

James Madison University
Interlibrary Loan (VMC)

Borrower: HNI

Lending String:

AGL,*VMC,SMI,LRU,UIU,MTH,FTU,SBM,WIE

Volume: <#PhotoJournalVolume **Issue:**

Month/Year: 2014

Pages:

Article Author:

Article Title: Morphological and molecular description of a new species of *Fredius* (Decapoda: Pseudothelphusidae) from Rondônia, south

ISSN:

**Advances in Freshwater
Decapod Systematics and
Biology,**

Call #: QL444.M33 A33 2014

Rose Lib-Books AVAILABLE

Article Exchange

IFM

VMC TN: 601161

ILL Number: 172538913

CS114te

MORPHOLOGICAL AND MOLECULAR CHARACTERIZATION OF A
NEW SPECIES OF *FREDIUS* (DECAPODA, PSEUDOTHELPHUSIDAE)
FROM RONDÔNIA, SOUTHERN AMAZONIA, BRAZIL

BY

CÉLIO MAGALHÃES^{1,4}), VITOR Q. A. SANCHES^{2,5}), LEONARDO G. PILEGGI^{3,6}) and
FERNANDO L. MANTELATTO^{3,7})

¹) Instituto Nacional de Pesquisas da Amazônia (INPA), Caixa Postal 2223, 69080-971
Manaus, AM, Brazil

²) Instituto Federal de Educação, Ciência e Tecnologia do Mato Grosso do Sul (IFMS), Av.
Júlio de Castilho, 4960 – Panamá, 79113-000 Campo Grande, MS, Brazil

³) Laboratório de Bioecologia e Sistemática de Crustáceos (LBSC), Programa de
Pós-Graduação em Biologia Comparada, Departamento de Biologia, Faculdade de Filosofia,
Ciências e Letras de Ribeirão Preto (FFCLRP), Universidade de São Paulo (USP), Av.
Bandeirantes 3900, 14040-901, Ribeirão Preto, SP, Brazil

ABSTRACT

A new species of freshwater crab of the genus *Fredius* Pretzmann, 1967, from the state of Rondônia, Brazil, is described, illustrated, and characterized in terms of an mtDNA sequence (16S rRNA). *Fredius buritizatilis* sp. nov. is distinguished from its congeners by the following characters of the male first gonopod: a mesial lobe comprising a long, narrow, spear-like projection that is recurved upward; a cephalic lobe with a distinctly inflated proximal portion with a large patch of strong, corneous spines along its mesial and caudal surfaces; and an auxiliary lobe on the caudal surface that is inflated and shorter than cephalic lobe. The mt16S rRNA sequence of *Fredius buritizatilis* sp. nov. establishes its systematic position in relation to other species of *Fredius* included in the analysis. The occurrence of several species of Pseudothelphusidae in the state of Rondônia, Brazil, as well as the relationships of *Fredius buritizatilis* sp. nov. to other species of the genus, suggests that the affinities of some Brazilian pseudothelphusids are not as close as their geographical proximity might suggest.

⁴) Corresponding author; e-mail: celiomag@inpa.gov.br

⁵) e-mail: vitor.sanches@ifms.edu.br

⁶) e-mail: lpileggi@gmail.com

⁷) e-mail: flmantel@usp.br

(Magalhães, 2003), Tocantins (Magalhães, 2005), Madeira (Magalhães, 2009), and Aripuanã (Magalhães & Türkay, 2010) drainage basins. The discovery of this new species in Rondônia indicates that the southern Amazonian pseudothelphusid crab fauna is more diverse than previously thought. The new species is described, illustrated, and characterized in terms of a mtDNA sequence (16S rRNA). The new species is described by C. Magalhães and F. L. Mantelatto, who are the taxonomic authorities for *F. buritizatis* sp. nov.

MATERIAL AND METHODS

Sampling was carried out on 21 May 2010 and on 13 October 2010, and all crabs were captured by hand, after 7:00 pm. Specimens were deposited in the crustacean collections of the Departamento de Biologia, Faculdade de Filosofia, Ciências e Letras de Ribeirão Preto, Universidade de São Paulo, Ribeirão Preto (CCDB), at the Instituto Nacional de Pesquisas da Amazônia, Manaus (INPA), and the Museu de Zoologia, Universidade de São Paulo, São Paulo (MZUSP). The morphological description is based on the male holotype. The following abbreviations were used: carapace breadth (cb), measured across the carapace at its widest point; carapace length (cl), measured along the midline, from the frontal to the posterior margin; carapace height (ch), the maximum height of the cephalothorax; frontal breadth (fb), the breadth of the frontal margin measured along the upper border. Measurements are in millimeters. Other abbreviations used are: P = pereopod; s = thoracic sternite. The word gonopod, when used alone, refers to the first male gonopod; “igarapé” means small stream in Portuguese. Terminology for gonopod morphology follows Magalhães & Rodríguez (2002).

