

Alpheus rudolphi spec. nov., a new snapping shrimp from northeastern Brazil (Crustacea: Decapoda: Alpheidae)

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Almeida, A.O. & A. Anker. *Alpheus rudolphi* spec. nov., a new snapping shrimp from northeastern Brazil (Crustacea: Decapoda: Alpheidae).

Zool. Med. Leiden 85 (1), 29.iv.2011: 1-10, figs 1-26, table 1.— ISSN 0024-0672.

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Key words: Caridea; Alpheidae; *Alpheus*; cryptic species; snapping shrimp; West Atlantic; Alagoas; Brazil. A new snapping shrimp of the *Alpheus armatus* Rathbun, 1901 species complex, *Alpheus rudolphi* spec. nov., is described based on a single female holotype collected off Alagoas, northeastern Brazil (09°55.11'S 35°32.73'W). The new species differs from all other species of the *A. armatus* complex by the unique configuration of the orbito-rostral region of the carapace.

Introduction

The *Alpheus armatus* Rathbun, 1901 species complex is a morphologically and genetically distinctive clade within the snapping shrimp genus *Alpheus* Fabricius, 1798 (Knowlton & Keller, 1985; Williams et al., 2001). This complex presently includes four species: *A. armatus*, *A. immaculatus* Knowlton & Keller, 1983, *A. polystictus* Knowlton & Keller, 1985 and *A. roquensis* Knowlton & Keller, 1985. All of them are obligate associates of sea anemones in shallow waters of the tropical and subtropical West Atlantic (Knowlton, 1980; Knowlton & Keller, 1983, 1985).

Alpheus armatus was described by Rathbun (1901) based on a single, incomplete specimen from Puerto Rico. It is the most common and widespread species of the *A. armatus* complex and well known for its association with the curly-cue or corkscrew anemone, *Bartholomea annulata* (Le Sueur, 1817) (Knowlton, 1980; Knowlton & Keller, 1985). *Alpheus immaculatus* was described from Jamaica and also associates with *B. annulata* (see Knowlton & Keller, 1983). It differs from *A. armatus* mainly by the longer, more slender rostrum (more obvious in adults) and the absence of yellow dots on the body and appendages, which are very conspicuous in *A. armatus*. *Alpheus polystictus* and *A. roquensis* were both described from the Los Roques Archipelago off Venezuela. The first species also associates with *B. annulata*, whereas the second species is found mainly with *Ragactis lucida* (Duchassaing & Michelotti, 1860) (formerly *Heteractis lucida*) and only occasionally with *B. annulata* (Knowlton & Keller, 1985). *Alpheus polystictus* can be easily distinguished from the other three species of the *A. armatus* complex by its unique “reverse” colour pattern on the chelipeds: it has white dots on a dark-red background instead of dark-red spots on a pale-reddish or pink background (Knowlton & Keller, 1985). Without information on colour, *A. polystictus* can be reliably separated from *A. armatus* and *A. roquensis* only by the relative length of the aesthetasc brush on the lateral antennular flagellum (Knowlton & Keller, 1985), a

feature also used to distinguish species in the Indo-West Pacific *Alpheus gracilipes* Stimpson, 1860 complex (Nomura & Anker, 2005). *Alpheus roquensis* differs from the other species by the relatively smaller (sometimes absent) post-rostral tooth and the proportionally larger uropodal spine in males (Knowlton & Keller, 1985).

The first record of a species of the *A. armatus* complex in Brazilian waters was by Coelho et al. (1983), who listed *A. armatus* among decapod crustaceans collected on the continental shelf off Alagoas and Sergipe in 1965-1966. This material was collected on a calcareous algal bottom at a depth of 36 m, off Porto de Pedras, Alagoas (Akaroa, Sta. 3, 8°56'15"S 34°57'40"W), and deposited in the Crustacea Collection of the Departamento de Oceanografia da Universidade Federal de Pernambuco, Recife, Brazil (DOUFPE). All subsequent listings of *A. armatus* from Brazil (Coelho et al., 1990; 2006) refer to this record, with no additional specimens recorded. Christoffersen (1998) apparently overlooked Coelho et al.'s (1983) record, as he did not list *A. armatus* in his checklist of Brazilian alpheids.

