), described by him from Sergipe.

Alpheus christofferseni Anker, Hurt and Knowlton, 2007a

Alpheus christofferseni Anker, Hurt and Knowlton, 2007a: 3, figs. 1-6, 11a-c, 12b, c.

Distribution: Western Atlantic – Panama and Brazil (Atol das Rocas) (Anker *et al.*, 2007a).

Previous records: Atol das Rocas (Anker *et al.*, 2007a).

Remarks: Illustrations of the type material from Atol das Rocas were provided by Anker *et al.* (2007a, figs. 1-3).

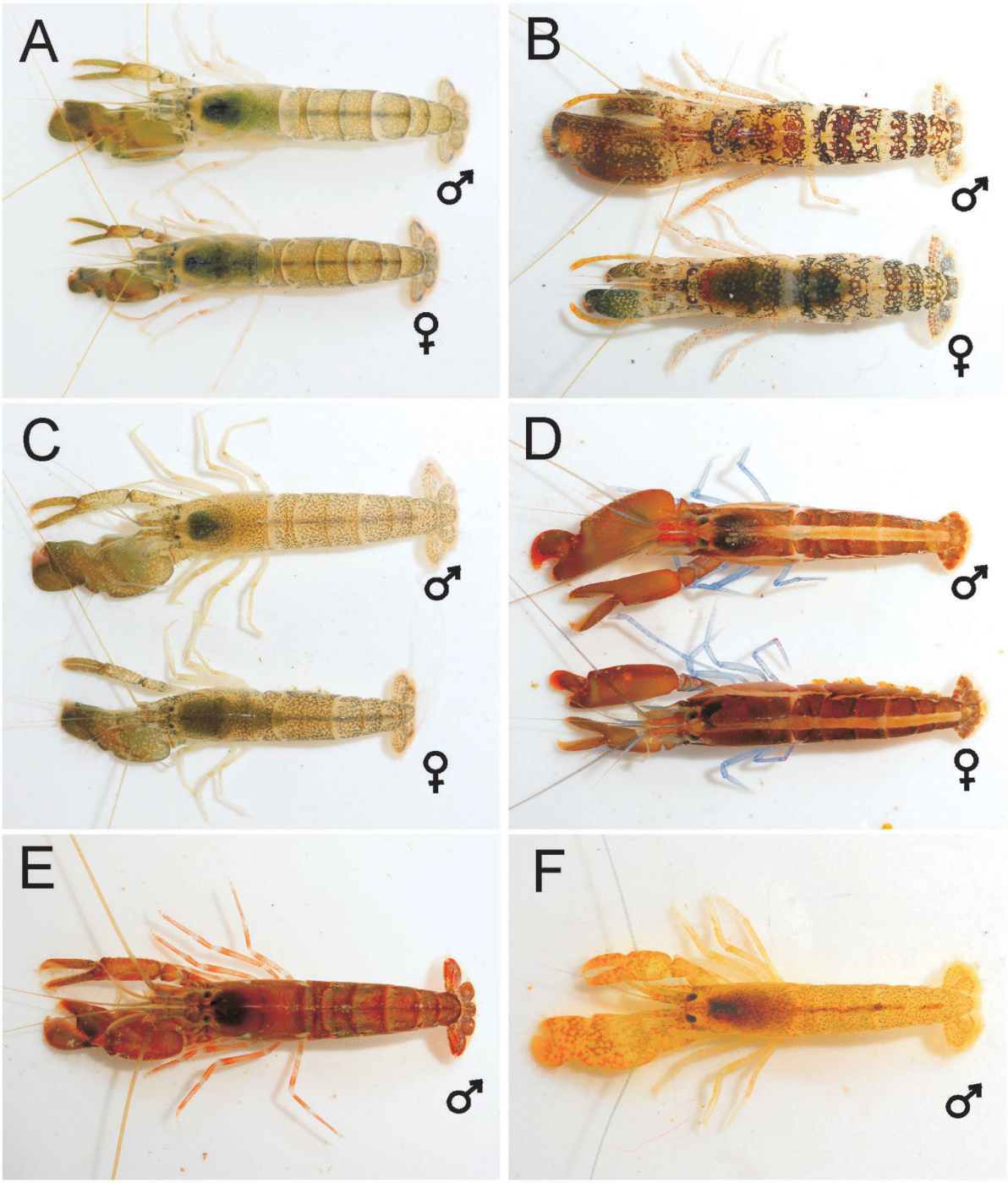

Figure 5. Color pattern of some snapping shrimps of the genus *Alpheus* Fabricius, 1798 from Brazil: (A) *Alpheus chacei* Carvacho, 1979; (B) *Alpheus cristulifrons* Rathbun, 1900; (C) *Alpheus estuariensis* Christoffersen, 1984; (D) *Alpheus formosus* Gibbes, 1850; (E) *Alpheus intrinsecus* Spence Bate, 1888; (F) *Alpheus nuttingi* (Schmitt, 1924).

Alpheus cristulifrons Rathbun, 1900 * (Fig. 5B)

Alpheus cristulifrons Rathbun, 1900: 152.

Distribution: Western Atlantic – Florida, Gulf of Mexico, West Indies, Central America, northern South America, and Brazil (Atol das Rocas, Fernando de Noronha, and Rio Grande do Norte to Rio de Janeiro) (Christoffersen, 1998; Anker *et al.*, 2008a).

Previous records: Atol das Rocas (Christoffersen, 1998; Paiva *et al.*, 2007; Anker *et al.*, 2008a; Souza *et al.*, 2011), Fernando de Noronha (Pocock, 1890, as *A. obeso-manus*, see Rathbun, 1900; Crosnier and Forest, 1966;

Fausto Filho, 1974; Christoffersen, 1998; Coelho *et al.*, 2002; Alves *et al.*, 2008; Anker *et al.*, 2008a; Souza *et al.*, 2011), Rio Grande do Norte (Fausto Filho, 1970; Coelho *et al.*, 1986, 2006; Christoffersen, 1998), Paraíba (Young, 1986; Christoffersen, 1998; Coelho *et al.*, 2006), Pernambuco (Fausto Filho, 1980; Christoffersen, 1998; Coelho *et al.*, 2006; Anker *et al.*, 2008a; Souza *et al.*, 2011), Alagoas (Rathbun, 1900; Christoffersen, 1979, 1998; Fausto Filho, 1980; Coelho *et al.*, 1990, 2006; Anker *et al.*, 2008a), Bahia (Almeida *et al.*, 2012; Santos *et al.*, 2012), Espírito Santo (Christoffersen, 1979; Serejo *et al.*, 2006) and Rio de Janeiro (Christoffersen, 1979). Locality not provided: Coelho and Ramos (1972), Coelho and Ramos-Porto (1995).

Remarks: The record of Serejo *et al.* (2006) from Espírito Santo (not Bahia as in Almeida *et al.*, 2012) is below the typical depth reported for *A. cristulifrons* and therefore needs confirmation. Anker *et al.* (2008a) provided line drawings of material from Atol das Rocas. Color photographs of material from Bahia were provided by Almeida *et al.* (2012, fig. 2B) and Santos *et al.* (2012, fig. 3D).

Alpheus estuariensis Christoffersen, 1984 *
(Fig. 5C)

Alpheus estuariensis Christoffersen, 1984: 191, figs. 1-2.

Distribution: Western Atlantic – Florida, Mississippi to Texas, Cuba, Dominican Republic, Trinidad and Tobago, Curaçao, and Brazil (Pará to Paraná) (Christoffersen, 1984; Pires *et al.*, 2008).

Previous records: Pará (Pires *et al.*, 2008), Maranhão (Coelho *et al.*, 2006), Ceará (Christoffersen, 1984, 1998; Coelho *et al.*, 2006), Rio Grande do Norte (Christoffersen, 1984, 1998; Coelho *et al.*, 1986, 2006; Melo *et al.*, 2003), Paraíba (Rathbun, 1900, as *A. heterochaelis*, in part, see Christoffersen, 1984; Christoffersen, 1984, 1998; Coelho *et al.*, 2006), Pernambuco (Christoffersen, 1984, 1998; Coelho and Coelho-Santos, 1990; Coelho-Santos and Coelho, 2001; Coelho *et al.*, 2002, 2006; Souza *et al.*, 2011), Alagoas (Sousa *et al.*, 2000; Calado and Sousa, 2003; Coelho *et al.*, 2006), Sergipe (Arraes and Ramos-Porto, 1994), Bahia (Almeida *et al.*, 2006, 2007a, 2012; Coelho *et al.*, 2006), Rio de Janeiro and São Paulo (Christoffersen, 1984, 1998), Paraná (Christoffersen, 1984, 1998; Azambuja Corrêa and Loyola e Silva, 1995; Blankensteyn and Moura, 2002). Locality not provided: Coelho and Ramos-Porto (1995).

Remarks: Illustrations of the type material from the Potengi River estuary, Rio Grande do Norte, were provided by Christoffersen (1984, figs. 1-2). Calado and Sousa (2003) also provided a photograph (unnumbered) of a preserved specimen. Pires *et al.* (2008, figs. 1-4) described the first four zoeal stages based on material from Pará.

Alpheus cf. *floridanus* Kingsley, 1878a *

Alpheus floridanus Kingsley, 1878a: 193.

Distribution: Western Atlantic – southern Florida, Bahamas, Mexico (Veracruz and Quintana Roo), West Indies (Cuba to Curaçao), and Brazil (Atol das Rocas, and Piauí to Rio Grande do Sul) (Christoffersen, 1979, 1998, as *A. floridanus*; Martínez-Iglesias *et al.*, 1997, as *A. floridanus*).