Both DNA extraction and amplification were made using fresh walking leg muscle tissue of *Fredius buritizatis* sp. nov. DNA sequences from other species of *Fredius* were also obtained and compared to that of the new species (table I). Genetic vouchers of *F. buritizatis* sp. nov., from which the tissue samples were obtained, are deposited in the CCDB (larger male paratype CCDB 342) and INPA (holotype INPA 1891) crustacean collections. Other specimens were acquired from the INPA crustacean collection. All specimens used in this study were identified by the first author. All DNA sequences used in this study were generated from our own extractions. The procedures followed Mantelatto et al. (2007, 2009a, b) and Pileggi and Mantelatto (2010), with appropriate modifications. A polymerase chain

TABLE I

Freshwater crab species used for the molecular comparison with collection site and catalogue number, and genetic database accession numbers (GenBank). CCDB = Coleção de Crustáceos, Departamento de Biologia, Faculdade de Filosofia, Ciências e Letras de Ribeirão Preto, Universidade de São Paulo, Ribeirão Preto; INPA = Instituto Nacional de Pesquisas da Amazônia, Manaus; MZUSP = Museu de Zoologia, Universidade de São Paulo, São Paulo; SMF = Forschungsinstitut und Naturmuseum Senckenberg, Frankfurt a. M., Germany

Species	Collection site	Catalogue no.	GenBank accession no.
<i>Fredius buriticatilis</i> sp. nov.	Ji-Paraná, Rondônia, Brazil	INPA 1891	JN402376
<i>Fredius buriticatilis</i> sp. nov.	Ji-Paraná, Rondônia, Brazil	CCDB 342	JN402377
<i>Fredius denticulatus</i>	Serra do Navio, Amapá, Brazil	INPA 582	JN402372
<i>Fredius estevisi</i>	Posto Indígena Parafuri, Roraima, Brazil	INPA 839	JN402379
<i>Fredius fitkaui</i>	Aldeia Balawa-ú, Amazonas, Brazil	INPA 1330	JN402373
<i>Fredius platyacanthus</i>	Comunidade Paapi-ú, Roraima, Brazil	INPA 841	Pending
<i>Fredius reflexifrons</i>	Rio Chumucuí, Bragança, Pará, Brazil	INPA 1512	JN402378
<i>Fredius stenolobus</i>	Rio Tawadu, Bolívar, Venezuela	INPA 833	JN402374
<i>Fredius stenolobus</i>	Aldeia Palimi-ú, Rio Uraricoera basin, Roraima, Brazil	INPA 848	JN402375
<i>Trichodactylus dentatus</i>	Bahia, Brazil	SMF 32763	FM208777

reaction (PCR) was performed in a Thermo[®] PxE 0.2 Thermal Cycler, using the universal primers: 16Sar (5'-CCGGTCTGAACTCAGATCACGT-3') and 16Sbr (5'-CGCCTGTTTATCAAAAACAT-3') (Palumbi et al., 1991) for the 16S rRNA (the large subunit of the ribosomal rRNA). PCR products were purified using a SureClean Plus kit, and were sequenced with the ABI Big Dye[®] Terminator Mix in an ABI Prism 3100 Genetic Analyzer[®]. All sequences were confirmed by sequencing both strands. The consensus sequence for the two strands was obtained using BioEdit Version 7.0.7.1 (Hall, 1999). Sequences were edited using BioEdit and aligned in Clustal W (Thompson et al., 1994) with interface in BioEdit, using default parameters. All sequences were submitted to GenBank (table I). A genetic distance analysis (minimum evolution) was conducted using MEGA 5.0 software (Tamura et al., 2011). Support for the nodes on the dendrogram was measured using a bootstrap method (1000 replicates), and only confidence values >50% were reported.

TAXONOMY

Family PSEUDOTHELPHUSIDAE Ortman, 1893

Genus *Fredius* Pretzmann, 1967

Fredius buritizatis Magalhães & Mantelatto sp. nov.

(fig. 1)

Material examined. — Holotype: male (genetic voucher: cb 39.7, cl 25.7, ch 17.2, fb 11.8), INPA 1891, Brazil, Rondônia, municipality of Ji-Paraná, buritizal no campus do Centro Universitário Luterano de Ji-Paraná (CEULJI-ULBRA), 10°51'50.6"N 61°57'30.9"W, coll. F. D. de Almeida, 21 May 2010. Paratypes: male (cb 31.4, cl 21.0), female (cb 38.4, cl 24.0), INPA 1892, same data as holotype; 2 males (cb 21.3, cl 14.2; genetic voucher: cb 31.6, cl 20.4), 1 female (cb 23.4, cl 15.6), 1 female with juveniles (cb 35.7, cl 23.0), CCDB 342, same data as holotype, 13 Oct. 2010; 1 male (cb 28.3, cl 18.9), 1 female (cb 22.0, cl 14.8), MZUSP 24441, same data as holotype, 13 Oct. 2010.

Other material examined. — *Fredius beccarii* (Coifmann, 1939), 1 male, Venezuela, Bolívar, Rio Uey, Serranía de Lema, trib. Rio Cuyuní, 06°02'23.5"N 61°30'26.4"W, 135 m elevation, coll. C. Lasso et al., 23 Jan. 2008. *Fredius denticulatus* (H. Milne Edwards, 1853): 1 male (genetic voucher), INPA 582, Brazil, Amapá, Serra do Navio, coll. Projeto Diversitas Neotropica, 7 May 1994. *Fredius estevisi* (Rodríguez, 1966): 1 male (genetic voucher), INPA 839, Brasil, Roraima, igarapé Inajá, Posto Indígena Parafuri, coll. Victor Py-Daniel et al., 22 Apr. 1994. *Fredius fitkaui* (Bott, 1967): 1 male (genetic voucher: cb 69.0, cl 43.2), INPA 1330, Brasil, Amazonas, unnamed stream, Rio Demini watershed, Balawa-ú Yanomami village, 01°47'N 63°46'W, coll. U. C. Barbosa, 5 Sep. 2003. *Fredius platyacanthus* Rodríguez & Pereira, 1992: 2 males, INPA 1328, Brasil, Amazonas, surroundings of Balawa-ú village, igarapé Loahik, affluent Rio Balawa-ú, Rio Demini watershed, 01°47'N 63°46'W, coll. J. Yanomami, 12 Nov. 2003; 1 male, INPA 841, Brasil, Roraima, Comunidade Paapi-ú, 02°39'N 63°09'W, igarapé unnamed, coll. U. C. Barbosa et al., 28 Apr. 1994. *Fredius*

