A new species of freshwater crab (Decapoda: Pseudothelphusidae) from the southeastern Amazon Basin

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Abstract

A new species of pseudothelphusid crab, genus *Kingsleya* Ortmann, 1897, is described from Rio Tocantins Basin in the state of Pará, Brazil. The new species is distinguished by the morphology of the apical plate of the first male gonopod, in which the distal lobe has an enlarged cephalic border that is produced mesially into a subapical rounded prominence. The new species is compared to *Kingsleya siolii* Bott, 1967 and their geographical distribution are discussed.

Key words: Freshwater crab, Amazon Basin, new species, Pseudothelphusidae, *Kingsleya*, Rio Tocantins.

Introduction

The drainage basin of the Rio Tocantins covers more than 750,000 km^2 and is the easternmost large river in the Amazon Basin (Goulding *et al.*, 2003). The Rio Tocantins drains the Brazilian Shield highlands, and the Rio Itacaiúnas is its main tributary that drains the Serra dos Carajás region.

The trichodactylid crab fauna of the Rio Tocantins Basin is fairly well known (Magalhães and Türkay, 1996a,b; Magalhães, 2003a), but little is known of the river's pseudothelphusid crabs. In 1986, Magalhães (1986) recorded an unidentified juvenile pseudothelphusid crab from Serra dos Carajás (Serra Norte), and a female pseudothelphusid that he assigned to *Fredius reflexifrons* from the mouth of the Rio Tapirapé, a left bank tributary of the Rio Araguaia, in the state of Mato Grosso. However, the identification of this female was later considered as uncertain (Magalhães and Rodríguez, 2002). Port-Carvalho *et al.* (2004) reported on predation of pseudothelphusid crabs by tufted capuchin monkeys, *Cebus apela* (Linnaeus, 1758), in a forest fragment known as Santa Rosa (05°05'S, 48°15'W) near the Rio Traíras, a small right bank tributary of the Rio Tocantins, in the state of Maranhão. Unfortunately the damaged crab specimens examined were all females, which prevented even their generic identification. However, these specimens are probably not *Kingsleya*, because Port-Carvalho *et al.* (2004) described them as terrestrial crabs most likely pertaining to the genus *Fredius*.

Extensive deforestation for cattle ranching and soybean farming, mining and dam constructions make the Rio Tocantins Basin the most disturbed of the larger tributaries of the Amazon Basin (Goulding *et al.*, 2003). Therefore, a better knowledge about the composition and distribution of its decapod crustacean fauna is urgently needed.

The specimens are deposited at the Instituto Nacional de Pesquisas da Amazônia, Manaus (INPA), Museu Paraense Emílio Goeldi, Belém (MPEG), Museu Nacional - Universidade Federal do Rio de Janeiro, Rio de Janeiro (MNRJ), and Museu de Zoologia - Universidade de

São Paulo (MZUSP). The following abbreviations were used in the text: 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 cephalotorax; frontal breadth (fb), the breadth of the front measured along the upper border; P = pereiopods; s = thoracic sternite. Measurements are in millimeters. The word gonopod, when used alone, refers to the first male gonopod. Terminology for describing the gonopod morphology followed the criteria established by Smalley (1964) and Rodríguez (1982).

Taxonomic part

Family Pseudothelphusidae Rathbun, 1893
Tribe Kingsleyini Bott, 1970
Genus *Kingsleya* Ortmann, 1897

Kingsleya gustavoi n. sp.
(Fig. 1 A - H)

Holotype.– ♂ (INPA 1320), Brazil, Pará, Rio Parauapebas, Canaã dos Carajás [06º30'S 49º50'W], 25.iv.2002, leg. R.P. Ribeiro.