Previous records: Seamounts of the North Chain (Coelho Filho, 2006), Atol das Rocas (Crosnier and Forest, 1966; Coelho and Ramos, 1972; Christoffersen, 1979, 1998; Coelho Filho, 2006; Paiva *et al.*, 2007; Souza *et al.*, 2011), Fernando de Noronha (Coelho *et al.*, 2002; Alves *et al.*, 2008; Souza *et al.*, 2011), Piauí (Ramos-Porto *et al.*, 1996; Coelho Filho, 2006), Paraíba (Coelho Filho, 2006), Pernambuco (Ramos-Porto *et al.*, 1996; Coelho *et al.*, 2002, 2006; Souza *et al.*, 2011), Alagoas (Coelho *et al.*, 1983; 1990; 2006; Silva and Calado, 2002), Bahia (Christoffersen, 1979; Carqueija *et al.*, 1995; Coelho *et al.*, 2006; Serejo *et al.*, 2006, 2007; Almeida *et al.*, 2007a, 2012), Espírito Santo (Serejo *et al.*, 2007), Rio de Janeiro (Christoffersen, 1979, 1982), São Paulo (Ejchel, 1965; Christoffersen, 1979, 1982; Pires-Vanin *et al.*, 1997; Costa *et al.*, 2000), Paraná (Christoffersen, 1979, 1982; ? Masunari and Dubiaski-Silva, 1998; ? Masunari *et al.*, 1998), Santa Catarina (Christoffersen, 1979, 1982; Boos *et al.*,

2012), and Rio Grande do Sul (Christoffersen, 1979, 1982). Locality not provided: Coelho *et al*. (1980), Coelho and Ramos-Porto (1995), Spivak (1997). All references above as *A. floridanus*, except Crosnier and Forest (1966) and Coelho and Ramos (1972) (as *A. floridanus floridanus* Kingsley, 1878a), and Masunari and Dubiaski-Silva (1998), Masunari *et al.* (1998) and Almeida *et al.* (2007a, 2012) (as *A.* cf. *floridanus*). Crosnier and Forest (1966) and Coelho and Ramos (1972) also reported the occurrence of the subspecies *A. floridanus africanus* Balss, 1916 from Pernambuco to Bahia.

Remarks: Alpheus floridanus is a species complex (Anker, 2001; Williams *et al*., 2001). The eastern-Pacific and Atlantic records (e.g., Crosnier and Forest, 1966; Kim and Abele, 1988) refer to other species (A. Anker, pers. com.). The identity of the Brazilian material is presently unknown. Christoffersen (1979, figs. 6-8) provided line drawings of material from Rio de Janeiro.

Alpheus formosus Gibbes, 1850 * (Fig. 5D)

Alpheus formosus Gibbes, 1850: 196.

Distribution: Western Atlantic – Bermuda, North Carolina, Florida, Gulf of Mexico, Bahamas, West Indies, Central America, Colombia, Venezuela, and Brazil (Atol das Rocas, Fernando de Noronha, and Ceará to Paraná) (Christoffersen, 1998; Masunari *et al*., 1998; Anker *et al*., 2008c).

Previous records: Atol das Rocas (Anker *et al.*, 2008c), Fernando de Noronha (Pocock, 1890, as *A. panamensis* Kingsley, 1878a; Fausto Filho, 1974, as *A. panamensis*; Christoffersen, 1998; Coelho *et al*., 2002; Alves *et al*., 2008; Souza *et al*., 2011), Ceará (Fausto Filho, 1970, 1980; Coelho *et al*., 2006), Rio Grande do Norte (Rathbun, 1900; Christoffersen, 1979; Fausto Filho, 1980; Coelho *et al*., 1986; 2006), Paraíba (Fausto Filho, 1980; Young, 1986; Riul *et al*., 2008), Pernambuco (Rathbun, 1900; Christoffersen, 1979; Fausto Filho, 1980; Austregésilo-Filho and Ramos-Porto, 1995; Coelho-Santos and Coelho, 1995, 1998; Calado, 1996; Coelho *et al*., 2002, 2006; Almeida *et al*., 2008, as *A.* cf. *formosus*; Anker *et al.*, 2008c; Souza *et al*., 2011), Alagoas (Rathbun, 1900; Christoffersen, 1979; Fausto Filho, 1980; Coelho *et al*., 1983, 1990, 2006), Bahia (Gomes Corrêa, 1972; Christoffersen, 1979; Coelho *et al*., 2006; Almeida *et al*., 2007a, as *A.* cf. *formosus*; 2012; Santos *et al*., 2012), Espírito Santo and Rio de Janeiro (Christoffersen, 1979), São Paulo (Williams, 1965; Christoffersen, 1979; Morgado and Tanaka, 2001), Paraná (Masunari and Dubiaski-Silva, 1998; Masunari *et al*., 1998). Locality not provided: Coelho and Ramos (1972), Coelho and Ramos-Porto (1995), Christoffersen (1998).

Remarks: Illustrations of the Brazilian material were provided by Anker *et al.* (2008d; Atol das Rocas, figs. 1-3), Almeida *et al*. (2012; Bahia, fig. 2C), Santos *et al.* (2012; Bahia, fig. 3E). Coelho-Santos and Coelho (1998) reproduced Williams' (1984) drawings.

Alpheus heterochaelis Say, 1818 *

Alpheus heterochaelis Say, 1818: 243.

Distribution: Western Atlantic – Delaware, North Carolina, Gulf of Mexico, and Brazil (Pará, Paraíba, and Bahia) (Christoffersen, 1984; Silliman *et al.*, 2003; Almeida *et al.*, 2006).

Previous records: Pará (Christoffersen, 1984, 1998; Barros and Pimentel, 2001; Coelho *et al*., 2006), Paraíba (Christoffersen, 1984, 1998; Coelho *et al*., 2006), Bahia (Almeida *et al*., 2006; 2012).

Remarks: Many previous records of *A. heterochaelis* from Brazil were based on misidentifications and confusion of *A. armillatus* with various congeners [for more details see Chace (1972) and Christoffersen (1984, 1998)]. We listed in previous records only material examined by Christoffersen (1984) and by us (reported by Almeida *et al*., 2006, 2012), and the references from Brazil based on these reports (Christoffersen, 1998; Barros and Pimentel, 2001; Coelho *et al*., 2006). All other records (e.g., Kingsley, 1878b; Moreira, 1901; Luederwaldt, 1929; Oliveira, 1940; Coelho, 1964, 1966a, 1966b; Coelho *et al*., 1970, 1986, 2002; Coelho and Ramos, 1972; Gomes Corrêa, 1972; Ramos-Porto *et al*.,

1978; Abreu, 1980; Coelho and Ramos-Porto, 1980a, 1995; Fausto Filho, 1980; Ramos-Porto, 1980; Coelho and Coelho-Santos, 1990; Sousa *et al.*, 2000; Bosa and Masunari, 2002; Ferreira and Sankarankutty, 2002; Calado and Sousa, 2003; Young and Serejo, 2005; Mortari and Negreiros-Fransozo, 2007; Souza *et al.*, 2011) must be treated with much caution because they potentially include misidentified material. The records of Smith (1869) from Bahia, Rathbun (1900) from Paraíba (in part), and Luederwaldt (1919) from São Paulo (in part) correspond to species of the *A. armillatus* complex (see Christoffersen, 1984; Anker, 2012). Finally, morphological and molecular evidence indicates that *A. heterochaelis* is a species complex (A.O. Almeida, under study), with at least two species involved in the western Atlantic. For this reason, the occurrence of *A. heterochaelis* still needs to be confirmed. Material from Brazil was illustrated by Christoffersen (1984; Pará, figs. 5-7).

Alpheus intrinsecus Spence Bate, 1888 *
(Fig. 5E)

Alpheus intrinsecus Spence Bate, 1888: 557, pl. 100, fig. 1.

Distribution: Western Atlantic - Puerto Rico to Brazil (Piauí to Santa Catarina). Eastern Atlantic - Western Sahara to Gabon (Crosnier and Forest, 1966; Christoffersen, 1979; Coelho *et al.*, 2006).

Previous records: Piauí (Fausto Filho, 1980; Coelho *et al.*, 2006), Ceará (Fausto Filho, 1970, 1978, 1980; Christoffersen, 1979; Sampaio and Fausto-Filho, 1984; Coelho *et al.*, 2006), Rio Grande do Norte (Fausto Filho, 1980; Coelho *et al.*, 1986, 2006), Paraíba (Fausto Filho, 1980), Pernambuco (Coelho and Ramos, 1972; Fausto Filho, 1980; Ramos-Porto, 1980; Coelho-Santos and Coelho, 1995, 1998; Coelho *et al.*, 2002, 2006; Souza *et al.*, 2011), Alagoas (Fausto Filho, 1980; Silva and Calado, 2002; Coelho *et al.*, 2006), Bahia (Spence Bate, 1888; Moreira, 1901; Almeida *et al.*, 2006, 2007a, 2007b, 2012; Coelho *et al.*, 2006; Santos *et al.*, 2012), Espírito Santo and Rio de Janeiro (Christoffersen, 1979, 1982), São Paulo (Moreira, 1906; Luederwaldt, 1919, 1929; Christoffersen, 1979, 1982; Costa *et al.*, 2000) and Santa Catarina (Christoffersen, 1979, 1982; Boos *et al.*, 2012). Locality not provided: Coelho *et al.* (1980), Coelho and Ramos-Porto (1995), Christoffersen (1998).

Remarks: Illustrations of the Brazilian material were provided by Spence Bate (1888; Bahia, fig. 1, original description), Christoffersen (1979; São Paulo and Santa Catarina, figs. 9-10) and Santos *et al.* (2012; Bahia, fig. 3F). The drawings provided by Coelho-Santos and Coelho (1998) were reproduced from Christoffersen (1979).

Alpheus macrocheles (Hailstone, 1835)

Hippólyte macrochèles Hailstone, 1835: 395.

Distribution: Western Atlantic – Antilles (?) and Brazil (Seamounts of the North Chain, Fernando de Noronha, Amapá to Espírito Santo). Central Atlantic – Ascension and Saint Helena. Eastern Atlantic – southwestern England to Gabon, Mediterranean Sea (Ramos-Porto, 1979; Manning and Chace, 1990; d'Udekem d'Acoz, 1999; Guterres *et al.*, 2005; Souza *et al.*, 2011).

