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PENSOFT

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Taxonomic status of *Aphyocharax avary* Fowler, 1913, *Aphyocharax pusillus* Günther, 1868 and *Chirodon alburnus* Günther, 1869 (Characiformes, Characidae)

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Abstract

The obscure taxonomic histories of three species of *Aphyocharax* (*A. alburnus*, *A. avary* and *A. pusillus*) are revised, based on both morphological and literature data. *Aphyocharax avary* is resurrected as a valid species and removed from synonymy with *A. alburnus*. Based on examinations of type specimens, *A. alburnus* is considered a junior synonym of *A. pusillus*.

Introduction

Aphyocharax Günther, 1868, is a genus of small-sized characids, no larger than 80 mm standard length (Souza–Lima 2003), occurring in most river basins in the Neotropical region: the Orinoco, Amazon, and La Plata River systems (Taphorn and Thomerson 1991, Tagliacollo et al. 2012). According to Tagliacollo et al. (2012), Froese and Pauly (2018) and Eschmeyer et al. (2018), the genus comprises 11 valid species: *Aphyocharax agassizii* (Steindachner, 1882), *A. alburnus* (Günther, 1869), *A. anisitsi* Eigenmann & Kennedy, 1903, *A. colifax* Taphorn & Thomerson, 1991, *A. dentatus* Eigenmann & Kennedy, 1903, *A. erythrurus* Eigenmann, 1912, *A. gracilis* Fowler, 1940, *A. nattereri* (Steindachner, 1882), *A. pusillus* Günther, 1868 (the type species of the genus), *A. rathbuni*

Eigenmann, 1907, and *A. yekwanae* Willink, Chernoff & Machado-Allison, 2003. However, some authors (e.g., Souza-Lima 2007, Ferreira et al. 2011, Lima et al. 2013) consider *A. avary* Fowler, 1913, as a 12th valid species. *Aphyocharax avary* was described by Fowler (1913) based on a single specimen from the "Madeira River, about 200 miles east of Long. 62°20'W., Brazil". Fowler (1940) later considered it a synonym of *A. alburnus*. That taxonomic decision was based on a supposed morphological colour pattern variation and the number of teeth of those species – and influenced by their confusing taxonomic histories, principally the work published by Eigenmann (1915). Géry (1977) considered *A. avary* a valid species and included it in his species identification key of the genus. More recently, Souza-Lima (2003), following the taxonomic decision of Fowler (1940), also considered it a synonym of *A. alburnus*. Shortly afterwards, however, Souza-Lima (2007) considered *A. avary* to be a valid species. Tagliacollo et al. (2012) did not consider *A. avary* as one of the 11 valid species of the genus, although those authors did not specify which species they would consider it a synonym of; we presume that they again considered it a junior synonym of *A. alburnus*.

Aphyocharax pusillus was described by Günther (1868) based on three specimens from "Huallaga and Xeberos" [Amazon River Basin, Peru] (Souza-Lima 2003, 2007, Eschmeyer et al. 2018). Günther described the genus *Aphyocharax* in that same work, comprising only *A. pusillus*, which could be distinguished from *Chirodon* mainly by the presence of maxillary teeth (vs. their absence in *Chirodon*). Just one year later, Günther (1869) described *Chirodon alburnus* (currently a species of *Aphyocharax*) based on four specimens from the Peruvian Amazon, without providing a more precise and specific locality (Souza-Lima 2003, 2007, Eschmeyer et al. 2018), and did not detect maxillary teeth. Eigenmann (1915) re-described *Chirodon alburnus* without examining the type material, repeating the briefly informative description of the species provided by Günther (1869). Eigenmann (1915) examined five new lots from several distant localities, and characterized the species as possessing a humeral blotch and "maxillary with ten to sixteen teeth on over half the length of the maxillary" – character traits never before proposed for that species. Those specimens examined by Eigenmann probably corresponded to another species. The confusion caused by Eigenmann was followed by subsequent studies of the genus (e.g. Taphorn and Thomerson 1991, Willink et al. 2003).