Paratypes.– 1 ♀ (cb 30.1 mm, cl 23.3 mm) (INPA 1319), idem holotype; 2 ♂♂ (cb 13.4 mm cl 7.4 mm; cb 30.7 mm cl 17.7 mm) (MZUSP 9699), Brazil, Pará, Rio Itacaiúnas, Projeto Carajás, 17.vii.1988, col. unknown; 1 ♂ (cb 33.8 mm, cl 21.5 mm) (MPEG 793), Brazil, Pará, Serra dos Carajás (Serra Norte), "bomba d'água N_4" in a small forest stream that empties into the Rio Itacaiúnas, 29.vi.1985, M. Zanuto; 1 ♂ (cb 33.8 mm, cl 21.9 mm) (MNRJ 1013), Brazil, Pará, Rio Tocantins, Tucuruí [03º42'S 49º42'W], i.1979, L.C.F. Alvarenga and C.N. Ricci.

Type locality.– Município de Canaã dos Carajás, Rio Parauapebas, Pará, Brazil.

Diagnosis.– First male gonopod with narrow apical plate, subtriangular, formed by two obliquely juxtaposed lobes in which the distal one has its cephalic border enlarged and produced mesially into a subapical rounded prominence better seen in caudomesial view.

Description of the holotype.– Carapace outline ellipsoid, widest at middle (cb/cl 1.61); dorsal surface smooth, very slightly convex, regions ill defined. Pair of gastric pits distinct, very close to each other on metagastric region. Cervical grooves deep, narrow, nearly straight; their extremities ending near anterolateral margin. Postfrontal lobules very low, almost indistinct; median groove indistinct between postfrontal lobules. Surface of carapace between front and postfrontal lobules smooth and slightly inclined anteriorly and medianly. Upper border of front smooth, marked by faint ridge, nearly straight in dorsal view; lower border carinate, sinuous in both frontal and dorsal view, and a little more projected anteriorly than upper one, except in middle. Upper orbital margin smooth, lower one marked by row of very faint papillae; exorbital angle obtuse. Anterolateral margins of carapace uniformly convex, fringed by set of very faint tubercles which extend themselves as far as the beginning of posterolateral margin; posterolateral margins otherwise smooth and rounded, marked by faint suture. Epistome narrow, densely pilose; epistomial tooth triangular, deflexed, borders carinate and slightly granulated. Suborbital and subhepatic regions of carapace sidewall smooth; pterygostomial regions smooth, except for strip of small setae along mesial and posterior borders.

Endopod of third maxilliped with outer margin of ischium slightly convex, inner margin straight. Exopod of third maxilliped short and narrow, less than 0.25 times the length of outer margin of ischium. Aperture of efferent branchial channel wide, subquadrate.

