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Revalidation of *Ptychophallus campylus* Pretzmann, 1968, a freshwater crab species from Costa Rica (Decapoda: Brachyura: Pseudothelphusidae)

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ABSTRACT

Introduction: Freshwater crab diversity in the Neotropics is high, comprising three families: Epiloboceridae, Pseudothelphusidae and Trichodactylidae. The genus *Ptychophallus* consists of 13 species, all from Panama and Costa Rica. *Ptychophallus campylus* has not been recognized as a valid species and has been treated as a presumptive junior synomym of *Ptychophallus tristani*.
Objective: The present study aims to formalize the resurrection of *P. campylus* as a valid species.
Methods: An additional specimen of *P. campylus* collected in the province of Limón, Costa Rica, was analyzed and compared to both the holotype of *P. campylus* and the description of *P. tristani*.
Results: The gonopod 1 of *P. campylus* is morphologically similar to that of *P. tristani* but can be differentiated by the shape of the lateral process of the male first gonopod. Moreover, both species show different geographic distributions: whereas *P. tristani* occurs in hydrographic basins of the Pacific versant of Costa Rica, *P. campylus* seems to be restricted to the Caribbean slope in eastern Costa Rica.
Conclusions: *Ptychophallus campylus* is formally revalidated from the synonymy of *P. tristani*, confirming recently published results of multigene analysis that recovered both species in different lineages. This revalidation of *P. campylus* increases the number of valid species of the genus *Ptychophallus* to a total of 14, with nine species or 64.2% of all *Ptychophallus* species occurring in Costa Rica.

Keywords: Central America, Neotropical region, Ptychophallinae, synonymy, taxonomy.

RESUMEN

Revalidación de *Ptychophallus campylus* Pretzmann, 1968, una especie de cangrejo de agua dulce de Costa Rica (Brachyura: Decapoda: Pseudothelphusidae)

Introducción: La diversidad de cangrejos de agua dulce en el Neotrópico es alta y comprende tres familias: Epiloboceridae, Pseudothelphusidae y Trichodactylidae. El género *Ptychophallus* consta de 13 especies, todas

de Panamá y Costa Rica. *Ptychophallus campylus* no se ha reconocido como especie válida y se ha tratado como presunto sinónimo junior de *Ptychophallus tristani*.
Objetivo: El presente estudio pretende formalizar la resurrección de *P. campylus* como especie válida.
Métodos: Se analizó un espécimen adicional de *P. campylus* recolectado en la provincia de Limón, Costa Rica, y se comparó tanto con el holotipo de *P. campylus* como con la descripción de *P. tristani*.
Resultados: El gonópodo 1 de *P. campylus* es morfológicamente similar al de *P. tristani*, pero puede diferenciarse por la forma del proceso lateral del primer gonópodo del macho. Además, ambas especies muestran distribuciones geográficas diferentes: mientras que *P. tristani* habita en cuencas hidrográficas de la vertiente Pacífico de Costa Rica, *P. campylus* parece estar restringida a la vertiente del Caribe en el este de Costa Rica.
Conclusión: *Ptychophallus campylus* se revalida formalmente de la sinonimia de *P. tristani*, confirmando los resultados recientemente publicados del análisis multigénico que recuperó ambas especies en linajes diferentes. Esta revalidación de *P. campylus* aumenta el número de especies válidas del género *Ptychophallus* a un total de 14, con nueve especies o el 64,2% de todas las especies de *Ptychophallus* presentes en Costa Rica.

Palabras clave: América Central, región neotropical, Ptychophallinae, sinonimia, taxonomía.

INTRODUCTION

Primary or true freshwater crabs inhabit tropical and subtropical regions around the world and are characterized by having adopted freshwater, semi-terrestrial or terrestrial modes of life, being completely independent of marine environments, and showing direct development, hatching as fully developed juveniles (Cumberlidge & Ng, 2009; Magalhães et al., 2016; Vogt, 2016; Yeo et al., 2008).

Freshwater crabs are highly diverse in the Neotropics, comprising 311 species within three families: Epiloboceridae, Pseudothelphusidae and Trichodactylidae (Álvarez et al., 2020; Cumberlidge et al., 2014; Magalhães et al., 2016). Colombia and Mexico are considered as hotspots of freshwater crab diversity (Cumberlidge et al., 2014), and in Central America Panama and Costa Rica have the highest diversity with 17 and 15 species, respectively (Magalhães et al., 2015).