Wirtz et al. (2009) published a photograph of a pair of snapping shrimps identified as *A. aff. armatus*, associated with an aiptasiid sea anemone, *Bellactis ilkalysae* Dube, 1983, at a depth of 15 m off the coast of Guararari, Espírito Santo. Unfortunately, these were not collected (P. Wirtz, pers. comm.) and therefore their identity could not be established. However, the conspicuous white patch on the dorsomesial surface of the major chela and a different host anemone suggest that these shrimps most probably belong to an undescribed species.

The material of *A. armatus* reported by Coelho et al. (1983) could not be located in the DOUFPE collection. However, our search there resulted in the discovery of a more recently collected single specimen identified as *A. armatus*, a female collected in 1998 off Alagoas during the Program Recursos Vivos da Zona Econômica Exclusiva (REVIZEE), Northeast Score, by the R/V Antares (Brazilian Navy). This specimen was dredged with a 70-L rectangular dredge (0.5 mm mesh size), pulled for 5 minutes at a speed of 2 knots (Souza-Filho, 2007), at a depth of 49 m. Neither colour pattern nor host association were recorded. However, this specimen was found to differ from all four described species of the *A. armatus* complex by the unique configuration of the rostrum, adrostral furrows, and orbital hoods. Therefore, a new species of the *A. armatus* complex is described herein.

The holotype of the new species is deposited in the Crustacea Collection of DOUFPE. Comparative material (*A. armatus*, *A. immaculatus*, *A. polystictus*) remains deposited in the collections of the Netherlands Centre for Biodiversity Naturalis, Leiden, The Netherlands (RMNH), Muséum national d'Histoire naturelle, Paris, France (MNHN), and Florida Natural History Museum, Gainesville, USA (FLMNH). Drawings were made under dissecting microscope equipped with a camera lucida. Carapace length (CL) and total length (TL) were measured from the tip of the rostrum to the posterior margin of carapace and telson, respectively.

Figs 1-8. *Alpheus rudolphi* spec. nov., holotype, female (DOUFPE 13062): 1, frontal region, dorsal view; 2, same, lateral view; 3, tooth on ventromesial carina of first segment of antennular peduncle, lateral view; 4, scaphocerite, dorsal view (setae omitted); 5, third maxilliped, lateral view; 6, telson and uropods, dorsal view (setae omitted); 7, uropodal exopod, detail of distolateral margin, dorsal view (setae omitted); 8, posterior half of telson, dorsal view (setae omitted). Scale bars: 1, 2, 5, 6 = 1 mm; 4, 7, 8 = 0.5 mm; 3 = 0.25 mm. ►