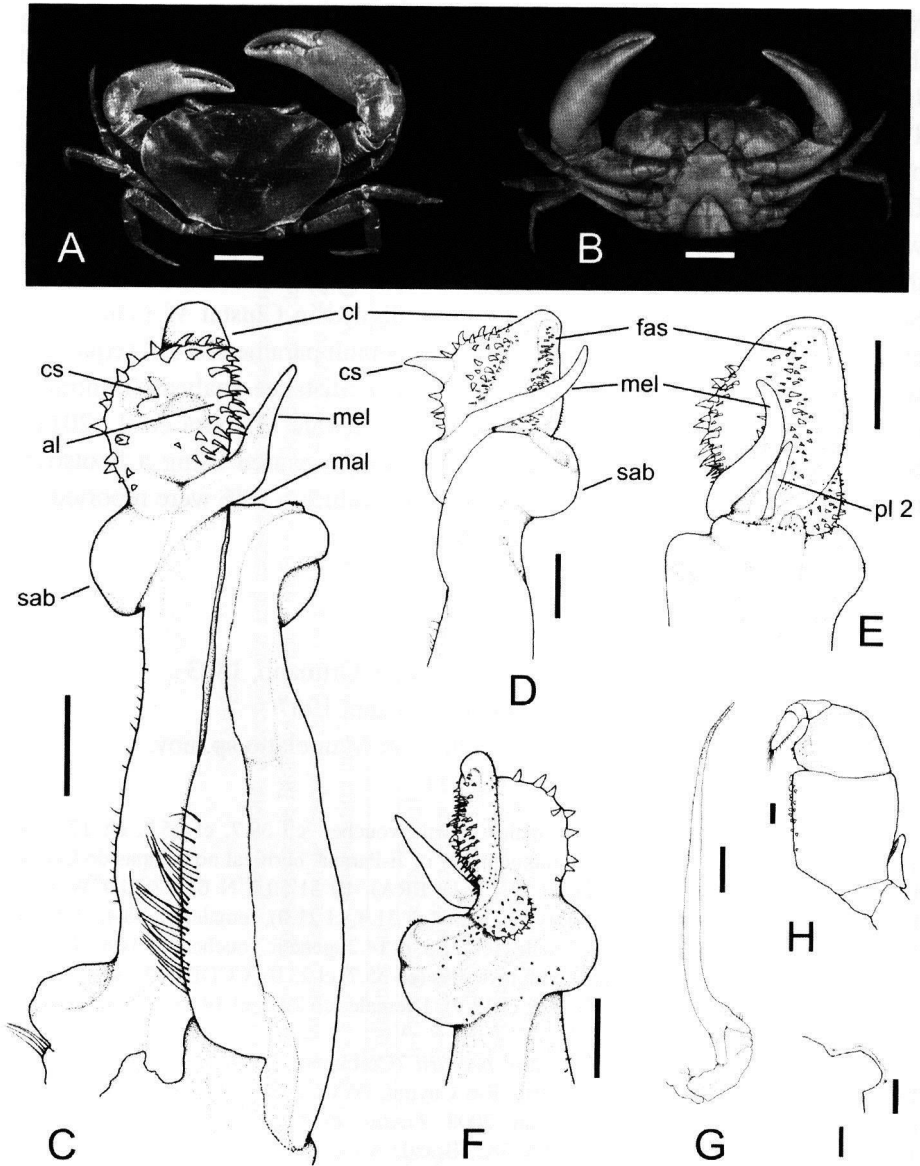


Fig. 1. *Fredius buritizatilis* sp. nov., male holotype (cb 39.7, cl 25.7), INPA 1891. A, dorsal view; B, ventral view; C, left first gonopod, whole limb, mesiocaudal view; D, distal part of left first gonopod, caudal view; E, distal part of left first gonopod, lateral view; F, distal part of left first gonopod, laterocephalic view; G, left second gonopod, whole limb, mesiocaudal view; H, left third maxilliped, external view; I, left aperture of efferent branchial channel. Abbreviations: al = auxiliary lobe; cl = cephalic lobe; cs = cephalic spine; fas = field of apical spines; mal = marginal lobe; mel = mesial lobe; pl 2 = left second gonopod (distal part only); sab = subapical bulge. Scales: A, B = 10 mm; C-I = 1 mm.