A total of eight subfamilies have been recognized within the family Pseudothelphusidae, and the genus *Ptychophallus* forms part of the subfamily Ptychophallinae (see Álvarez et al., 2020). According to Magalhães et al. (2015), the genus *Ptychophallus* consists of 13 species, exclusively reported from Costa Rica and Panama. One of these species is *Ptychophallus campylus* Pretzmann, 1968, only known from Costa Rica, presenting a somewhat enigmatic case since Pretzmann (1968) provided only a brief description from a single male collected in an unknown location in Costa Rica. Moreover, this description lacks illustrations of both the specimen and of its male first gonopod (G1), which is typically used for the species identification of freshwater crabs (Smalley, 1964a; Rodriguez, 1982). He later provided some low-resolution photographs of the carapace and G1 of *P. campylus* in his taxonomic revision of the pseudothelphusid crabs (Pretzmann, 1972). Judging solely from Pretzmann's (1972) description, Rodriguez (1982) considered *P. campylus* indistinguishable from *Ptychophallus tristani* (Rathbun, 1896) regarding morphological characters of their G1s. Even though Magalhães et al. (2015) examined the holotype of *P. campylus*, they also preferred to keep it provisionally as a junior subjective synonym of *P. tristani*. Although these authors verified some morphological differences between the G1s of both species, they cautiously preferred to wait until additional collections could clearly show the differentiation between these taxa. Following the identification of a specimen as *Ptychophallus campylus* and its inclusion in a recent multigene study of several species within the genus *Ptychophallus* Smalley, 1964b, (Mantelatto et al., 2024), the phylogenetic distinction between the two species was confirmed. Therefore, the present study aims to formalize the resurrection of *P. campylus* as a valid species.

MATERIALS AND METHODS

The specimens examined are deposited in the crustacean collection of the Museo de Zoología, Centro de Investigación en Biodiversidad y Ecología Tropical (CIBET), Universidad de Costa Rica, San José (UCR-MZ), Naturhistorisches Museum Wien, Vienna (NHMW), and National Museum of Natural History, Smithsonian Institution, Washington, DC (USNM). The following abbreviations were used: carapace width (cw), measured across the carapace at its widest point; carapace length (cl), measured along the midline, from the frontal to the posterior margin; male first gonopod (G1). Measurements are in millimeters. The terminology for the description of the gonopod morphology follows Magalhães et al. (2015).

RESULTS

Family Pseudothelphusidae Ortmann, 1893

Subfamily Ptychophallinae Álvarez, Ojeda, Souza-Carvalho, Villalobos, Magalhães, Wehrtmann & Mantelatto, 2020

Genus *Ptychophallus* Smalley, 1964b

Ptychophallus campylus Pretzmann, 1968 stat. restit. (Fig. 1)

Ptychophallus (*Ptychophallus*) *campylus* Pretzmann, 1968: 13. — Pretzmann, 1971: 21. — Pretzmann, 1972: 87, figs. 537–539, 559–561.

Ptychophallus campylus — Rodriguez, 1982: 80. — Mantelatto et al., 2024: 3 (table 1), 4 (fig. 1), 5.

Ptychophallus tristani — Magalhães et al., 2015: 320, fig. 41 [part; only holotype of *P.* (*P.*) *campylus*, NHMW 21849]

Description of G1 (Fig. 1A, B). Robust and straight in mesiocaudal view. Marginal suture on mesial side, nearly straight; marginal process rounded, not produced beyond distal border of apex, strongly bent to cephalic side. Mesial process large, subrectangular, axe-shaped. Lateral process long, approximately 60% of stem length (measured from proximal opening to caudal border of apex), clearly bilobed; lobes strongly asymmetric, with wide median concavity on caudal surface between lobes; proximal lobe rounded, slightly broader than distal lobe, with