Previous records: Seamounts of the North Chain (Coelho Filho, 2006), Fernando de Noronha (Souza *et al.*, 2011), Amapá (Fausto Filho and Sampaio Neto, 1976; Ramos-Porto, 1979; Coelho *et al.*, 2006), Pará (Ramos-Porto, 1979; Ramos-Porto *et al.*, 1996; Barros and Pimentel, 2001; Coelho *et al.*, 2006), Maranhão (Coelho and Ramos, 1972; Ramos-Porto, 1979; Coelho and Ramos-Porto, 1980b; Ramos-Porto *et al.*, 1996; Coelho *et al.*, 2006), Ceará (Ramos-Porto, 1979; Fausto Filho, 1980; Ramos-Porto *et al.*, 1996; Coelho *et al.*, 2006), Rio Grande do Norte (Fausto Filho, 1980; Coelho *et al.*, 1986; 2006), Paraíba (Fausto Filho, 1980), Pernambuco (Coelho and Ramos, 1972; Ramos-Porto, 1979, 1980; Fausto Filho, 1980; Coelho *et al.*, 2002, 2006; Alves *et al.*, 2008; Souza *et al.*, 2011), Bahia (Guterres *et al.*, 2005; Almeida *et al.*, 2012), and Espírito Santo (Guterres *et al.*, 2005). Locality not provided: Coelho *et al.* (1980), Coelho and Ramos-Porto (1995), Christoffersen (1998).

Remarks: Alpheus macrocheles is very similar to *A. amblyonyx,* and its occurrence in the western Atlantic has long been discussed. In fact, some authors considered all western-Atlantic material as belonging to the latter species (e.g., Chace, 1972; Christoffersen, 1979). On the other hand, possible morphological differences between material of *A. macrocheles* from Brazil and *A. amblyonyx* were also observed (Ramos-Porto, 1979). According to Anker and De Grave (2012), all records of *A. macrocheles* in the western Atlantic must be treated with caution because they may actually represent *A. amblyonyx* or other species of the complex present in the western Atlantic. Drawings of the Brazilian material from Maranhão ("Estampas" 1-3, 5, 6) and Amapá ("Estampa" 4) were provided by Ramos-Porto (1979).

Alpheus malleator Dana, 1852a *

Alpheus malleator Dana, 1852a: 23.

Distribution: Western Atlantic – Gulf of Mexico, Florida, Caribbean Sea (Panama, Cuba, Puerto Rico, Trinidad and Tobago, Barbados), and Brazil (Fernando de Noronha ?, Rio de Janeiro and São Paulo). Eastern Atlantic – Cape Verde, Senegal, Guinea, São Tomé, Annobon and Congo (Anker and Pachelle, 2013).

Previous records: Fernando de Noronha? (Coutière, 1898; Christoffersen, 1998; Coelho *et al.*, 2006; Alves *et al.*, 2008; Souza *et al.*, 2011 – all references as *A. belli*), Rio de Janeiro (Dana, 1852a; Smith, 1869; Moreira, 1901; Oliveira, 1940, 1945; Christoffersen 1998) and São Paulo (Luederwaldt, 1919; Christoffersen, 1998; Anker and Pachelle, 2013). Locality not provided: Coelho and Ramos (1972).

Remarks: According to Dana (1852a), the type locality of *A. malleator* is probably Rio de Janeiro. Drawings of the holotype were published by Dana (1852b; pl. 35, fig. 9a-h). In a recent revision of the *A. malleator* species complex, *A. malleator* was recognized as the species occurring in the Atlantic basin and a full specific status was given to the eastern Pacific form (*A. wonkimi* Anker and Pachelle, 2013) (Anker and Pachelle, 2013). Moreover, those authors also tentatively synonymized *A. belli* and *A. malleator*. *Alpheus belli* was described by Coutière (1898) from Fernando de Noronha and, since then, it has been reported from Brazil only from that archipelago (Christoffersen, 1998; Coelho *et al.*, 2006; Alves *et al.*, 2008; Souza *et al.*, 2011). Unfortunately, the holotype of *A. belli* is apparently no longer available and the synonymy proposal was based on drawings and comments provided by Coutière (1998) in the original description (see Anker and Pachelle, 2013). Analysis of material from the type locality is highly desirable in order to confirmate the status of that species.

Alpheus nuttingi (Schmitt, 1924) * (Fig. 5F)

Crangon nuttingi Schmitt, 1924: 78, pl. 2, figs. 4-6.

Distribution: Western Atlantic - southern Florida, southwestern Gulf of Mexico, and West Indies to Brazil (Ceará to Santa Catarina) (Coelho *et al.*, 2006; Anker *et al.*, 2007b; Boos *et al.*, 2012).

Previous records: Ceará and Rio Grande do Norte (Coelho *et al.*, 2006), Paraíba (Rathbun, 1900, as *A. heterochaelis*, in part, see Christoffersen, 1984; Coelho *et al.*, 2006; Riul *et al.*, 2008), Pernambuco (Austregésilo-Filho and Ramos-Porto, 1995; Coelho-Santos and Coelho, 1995, 1998; Calado, 1996; Coelho *et al.*, 2002, 2006; Souza *et al.*, 2011), Alagoas (Rathbun, 1900, as *A. heterochaelis*, in part, see Christoffersen, 1984, 1998; Sousa and Calado, 1998; Calado and Sousa, 2003; Coelho *et al.*, 2006); Bahia (Coelho *et al.*, 2006?; Santos *et al.*, 2012), Rio de Janeiro (Cardoso *et al.*, 2011) and São Paulo (Luederwaldt, 1919, as *A. heterochaelis*, in part, see Christoffersen, 1984; Costa *et al.*, 2000; Mossolin *et al.*, 2006; Amaral *et al.*, 2010, 2011; Pavanelli *et al.*, 2010; Nucci and Melo, 2011), Santa Catarina (Boos *et al.*, 2012). Locality not provided: Coelho and Ramos-Porto (1995), Spivak (1997).

Remarks: Pavanelli *et al.* (2010) studied the egg production of *A. nuttingi* at São Sebastião, northern São Paulo. Illustrations of Brazilian material were provided by Coelho-Santos and Coelho (1998; fig. 16, reproduced, according to them, from Christoffersen, 1979

– figure not found there [most likely based on Christoffersen, 1980: Ph.D. thesis]), Calado and Sousa (2003; unnumbered figure, of a preserved specimen from Alagoas), and Santos *et al*. (2012; fig. 3G, color photograph of a specimen from Bahia).

Alpheus cf. *packardii* Kingsley, 1880 * (Fig. 6A)

Alpheus packardii Kingsley, 1880: 417.

Distribution: Western Atlantic – Bermuda, Virginia to South Carolina, Florida, Gulf of Mexico, Bahamas, Mexico (Quintana Roo and Yucatan), West Indies, and Brazil (Atol das Rocas, Fernando de Noronha, and Amapá to São Paulo) (Christoffersen 1979, 1998, as *A. normanni* Kingsley, 1878c; Martínez-Iglesias *et al.* 1997, as *A. normanni*).

Previous records: Seamounts of the North Chain (Coelho Filho, 2006, as *A. beanii* Verrill, 1922), Atol das Rocas (Christoffersen, 1979, 1998, as *A. normanni*; Coelho *et al*., 2002, as *A. normanni*; Paiva *et al*., 2007, as *A. normanni*; Souza *et al*., 2011, as *A.* cf. *packardii*), Fernando de Noronha (Christoffersen, 1979, 1998, as *A. normanni*; Coelho *et al*., 2002, as *A. normanni*; Alves *et al*., 2008, as *A. normanni*; Souza *et al*., 2011, as *A.* cf. *packardii*), Amapá (Christoffersen, 1979, as *A. normanni*; Coelho *et al*., 2006, as *A. normanni*), Pará? (Barros and Pimentel, 2001), Piauí (Ramos-Porto *et al*., 1996, as *A. normanni*; Coelho Filho, 2006, as *A. beanii*), Ceará (Ramos-Porto *et al*., 1996, as *A. normanni*), Rio Grande do Norte (Ramos-Porto *et al*., 1996, as *A. normanni*; Ferreira and Sankarankutty, 2002, as *A. normanni*), Paraíba (Christoffersen, 1979, as *A. normanni*; Coelho *et al*., 2006, as *A. normanni*; Riul *et al*., 2008, as *A. normanni*), Pernambuco (Christoffersen, 1979, as *A. normanni*; Ramos-Porto *et al*., 1996, as *A. normanni*; Coelho *et al*., 2002, 2006, as *A. normanni*; Almeida *et al*., 2008, as *A.* cf. *packardii*; Souza *et al*., 2011, as *A.* cf. *packardii*), Alagoas (Christoffersen, 1979, as *A. normanni*; Coelho *et al*., 1990, 2006, as *A. normanni*; Silva and Calado, 2002, as *A normanni*), Bahia (Christoffersen, 1979, as *A. normanni*; Young and Serejo, 2005, as *A. normanni*; Coelho *et al*., 2006, as *A. normanni*; Almeida *et al*., 2007a, 2012, as *A.* cf. *packardii*; Santos *et al*., 2012, as *A.* cf. *packardii*), Rio de Janeiro (Christoffersen, 1979, 1982, as *A. normanni*), São Paulo (Christoffersen, 1979, 1982, as *A. normanni*; Amaral *et al*., 2010, as *A. normanni*). Locality not provided: Coelho and Ramos-Porto (1995, as *A. normanni*).

Remarks: Most Brazilian records of *A. packardii* were given as *A. normanni*, an eastern-Pacific species (see Kim and Abele, 1988), or as *A. beanii*, a junior synonym of *A. packardii* (see Christoffersen, 1979). However, the taxonomy of *A. normanni* and *A. packardii* remains unsettled due to the presence of cryptic taxa on both sides of the Americas (Williams *et al*., 2001; A. Anker, under study). Currently, the true identity of the material from Brazil remains unknown. Santos *et al*. (2012, fig. 3H) provided a color photograph of material from Bahia.

Alpheus cf. *paracrinitus* Miers, 1881 * (Fig. 6B)

Alpheus paracrinitus Miers, 1881: 365, pl. 16, fig. 6.

Distribution: Western Atlantic – Bermuda, West Indies, Panama and Brazil (Fernando de Noronha, Paraíba and Espírito Santo). Central Atlantic – Ascension Island. Eastern Atlantic – Cape Verde to Gulf of Guinea and Angola. Eastern Pacific and Indo-West Pacific (Crosnier and Forest, 1966; Chace, 1972, 1988; Banner and Banner, 1982; Kim and Abele, 1988; Manning and Chace 1990; Christoffersen, 1998 – all references as *A. paracrinitus*).