reflexifrons (Ortmann, 1897): 1 male (genetic voucher), INPA 1512, Brazil, Pará, Bragança, Rio Chumucuí, coll. S. Alves, 12 Nov. 2004. *Fredius stenolobus* Rodríguez & Suárez, 1994: 1 male (genetic voucher: cb 65.6, cl 42.0), INPA 833, Venezuela, Bolívar, Rio Tawadu, 06°20.147'N 65°02.057'W, coll. C. Magalhães & G. Pereira, 5 Dec. 2000; 1 male (genetic voucher: cb 74.0, cl 48.7), INPA 848, Brasil, Roraima, Rio Uraricoera, Palimi-ú Yanomami village, coll. Victor Py-Daniel et al., 22 May 1995. *Fredius ykaa* Magalhães, 2009: male, holotype, INPA 1465, Brazil, Amazonas, municipality of Maués, Rio Marau, tributary of Rio Maués-Açu, Vila Nova I, 03°44'48''S 57°11'23''W, coll. M. A. V. Correa, 14-28 Jul. 2004.

Diagnosis. — Mesial lobe of male first gonopod long, narrow, spear-like projection recurved upward; cephalic lobe with proximal portion distinctly inflated, bearing large patch of strong, corneous spines along mesial, caudal surfaces. Auxiliary lobe on caudal surface inflated, shorter than cephalic lobe.

Description of the holotype. — Carapace outline ellipsoid (fig. 1A), widest in middle (cb/cl average: 1.54); dorsal surface smooth, convex, regions poorly defined. Pair of distinct gastric pits very close to each other on metagastric region. Cervical grooves narrow, deep, nearly straight, extremities barely reaching anterolateral margin. Postfrontal lobules small, oval; median groove indistinct between postfrontal lobules. Carapace surface between front, postfrontal lobules smooth, sloping gently downwards. Front with distinct upper border; upper border slightly convex in dorsal view, marked with row of very faint papillae; lower border carinate, barely visible in dorsal view, slightly sinuous in frontal view. Upper, lower orbital margins marked by row of very faint papillae; exorbital angle obtuse. Anterolateral margins of carapace with poorly defined notch just behind exorbital angle, fringed by 3 tubercles before cervical groove, followed by row of minute, tuberculiform teeth; posterolateral margins smooth, rounded, marked by faint suture. Epistome narrow; epistomial tooth triangular, deflexed, borders carinate. Suborbital, subhepatic regions of carapace sidewall smooth; pterygostomial regions covered by rather thin pubescence around mouthparts, otherwise smooth.

Endopod of third maxilliped with outer margin of ischium slightly convex, inner margin straight. Exopod of third maxilliped short, approximately 0.31 times length of outer margin of ischium (fig. 1H). Orifice of efferent branchial channel wide, subquadrate (fig. 1I).

First pereopods moderately heterochelous, holotype with right cheliped larger than left. Major cheliped with merus subtriangular in cross section; upper crest rounded, with irregular longitudinal row of tubercles; internal lower crest with irregular row of conical, blunt teeth increasing in size distally; external lower crest delimited by regular row of low tubercles. Carpus with row of small tubercles and prominent spine on inner side; outer side rounded,

smooth. Palm slightly swollen (length/breadth 1.1), smooth on both sides; upper, lower borders rounded, smooth. Fingers slightly gaping when closed (not gaping in smaller cheliped), tips not crossing; both fingers with large rounded teeth, smaller distally; smaller teeth sometimes interspersed with larger ones. Pereiopods 2-5 slender, dactyli 1.42-1.68 times as long as propodi, with 5 longitudinal rows of corneous spines diminishing in size proximally.

Thoracic sternites (fig. 1B) of third maxillipeds, first pereiopods completely fused, except for small notches at lateral edges of sternum. Sternal sulci s4/s5, s5/s6, s6/s7 distinct, faint in middle, deeper near midline of thoracic sternum, ending just before reaching midline; sternal sulcus s7/s8 deep throughout length, reaching midline. Midline of thoracic sternum marked by deep groove in sternites VII-VIII; indistinct in sternites V-VI. Sternoabdominal cavity densely pilose, especially in sternites V-VI.

All abdominal segments free (fig. 1B). Lateral margins of male telson parallel in line with midline axis, tip rounded.

First gonopod robust, widest at base, narrowest approximately 2/3 along length; subapical bulge well developed around lateral, cephalic sides. Marginal suture straight, situated on mesial side (fig. 1C). Marginal lobe large, short, distal border nearly straight, with scattered patch of minute teeth (fig. 1C); marginal lobe separated from caudal surface by shallow groove. Mesial lobe extremely developed as long, narrow, sinuous projection recurved upwards, directed laterally, distally (fig. 1C-F). Cephalic spine strong, recurved, conical, with acuminate tip pointing in mesocaudal direction (fig. 1C, D). Cephalic lobe enlarged, rounded distally, its proximal portion distinctly inflated, bearing large patch of strong, corneous spines along mesial, caudal sides (fig. 1C, D, F). Auxiliary lobe on caudal side, rather inflated, slightly shorter than cephalic lobe (fig. 1C-E); lateral channel indistinct. Field of apical spines well developed as elongated, dense patch of strong spines along lateral side, delimited by cephalic, caudal borders of apex (fig. 1D-F). Second gonopod (fig. 1G) slightly shorter than first, very slender, tapering, distal part rather flattened, with dense patch of minute teeth.