Some authors who have recently described new species of *Aphyocharax*, or proposed phylogenetic relationships for the group, have overlooked the type locality of *A. alburnus* and examined and included material solely from Venezuelan river drainages (e.g., Taphorn and Thomerson 1991, Willink et al. 2003, Tagliacollo et al. 2012).

The aim of the present paper was to untangle the confusing taxonomic histories of those three species names, clarify their taxonomic statuses, and present, for the first time, the morphological features of their type specimens. We also provide a diagnosis for the species considered herein as valid, based on the examinations of type materials, information from the original descriptions, and the literature. The resolution of this confusing taxonomic history, the description of some morphological features of the type materials, and determinations of which of the three species are valid, will be important to solving taxonomical incongruities in the literature related to the genus and to enabling descriptions of new species of *Aphyocharax*. According to Souza-Lima (2007), there are at least four undescribed species, and the taxonomic identifications of several populations are still inaccurate (e.g. Lima et al. 2013, Ohara et al. 2017).

Materials and methods

Measurements and counts were made according to Fink and Weitzman (1974), except for the perforated lateral line scales (which are interrupted) and the last scale on caudal-fin base (Y) which is counted separately from the other perforated scales (X), following the formula (X + Y). Internal counts, as well as some fins counts, were made only on radiograph images. The four modified vertebrae that constitute the Weberian apparatus were not included in the vertebrae counts, and the fused PU1 + U1 was considered a single element. Osteological nomenclature follows Weitzman (1962). C&S means cleared and stained, prepared according to Taylor and Van Dyke (1985). The materials herein examined are deposited in the following institutions: Academy of Natural Sciences of Philadelphia (ANSP), California Academy of Sciences, San Francisco, California, U.S.A. (CAS), Coleção Ictiológica do Centro de Ciências Agrárias e Ambientais da Universidade Federal do Maranhão (CICCAA), Coleção Ictiológica do Instituto de Biologia da Universidade Federal do Rio de Janeiro (UFRJ), British Museum of Natural History (BMNH) and Field Museum of Natural History (FNMH), and the Information about *Aphyocharax* was based on both examined material and the literature (e.g., Günther 1868, 1869, Fowler 1940, Eigenmann 1915, Géry 1977, Taphorn and Thomerson 1991, Souza-Lima 2003, 2007, Willink et al. 2003, Tagliacollo et al. 2012, Eschmeyer et al. 2018, Froese and Pauly 2018).

Taxonomy

Aphyocharax pusillus Günther, 1868

Aphyocharax pusillus Günther, 1868: 480. Type locality: Huallaga and Xeberos [Amazon River Basin, Peru]. Syntypes: (1) BMNH 1867.6.13.46, (2) BMNH 1867.6.13.58-59.

Chirodon alburnus Günther, 1869:424: Type locality: Peruvian Amazons [Amazon River Basin, Peru]. Lectotype: BMNH 1869.5.21.10; Paralectotypes: (3) BMNH 1869.5.21.11-13. **New synonym.**

Material examined. BMNH 1867.6.13.46, 1 (Syntype), Huallaga and Xeberos [Amazon River Basin, Peru], Mr. Bartlett. BMNH 1867.6.13.58-59, 2 (Syntypes), Huallaga

Figure 1. Syntypes of *Aphyocharax pusillus*: BMNH 1867.6.13.58-59. Photographed by Kevin Webb.

Figure 2. Lectotype of *Aphyocharax alburnus*: BMNH 1869.5.21.10. Photographed by Harry Taylor.