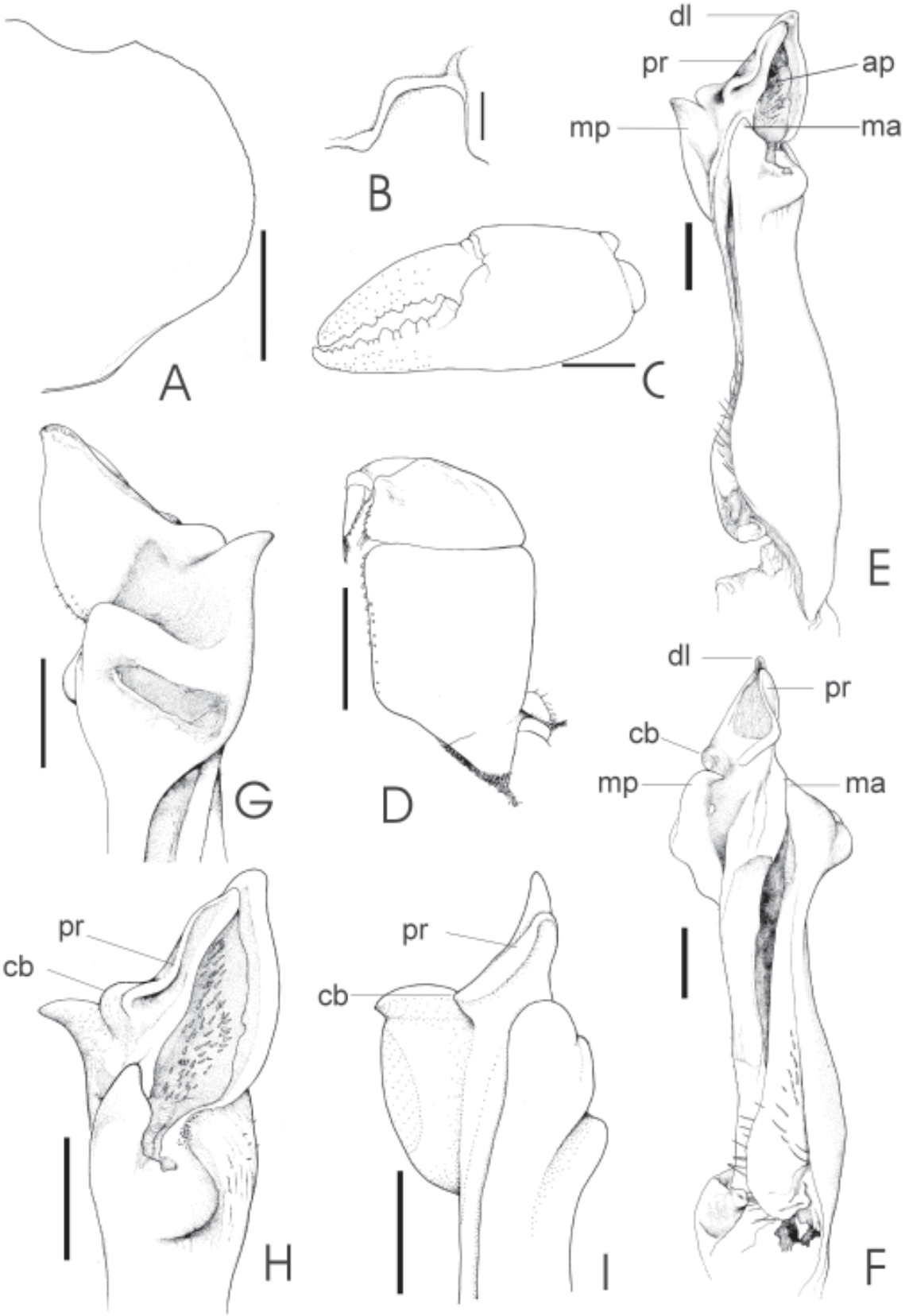

Figure 1: *Kingsleya gustavoi* n. sp., male holotype, INPA 1320: A, outline of the lateral margin of the carapace; B, opening of the left efferent branchial chamber; C, left chela; D, third maxilliped, left; E, first left gonopod, caudal view; F, same, mesial view; G, same, detail of distal part, lateromesial view; H, same, caudomesial view. *Kingsleya siolii* Bott, INPA 391: I, first left gonopod, detail of distal part, mesial view. Abbreviations: ap, field of apical spines; cb, proximal end of apical plate cephalic border; dl, distal lobe of apical plate; ma, marginal process; mp, mesial process; pr, proximal lobe of apical plate. Scale bars: A, C, D = 10 mm; B, E-I = 1 mm.

First pereiopods moderately heterochelous, left cheliped larger than right one. Larger cheliped with merus subtriangular in cross section; superior margin rounded, with faint granules; medial margin lined by longitudinal row of tubercles, slightly increasing size distally; inferior lateral margin marked by row of small tubercles; distal margin arched and smooth laterally, straight and marked by row of small tubercles mesially. Carpus with inner margin granular proximally, with prominent median spine, and smooth distally; outer margin rounded, smooth. Palm relatively narrow (length/breadth 1.56), smooth on both sides. Fingers gaping a little, tips not crossing; both fingers with large triangular teeth, smaller distally; dactylus with smaller teeth sometimes interspersed with larger ones. Dactylus slightly arched, longer than palm (dactylus/palm 1.19, measured dorsally), upper and outer surface of dactylus with longitudinal rows of minute granules. Propodal finger also with longitudinal rows of minute granules, more distinct distally, otherwise surfaces smooth. Pereiopods 2-5 slender, ratios dactylus/propodus and dactylus/merus, respectively, as follows: P2 = 1.63 and 1.52; P3 = 1.63 and 1.59; P4 = 1.56 and 1.45; P5 = 1.53 and 1.50. P2 to P5 with dactylus bearing five longitudinal rows of sharp, corneous spines, increasing in size distally.

