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RESEARCH ARTICLE

Neotropical Monogenoidea 62. *Biotodomella mirospinata* gen. nov., sp. nov. (Polyonchoinea: Dactylogyridae): a parasite of the gills of *Biotodoma cupido* (Cichliformes: Cichlidae), from the Peruvian Amazon

Germán Augusto Murrieta Morey[1], Mariana Vásquez Arimuya[1], Walter A. Boeger[2]

[1] Instituto de Investigaciones de la Amazonía Peruana. Iquitos, Maynas Province, Peru.
[2] Biological Interactions, Universidade Federal do Paraná. Caixa Postal 19073, 81531-890 Curitiba, PR, Brazil.
Corresponding author: Walter A. Boeger (wboeger@gmail.com)

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ABSTRACT. *Biotodomella* **gen. nov.** (Monogenoidea: Dactylogyridae) is proposed to accommodate *Biotodomella mirospinata* **sp. nov.**, found on the gills of *Biotodoma cupido* (Heckel, 1840) ("cara bonita" or "green-streaked eartheater"), a freshwater cichlid from the Peruvian Amazon. The new genus and species differ from other Neotropical dactylogyrids in having the hooks of each hook pair well-differentiated from the remaining pairs, shafts varying in robustness, weakly sclerotized expansions at the proximal end of shaft, and a dorsal anchor with grooved shaft, bifid point. This study represents the first record of a monogenoid from a species of *Biotodoma* Eigenmann & Kennedy, 1903.

KEY WORDS. *Biotodoma*, Cichlidae, Dactylogyridae, Monogenoidea, taxonomy.

INTRODUCTION

During a survey of monogenoid parasites from the freshwaters of the Peruvian Amazon, 20 specimens of a new genus and species were collected from the cichlid *Biotodoma cupido* (Heckel, 1840) ("cara bonita" or "greenstreaked eartheater"). This fish species can reach up to 9.7 cm and is distributed in the Amazon River basin in Peru, Bolivia, Brazil, and in the Essequibo River in Guyana (Reis et al. 2003). To date, there are no records of monogenoids parasitizing a species of *Biotodoma* Eigenmann & Kennedy, 1903. The new genus and species of Monogenoidea are unique among the Neotropical Dacylogyridae in having pairs of hooks conspicuously distinct from each other and a bifid point in the dorsal anchor.

MATERIAL AND METHODS

Twenty fish specimens were collected in March 2018 by local fishermen in the "Shiruy Caño" in the Nanay River, in Iquitos, Peru. Symbiotypes (Brooks 1993) are deposited in the Colección ictiologica del Instituto de Investigaciones de la Amazonia Peruana (CIIAP) number IIAP-CIIAP 1003. Fish were euthanized, gill arches were removed and placed in vials containing heated water (68 °C). Each vial was shaken vigorously, and 96% ethanol was added to the final concentration of 75–80%. In the laboratory, the content of each vial was examined under a dissecting microscope. Helminths were removed from the gills or sediment using dissection needles. Some specimens were stained with Gomori's trichrome (Humason 1979) and mounted in Dammar's gum, to determine internal morphology, while others were mounted in Hoyer's mounting medium (Humason 1979), for the study of sclerotised structures.

Illustrations were prepared with the aid of a drawing tube and a micro-projector attached to an Olympus BX 50 microscope (both phase contrast and DIC). Measurements were made following the procedures of Mizelle and Klucka (1953). Lengths of curved or bent structures (anchors, bars, MCO, and accessory piece) represent the straight-line distances between extremes. All measurements are in micrometres and are presented as the average followed by the range in parentheses. The type-specimens are deposited in the Collection of the "Instituto Nacional de Pesquisas da Amazônia" (INPA), Manaus, Brazil.

TAXONOMY

Class Monogenoidea Bychowsky, 1937
Subclass Polyonchoinea Bychowsky, 1937
Dactylogyridae Bychowsky, 1933

Biotodomella gen. nov.