Distribution. — *Fredius buritizatilis* sp. nov. is currently known only from the type locality, which is the drainage area of the middle course of the Rio Machado, a tributary of the Rio Madeira, in turn, a right bank tributary of the Amazon River. Magalhães (1986) previously assigned to *Fredius reflexifrons* two ovigerous females (MZUSP 7047) from Santa Cruz da Serra (in Rio Jaru watershed, an affluent of Rio Machado) and a female (MZUSP 6382) from Nova Esperança, also in the Rio Machado drainage. However, these

records of female specimens were later considered uncertain (Magalhães & Rodríguez, 2002) because the taxonomy of these crabs relies almost entirely on the morphology of the male first gonopod. Magalhães (1986) also reported two other records of undetermined pseudothelphusid specimens from Rondônia: one female (MZUSP 6392 — the male symbol was a printing mistake) from the Rio Jaru watershed, and a juvenile (INPA) from the headwaters of Rio Formoso, in the Rio Jaciparaná drainage. Therefore *Fredius buritizalis* is the first identified pseudothelphusid species to be recorded from the state of Rondônia. It is possible that the females of uncertain identity that were recorded earlier from localities in the Rio Machado drainage basin might also belong to *Fredius buritizalis* sp. nov., but without gonopod characters or DNA sequences their identity cannot be confirmed. More comprehensive surveys of the decapod fauna of Rondônia are needed in order to establish the actual distribution of this new species.

Fredius buritizalis sp. nov. is the southernmost record of any species of *Fredius* known to date. Apart from a few records of *F. reflexifrons* from the state of Ceará (Brazil) and from the main axis of the Amazon River (Magalhães et al., 2005), and *F. ykaa* from the lower Rio Madeira basin (Magalhães, 2009). All other species of the genus are found north of this in northern Brazil, French Guiana, Suriname, Guiana, Colombia, and Venezuela (Rodríguez, 1982; Rodríguez & Campos, 1998; Magalhães & Rodríguez, 2002; Magalhães et al., 2005, 2006; Magalhães, 2009). Both *F. buritizalis* sp. nov. and *F. ykaa* are found in the Rio Madeira basin. However the latter species occurs in the lower part of the basin and was found in “terra firme” (highlands never inundated by the periodical floods of the main rivers of the Amazon basin) forest streams, while the former occurs a little more than 7 degrees latitude southwards in a different kind of habitat (see below).

Habitat. — Specimens of the new species were collected in a “buritizal” swamp of the Centro Universitário Luterano de Ji-Paraná (CEULJI-ULBRA), within the urban area of the city of Ji-Paraná. A “buritizal” is a “forest” of basically the *Mauritia flexuosa* palm popularly known as “buriti” which tends to occur in moist depressions with poorly drained soils (Ribeiro & Walter, 2008). The sampling area was about 195 m long and 80 m wide and is currently impacted by human activities, invasion by domestic fauna, and domestic sewage discharge. According to the Secretaria de Estado do Desenvolvimento Ambiental (Rondônia, 2009), the temperature during the year varies between 21.6 and 31.5°C (mean of 26.5°C), the humidity ranges from 35 to 84%, and the mean precipitation is 1711.2 mm/year (varying from 1.8 mm in July to

337 mm in January). The capture of crabs is easier during the dry season when lower water levels expose the entrances of the crab burrows. Male and female crabs were collected from the same burrow.

Etymology. — The species is named after its habitat and the name is formed from the word “buritizal” (forest of buritis) and the Latin suffix, *-atilis*, meaning place of growth.

Molecular aspects. — A 543 base sequence of the 16S rRNA gene from a number of species of *Fredius* was aligned, and the sequence included insertions and deletions. The sequence divergence rates (i.e., uncorrected pairwise differences) estimated among all species of *Fredius* included in the analysis ranged from 1.4-20.9% for the 16S rRNA gene; sequence divergence rates for intraspecific individuals were 0% for 16S rRNA gene. Sequence divergence between *F. buritizatilis* sp. nov. and a number of closely related congeneric species is shown in the Minimum Evolution dendrogram (fig. 2).

Remarks. — The new species is included in the genus *Fredius* based on characters of the male first gonopod such as the open, ear-shaped field of apical spines, the well developed subapical bulge around the lateral and cephalic surfaces (“bourrelet subapical”, after Rodríguez, 1982), and the simple marginal process. The molecular analysis positions this taxon within the group formed by the other species of the genus *Fredius* used in this study (table I, fig. 2).

Comparisons between *F. buritizatilis* sp. nov. and *F. ykaa* (whose distribution is closest to that of the new species), suggest that their affinities are not

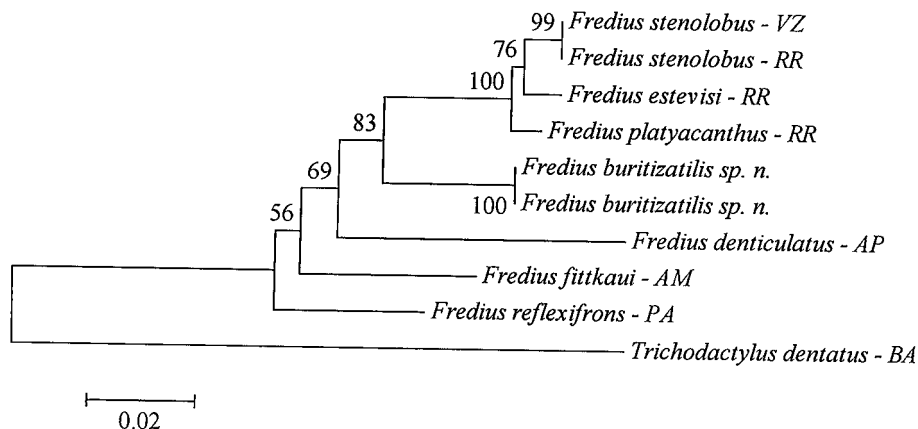


Fig. 2. Dendrogram of distance analysis among some species of *Fredius*, based on the 16S rRNA gene.