Thoracic sternites of third maxillipeds and first pereiopods completely fused, except for small notches at lateral edges of sternum; sternal sulci s4/s5, s5/s6 and s6/s7 distinct, failing to reach midline of thoracic sternum by a short distance; sternal sulcus s7/s8 reaching midline. Midline of thoracic sternum marked by deep groove in sternite VII and shallow one in sternite VIII.

All abdominal segments free. Lateral margins of male telson slightly concave, tip rounded.

First male gonopod straight, enlarged distally, bearing well developed mesial process. Marginal suture situated on mesial side, bearing several setae proximally. Mesial process large, lower proximally and bearing strong, conical spine distally, pointing in mesial direction. Marginal process long, rather narrow, not projecting distally over spine field area. Mesial process juxtaposed to apical plate, but both structures clearly separated by deep incision. Apical plate narrow, subtriangular; proximal lobe well developed, situated obliquely to the distal lobe, and partially folded over mesial crest of field of apical spines; distal lobe with apex narrow and rounded; proximal portion of apical plate's cephalic border enlarged and produced mesially into subapical rounded prominence better seen in caudal view. Field of apical spines well developed, longitudinally directed along caudolateral surface of apical plate, surrounded by crests formed by mesial and lateral borders of the apical plate, opened distally by deep notch between apex of apical plate's proximal and distal lobes.

Second male gonopod slightly shorter than first one (ca. 0.95 times length of first gonopod), flagellum slender, tapering, tip compressed.

Size. – Holotype male: cb 49.6 mm, cl 30.8 mm, ch 19.9 mm, fb 17.6 mm.

Distribution.– Brazil, state of Pará, Rio Tocantins Basin.

Etymology.– The species has been named for Prof. Dr. Gustavo Augusto Schmidt de Melo, curator of Crustacea of the Museu de Zoologia da Universidade de São Paulo, Brazil. During his 41 year of professional activities, Dr. Gustavo de Melo made an outstanding contribution to the development of the Brazilian carcinology by his research activities, as well as by teaching, supporting the establishment of crustacean collections all over the country, and graduating a generation of young carcinologists. As his first doctorate student, I also dedicate this species to him as a personal recognition for his confidence and support to my career.

Ecological aspects. – Very little information is available on the biological and ecological aspects of the present new species. The specimen from Serra dos Carajás (MPEG 793) was found in a narrow, shallow, clear water forest stream running from a spring (M. Zanuto, pers. communication), while the one from Rio Itacaiúnas (MZUSP 9699) came from a flooded forest area, in a pond with a sandy-rocky bottom, according to a label note.

Additional material examined. – *Kingsleya siolii* Bott, 1967: 1 ♂ (INPA 391), Brazil, state of Pará, upper Rio Paru do Oeste, igarapé Akahé, Missão Tiriyó, iii-iv.1962, E.-J. Fittkau (Fig. 1 I).

Remarks.– *Kingsleya gustavoi* clearly belongs to this genus due to the following gonopodal characters: the marginal process is not projected over the apical spine field; the mesial process stands out from the cephalic surface of the stem and is separated from the apical plate by a deep incision; the apical plate bears two lobes; and the field of apical spines is distally divided by a terminal notch.

With the description of *K. gustavoi* n. sp., the genus *Kingsleya* currently comprises six species, all distributed within the limits of the Guyanan and/or Brazilian Shields. The present new species is most similar to *K. siolii* Bott, 1967. The gonopod of both species bears a subtriangular apical plate with two lobes, a bulged mesial processes with a strong conical spine, and a well developed, longitudinally directed field of apical spines along the caudolateral side. The main distinguishing characters between the gonopods of these two species are: (a) in *K. gustavoi*, the apical plate is enlarged on the proximal end of its cephalic border, forming a distinct rounded prominence which is salient from, but continuous with the distal lobe (Fig. 1H); in *K. siolii*, the apical plate is not enlarged proximally, and the proximal end of the distal lobe cephalic border is angulated (Fig. 1I); (b) the folding of the apical plate proximal lobe, which is more pronounced in *K. gustavoi* (Fig. 1H) than in *K. siolii* (Fig. 1I).