Systematic part

Family Alpheidae Rafinesque, 1815

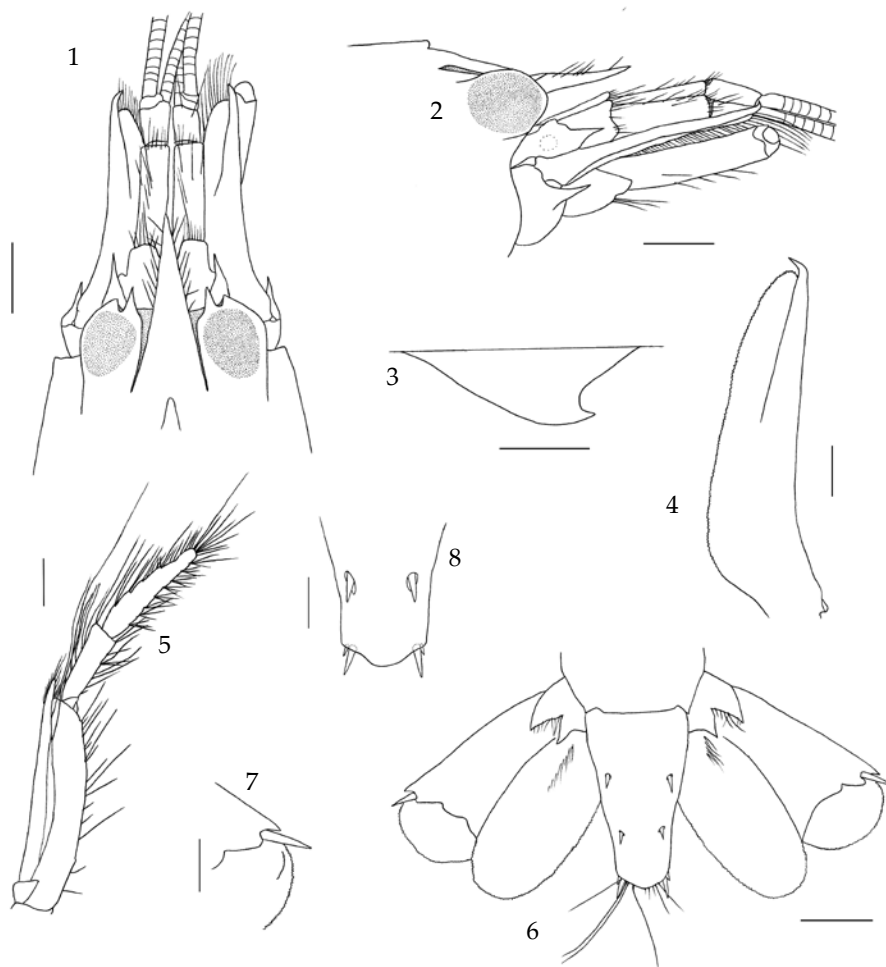
Genus *Alpheus* Fabricius, 1798

Alpheus rudolphi spec. nov.

(figs 1-22)

Material examined.— Holotype, female, CL 9.3 mm, TL 22 mm (DOUFPE 13062), Brazil, off Alagoas, REVIZEE Program, Score Nordeste III, Sta. 171, 6° Pernada, 09°55.11'S; 35°32.73'W, depth: 49 m, 16.vii.1998, P.A. Coelho-Filho det. *A. armatus*.

Comparative material.— *Alpheus immaculatus*: 1 female (RMNH.Crus 26225), Dutch West Indies, Curaçao, Piscadera Bay, Marine Biology Institute, associated with *Bartholomea annulata*, leg. F. Nijhout, viii.1968; 1 male (RMNH.Crus 30648), USA, Florida, north of Miami, Hollywood reef, associated with sea anemone, 17 m, leg. R. Guest, 08.iii.1974. *Alpheus polystictus*: 1 male, 1 female (MNHN-Na 15559), French Antilles, Guadeloupe, associated with *Bartholomea annulata*, leg. F. Fasquel, 2002. *Alpheus armatus*: 1 male (FLMNH UF Arthropoda 6947), US Virgin Islands, leg. V. Bonito, no further data.



Description.— Carapace smooth, glabrous; rostrum flattened dorsally, with lateral margins straight, arrow-shaped, with acute tip reaching $\frac{1}{3}$ length of second segment of antennular peduncle (figs 1-2); proximal $\frac{2}{3}$ of rostrum somewhat concave, distal $\frac{1}{3}$ slightly ascendant; distal half of rostrum fringed with a row of long marginal setae, proximal half without setae; adrostral furrows deep, sharply delimited, very narrow; orbital hoods inflated dorsally, each with strong sharp tooth on anteromesial margin, reaching beyond anterior margin of orbital hoods (fig. 1); anterior margin of orbital hoods angular, anteriorly protruding; post-rostral region with strong, blunt mid-dorsal tooth (figs 12) situated at some distance from posterior margins of adrostral furrows; pterygostomial angle rounded (fig. 2); cardiac notch well developed.