as close as their relative geographical proximity might suggest. The first gonopod of *F. buritizatilis* sp. nov. bears a very long, spear-like, distally recurved mesial lobe while in *F. ykaa* this lobe is very small, and is reduced to a small triangular spine pointing in the caudal direction. Other differences between the gonopod of these two taxa can be seen in the cephalic lobe (proximal portion inflated and bearing patch of strong, corneous spines in *F. buritizatilis* sp. nov. vs. flat, with a patch of very small spines in *F. ykaa*), and the cephalic spine (conical, with sharp tip pointing in mesiocaudal direction in of *F. buritizatilis* sp. nov. vs. broadly triangular, with a blunt tip pointing laterally in *F. ykaa*). In addition, the position of the mesial lobe of the gonopod in relation to the cephalic spine, and the situation of the auxiliary lobe are very distinct between both species.

The new species seems to be morphologically most closely related to *F. platyacanthus* Rodríguez & Pereira, 1992, *F. estevisi*, and *F. stenolobus*, based on similar morphologies and positions of the mesial lobe and cephalic spine of the adult male gonopod, in spite of differences in the shape of these processes. Similarly, *F. buritizatilis* sp. nov., *F. platyacanthus* and *F. estevisi* all have a gonopod that has a mesial lobe that is much larger than the cephalic spine (see Rodríguez & Pereira, 1992: 306, fig. 4A-E), and this character is a little larger than that of both *F. stenolobus* (see Rodríguez & Campos, 1998: 766, fig. 2A, B) and *F. adpressus* Rodríguez & Pereira, 1992 (see Rodríguez & Pereira, 1992: 306, fig. 4H-J). The mesial lobe of the male gonopod is equally as developed as the cephalic spine in *F. granulatus* Rodríguez & Campos, 1998 (see Rodríguez & Campos, 1998: 766, fig. 2C, D), *F. chaffanjonii* (Rathbun, 1905) (see Rodríguez & Pereira, 1992: 306, fig. 4F, G), and *F. beccarii* (see Rodríguez & Pereira, 1992: 306, fig. 4FM, N). Other species of *Fredius* [e.g., *F. ykaa*, *F. reflexifrons*, *F. fittkai* (Bott, 1967), and *F. denticulatus* (H. Milne Edwards, 1853)] have a gonopod with a cephalic spine that is more developed than the mesial lobe (see Magalhães & Rodríguez, 2002: 679, fig. 1; 683, fig. 2, respectively; Rodríguez & Campos, 1998: 766, fig. 2O, P).

These affinities are supported by the dendrogram based on the mt16S rRNA gene (fig. 2). Although the analysis is incomplete due to the unavailability of samples for all species of the genus, *F. buritizatilis* sp. nov. lies closer to *F. platyacanthus*, *F. estevisi* and *F. stenolobus* than to the other species that have a weakly developed mesial lobe. Integration of molecular taxonomy and comparative morphology of pending available species will provide a more robust insight into the systematics of this genus in South America.

ACKNOWLEDGEMENTS

CM and FLM are grateful to the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for an ongoing Research Grant (304468/2009-6 and 302748/2010-5, respectively) and LGP is supported by an ongoing Post-Doctoral fellowship CAPES (02630/2009-5). Additional support for this project was provided by FAPESP (Biota Proc. 2010/50188-8; Coleções Científicas Proc. 2009/54931-0), CNPq (Proc. 491490/2004-6; 490353/2007-0; 471011/2011-8) and CAPES/DAAD (Proc. 315/09) to FLM. We are deeply grateful to Francisco Dutra de Almeida for help in collecting the new species, and to Jose Christopher E. Mendoza and an anonymous reviewer for valuable comments that greatly improved the text. The authors thank Barbara Robertson for correcting the English text, and Darren Yeo and Sebastian Klaus for the invitation to contribute to this special volume on freshwater decapods.