Previous records: Fernando de Noronha (Coelho Filho, 2006; Alves *et al*., 2008; Souza *et al*., 2011), Paraíba (Young, 1986; Christoffersen, 1998; Coelho *et al*., 2006), Pernambuco (Coelho *et al*., 2006; Souza *et al*., 2011), Bahia (Almeida *et al*., 2012; Santos *et al*., 2012), Espírito Santo (Christoffersen, 1998). All references above as *A. paracrinitus*, except Almeida *et al*. (2012) and Santos *et al*. (2012), as *A.* cf. *paracrinitus.*

Remarks: Color-pattern analyses as well as preliminary molecular data indicate that *A. paracrinitus* is a species complex (Knowlton and Mills, 1992; Anker, 2001; Williams *et al.,* 2001; Almeida *et al*., 2012; A. Anker, under

study). For this reason, the true identity of the Brazilian material remains uncertain and all records of this species from Brazil must be treated with caution (Almeida *et al*., 2012). Color photographs of material from Bahia were provided by Almeida *et al*. (2012, fig. 2D) and Santos *et al*. (2012, fig. 3I).

Alpheus peasei (Armstrong, 1940) * (Fig. 6C)

Crangon peasei Armstrong, 1940: 1.

Distribution: Western Atlantic - Bermuda and Florida Keys to Tobago, westward to Providencia Island and the Yucatan Peninsula, Brazil (Bahia) (Chace, 1972; Rodríguez, 1980; Santos *et al*., 2012).

Previous records: Bahia (Santos *et al*., 2012).

Remarks: In the southwestern Atlantic, *A. peasei* has only been recorded from Bahia (Santos *et al*., 2012, fig. 3F).

Alpheus pontederiae de Rochebrune, 1883 * (Fig. 6D)

Alpheus pontederiae de Rochebrune, 1883: 174.

Distribution: Western Atlantic - Venezuela to Brazil (Pará, Maranhão, Paraíba, Alagoas, Bahia, São Paulo, Paraná). Eastern Atlantic - Senegal to Congo (Crosnier and Forest, 1966; Christoffersen, 1984; Almeida *et al*., 2006).

Previous records: Pará (Christoffersen, 1984, 1998; Barros and Pimentel, 2001; Coelho *et al*., 2006), Maranhão (Christoffersen, 1984, 1998; Coelho *et al*., 2006), Paraíba (Coelho *et al*., 2006), Alagoas (Sousa *et al*., 2000; Calado and Sousa, 2003; Coelho *et al*., 2006), Bahia (Almeida *et al*., 2006, 2012), São Paulo and Paraná (Christoffersen, 1984, 1998).

Remarks: Material from São Paulo was illustrated by Christoffersen (1984, figs. 3-4). Calado and Sousa (2003) provided a photograph (unnumbered) of a specimen from Alagoas.

Alpheus pouang Christoffersen, 1979

Alpheus pouang Christoffersen, 1979: 324, figs. 14-15.

Distribution: Western Atlantic - Brazil (São Paulo to Rio Grande do Sul) and Uruguay (Christoffersen, 1979, 1998).

Previous records: São Paulo (Christoffersen, 1979, 1982, 1998; Melo *et al*., 2003), Paraná (Christoffersen, 1979, 1982, 1998), Santa Catarina (Christoffersen, 1979, 1982, 1998; Boos *et al*., 2012), Rio Grande do Sul (Christoffersen, 1979, 1998). Locality not provided: Spivak (1997).

Remarks: The original description of *A. pouang* contains illustrations of the holotype, from off São Paulo and of a paratype from Rio Grande do Sul (Christoffersen, 1979, figs. 14 and 15 respectively).

Alpheus puapeba Christoffersen, 1979 *

Alpheus puapeba Christoffersen, 1979: 328, figs. 16-18.

Distribution: Western Atlantic - Brazil (Espírito Santo to Rio Grande do Sul) to Argentina (Province of Buenos Aires) (Christoffersen, 1979, 1998).

Previous records: Espírito Santo (Christoffersen, 1979, 1998), Rio de Janeiro (Moreira, 1906, as *A. dentipes* Guérin, 1832, see Christoffersen, 1979; Coelho and Ramos, 1972, as *A. candei*, see Christoffersen, 1998; Christoffersen, 1979, 1982, 1998), São Paulo, Santa Catarina and Rio Grande do Sul (Christoffersen, 1979, 1982, 1998). Locality not provided: Spivak (1997).

Remarks: The only illustrations available are those in the original description, of the holotype and a paratype from Argentina (Christoffersen, 1979, figs. 16-18).

Alpheus cf. *rostratus* Kim and Abele, 1988 * (Fig. 6E)

Alpheus rostratus Kim and Abele, 1988: 51, fig. 21.

Distribution: Western Atlantic - Brazil (Bahia) (Almeida *et al*., 2012; Santos *et al*., 2012).

Previous records: Bahia (Almeida *et al*., 2012; Santos *et al*., 2012).

Remarks: Alpheus cf. *rostratus* may represent a new species of the *A. paracrinitus* complex. The occurrence of this form, recognized by its color pattern, has only

been documented from Bahia [see color photographs provided by Almeida *et al*. (2012, fig. 2E) and Santos *et al*. (2012, fig. 4A)], but it is possibly widespread along the northeastern Brazilian coast where suitable hard substrata are available. For more details, see Almeida *et al*. (2012) and Santos *et al*. (2012).

Alpheus rudolphi Almeida and Anker, 2011 *

Alpheus rudolphi Almeida and Anker, 2011: 3, figs. 1-22.

Distribution: Western Atlantic - Brazil (Alagoas) (Almeida and Anker, 2011).

Previous records: Alagoas (Almeida and Anker, 2011).

Remarks: Presently known only from the type locality (off Alagoas) (Almeida and Anker, 2011).

Alpheus simus Guérin-Méneville, 1855 * (Fig. 6F)

Alpheus simus Guérin-Méneville, 1855

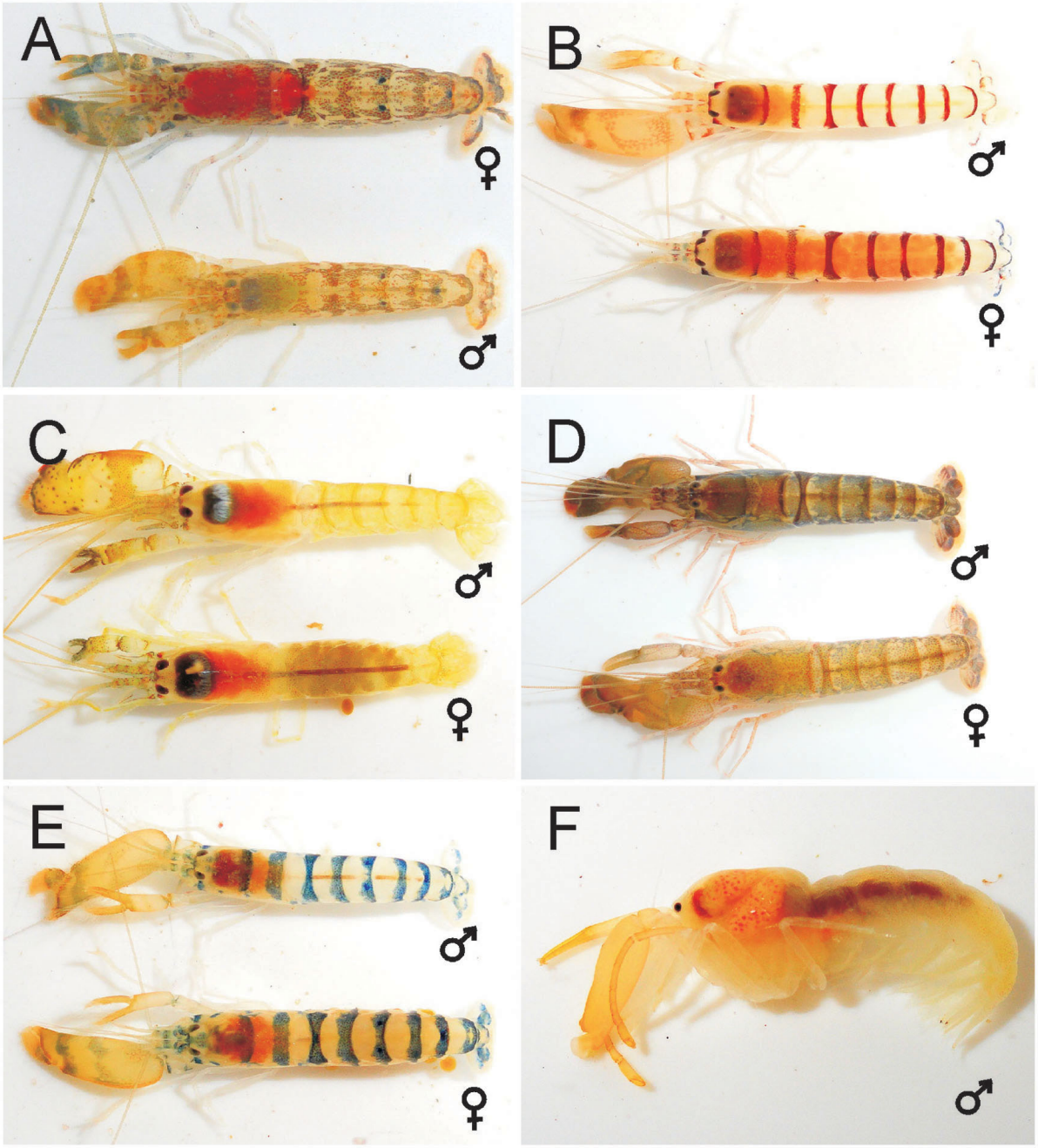

Figure 6. Color pattern of some snapping shrimps of the genus *Alpheus* Fabricius, 1798 from Brazil: (A) *Alpheus* cf. *packardii* Kingsley, 1880; (B) *Alpheus* cf. *paracrinitus* Miers, 1880; (C) *Alpheus peasei* (Armstrong, 1940); (D) *Alpheus pontederiae* Rochebrune, 1883; (E) *Alpheus* cf. *rostratus* Kim and Abele, 1988; (F) *Alpheus simus* Guérin-Méneville, 1855.