Abdominal somites smooth, glabrous, ventral and posterior margins of pleurae broadly rounded; preanal plate subtriangular. Telson about twice as long as wide at base; lateral margins slightly concave posteriorly; dorsal surface slightly convex, without median groove, with two pairs of large spines, inserted approximately at $\frac{1}{3}$ and $\frac{2}{3}$ length of telson (fig. 6); posterior margin broadly rounded, fringed with long setae, posterolateral angle each with two pairs of spines, lateral much shorter than mesial (fig. 8); anal tubercles well developed.

Eyes concealed in lateral and dorsal view; cornea well developed, rounded. Ocellar beak protruding between eyes, apically rounded.

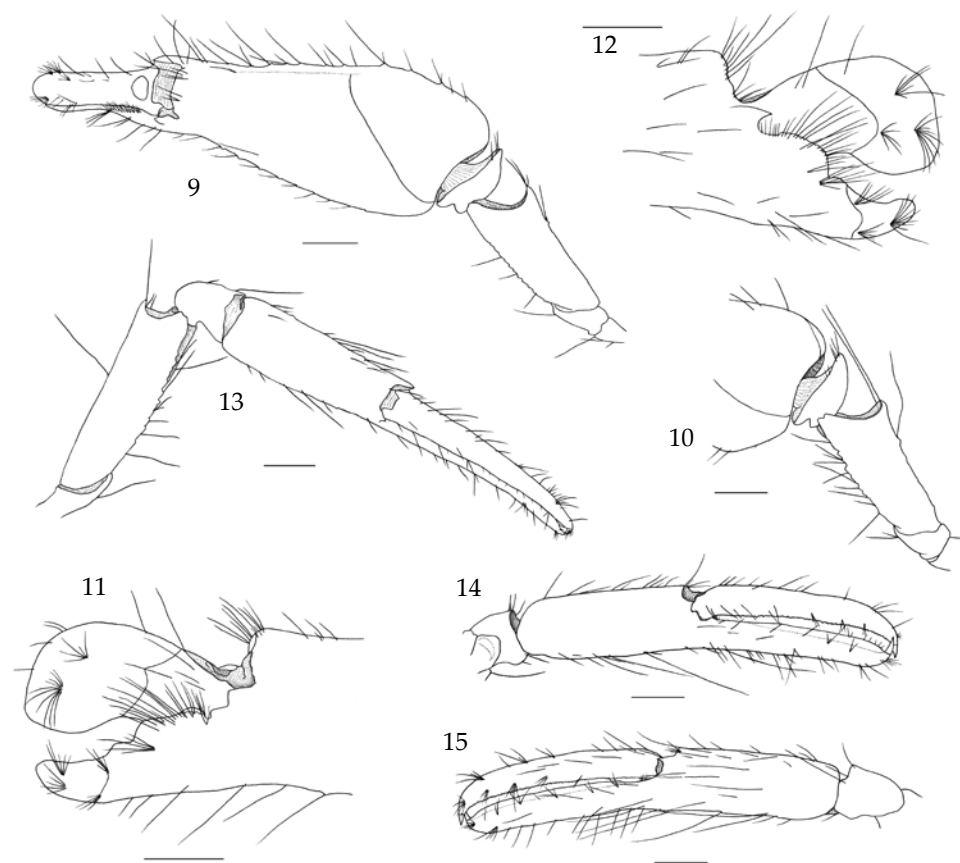
Antennular peduncle with small, distally acute stylocerite, latter not reaching distal margin of first segment of antennular peduncle; ventromesial carina of first segment with strong, shark fin-shaped tooth (fig. 3); second segment longest, slightly less than four times as long as wide; lateral antennular flagellum with row of aesthetascs starting at 14th segment. Antenna with basicerite bearing robust, sharp distolateral tooth (fig. 2); carpocerite reaching slightly beyond end of antennular peduncle and tip of distolateral tooth of scaphocerite; scaphocerite narrow, with lateral margin almost straight, slightly concave proximally; blade slender, separated from distolateral tooth by deep cleft running about half-length of scaphocerite (fig. 4); distolateral tooth well developed, over-reaching distal margin of blade, reaching slightly beyond end of antennular peduncle (fig. 1).