The carapace and cheliped characters of *K. gustavoi* closely resemble those of *K. siolii*, *K. besti* Magalhães, 1990, and *K. junki* Magalhães, 2003. The known species of *Kingsleya* can be distinguished from each other by following key, modified after Magalhães (1990):

Key to the species of *Kingsleya*

1. Anterolateral border of the carapace with an irregular outline, bearing about 5 to 8 large, acute teeth 2
-. Anterolateral border of the carapace with a regular outline, fringed by set of very faint tubercles or very low, small, rounded teeth 3
2 (1). Gonopod with apical plate showing narrow apex ..... *K. latifrons*
-. Gonopod with apical plate showing enlarged apex ..... *K. ytupora*
3 (1). Gonopod with a narrow, subtriangular apical plate, its proximal lobe well developed, distal lobe with mesial margin smooth 4
-. Gonopod with a much enlarged apical plate, its proximal lobe poorly developed, distal lobe with mesial margin indented ..... *K. junki*
4 (3). Gonopod with the apical setal field developed and situated along almost all the caudolateral side of the apical plate; proximal lobe of the apical plate situated oblique to the distal lobe 5
-. Gonopod with the apical setal field reduced and restricted to a depression near the base of the apical plate; proximal lobe of the apical plate partially involving the lower part of the distal lobe ..... *K. besti*
5 (4). Gonopod with the apical plate not enlarged, but angulated, on the proximal end of its cephalic border ..... *K. siolii*
-. Gonopod with the apical plate enlarged on the proximal end of its cephalic border, forming a distinct rounded prominence ..... *K. gustavoi* sp. n.

Magalhães (2003b) discussed possible affinities between the genera *Kingsleya* and *Brasiliothelphusa* Magalhães & Türkay, 1986, based on the morphology of the gonopod's apical plate. The subapical rounded prominence in the proximal portion of the apical plate's cephalic

border of *K. gustavoi* could indicate another likely relationship between the two genera, as the proximal portion of apical plate of *B. tapajoense* Magalhães & Türkay, 1986, also bears a distinct prominence, although triangular and spine-like in shape. Rodríguez (1982) discussed the similarities of the *K. siolii* and *K. latifrons*' (Randall, 1840) gonopods with that of *Neopseudothelphusa fossor* (Rathbun, 1898), and this discussion can also be applied to the new species. In spite of the affinities between the two genera, Rodríguez (1982) kept them separated due to differences in other gonopod characters and due to differences in geographic distribution. He recognized that *Neopseudothelphusa* could represent an artificial arrangement and stated that the position of *Kingsleya* within the Kingsleyini was obscure, a point of view shared by Sternberg *et al.* (1999). The description of four other species of *Kingsleya* since then has not changed this situation, but indicates that a better knowledge about the southern Amazonian Kingsleyini is critical for understanding the relationships within this group.

Zoogeography.– The available records indicate that *K. gustavoi* is distributed in the Rio Tocantins Basin (Fig. 2). The distribution of *Kingsleya* spp. was briefly discussed by Magalhães (2003b), who recorded two *Kingsleya* species (*K. junki* and *K. ytupora*) from the Rio Xingu, whose basin is adjacent to Rio Tocantins to the west. The presence of *K. gustavoi* in the Rio Tocantins Basin would mark the easternmost occurrence of the genus.