[in Guérin-Méneville, 1855-1856]: xix; pl. 2, fig. 11.

Distribution: Western Atlantic - Florida, Yucatan, West Indies, Central America, northern South America, and Brazil (Rio Grande do Norte and Bahia) [Chace, 1972, as *Thunor rathbunae* (Schmitt, 1924); Christoffersen, 1979, as *T. rathbunae*; Bezerra and Almeida, 2008].

Previous records: Rio Grande do Norte (Bezerra and Almeida, 2008) and Bahia (Christoffersen, 1979, as *T. rathbunae*; 1998; Coelho *et al.*, 2006; Almeida *et al.*, 2012; Santos *et al.*, 2012). Locality not provided: Coelho and Ramos-Porto (1995).

Remarks: Line drawings and a color photograph of Brazilian material were provided by Bezerra and Almeida (2008, fig. 2) and Santos *et al.* (2012, fig. 4B), respectively.

Alpheus thomasi Hendrix and Gore, 1973 *

Alpheus thomasi Hendrix and Gore, 1973: 415, figs. 1-3.

Distribution: Western Atlantic – Florida, Cuba, Gulf of Mexico, Panama, and Brazil (Paraíba, Espírito Santo to Paraná) (Christoffersen, 1998; Blankensteyn and Moura, 2002; Anker *et al.*, 2008b; Felder *et al.*, 2009).

Previous records: Paraíba (? Young, 1986, as *A.* cf. *thomasi*; Riul *et al.*, 2008), Espírito Santo (Christoffersen, 1998), Rio de Janeiro (Christoffersen, 1998) and São Paulo (Christoffersen, 1998; Morgado and Tanaka, 2001), Paraná (Blankensteyn and Moura, 2002).

Remarks: In view of similarities in the morphology and color pattern, *A. thomasi* may be part of the *A. websteri* species complex (Anker *et al.*, 2008b).

Alpheus vanderbilti Boone, 1930 *

Alpheus vanderbilti Boone, 1930: 163, pl. 58, fig. 5.

Distribution: Western Atlantic – Bermuda, Florida, Gulf of Mexico, Bahamas, Caribbean Sea, and Brazil (Maranhão, Paraíba, Pernambuco, Alagoas, and Bahia). Eastern Atlantic – Gulf of Guinea (São Tomé, Príncipe and Annobon) (Crosnier and Forest, 1966, as *A. cylindricus*; Christoffersen, 1998, as *A. cylindricus*; Anker *et al.*, 2008d).

Previous records: Maranhão (Coelho and Ramos, 1972; Coelho and Ramos-Porto, 1980b; Christoffersen, 1998; Coelho *et al.*, 2006), Paraíba (Christoffersen, 1979, 1998; Coelho *et al.*, 2006), Pernambuco (Coelho *et al.*, 2006; Souza *et al.*, 2011), Alagoas (Coelho *et al.*, 1990, 2006), Bahia (Christoffersen, 1979, 1998; Coelho *et al.*, 2006; Almeida *et al.*, 2012). Locality not provided: Coelho *et al.* (1980), Coelho and Ramos-Porto (1995). All records above as *A. cylindricus*, except that of Souza *et al.* (2011) and Almeida *et al.* (2012) as *A. vanderbilti*.

Remarks: The occurrence of *A. cylindricus*, previously believed to be distributed in the Atlantic and the eastern Pacific, now appears to be restricted to the latter basin (see Anker *et al.*, 2008d).

Alpheus verrilli (Schmitt, 1924)

Crangon verrilli Schmitt, 1924: 77, pl. 2, figs. 7-10 (part, holotype only, see Anker, 2012).

Distribution: Western Atlantic - Florida, Belize, Panama, Barbados and Brazil (Rio de Janeiro and São Paulo) (Anker, 2012).

Previous records: Rio de Janeiro (Anker, 2012) and São Paulo (Amaral *et al.*, 2010, as *A. armillatus*, see Anker, 2012; Anker, 2012).

Remarks: Anker (2012) pointed out that the status of the Brazilian material requires confirmation, based on minor morphological and color-pattern differences observed by him. A color photograph of a specimen from São Paulo was provided by Anker (2012, fig. 18D).

Alpheus websteri Kingsley, 1880

Alpheus websteri Kingsley, 1880: 416.

Distribution: Western Atlantic - Florida, Bahamas, eastern Mexico (Quintana Roo) to Panama, Cuba to Tobago, Venezuela, and Brazil (Atol das Rocas, Fernando de Noronha and Alagoas?) (Chace, 1972; Rodríguez, 1980; Anker *et al.*, 2008b).

Previous records: Atol das Rocas (Anker *et al.*, 2008b), Fernando de Noronha (Pocock,

1890, as *A. ridleyi*, see Anker *et al.*, 2008b; Coelho and Ramos, 1972, as *A. ridleyi*; Fausto Filho, 1974, 1980, as *A. ridleyi*; Christoffersen, 1998; Alves *et al.*, 2008; Souza *et al.*, 2011), Alagoas (Coelho *et al.*, 2006).

Remarks: The record from Alagoas, which would be the current southern limit of the distribution of *A. websteri* in the western Atlantic, needs confirmation because of a possible mistaken identification of *A. thomasi* (see Anker *et al.*, 2008b). Drawings of the material from Atol das Rocas were provided by Anker *et al.* (2008b, fig. 2).

Key for the identification of the snapping-shrimp genus *Alpheus* from the Brazilian coast

1. Rostrum lacking, front emarginated between orbital hoods. (Orbital hoods rounded, unarmed) (Fig. 7A).....*A. simus*

1'. Rostrum present (Fig. 7B-F).....2

2. Frontal region evenly convex dorsally, adrostral depressions lacking; fingers of minor first chela strongly curved laterally (Fig. 8E)... .....*A. vanderbilti*

2'. Orbital hoods mesially delimited by adrostral depressions or furrows; fingers of minor first chela not noticeably curved laterally.....3

3. Rostrum dorsally flat, at least in distal portion (Fig. 7C); orbital hoods armed with teeth arising from surface of hood, not from margin.....4

3'. Rostrum either rounded or carinate in dorsal midline, not flat (Fig. 7E-F); orbital teeth, if present, arising from margin of hood 8

4. Teeth on orbital hoods arising from mesial slope, overhanging adrostral furrows (Fig. 7D); merus of third and fourth pereiopods armed with distal tooth on ventral margin (Fig. 10A).....5

4'. Teeth on orbital hoods arising from anterior slope, overhanging frontal margin (Fig. 7C); merus of third and fourth pereiopods unarmed at distal end of ventral margin (Fig. 10B).....7

5. No tooth or tubercle on midline of carapace; palm of major first chela notched both dorsally and ventrally (Fig. 9A); pollex not notched distal to fossa.....*A. intrinsecus*

5'. Small tooth or tubercle on midline of carapace in line with posterior limits of adrostral furrows; palm of major first chela with dorsal and ventral margins entire, not notched (Fig. 9C); pollex notched on opposable margin distal to fossa.....6

6. Lateral margin of rostrum broadly concave; setae on lateral margins of rostrum present along entire margin; notch between mesial teeth and anterior margin of orbital hoods wide, more or less V-shaped.....*A. armatus*

6'. Lateral margin of rostrum straight; setae on lateral margins of rostrum present only on distal half; notch between mesial teeth and anterior margin of orbital hoods narrow, U-shaped.....*A. rudolphi*

7. Merus of chelipeds with distal tooth on ventromesial margin (Fig. 8A); palm of major first chela with both dorsal and ventral margins entire, not notched (Fig. 9C); minor first chela with balaeniceps setae (Fig. 8C) in both males and females; spiniform setae of the lateral branch of uropod dark-colored (Fig. 10I).....*A. formosus*

7'. Merus of chelipeds without distal tooth on ventromesial margin (Fig. 8B); palm of major first chela notched dorsally (Fig. 9B); minor first chela with no balaeniceps setae (Fig. 8D) in either male or female; spiniform setae of the lateral branch of uropod light in color.... .....*A. malleator*

8. Orbital hoods armed with teeth (Fig. 7C-D) 9

8'. Orbital hoods unarmed (Fig. 7E-F) 16

9. Ventrolateral tooth on basal segment of antennal peduncle distinctly overreaching stylocerite.....10

9'. Ventrolateral tooth on basal segment of antennal peduncle not overreaching stylocerite.....11