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Diagnosis. Dactylogyridae. Body comprising cephalic region, trunk, peduncle and haptor. Tegument smooth. Head organs and two pairs of cephalic lobes present. Eyespots 4. Mouth ventral; pharynx muscular; intestinal caeca two, confluent posteriorly to testis. Common genital pore mid-ventral, at level of intestinal bifurcation. Gonads intercaecal, tandem; germarium anterior to testis. Vas deferens loops left intestinal caecum; seminal vesicle a simple dilation of vas deferens. Copulatory complex comprising male copulatory organ (MCO) and accessory piece. MCO sclerotized, clockwise; accessory piece articulated to base of MCO by delicate process. Seminal receptacle present, anterior to germarium; vaginal aperture dextral, sclerotized; vaginal duct a sclerotized tube. Vitelline follicles dense, overlapping caeca. Haptor armed with seven pairs of hooks with ancyrocephaline distribution (Mizelle 1936), ventral and dorsal pairs of anchors, and ventral and dorsal bars. Hooks of each hook pair well-differentiated from the remaining pairs; shaft varying in robustness, proximal end of shaft of pairs 1–3, 6–7 with variably sclerotized expansions. Ventral and dorsal bars elongate, distinct. Anchors of distinct morphology and size; both with short deep, elongate superficial roots. Dorsal anchor with grooved shaft, bifid point. Parasites of the gill filaments of *B. cupido* (Perciformes: Cichlidae).

Type-species. *Biotodomella mirospinata* sp. nov.

Etymology. The generic epithet derived from the genus of the host, *Biotodoma* Eigenmann & Kennedy, 1903.

Biotodomella mirospinata sp. nov.

http://zoobank.org/D808CB11-6EFD-4903-ABAC-BCFBDF4F84E3
Figs 1-14

Type-host: *Biotodoma cupido* (Heckel, 1840) (Cichliformes: Cichlidae).

Type-locality: "Shiruy caño" in the Nanay River (3°44'42.10"S, 73°16'46.89"W, Peru.

Type-material: Holotype: INPA 785a. 16 Paratypes: INPA 785 b-g, INPA 797 a-j.

Site in host: Gill filaments.

Prevalence: 35% (7 fish parasitized of 20 sampled).

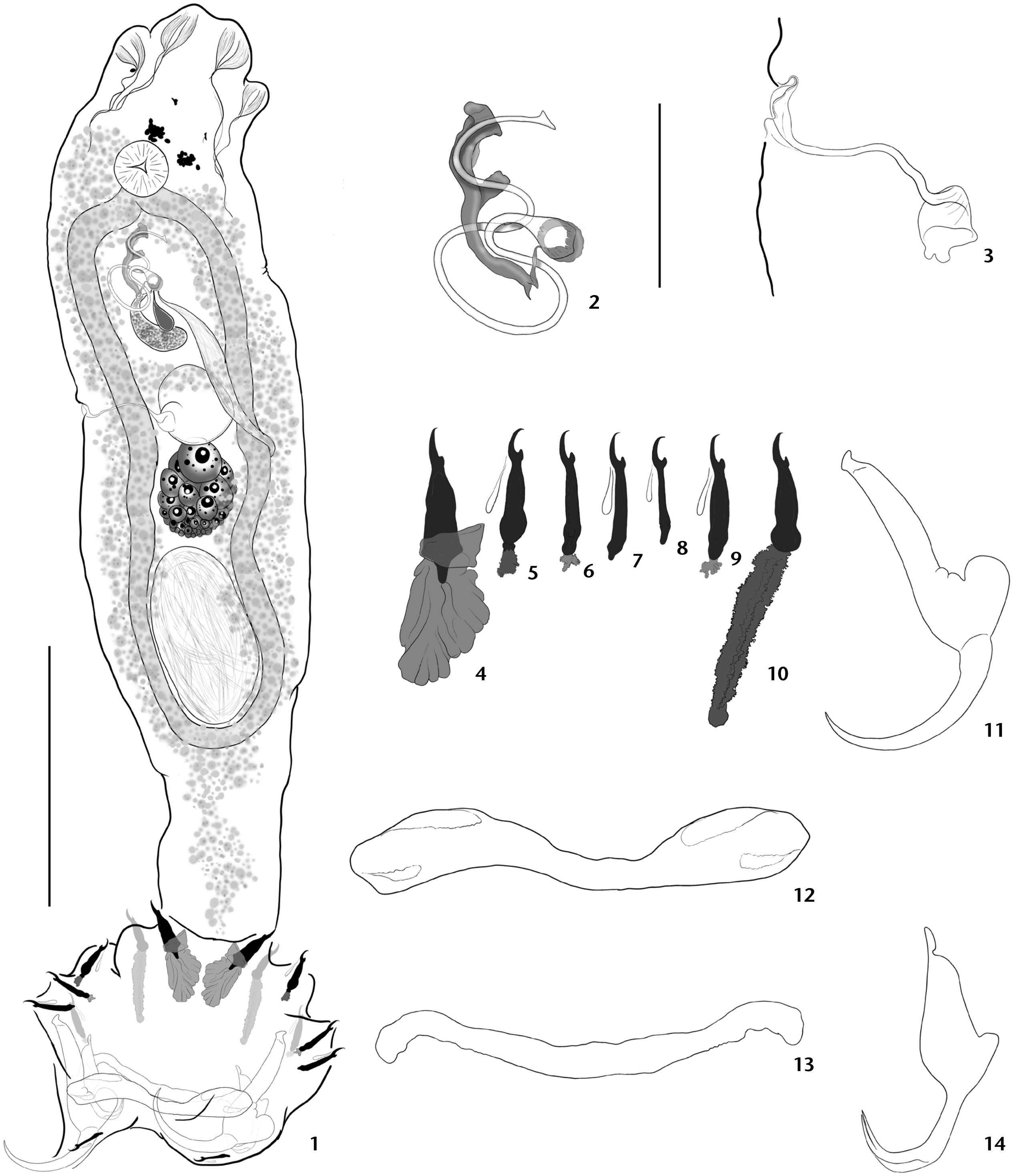
Mean intensity: 1.57.