Morphological evidence indicates that *K. siolii* should be the sister species of *K. gustavoi*, with the latter a southern counterpart of the former. *K. siolii* has a Guyanan Shield distribution and is apparently restricted to the upper courses of rivers and streams in the Trombetas and Coppename River Basins, while *K. gustavoi* would have evolved in the Brazilian Shield area. Jégu (1992a,b) hypothesized that the dispersal routes of eastern Amazonian rheophilous fishes are related to the succession of glacial and interglacial periods during the Quaternary. According to that author, glacial periods caused sea regressions to increase the area covered by rapids along the eastern Amazon region, allowing for a distributional expansion of rheophilous species. Rising sea levels during the interglacial periods caused the fragmentation of the rapid zones and a retreat towards more upstream areas. Jégu (1992a,b) argued that such changes favored the dispersion of rheophilous species and their subsequent speciation by vicariance of isolated populations. Jégu found evidence of a north/south dispersion route for rheophilous species between the south of the Guyanan Shield and the Brazilian Shield area of the Rio Tocantins, as verified by the distribution patterns of some rheophilous serrasalmid fishes of the genera *Acnodon* Eigenmann and *Mylesinus* Valenciennes, which have sister species in both northern tributaries (*A. senai* Jégu & Santos, in the Rio Jari; *M. paraschomburgkii* Jégu, Santos & Ferreira, from Rio Uatumã to Rio Jari) and southern tributaries (*A. normani* Gosline, in the Rio Xingu and Rio Tocantins; *M. paucisquamatus* Jégu & Santos, in the Rio Tocantins) of the Amazon River.

Kingsleya species are typically rheophilous (Magalhães, 1986; 2003b). Although the distribution pattern of *K. siolii* and *K. gustavoi* in the Guyanan and Brazilian Shields, respectively, corroborates Jégu's (1992a,b) model for a Quaternary speciation, it is equally likely that an earlier differentiation between these two taxa could have occurred. Porto (1999) analysed mtDNA segments (ND4L/ND4 and D-loop) of *Mylesinus paraschomburgkii*, and estimated that the populations from the Uatumã, Trombetas and Jari river basins could have begun their separation in the late Tertiary or early Quaternary. A genetic study of two sibling species of Amazonian *Palaemonetes* shrimps (Decapoda: Palaemonidae), based on the mitochondrial cytochrome oxidase I (COI) gene, estimated that their differentiation occurred from middle to late Miocene (between 6.5 and 14 million years ago) (García-Dávila, 2002). Paleontological

events related to climatic changes as one of the main factors for faunal differentiation and speciation events in the Amazon Basin are not restricted to glacial/interglacial periods during the Quaternary, but extend farther back into the Cenozoic Era (Bush, 1994; Webb, 1995; Haffer, 1996).