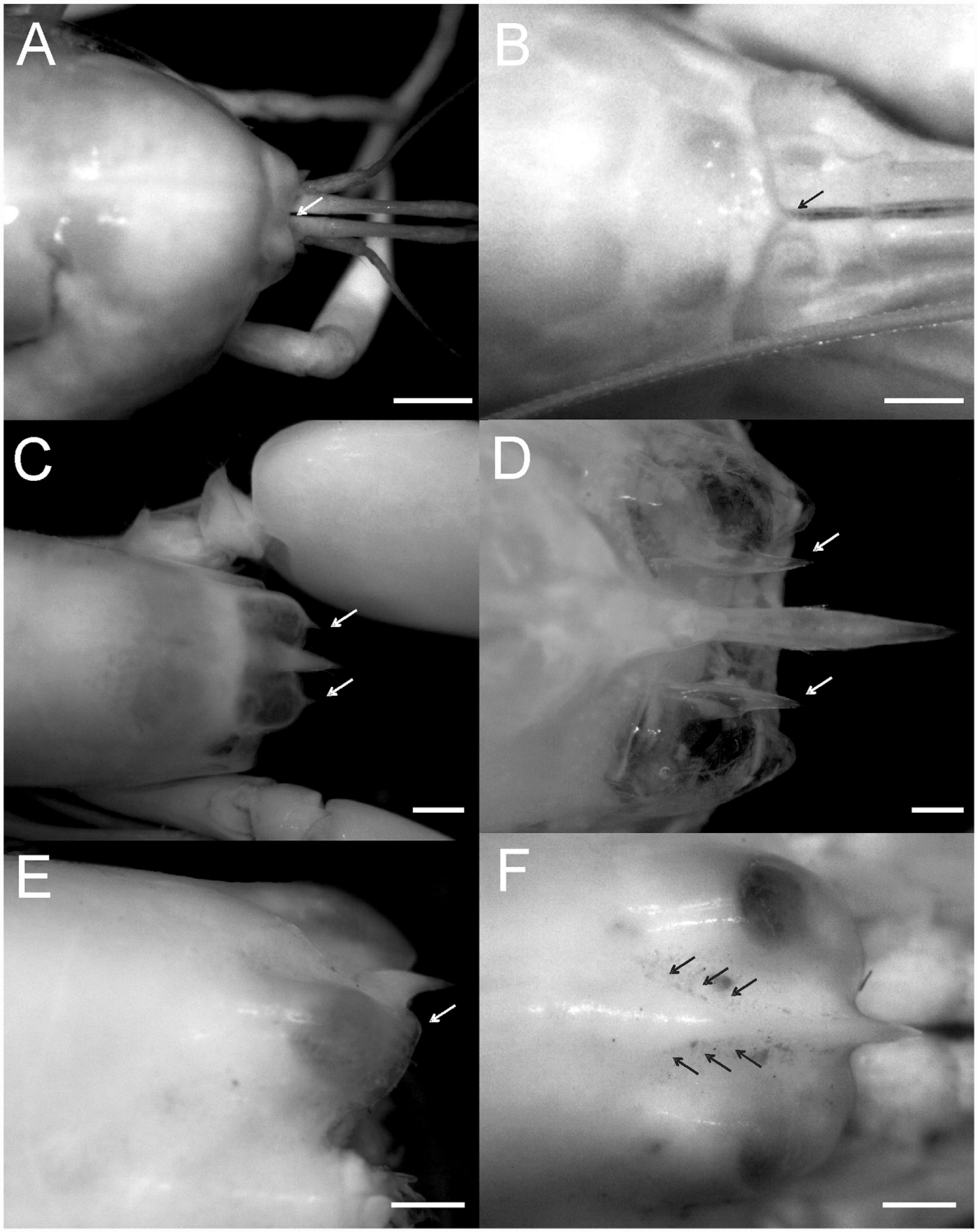

Figure 7. Morphology of snapping shrimps of the genus *Alpheus* Fabricius, 1798 from Brazil: types of configuration of anterior region of carapace in dorsal (A–D, F) and lateral (E) views. (A) Anterior region emarginated between the orbits (arrow), with no rostral projection; (B) anterior region with rostrum short (arrow); (C) anterior region with rostrum flat and ocular hoods toothed, teeth arising from anterior slope (arrows); (D) anterior region with rostrum flat and ocular hoods toothed, teeth arising from mesial slope (arrows); (E) anterior region with rostrum carinate in dorsal midline, ocular hoods unarmed (arrow); (F) anterior region with rostrum carinate in dorsal midline, with V-shaped post-rostral plate (contour indicated by arrows), typical of *A. armillatus* complex. Scale bars = 1 mm.

10. Third and fourth pereiopods without distal tooth on ventral margin of merus (Fig. 10B).....*A. candei*

10'. Third and fourth pereiopods with distal tooth on ventral margin of merus (Fig. 10A).....*A. peasei*

11. Palm of major chela without sharp tooth at lateral articulation with dactylus.....12

11'. Palm of major chela with sharp tooth at lateral articulation with dactylus (Fig. 9D).....13

12. Frontal margin between rostrum and orbital hoods more deeply notched; ischium of third pereiopods with spiniform setae on ventrolateral surfaces; uropodal exopod with one distolateral tooth external to spiniform se tae.....*A. thomasi*

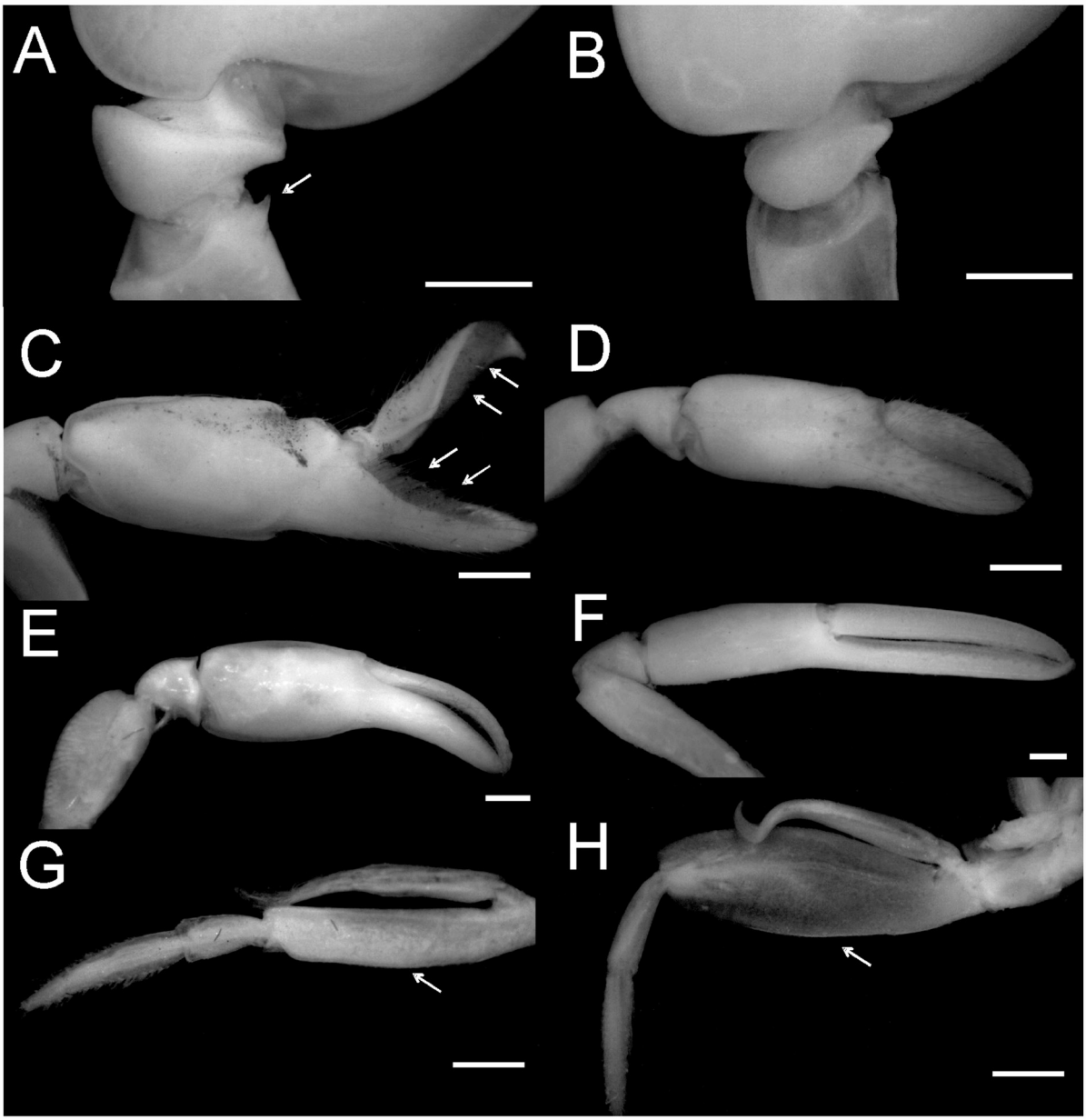

Figure 8. Morphology of snapping shrimps of the genus *Alpheus* Fabricius, 1798 from Brazil: chelipeds and third maxilliped. (A) distal region of merus of major cheliped with tooth on ventromesial margin (arrow), mesial view; (B) distal region of merus of major cheliped with ventromesial margin unarmed, mesial view; (C) fingers of minor male chela with "balaeniceps" setae (arrows), mesial view; (D) fingers of minor chela with no "balaeniceps" setae, fingers as long as palm, mesial view; (E) minor chela with curved fingers, mesial view; (F) fingers of minor chela with no "balaeniceps" setae, fingers longer than palm, ventromesial view; (G) antepenultimate segment of third maxilliped not broadly enlarged (arrow), ventral view; (H) antepenultimate segment of third maxilliped broadly enlarged (arrow), ventral view. Scale bars = 1 mm.

12'. Frontal margin between the rostrum and the orbital hoods being less deeply notched; ischium of third pereiopods without spiniform setae on ventrolateral surfaces; uropod with two distolateral teeth lateral and mesial to spiniform setae.....*A. websteri*

13. Dactylus of third pereiopod with minute denticle on dorsal margin; uropodal exopod ending posterolaterally in two sharp teeth (Fig. 10H).....14

13'. Dactylus of third pereiopod unarmed on dorsal margin; uropodal exopod ending posterolaterally with a single tooth (Fig. 10G).....15

14. Dactylus of major chela more bulbous distally; transverse notch on mesiodorsal

Figure 9. Morphology of snapping shrimps of the genus *Alpheus* Fabricius, 1798 from Brazil: major chelipeds. (A) palm dorsally and ventrally notched (arrows), mesial view; (B) palm dorsally notched (arrow), mesial view; (C) palm not notched, mesial view; (D) palm with distal tooth (arrow) on dorsal margin, mesial view; (E) fixed finger or pollex with distal margin distinctly truncated (arrow), lateral view; (F) fixed finger with distal margin rounded (arrow), lateral view; (G) dactylus plunger longer than broad (arrow), lateral view; (H) dactylus plunger as long as broad (arrow), lateral view. Scale bars = 1 mm.

surface of palm of major chela broader and less sharply defined.....*A. amblyonyx*

14'. Dactylus of major chela less bulbous distally; transverse notch on mesiodorsal surface of palm of major chela sharply defined .....*A. macrocheles*