Description (based on 17 specimens: 6 stained, 11 cleared): Body fusiform, 446 (418–496; n = 6) long, greatest width 124 (111–144, n = 6) at level of germarium. Cephalic region with two pairs of lobes, head organs. Eyespots 4, anterior pair smaller than posterior pair; granules small, ovate; accessory granules scattered in cephalic region. Pharynx spherical, 23 (18–27, n = 6) in diameter; esophagus short, inconspicuous. Testis ovate, 67 long (n = 1), posterior to germarium; vas deferens loops left intestinal caecum; seminal vesicle elongate; prostatic reservoirs 2, pyriform; smaller prostatic reservoir with thick walls. MCO 24 (20–27, n = 6) long, sclerotized, coiled, with about two clockwise rings, base with short sclerotized fringe, tip funnel-shaped. Accessory piece elongate, 19 (14–19, n = 6) long, with submedian thumb-like projection, articulated with MCO by delicate process. Germarium 39 long (n = 1), ovate. Uterus not observed. Vagina dextral, a sclerotized proximally funnel-shaped tube; atrium sclerotized; seminal receptacle immediately anterior to germarium, globose. Vitelline follicles dense, overlapping caeca, reaching peduncle. Haptor subcircular. Hooks of hook pair 1 more robust than remaining, with straight shaft, inconspicuous point, inconspicuous thumb, shank with fringe-like expansion on proximal, veil-like sclerotization on proximal portion of shank; hooks of hook pairs 2–7 with similar morphology of shaft, point, thumb (erected conspicuous thumb, slightly curved shaft, short point); shaft variably expanded among hook pairs through; hook pairs 2, 3, 6, 7 with sclerotized expansions on distal end, variable in length, especially long in hook pair 7 (longer than hook length); hook pairs 4, 5 lacking sclerotized expansions on proximal end; hook pair 5 comparatively more delicate than remaining hook pairs. Hook pair 1, 35 (32–37, n = 6) long (including cuticular expansion whenever present); hook pair 2, 23 (21–24, n = 6) long; hook pair 3, 15 (15–19, n = 6); hook pair 4, 15 (15–20, n = 6) long; hook pair 5, 14 (14–17, n = 6) long; hook pair 6, 20 (18–22, n = 6) long; hook pair 7, 42 (41–43, n = 6) long. Bars elongate, distinct. Ventral bar halter-shaped with anterior, posterior grooves, 54 (48–60, n = 6) long. Dorsal bar more delicate, with extremities slightly recurved posteriorly, 65 (62–68, n = 6) long. Ventral anchor 47 (42–51, n = 6) long, base 5 (3–6; n = 6) wide, with elongate superficial root, with slightly recurved tip, short round deep root, evenly curved shaft, point. Dorsal anchor, 30 (27–33, n = 6) long, base 17 (12–20, n = 6) wide, with robust superficial root with small digitiform tip, short deep root, shaft. Eggs not observed.

Etymology: The specific epithet "*mirunospinata*" (from the Latin *mirun* = wonderful; *spinus* = thorns) refers to the unique morphology of the hooks among Neotropical species of Monogenoidea.