Mouthparts not dissected, appearing typical in external view. Third maxilliped slender, shorter than antennular peduncle and carpocerite when extended (fig. 5); lateral plate subacute; antepenultimate segment narrow, not flattened; penultimate segment about three times as long as wide; lateral margin somewhat rugose; ultimate segment tapering distally, with lateral margin slightly rugose; exopod reaching beyond distal margin of antepenultimate segment.

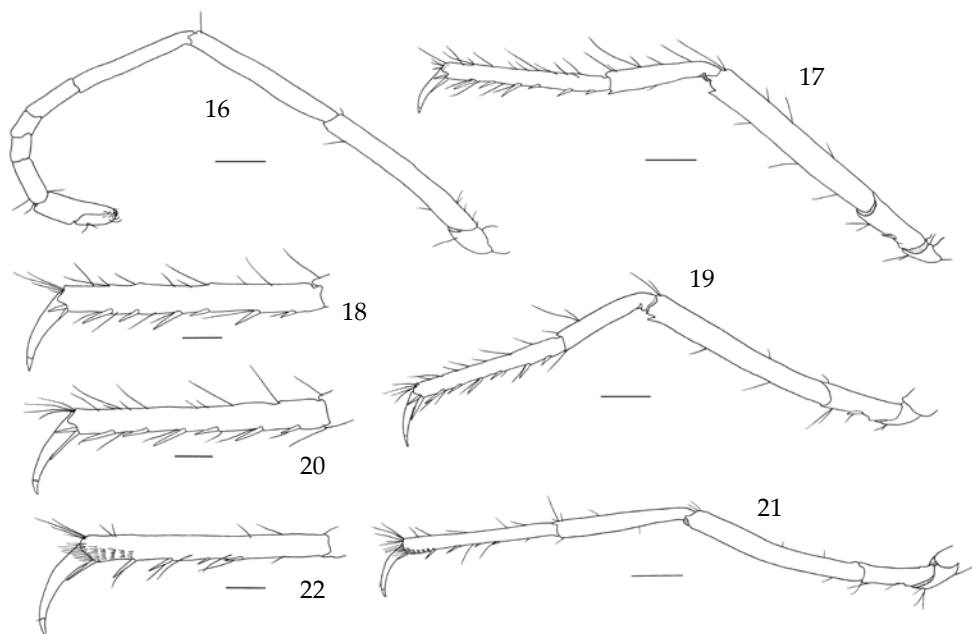
Major cheliped with short, stout ischium; merus flattened ventrally; ventromesial and ventrolateral margins serrated, both ending bluntly distally; dorsal margin ending in subacute tooth (figs 9, 10); carpus cup-shaped, with long setae distodorsally; chela somewhat compressed, twisted, fingers closing in nearly transversal plane to plane of proximal portion of palm; palm without notches; dorsal and ventral surfaces slightly convex, laterally compressed in dorsal view, more ovate in lateral and mesial view; dorsal surface with two low carinae each bearing a row of spaced, small, blunt tubercles; ventral surface with row of spaced blunt tubercles; lateral surface mostly smooth; linea impressa well marked; mesial surface with small tubercles and long setae, distally with large, acute distomesial tooth (fig. 12); fingers compressed, less than half palm

length; pollex with tip curved upwards, with bump on cutting edge anterior to moderately deep fossa; mesial surface surrounding fossa with a row of minute teeth; dactylus with rounded tip, cutting edge with short, stout plunger; adhesive disks conspicuous (figs 11, 12).