15. Scaphocerite with distal tooth reaching end of antennular peduncle; fingers

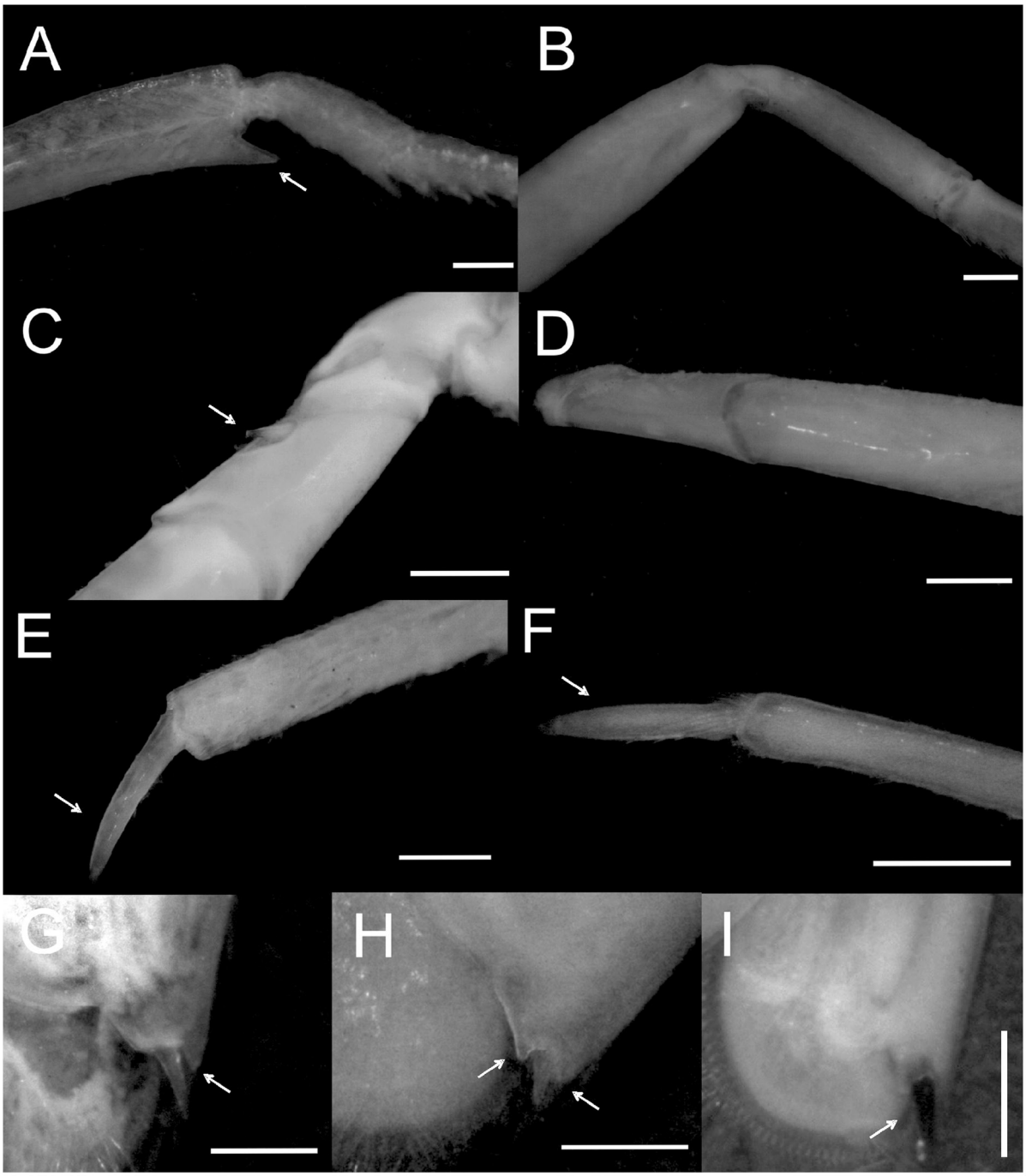

Figure 10. Morphology of snapping shrimps of the genus *Alpheus* Fabricius, 1798 from Brazil: third pereiopods and exopod of uropods. (A) third pereiopod with distoventral margin of merus armed with acute tooth (arrow), lateral view; (B) third pereiopod with distoventral margin of merus unarmed (rounded), lateral view; (C) third pereiopod with ventrolateral margin of ischium with spiniform seta (arrow), lateral view; (D) third pereiopod with ventrolateral margin of ischium without spiniform seta, lateral view; (E) third pereiopod with dactylus conical (arrow), dorsal view; (F) third pereiopod with dactylus subspatulate (arrow); (G) uropodal exopod with acute tooth external to distolateral spiniform seta (arrow), dorsal view; (H) uropodal exopod with acute teeth internal and external to distolateral spiniform seta (arrows), dorsal view; (I) uropodal exopod with distolateral spiniform seta colored black (arrow), dorsal view. Scale bars = 1 mm.

of minor chela not curved; dactylus of major chela with molar tooth vestigial.....*A. puapeba*

15'. Scaphocerite with distal tooth distinctly overreaching end of antennular peduncle; fingers of minor chela strongly curved in vertical plane (forming an angle of 90°); dactylus of major chela with molar tooth triangular.....*A. pouang*

16. Merus of third and fourth pereiopods with prominent acute tooth on distal end of ventral margin (Fig. 10A).....*A. cristulifrons*

16'. Merus of third and fourth pereiopods with distal end of ventral margin rounded or rectangular, not produced into prominent tooth (Fig. 10B).....17

17. Major first chela not notched ventrally (Fig. 9B).....18

17'. Major first chela notched ventrally (Fig. 9A).....22

18. Major first chela notched dorsally (Fig. 9A).....19

18'. Major first chela not notched dorsally (Fig. 9C).....20

19. Palm of minor first chela as wide as long (fingers longer than palm); minor first chela with balaeniceps setae in both males and females (Fig. 8C).....*A. christofferseni*

19'. Palm of the minor first chela distinctly longer than broad (fingers as long as palm); minor first chela with balaeniceps setae in males only.....*A.* cf. *packardii*

20. Rostrum dorsally carinate or subcarinate; proximal article of carpus of second pereiopod shorter than second article; dactylus of third and fourth pereiopods subspatulate (Fig. 10F).....*A.* cf. *floridanus*

20'. Rostrum dorsally convex, not subcarinate; proximal article of carpus of second pereiopod longer than second article; dactylus of third and fourth pereiopods conical (Fig. 10E).....21

21. Abdomen with narrow transverse bands, without dorsal spots on third segment (fresh specimens).....*A.* cf. *paracrinitus*

21'. Abdomen with broad transverse bands, with pair of dorsal spots on third segment (fresh specimens).....*A.* cf. *rostratus*

22. Merus of chelipeds unarmed at distal end of ventromesial margin (Fig. 8B).....23

22'. Merus of first chelipeds armed with sharp tooth at distal end of ventromesial margin (Fig. 8A).....29

23. Dactylus of third and fourth pereiopods conical, not subspatulate (Fig. 10E) 24

23'. Dactylus of third and fourth pereiopods usually subspatulate (Fig. 10F).... 27

24. Fingers of male minor chela without balaeniceps setae (Fig. 8D).....*A. nuttingi*

24'. Fingers of male minor chela with balaeniceps setae (Fig. 8C).....25

25. Dactylus of major first chela not strongly convex in proximal part of dorsal margin; second article of carpus of second pereiopod distinctly longer than fifth article..... .....*A. heterochaelis*

25'. Dactylus of major first chela regularly and highly arched throughout length of dorsal margin; second article of carpus of second pereiopod subequal to fifth article in le ngth.....26

26. Third and fourth pereiopods with spiniform setae on ventrolateral surface of ischium (Fig. 10C).....*A. agilis*

26'. Third and fourth pereiopods without spiniform setae on ventrolateral surface of ischium (Fig.10D).....*A. bouvieri*

27. Distal margin of pollex of major chela with rounded ending, not truncate (Fig. 9F); fingers of minor chela with balaeniceps setae in males (Fig. 8C); uropodal exopod with two sharp teeth on posterolateral margin, one on each side of spiniform setae (Fig. 10H)..... .....*A. pontederiae*

27'. Distal margin of pollex of major chela distinctly truncate (Fig. 9E); fingers of minor chela without balaeniceps setae in both males and females (Fig. 8D, F); uropodal

exopod with one sharp tooth on posterolateral margin, lateral to spiniform setae (Fig. 10G).... 28

28. Fingers of minor chela distinctly longer than palm (Fig. 8F); antepenultimate segment of third maxilliped broadly enlarged (Fig. 8H).....*A. chacei*

28'. Fingers of minor chela as long as palm (Fig. 8D); antepenultimate segment of third maxilliped not enlarged (Fig. 8G)..... .....*A. estuariensis*

29. Adrostral furrows shallow, not sharply delimited; fingers of minor chela of male with balaeniceps setae (Fig 8D).....*A. buckupi*

29'. Adrostral furrows deep, sharply delimited (Fig. 7E-F); fingers of minor chela of male without balaeniceps setae (Fig. 8D)... 30

30. Post-rostral plate abruptly delimited, with lateral margins clearly overhanging adjacent adrostral furrows, forming deep longitudinal channel.....*A. verrilli*

30'. Post-rostral plate more or less markedly delimited, with lateral margins not or only slightly overhanging adjacent adrostral furrows, not forming deep longitudinal channel.....31

31. Major chela with dactylus plunger relatively short, with proximal height at most 0.6 length of distolateral margin (Fig. 9H); dactylus plunger orange mesially (fresh specim ens).....*A. brasileiro*

31'. Major chela with dactylus plunger relatively long, with proximal height more than 0.7 length of distolateral margin (Fig. 9G); dactyls plunger whitish mesially (fresh specimens).....32

32. First and second abdominal sternite with strong median process in males; fifth pereiopod ischium with or without spiniform seta on ventrolateral surface.....*A. carlae*

32'. First abdominal sternite with small median process, second abdominal sternite unarmed in males; fifth pereiopod ischium always unarmed on ventrolateral surface..... .....*A. angulosus*

Discussion

Of the 33 species of *Alpheus* recorded from Brazil, 31 occur in shallower waters (less than 100 m deep) and two at depths over 100 m (*A. pouang* from 120 to 268 m and *A. puapeba* from 45 to 175 m; see Christoffersen, 1979). The former group comprises tropical species ranging, in the western Atlantic, mostly from North Carolina, Florida or the West Indies to southern Brazil; whereas the latter group includes subtropical species ranging from southeastern Brazil to Uruguay (*A. pouang*) or Argentina (*A. puapeba*) (*sensu* Christoffersen, 1982).