Remarks: Species of five genera have been reported from native species of Cichlidae in the Neotropical region: *Trinidactylus* Hanek, Molnar & Fernando, 1974; *Gussevia* Kohn & Paperna, 1964; *Sciadicleithrum* Kritsky, Thatcher & Boeger, 1989; *Tucunarella* Mendoza-Franco, Scholz & Rozkošná, 2010; and *Parasciadicleithrum* Mendoza-Palmero, Blasco-Costa, Hernández-Mena & Pérez-Ponce de León, 2017. *Biotodomella mirospinata* sp. nov. does not conform with the diagnostic features of any of these genera, nor to any other genus reported from cichlids worldwide (see Boeger and Vianna 2006, Pariselle et al. 2011, Mendoza-Franco et al. 2010).

Biotodomella mirospinata sp. nov. is the only known species of the new genus proposed herein. The putative most distinctive diagnostic feature of *Biotodomella*, i.e. hook pairs distinct from each other with morphology unique among Neotropical freshwater monogenoids, is not shared with any other known species in the region and justifies the proposal of the new genus. The morphology of the dorsal anchor (with a groove on the distal portion of the shaft and a bifid point) is also unique among Neotropical dactylogyrids and is putatively considered another key diagnostic feature for the genus. Finally, no other genus of Dactylogyridae from Neotropical Cichlidae present species with tandem gonads as *Boitodomella*.



Figures 1-14. *Biotodomella mirospinata* gen. nov., sp. nov. (1) composite, ventral view; (2) male copulatory complex, dorsal view; (3) vagina; (4) hook pair 1; (5) hook pair 2; (6) hook pair 3; (7) hook pair 4; (8) hook pair 5; (9) hook pair 6; (10) hook pair 7; (11) ventral anchor; (12) ventral bar; (13) dorsal bar; (14) dorsal anchor. Scale-bars: 1 = 100 µm; 2–14 = 25 µm.

DISCUSSION

The phylogenetic relationships of *B. mirospinata* sp. nov. within the Dactylogyridae are not clear due to the uniqueness of its diagnostic features. The definition of its sister-group relationships among the Dactylogyridae will most likely require the integration of molecular and morphological characters. However, some features on the single species of *Biotodomella* are shared with species of *Gussevia*, *Sciadicleithrum,* and *Parasciadicleithrum*. Among the shared features are the dextral vaginal aperture (as in species of *Gussevia* and *Sciadicleithrum*), a long and slender dorsal bar (as in *Gussevia* spp.), and clockwise MCO (as in most species of these genera). This indicates that species of these genera represent descendants of a single ancestral marine or Neotropical freshwater species.

As suggested by Matschiner (2019) and references thereof, the ancestral of all Neotropical cichlids probably dispersed through the Atlantic Ocean long time after splitting of the Gondwana continent (app. 140-100 Ma according to McLoughlin 2001), around 75-60 Ma. For Pariselle et al. (2011), because of the dispersion of Cichlidae through the marine environment, freshwater parasites are likely lost and the fish lineage that reaches the new freshwater environs either bring parasite acquired during dispersion (marine lineages of parasites) or are colonized by local freshwater Monogenoidea.

Hence, there is a great possibility that the community of monogenoids in each geographic area derive from distinct processes resulting in a mosaic structure (Hoberg and Brooks 2013). Support for this expectation is provided by the phylogenetic analysis of Mendoza-Palmero et al. (2017), suggesting the existence of, at least two distinct and distant lineages composing the community of Monogenoidea from Neotropical Cichlidae.

When Mendoza-Palmero et al. (2017) suggested that *Parasciadicleithrum* and *Sciadicleithrum* represent independent evolutionary lineages in their phylogeny, they did not offer any evolutionary explanation for the obvious morphological similarity among species of these two genera. Their proposal for the new genus is, therefore, "... based mainly on the results of the molecular phylogenetic analyses" (Mendoza-Palmero et al. 2017). The lack of morphological diagnostic features (e.g. synapomorphies) creates a fragile taxon. This is especially true when new taxonomic groups are justified on phylogenetic hypotheses based on a single species (as for *Parasciadicleithrum*) since the analysis provides no test for the monophyletic nature of the proposed taxon (a monotypic taxon is monophyletic by definition). Accumulation of erroneous taxonomic decisions generates unstable classifications, as in the case of the Neotropical Dactylogyridae. Ideally, the proposal of new taxa should be based on a reasonable sample of subordinate species or robust morphological diagnostic features (as in the present proposal). Mistakes can be made even following these guidelines, but classifications evolve and there are formal protocols for that (Ride et al. 1999). When there are fewer accumulated mistakes the classification is more stable.

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