Minor chela with merus proportionally longer than that of major cheliped; ventro-mesial and ventrolateral margins serrated, unarmed distally; dorsal margin subacute distally; carpus cup-shaped, proportionally longer than that of major chela; palm slender, with surface smooth, covered with setae, latter longer and more abundant on mesial surface; dorsomesial and dorsolateral angle of palm each with strong acute tooth (figs 13-15); dorsal surface somewhat flattened, with two low carinae each bearing a row of small tubercles; mesial surface somewhat flattened; linea impressa less conspicuous than on major cheliped; fingers slender, slightly curved laterally, distinctly longer than palm; tips acute, curved, crossing distally; pollex with sharp cutting edge; dactylus with minute serrations on sharp cutting edge (figs 14, 15).



Figs 9-15. *Alpheus rudolphi* spec. nov., holotype, female (DOUFPE 13062): 9, major (left) cheliped, lateral view; 10, same, ischium to carpus, lateral view; 11, same, detail of chela, lateral view; 12, same, detail of chela, mesial view; 13, minor (right) cheliped, lateral view; 14, same, chela, lateral view; 15, same, chela, mesial view. Scale bars = 1 mm.



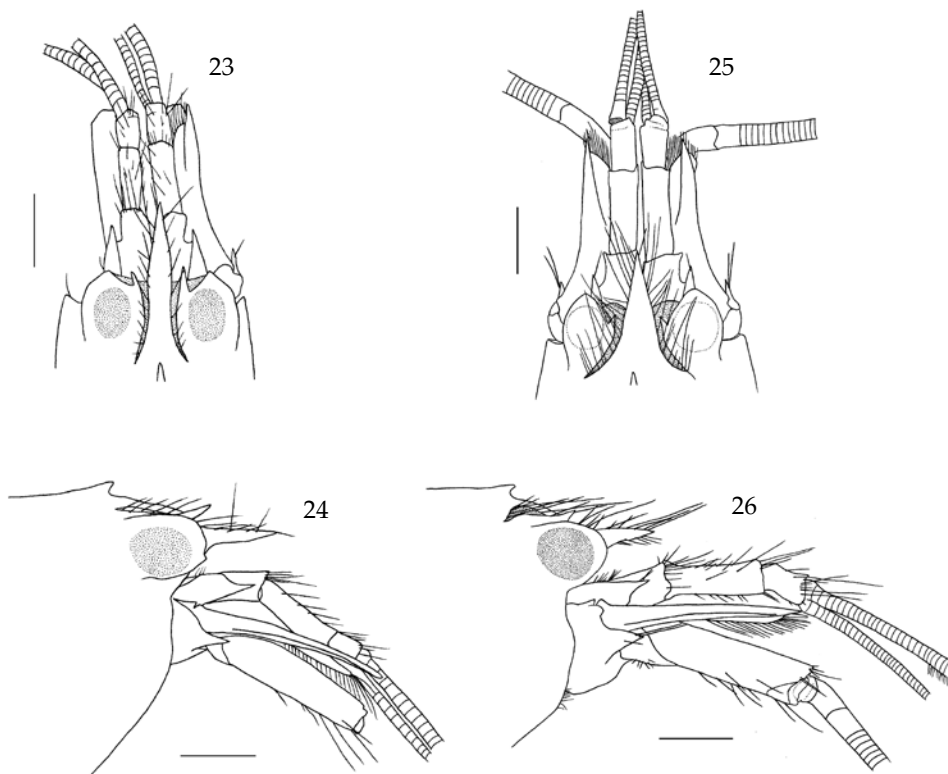
Figs 16–22. *Alpheus rudolphi* spec. nov., holotype, female (DOUFPE 13062): 16, second pereiopod, lateral view; 17, third pereiopod, lateral view; 18, same, dactylus and propodus, lateral view; 19, fourth pereiopod, lateral view; 20, same, dactylus and propodus, lateral view; 21, fifth pereiopod, lateral view; 22, same, dactylus and propodus, lateral view. Scale bars: 16, 17, 19, 21 = 1 mm; 18, 20, 22 = 0.5 mm.