REFERENCES

- BOTT, R., 1967. Flusskrabben aus Brasilien und benachbarter Gebiete. *Potamocarcinus* (*Kingsleya*) Ortman 1987 (Crustacea, Decapoda). *Senckenbergiana biologica*, **48**(4): 301-312.
- COIFMANN, I., 1939. Potamonidi dell R. Museo Zoologico di Torino. *Archivo Zoologico Italiano*, **27**: 93-116.
- CUMBERLIDGE, N. & P. K. L. NG, 2009. Systematics, evolution, and biogeography of freshwater crabs. In: J. W. MARTIN, K. A. CRANDALL & D. L. FELDER (eds.), *Decapod crustacean phylogenetics*. *Crustacean Issues*, **18**: 245-260. (Taylor & Francis/CRC Press, Boca Raton).
- DE GRAVE, S., N. D. PENTCHEFF, S. T. AHYONG, T. Y. CHAN, K. A. CRANDALL, P. C. DWORSCHAK, D. L. FELDER, R. M. FELDMANN, C. H. J. M. FRANSEN, L. Y. D. GOULDING, R. LEMAITRE, M. E. Y. LOW, J. W. MARTIN, P. K. L. NG, C. E. SCHWEITZER, S. H. TAN, D. TSHUDY & R. WETZER, 2009. A classification of living and fossil genera of decapod crustaceans. *Raffles Bulletin of Zoology*, (Supplement) **21**: 1-109.
- HALL, T. A., 1999. BioEdit: a user-friendly biological sequence alignment editor and analysis program for Windows 95/98/NT. *Nucleic Acids Symposium Series*, **41**: 95-98.
- MAGALHÃES, C., 1986. Revisão taxonômica dos caranguejos de água doce brasileiros da família Pseudothelphusidae (Crustacea, Decapoda). *Amazoniana*, **9**(4): 609-636.
- —, 2003. The occurrence of freshwater crabs (Crustacea: Decapoda: Pseudothelphusidae, Trichodactylidae) in the Rio Xingu, Amazon Region, Brazil, with description of a new species of Pseudothelphusidae. *Amazoniana*, **17**(3/4): 377-386.
- —, 2005. A new species of freshwater crab (Crustacea: Decapoda: Pseudothelphusidae) from the southeastern Amazon Basin. *Nauplius*, **12**(2): 99-107 [2004].
- —, 2009. A new species of freshwater crab of the genus *Fredius* Pretzmann, 1967 from the middle Amazon River basin, Brazil (Crustacea: Decapoda: Pseudothelphusidae). *Proceedings of the Biological Society of Washington*, **112**(1): 81-86.

- MAGALHÃES, C., F. A. ABRUNHOSA, M. O. PEREIRA & M. A. MELO, 2005. New records of *Fredius denticulatus* (H. Milne Edwards, 1853) and *F. reflexifrons* (Ortmann, 1897), and the eastern limits of the distribution of the pseudothelphusid crabs (Crustacea: Decapoda) in Brazil. *Acta Amazonica*, **35**(1): 93-96.
- MAGALHÃES, C., U. C. BARBOSA & V. PY-DANIEL, 2006. Decapod crustaceans used as food by the Yanomami Indians of the Balawa-ú village, State of Amazonas, Brazil. *Acta Amazonica*, **36**(3): 369-374.
- MAGALHÃES, C. & G. RODRÍGUEZ, 2002. The systematic and biogeographical status of *Fredius reflexifrons* (Ortmann, 1897) and *Fredius fitkaui* (Bott, 1967) (Crustacea: Brachyura: Pseudothelphusidae) from the Amazon and Atlantic Guianas river basins. *Acta Amazonica*, **34**(2): 677-689.
- MAGALHÃES, C. & M. TÜRKAY, 1986. *Brasiliothelphusa*, a new Brazilian freshwater-crab genus (Crustacea: Decapoda: Pseudothelphusidae). *Senckenbergiana biologica*, **66**(4/6): 371-376.
- — & — —, 2010. A new freshwater crab of the genus *Brasiliothelphusa* Magalhães & Türkay, 1986 from Rio Aripuanã, southern Amazon Region, Brazil (Crustacea: Decapoda: Pseudothelphusidae). *Nauplius*, **18**(2): 103-108.
- MANTELATTO, F. L., L. M. PARDO, L. G. PILEGGI & D. L. FELDER, 2009b. Taxonomic re-examination of the hermit crab species *Pagurus forceps* and *Pagurus comptus* (Decapoda: Paguridae) by molecular analysis. *Zootaxa*, **2133**: 20-32.
- MANTELATTO, F. L., R. ROBLES & D. L. FELDER, 2007. Molecular phylogeny and taxonomic approach of the crab genus *Portunus* (Crustacea, Portunidae) from Western Atlantic. *Zoological Journal of the Linnean Society*, **150**(1): 211-220.
- MANTELATTO, F. L., R. ROBLES, C. D. SCHUBART & D. L. FELDER, 2009a. Molecular phylogeny of the genus *Cronius* Stimpson, 1860, with reassignment of *C. tumidulus* and several American species of *Portunus* to the genus *Achelous* De Haan, 1833 (Brachyura: Portunidae). In: J. W. MARTIN, K. A. CRANDALL & D. L. FELDER (eds.), *Decapod crustacean phylogenetics*. *Crustacean Issues*, **18**: 567-579. (Taylor & Francis/CRC Press, Boca Raton).
- MILNE EDWARDS, H., 1853. Mémoire sur la famille des Ocypodien. *Annales des Sciences Naturelles, Zoologie*, 3^e série, **20**: 163-228.
- NG, P. K. L., D. GUINOT & P. J. F. DAVIE, 2008. *Systema Brachyurorum: Part I. An annotated checklist of extant brachyuran crabs of the world*. *Raffles Bulletin of Zoology*, (Supplement) **17**: 1-286.
- ORTMANN, A., 1893. Die Decapoden-Krebse des Straßburger Museum, mit besonderer Berücksichtigung der von Herrn Dr. Döderlein bei Japan und bei den Liu-Kiu Inseln gesammelten und zur Zeit im Straßburger Museum aufbewahrten Formen. VII. Theil. Abtheilung: Brachyura (*Brachyura genuina* Boas) II. Unterabtheilung: Cancroidea, 2. Section: Cancrinea, 1. Gruppe: Cyclometopa. *Zoologischen Jahrbücher, Abtheilung für Systematik, Geographie und Biologie der Thiere*, **7**: 411-495, pl. 17.
- —, 1897. *Carcinologische Studien*. *Zoologische Jahrbücher, Abteilung für Systematik, Geographie und Biologie der Tiere*, **10**: 258-372, pl. 17.
- PALUMBI, S., A. MARTIN, S. ROMANO, W. O. McMILLAN, L. STICE & G. GRABOWSKI, 1991. The simple fool's guide to PCR: 1-46. (University of Hawaii, Department of Zoology, Honolulu).
- PILEGGI, L. G. & F. L. MANTELATTO, 2010. Molecular phylogeny of the freshwater prawn genus *Macrobrachium* (Decapoda, Palaemonidae), with emphasis on the relationships among selected American species. *Invertebrate Systematics*, **24**(2): 194-208.