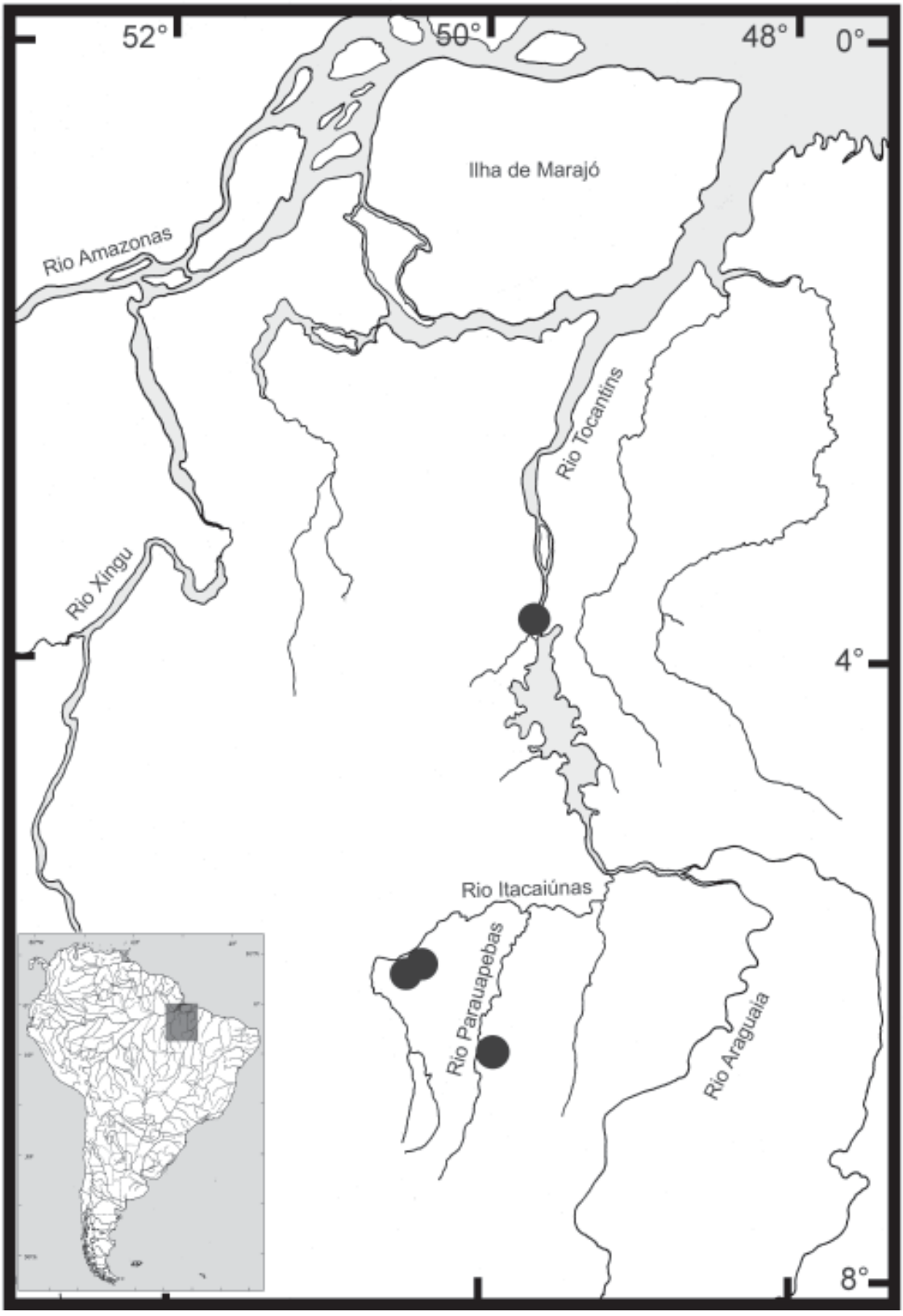

Figure 2: Geographic distribution of *Kingsleya gustavoi* n. sp. in the Rio Tocantins basin, state of Pará, Brazil.

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References

Bott, R. 1967. Flusskrabben aus Brasilien und benachbarter Gebiete. *Potamocarcinus (Kingsleya)* Ortmann, 1897 (Crustacea, Decapoda). Senckenbergiana biologica, 48(4): 301-312, 13 pls.

Bott, R. 1970. Betrachtungen über die Entwicklungsgeschichte und Verbreitung der Süsswasser-Krabben nach der Sammlung des Naturhistorischen Museums in Genf/Schwein. Revue Suisse de Zoologie, 77(2)24: 327-244.

Bush, M. B. 1994. Amazonian speciation: a necessarily complex model. Journal of Biogeography, 21: 5-17.

García-Dávila, C. R. 2002. Estudos morfométricos e moleculares comparativos das populações de *Palaemonetes carteri* Gordon, 1935 e *Palaemonetes ivonicus* Holthuis, 1950 (Decapoda: Palaemonidae) da Amazônia. Doctorate thesis, Instituto Nacional de Pesquisas da Amazônia/ Universidade Federal do Amazonas, Manaus. 189 pp. [Unpublished]

Goulding, M.; Barthem, R. and Ferreira, E. 2003. The Smithsonian Atlas of the Amazon. Washington, Smithsonian Books. 253 pp.

Haffer, J. 1996. Time's cycle and time's arrow in the history of Amazonia. *In*: Pavan, C. (ed.). Uma Estratégia Latino-Americana para a Amazônia. Vol. 1. São Paulo, Fundação Memorial da América Latina/Ed. UNESP. p. 21-47.

Jégu, M. 1992a. Influência das alterações climáticas do Quaternário sobre a distribuição e evolução dos peixes na Amazônia. Revista Brasileira de Genética, 15(1), suplemento 1: 234-237.

Jégu, M. 1992b. Variations du niveau marin et distribution des poissons d'eau douce en Amazonie orientale. *In*: Prost, M. T. (ed.). Évolution des Littoraux de Guyane et de la Zone Caraïbe Meridionale pendant le Quaternaire. Paris, ORSTOM. p. 281-297.