Second pereiopod with ischium and merus subequal in length; carpus five-segmented, first segment longest; segment ratio (proximal to distal) subequal to 5 : 2 : 1 : 1 : 2 (fig. 16); chela simple, with fingers subequal to palm and bearing tufts of short curved setae distally. Third pereiopod slender; ischium armed with spine on ventrolateral surface (fig. 17); merus longer than propodus, about eight times as long as wide, with small subacute tooth on distoventral margin; carpus unarmed, about half merus length and $\frac{2}{3}$ propodus length; propodus with six spines along ventral margin plus one distal pair of spines near dactylus; dactylus around $\frac{1}{4}$ propodus length, simple, conical, slightly curved, acute distally (fig. 18). Fourth pereiopod (figs 19, 20) generally similar to third. Fifth pereiopod with ischium and merus unarmed (fig. 21); carpus about $\frac{3}{4}$ merus length; propodus slightly longer than carpus, with four spines along ventral margin plus one distal pair of spines near dactylus (fig. 22); distolateral surface with cleaning brush consisting of seven transverse rows of short setae; dactylus similar to that of third pereiopod, proportionally slightly longer, about $\frac{1}{3}$ propodus length.

Uropods with bifid protopod, each lobe ending in acute tooth (fig. 6); exopod and endopod subequal in length; distolateral spine slender, not exceeding posterior margin of exopod, not pigmented; diaeresis sinuous, with large blunt lobe adjacent to distolateral spine; distolateral tooth subacute (fig. 7).

Gill formula typical for genus.

Colour pattern.— Unknown.



Figs 23-26. *Alpheus immaculatus* Knowlton & Keller, 1983, female, CL 5.9 mm (RMNH.Crus 26225): 23, frontal region, dorsal view (left scaphocerite and basicerite damaged, not drawn); 24, same, lateral view. *Alpheus polystictus* Knowlton & Keller, 1985, male, CL 14.3 mm (MNHN-Na 15559): 25, frontal region, dorsal view (setae partially omitted on antennular peduncle); 26, same, lateral view. Scale bars: 23, 24 = 1 mm; 25, 26 = 2 mm.

Type locality.— Northeastern Brazil, off Alagoas.

Distribution.— Northeastern Brazil, presently known only from the type locality in Alagoas.

Ecology.— The holotype was dredged from the depth of 49 m; no other notes are available.

Etymology.— We are very pleased to name this new species in honour of the Chilean carcinologist, Prof. Dr Erich H. Rudolph Latorre (Departamento de Ciencias Básicas, Universidad de Los Lagos, Osorno).

Remarks.— *Alpheus rudolphi* spec. nov. clearly belongs to the *A. armatus* species complex, defined by the configuration of the frontal region of the carapace and the shape of the major and minor chelipeds (see Knowlton & Keller, 1983, 1985). The new species can be distinguished from the other four species of this complex (*A. armatus*, *A. immaculatus*, *A. polystictus*, *A. roquensis*) by the combination of characters summarised in Table 1. For instance, *A. rudolphi* spec. nov. may be separated from all four species at once by the lateral margins of the rostrum being straight, arrow-shaped (fig. 1) vs. more

Table 1. Characters useful for separation of the five presently known species of the *Alpheus armatus* Rathbun, 1901 complex (including morphology, colour pattern, ecology and distribution).