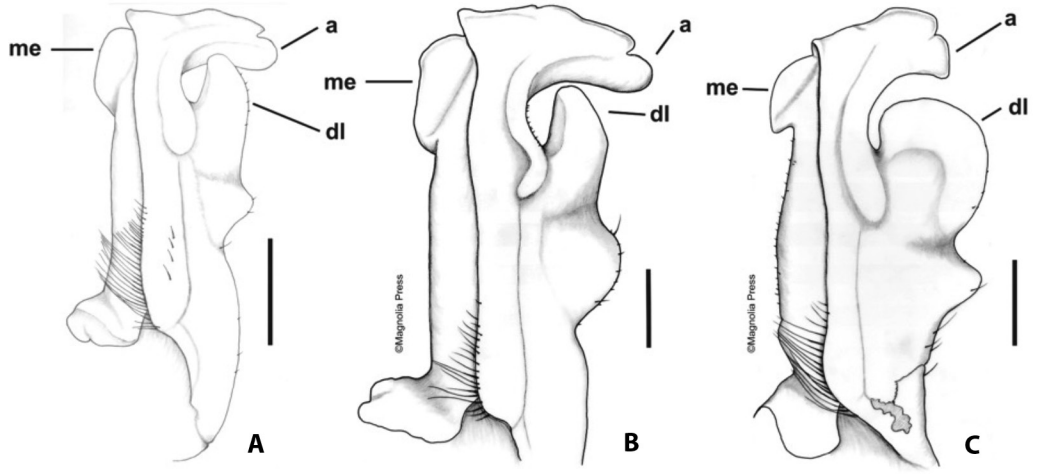

Fig. 1. Male left first gonopod, caudomesial view. **A**. *Ptychophallus campylus* Pretzmann, 1968: UCR-MZ 3226-02; **B**. *Ptychophallus campylus*: holotype, NHMW 21849. **C**. *Ptychophallus tristani* (Rathbun, 1896): holotype, USNM 19047. Abbreviations: a, lateral end of the apex; me, mesial process; dl, distal lobe of the lateral process. Scale bar: A = 2 mm; B, C = 1 mm. B and C from Magalhães et al. (2015: 316, figs. 41 and 39, respectively), reproduced with permission from the copyright holder.

some scattered minute setae on caudal, lateral surfaces; distal lobe narrower, slightly transversal and thicker distally on cephalic surface, distinctly shorter than lateral end of apex. Distocaudal ridge narrow, somewhat sinuous, not reaching level of median depression of lateral process, well separated from distal border of lateral process by distinct depression. Apex bent approximately 90° towards lateral side; oblong, narrow in distal view; caudal border with narrow notch near lateral end. Field of apical spines well developed, facing towards cephalolateral side.

Material examined. Costa Rica: male (cw 29.4, cl 19.4), holotype, NHMW 21849, collection location unknown, 1913, Fassl leg.; 1 male (cw 35.2 mm, cl 22.4 mm), UCR-MZ 3226-02, province Limón, Veraguas Rainforest Adventure Park [09°55'34.75"N 83°11'26.75"W], quebrada Campamento, 26.vii.2013, D. Hernández and L. Vargas leg.

Distribution. The species is currently only known from eastern Costa Rica, in the Caribbean versant.

Genetic sequences accession number (GenBank): 16S ribosomal RNA - OR116815; Cytochrome Oxidase Subunit I - OR122823; Histone 3 (H3) OR141946.

DISCUSSION

Despite some differences in the G1 morphology, Magalhães et al. (2015) did not recognize *P. campylus* as a valid species and preferred to treat it as a presumptive junior synomym of *P. tristani* until additional material was available. The G1 morphology of an adult male specimen from eastern Costa Rica (Fig. 2A) proved to be nearly identical to that of the holotype of *P. campylus* (Fig. 2B). In the molecular phylogenetic analysis carried out by Mantelatto et al. (2024) using two mitochondrial (16 S rRNA and COI) and one nuclear (H3) genes, these two species were clearly recovered as separate lineages either in the concatenated phylogram: *P. campylus* in the Lineage A and *P. tristani* in Lineage C (Mantelatto et al., 2024: fig. 1) or in the individual phylograms for each gene (Supplementary material, figs. S2–S4 in Mantelatto et al., 2024). Considering these results, the authors recommended a reassessment of the taxonomic status of both species.

Although positioned in separate lineages in the Mantelatto's et al. (2024) study, the G1 of *P. campylus* is morphologically similar to that of *P. tristani* in terms of the large, subrectangular, axe-shaped mesial process, a character only shared by these two among all the species of the genus. The G1 of both species can be differentiated by the shape of the lateral process: in the adult specimen of *P. campylus* examined herein, the distal lobe of the lateral process is less developed than in *P. tristani* (it is distinctly shorter than the lateral end of apex and narrower in the former species versus longer and broader in the latter one — see Fig. 1). The shape of the lateral process in *P. tristani* can be somewhat variable and, in a few cases, appears to be similar to that of *P. campylus* (see Magalhães et al., 2015). Their geographic distribution areas, however, are different: whereas *P. tristani* occurs in hydrographic basins of the Pacific versant of Costa Rica (Magalhães et al., 2015: 339, fig. 83), *P. campylus* seems to be restricted to the Caribbean slope in eastern Costa Rica (present paper).

After more than five decades since the original description and after serious doubts about the systematic position of the species, the revalidation of *P. campylus* is herein presented and increases the number of valid species of the genus *Ptychophallus* to a total of 14. Of these, nine species or 64.2% of all *Ptychophallus* species have been reported from Costa Rica.

Ethical statement: The authors declare that they all agree with this publication and made significant contributions; that there is no conflict of interest of any kind; and that we followed all pertinent ethical and legal procedures and requirements. All financial sources are fully and clearly stated in the acknowledgments

section. A signed document has been filed in the journal archives.

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