Magalhães, C. 1986. Revisão taxonômica dos caranguejos de água doce brasileiros da família Pseudothelphusidae (Crustacea, Decapoda). Amazoniana, 9(4): 609-636.

Magalhães, C. 1990. A new species of the genus *Kingsleya* from Amazonia, with a modified key for the Brazilian Pseudothelphusidae (Crustacea: Decapoda: Brachyura). Zoologische Mededelingen, 62(21): 275-281.

Magalhães, C. 2003a. Famílias Pseudothelphusidae e Trichodactylidae. *In*: Melo, G.A.S. (ed.). Manual de Identificação dos Crustacea Decapoda de Água Doce do Brasil. São Paulo, Editora Loyola. p. 143-287.

Magalhães, C. 2003b. The occurence 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.

Magalhães, C. and Rodríguez, G. 2002. The systematic and biogeographical status of *Fredius reflexifrons* (Ortmann, 1897) and *Fredius fittkaui* (Bott, 1967) (Crustacea: Brachyura: Pseudothelphusidae) from the Amazon and Atlantic Guianas river basins. Acta Amazonica, 34(2): 677-689.

Magalhães, C. and Türkay, M. 1986. *Brasiliothelphusa*, a new Brazilian freshwater-crab genus (Crustacea: Decapoda: Pseudothelphusidae). Senckenbergiana biologica, 66(4/6): 371-376.

Magalhães, C. and Türkay, M. 1996a. Taxonomy of the Neotropical freshwater crab family Trichodactylidae II. The genera *Forsteria*, *Melocarcinus*, *Sylviocarcinus*, and *Zilchiopsis* (Crustacea: Decapoda: Brachyura). Senckenbergiana biologica, 75(1/2): 97-130.

Magalhães, C. and Türkay, M. 1996b. Taxonomy of the Neotropical freshwater crab family Trichodactylidae II. The genera *Fredilocarcinus* and *Goyazana* (Crustacea: Decapoda: Brachyura). Senckenbergiana biologica, 75(1/2): 131-142.

Ortmann, A. 1897. Carcinologische Studien. Zoologische Jaarbücher, Abteilung für Systematik, Geographie und Biologie der Tiere, 10: 258-372, pl. 17.

Port-Carvalho, M.; Ferrari, S.F. and Magalhães, C. 2004. Predation of crabs by tufted capuchins (*Cebus apella*) in eastern Amazonia. Folia Primatologica, 75(3): 154-156.

Porto, J. I. R. 1999. Análises cariotípicas e seqüenciamento de mtDNA de populações de *Mylesinus paraschomburgkii* (Characiformes, Serrasalimidae) da bacia amazônica. Doctorate thesis, Instituto Nacional de Pesquisas da Amazônia/Universidade Federal do Amazonas, Manaus. 120 pp. [Unpublished]

Randall, J. W. 1840. Catalogue of the Crustacea brought by Thomas Nuttall and J.K. Townsend, from the West Coast of North America and the Sandwich Islands, with descriptions of such species as are apparently new, among which are included several species of different localities, previously existing in the collection of the Academy. Journal of the Academy of natural Sciences of Philadelphia, 8(1): 106-147, pls. 3-7.

Rathbun, M. J. 1893. Descriptions of new species of American freshwater crabs. Proceedings of the United States national Museum, 16(959): 649-661.

Rodríguez, G. 1982. Les crabes d'eau douce d'Amerique. Famille des Pseudothelphusidae. Faune Tropicale 22. ORSTOM, Paris. 224 p.

Smalley, A. 1964. A terminology for the gonopods of the American river crabs. Systematic Zoology, 13: 28-31.

Sternberg, R. V.; Galindo, L. A. and González, E. M. 1999. Cladistic analysis of the *Eudaniela* species complex (Crustacea: Decapoda: Pseudothelphusidae). Hydrobiologia, 416: 139-147.

Webb, S. D. 1995. Biological implications of the middle Miocene Amazon seaway. Science, 269: 361-362.

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