Species characters	<i>A. armatus</i>	<i>A. immaculatus</i>	<i>A. polystictus</i>	<i>A. roquensis</i>	<i>A. rudolphi</i> spec. nov.
Width of rostrum at base	~½ of rostrum length	~ ⅓ of rostrum length	~½ of rostrum length	~½ of rostrum length	between ⅓ and ⅓ of rostrum length
Lateral margin of rostrum	broadly concave	slightly concave proximally	broadly concave	broadly concave	straight
Rostrum length relative to segments of antennular peduncle	tip usually reaching distal margin of 1 st segment	tip reaching ¼ length of 2 nd segment	tip usually reaching distal margin of 1 st segment	tip barely reaching distal margin of 1 st segment	tip reaching ⅓ length of 2 nd segment
Setae on lateral margins of rostrum	present along entire margin	present along entire margin	present along entire margin	present along entire margin	present only in distal half
Shape of adrostral furrows	relatively wide	narrow	relatively wide	relatively wide	very narrow
Posterior margin of adrostral furrows	at the level of post-rostral tooth	slightly anterior to post-rostral tooth	at the level of post-rostral tooth	at the level of post-rostral tooth	distinctly anterior to post-rostral tooth
Anterior margin of orbital hood	rounded	angular	rounded	rounded ?	angular, produced
Anteromesial teeth of orbital hoods	directed upward; situated on mesial margin, at some distance from anterior margin	directed slightly upward, situated close to anteromesial margin (tips not reaching beyond anterior margin)	directed upward; situated on mesial margin, at some distance from anterior margin	directed upward; situated on mesial margin, at some distance from anterior margin	directed forward, situated almost at anteromesial margin (tips reaching beyond anterior margin)
Notch between mesial teeth and anterior margin of orbital hood	wide, more or less V-shaped	wide, more or less V-shaped	wide, more or less V-shaped	wide, more or less V-shaped	narrow, U-shaped
Ratio length of aesthetascs fan to antennular flagellum	not exceeding 0.3	not exceeding 0.3	close to 0.5	not exceeding 0.3	not exceeding 0.3
Distolateral spine of uropodal exopod in males	slender (see Knowlton & Keller, 1985 for morphometry)	slender (see Knowlton & Keller, 1985 for morphometry)	slender (see Knowlton & Keller, 1985 for morphometry)	broad (see Knowlton & Keller, 1985 for morphometry)	? (slender in female holotype)
Colour pattern: yellow dots on chelipeds	present	absent	present	present	unknown
Colour pattern: white spots on chelipeds	absent	absent	present	absent	unknown
Host anemone	<i>Bartholomea annulata</i>	<i>Bartholomea annulata</i>	<i>Bartholomea annulata</i>	<i>Ragactis lucida</i>	unknown
Typical depth range	1-10 m	13-25 m	1-10 m	5-15 m	49 m
Geographic range	Caribbean to Florida	Caribbean	Caribbean to Florida	5 Caribbean	NE Brazil

or less concave proximally, lanceolate (figs 23, 25). Furthermore, in *A. rudolphi* spec. nov., the lateral margins of the rostrum are only fringed with long setae distally (fig. 1), while in *A. immaculatus* (fig. 23), *A. polystictus* (fig. 25), *A. roquensis* and *A. armatus*, the lateral margins of the rostrum are fringed with long setae along their entire length. The new species also has the narrowest adrostral furrows and the most-anteriorly arising anteromesial teeth on the orbital hoods (compare figs 1, 23, 25). The posterior margin of the adrostral furrows in *A. rudolphi* spec. nov. do not reach the level of the post-rostral tooth (fig. 2), whereas in the other four species, the furrows reach the margin or fall just short of it (figs 24, 26). For additional characters that may be useful to separate *A. rudolphi* spec. nov. from the closely related species refer to Table 1.

The description of *A. rudolphi* spec. nov. brings the total number of Brazilian species of the genus *Alpheus* to 29 (Christoffersen, 1998; Coelho Filho, 2006; Anker et al., 2007, 2009). Some of them, e.g. *A. armillatus* H. Milne-Edwards, 1837, *A. normanni* Kingsley, 1878, *A. paracrinatus* Miers, 1884 and *A. floridanus* Kingsley, 1878, represent species complexes; once resolved a further increase in the number of species of *Alpheus* in Brazil is to be expected. On the other hand, the presence of *A. armatus* in Brazil remains to be confirmed since it is quite possible that Coelho et al. (1983) record of *A. armatus* from Alagoas actually refers to *A. rudolphi* spec. nov.

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