- PRETZMANN, G., 1967. Über einige südamerikanische Süßwasserkrabben (Pseudothelphusidae). Vorläufige Mitteilung. Entomologische Nachrichtenblatt, **14**(2): 23-26.
- RATHBUN, M. J., 1905. Les Crabes d'eau douce (Potamonidae). Nouvelles archives du Muséum national d'Histoire naturelle, **7**(4): 159-321.
- RIBEIRO, J. F. & B. M. T. WALTER, 2008. As principais fitofisionomias do cerrado. In: S. M. SANO, S. P. DE ALMEIDA & J. F. RIBEIRO (eds.), Cerrado: ecologia e flora, **1**: 151-212. (EMBRAPA Informação Tecnológica, Planaltina).
- RODRÍGUEZ, G., 1966. Three new species of *Pseudothelphusa* from Venezuela. Zoologische Mededelingen, **41**: 259-267.
- —, 1982. Les crabes d'eau douce d'Amerique. Famille des Pseudothelphusidae. Faune Tropicale, **22**: 1-224. (ORSTOM, Paris).
- RODRÍGUEZ, G. & M. CAMPOS, 1998. A cladistic revision of the genus *Fredius* (Crustacea: Decapoda: Pseudothelphusidae) and its significance to the biogeography of the Guianan lowlands of South America. Journal of Natural History, **32**(5): 763-775.
- RODRÍGUEZ, G. & G. PEREIRA, 1992. New species, cladistic relationships and biogeography of the genus *Fredius* (Crustacea: Decapoda: Pseudothelphusidae) from South America. Journal of Crustacean Biology, **12**(2): 298-311.
- RODRÍGUEZ, G. & H. SUÁREZ, 1994. *Fredius stenolobus*, a new species of freshwater crab (Decapoda: Brachyura: Pseudothelphusidae) from the Venezuelan Guiana. Proceedings of the Biological Society of Washington, **107**(1): 132-136.
- RONDÔNIA, 2009. Secretaria de Estado do Desenvolvimento Ambiental (SEDAM). Boletim Climatológico de Rondônia, **2007**: 1-36. (SEDAM, Porto Velho).
- TAMURA, K., D. PETERSON, N. PETERSON, G. STECHER, M. NEI & S. KUMAR, 2011. MEGA5: molecular evolutionary genetics analysis using maximum likelihood, evolutionary distance, and maximum parsimony methods. Molecular Biology and Evolution, **28**(10): 2731-2739.
- THOMPSON, J. D., D. G. HIGGING & T. J. GIBSON, 1994. CLUSTAL W: improving the sensitivity of progressive multiple sequence alignment through sequence weighting specific gap penalties and weight matrix choice. Nucleic Acids Research, **22**: 4673-4680.

This book is printed on acid-free paper.

Library of Congress Cataloging-in-Publication Data

Advances in freshwater decapod systematics and biology / by Darren C.J. Yeo, Neil Cumberlidge, and Sebastian Klaus (editors).

pages cm. — (Crustaceana monographs ; 19)

Includes bibliographical references.

ISBN 978-90-04-20760-8 (hardback : alk. paper) — ISBN 978-90-04-20761-5 (e-book)

I. Decapoda (Crustacea) 2. Decapoda (Crustacea)—Classification. 3. Freshwater invertebrates. I. Yeo, Darren C. J. (Darren Chong Jinn) II. Cumberlidge, Neil. III. Klaus, Sebastian.

QL444.M33A33 2014

595.3'8—dc23

2014016758

ISBN13: 978 90 04 20760 8

E-ISBN: 978 90 04 20761 5

© 2014 by Koninklijke Brill NV, Leiden, The Netherlands.

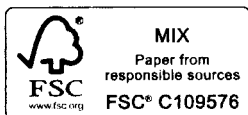
Koninklijke Brill NV incorporates the imprints Brill, Brill Nijhoff, Global Oriental and Hotel Publishing.

All rights reserved. No part of this publication may be reproduced, translated, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without prior written permission from the publisher.

Authorization to photocopy items for internal or personal use is granted by Koninklijke Brill NV provided that the appropriate fees are paid directly to The Copyright Clearance Center, 222 Rosewood Drive, Suite 910, Danvers, MA 01923, USA.

Fees are subject to change.

PRINTED IN THE NETHERLANDS



Printed by Printforce, the Netherlands