A more accurate analysis of the geographic distribution of certain shallow-water caridean groups is difficult at present, mainly because of factors such as the existence of areas or habitats that are still underexplored, the little-known ranges of some recently described species (e.g., *A. agilis*, *A. christofferseni, A. rudolphi*), the difficulty of collecting some small-sized and (ecologically) cryptic or symbiotic taxa, and the existence of a number of (morphologically) cryptic species complexes, especially in the Alpheidae (Almeida *et al.*, 2012).

Twenty-one of the 33 species currently known from Brazil are restricted to the western Atlantic, and eight are amphi-Atlantic (Table 1). The remaining four taxa treated here for which the status still needs to be confirmed were not included in this classification. According to Melo's (1985) patterns of latitudinal distribution, the group of western Atlantic species comprises 14 Antillean, 2 Carolinian, 2 Argentinian, 1 Virginian, and 2 species that are presently endemic to Brazil (Table 1). Regarding the amphi-Atlantic species, eastern- and western-Atlantic populations of *A. intrinsecus*, *A. pontederiae* and *A. macrocheles* have not been examined for possible cryptic biodiversity.

Of the 29 species classified according to distributional pattern, 14 have disjunct ranges in the western Atlantic (e.g., *A. peasei*, *A. simus*, *A. thomasi*, *A. verrilli*) (*sensu* Coelho and Ramos, 1972). Hiatuses in species ranges may result from their ecology, i.e., species that are absent from the Guyanas may not be adapted

Table 1. Snapping shrimps of the genus *Alpheus* Fabricius, 1798 from the Brazilian coast the northern and southern limits of their geographic ranges in the western Atlantic Ocean, patterns of distribution according to Melo (1985), and taxonomic observations.

Species	Northern limit	Southern limit	Pattern of distribution	Observations
Alpheus agilis	In the western Atlantic only known from Atol das Rocas		Amphi-Atlantic	*A. hebes* Kim and Abele, 1988 species complex (see Anker *et al.*, 2009)
A. amblyonyx	Gulf of Mexico	Espírito Santo	Antillean (Disjunct)	*A. macrocheles* species complex (see Anker and De Grave, 2012)
A. angulosus	North Carolina	Rio Grande do Sul	Carolinian (Continuous)	*A. armillatus* species complex (see Anker, 2012)
A. armatus	Florida	Alagoas?	Antillean (Disjunct)	*A. armatus* species complex (see Knowlton and Keller, 1983, 1985); record from Brazil needs confirmation.
A. bouvieri	North Carolina	Rio Grande do Sul	Amphi-Atlantic	*A. bouvieri* species complex (see Anker *et al.*, 2009)
A. brasileiro	Ceará	Santa Catarina	Endemic	*A. armillatus* species complex (see Anker, 2012)
A. buckupi	Venezuela	São Paulo	Amphi-Atlantic	*A. lobidens* species complex (see Almeida *et al.*, 2013)
A. candei	Florida	Seamounts of the North Chain (Brazil)	Antillean (Disjunct)	-
A. carlae	Florida	São Paulo	Antillean (Continuous)	*A. armillatus* species complex (see Anker, 2012)
A. chacei	West Indies	São Paulo	Antillean (Continuous)	-
A. christofferseni	Panama	Atol das Rocas	Antillean (Disjuct)	*A. barbatus* Coutière, 1897 species complex (Anker *et al.*, 2007a)
A. cristulifrons	Florida	Rio de Janeiro	Antillean (Disjunct)	*A. cristulifrons* species complex (see Anker *et al.*, 2008a)
A. estuariensis	Florida	Paraná	Antillean (Continuous)	-
A. cf. *floridanus*	Florida	Rio Grande do Sul	?	*A. floridanus* species complex (Anker, 2001; Williams *et al.*, 2001)
A. formosus	North Carolina	São Paulo	Carolinian (Disjunct)	*A. formosus* species complex (see Anker *et al.*, 2008c)
A. heterochaelis	Delaware	São Paulo	Virginian (Continuous)	Species complex; Brazilian records need confirmation (A.O. Almeida, under study)
A. intrinsecus	Puerto Rico	Santa Catarina	Amphi-Atlantic	-
A. macrocheles	West Indies?	Espírito Santo	Amphi-Atlantic	*A. macrocheles* species complex (see Anker and De Grave, 2012); records need confirmation
A. malleator	Gulf of Mexico	São Paulo	Amphi-Atlantic	*A. malleator* species complex (Anker, 2001; Anker and Pachelle, 2001); Williams *et al.*, 2013)
A. nuttingi	Florida	São Paulo	Antillean (Continuous)	*A. nuttingi* species complex (see Anker *et al.*, 2007b)
A. cf. *packardii*	Virginia	São Paulo	?	*A. packardii* species complex (Williams *et al.*, 2001; Anker, pers. com.)
A. cf. *paracrinitus*	West Indies	Espírito Santo	?	*A. paracrinitus* species complex; identity unknown (Williams *et al.*, 2001; Almeida *et al.*, 2012; A. Anker, pers. com.)
A. peasei	Florida	Bahia	Antillean (Disjunct)	-
A. pontederiae	Venezuela	Paraná	Amphi-Atlantic	-
A. pouang	São Paulo	Uruguai	Argentinian	*A. macrocheles* species complex (see Anker and De Grave, 2012)
A. puapeba	Espírito Santo	Province of Buenos Aires	Argentinian?	*A. macrocheles* species complex (see Anker and De Grave, 2012)
A. cf. *rostratus*	Reported from Bahia, Brazil		?	*A. paracrinitus* species complex; identity unknown (Almeida *et al.*, 2012; A. Anker, pers. com.)
A. rudolphi	Reported from Alagoas, Brazil		Endemic	*A. armatus* species complex (see Almeida and Anker, 2011)
A. simus	Florida	Bahia	Antillean (Disjunct)	-
A. thomasi	Florida	São Paulo	Antillean (Disjunct)	Possibly belonging to *A. websteri* species complex *sensu lato* (see Anker *et al.*, 2008b)
A. vanderbilti	Florida	Bahia	Amphi-Atlantic	*A. cylindricus* species complex (Anker *et al.*, 2008d)
A. verrilli	Florida	São Paulo	Antillean (Disjunct)	*A. armillatus* species complex; material from Brazil needs confirmation (see Anker, 2012)
A. websteri	Florida	Alagoas?	Antillean (Disjunct)	*A. websteri* species complex (see Anker *et al.*, 2008b)

to the oceanographic conditions in that coastal area, which is mainly characterized by low salinity and predominance of soft bottoms (Coelho, 1969; Coelho and Ramos, 1972). In fact, several of the species with disjunct distributions usually inhabit intertidal and/or shallow-water hard bottoms, including coral reefs; examples include *A. cristulifrons*, *A. formosus*, *A. peasei* and *A. simus*. With increased collection effort in these gap regions, it may be observed that some of these alpheids actually have continuous distributions, when there are suitable habitats. However, in some cases, some of these populations may represent different cryptic taxa.

Of the 33 species recorded from the Brazilian coast, at least 26 are members of complexes (see observations in Table 1). Cryptic speciation occurs through a wide genetic differentiation, which is not expressed in the same proportion morphologically (see Mathews *et al.*, 2002). This process has generated extensive cryptic biodiversity in the Alpheidae, especially in the genera *Alpheus* and *Synalpheus* Spence Bate, 1888 (Mathews and Anker, 2009). The existence of cryptic species complicates the identification of the taxa and may lead to misidentifications.

Currently, the largest species complex in terms of number of intertidal/shallow-subtidal species in Brazil is the *A armillatus* complex (Anker, 2012). *Alpheus armillatus* was considered one of the most common species in rocky intertidal coastal habitats along the Brazilian coast (see discussion in Christoffersen, 1984). Following a revision of the western-Atlantic species within this complex, the distribution of the *sensu stricto* form is presently understood to extend only from southern Florida to Venezuela (Anker, 2012). Some of the previous records of this shrimp in Brazil have been assigned to *A. angulosus* (Coelho and Ramos, 1972; Christoffersen, 1998; Coelho *et al.*, 2006, in part) and *A. carlae* (Holthuis, 1956; Mossolin *et al.*, 2006; Pavanelli *et al.*, 2008) (see Anker, 2012). The material reported by Almeida *et al.* (2006, 2007a, 2012) from the coast of Bahia was re-examined by us and corresponds to *A. carlae* and *A. angulosus*. However, most records of *A. armillatus* in Brazil lack morphological accounts or information about color (e.g., Gomes Corrêa, 1972; Fausto Filho, 1978, 1979; Sampaio and Fausto Filho, 1984; Coelho *et al.*, 1986; Austregésilo-Filho and Ramos-Porto, 1995; Sousa *et al.*, 1998; Young and Serejo, 2005), preventing the determination of the material's identity. These records may represent either of the Brazilian species in this complex, and were ignored here because of the impossibility of determining the true species involved.

Alpheus paracrinitus is another large species complex (A. Anker, pers. com.), represented in Brazil by at least two forms, *A.* cf. *paracrinitus* and *A.* cf. *rostratus* (see Almeida *et al.*, 2012; Santos *et al.*, 2012). Both forms are, at the moment, only distinguishable by the color pattern (see Figs. 6B, E). However, if these two forms actually represent distinct species, as strongly suggested by their different color patterns, this can only be confirmed after a comprehensive review of this widely distributed complex. Inclusion of both forms in this contribution and the publication of photographs of the color pattern of the material examined as provided by Almeida *et al.* (2012) and Santos *et al.* (2012) will aid in mapping the geographic distribution of the forms. Except for the species pair *A.* cf. *paracrinitus* – *A.* cf. *rostratus*, all other taxa treated here can be separated based on the morphological characters presented in the key.

We believe that the actual diversity of *Alpheus* from the Brazilian coast, as well as of the entire family Alpheidae, is still far from being understood, and the number of species known today is certainly underestimated. Thus, the Brazilian alpheid fauna is still awaiting a major taxonomic revision. With increasing research and collection efforts directed at this group, especially in regions and microhabitats that have been little explored (e.g., crevices in dead and living corals and coralline algae, in association with other marine invertebrates, deep sea, etc.) and the revision of species complexes that have not been studied, the number of species present on the Brazilian coast is expected to increase.

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