Table 1. Meristic data of *Chirodon alburnus* and *Aphyocharax pusillus.*

Measurements	BMNH 1867.6.13.46 *A. pusillus*	BMNH 1867.6.13.58-59 *A. pusillus*	BMNH 1869.5.21.10 *C. alburnus*	BMNH 1869.5.21.11-13 *C. alburnus*
Pored lateral-line scales	11+1	11–12+1	11+1	11+1
Longitudinal scales	36	36–38	37	37
Transverse scales	11	10–11	11	11
Dorsal-fin rays	10	10–11	11	10–11
Pectoral fin-rays	10	10–11	11	11
Pelvic-fin rays	7	7	7	7
Anal-fin rays	19	18–19	18	17–18
Premaxillary teeth	6	7	7	7
Maxillary teeth	8	8	8	7–8
Dentary teeth	15	16–18	16	15–18
Vertebrae	34	31–33	33	32–33

and Xeberos [Amazon River Basin, Peru], Mr. Bartlett. BMNH 1869.5.21.10, 1 (Lectotype of *Chirodon alburnus*), [Amazon River, Peru]. BMNH 1869.5.21.11-13, 3 (Paralectotypes of *Chirodon alburnus*), [Amazon River, Peru].

Diagnosis. *Aphyocharax pusillus* differs from all of its congeners, except *A. avary*, by having black or dark brown middle caudal-fin rays (Figs 1–3; Günther 1869, fig. 2). *Aphyocharax pusillus* is distinguished from *A. avary* by having fewer maxillary teeth, spread along the proximal half of the bone (Fig. 4B–G) [vs. more maxillary teeth spread along 2/3 of the maxillary extension (Fig. 4A].

Morphological notes. Meristic data of the type specimens are presented in Table 1. Body shape generally fusiform, slightly elongate, greatest body depth slightly anterior to dorsal-fin base. Dorsal body profile straight or slightly convex from snout to vertical through anterior nostrils; straight or slightly convex from posterior nostrils to tip of supraoccipital bone; straight or slightly convex from this point to dorsal-fin origin; slightly convex along dorsal-fin base; postdorsal profile straight from base of last dorsal-fin ray to adipose-fin origin; slightly concave from adipose-fin to end of caudal peduncle. Ventral profile convex from snout to pelvic-fin insertion; straight or

Figure 3. Recently preserved specimens of *Aphyocharax pusillus*: ANSP 178013, 4, 33.1–54.8 mm SL, Peru, Loreto, Rio Napo (Amazon river basin), right bank just upstream from mouth of Mazan river, near town of Mazan (3°29'10"S, 73°6'24"W). Photographed by Mark Sabaj Perez.

slightly convex from this point to anal-fin origin; straight and posterodorsally-aligned along anal-fin base; postventral profile slightly concave from base of last anal-fin ray to end of caudal peduncle. Snout rounded. Mouth terminal, Lower jaw protrudes slightly beyond upper jaw when mouth closed; aligned approximately to middle of eye. Long and truncated snout, with its length larger than orbital diameter. Mouth terminal; upper jaw slightly larger than lower one. Maxillary bone surpassing a vertical line through middle of the eye; maxillary teeth small and conical, spread along proximal half of the bone. Lateral line interrupted; last scale on caudal-fin base.

There no mention of the presence of a humeral spot in the original description of either *A. pusillus* or *C. alburnus*. Additionally, the type materials of both species do not show any humeral spot. The illustration of *C. alburnus* by Günther (1869, fig. 2), however, gives the impression of the possible presence of a very inconspicuous humeral spot. However, the examination of recently preserved specimens of *A. pusillus* evidences that a very inconspicuous humeral spot could be present on larger recently preserved specimens (Fig. 3). Thus, we conclude that: it does not exhibit a humeral spot on smaller specimens or on specimens preserved several years ago; or it could possess a very inconspicuous humeral spot on larger and recently preserved specimens (Figs 1–3; Günther 1869, fig. 2). Nominal taxa have black or dark brown middle caudal-fin rays (Figs 1–3; Günther 1869, fig. 2).

Remarks. *Aphyocharax pusillus* is the type species of the genus, designated by monotypy. The specimens were collected by Mr. Bartlett in Xeberos and Huallaga (Amazon River Basin, Peru), and succinctly described by Günther (1868); A. Günther did not, however, state the number of specimens used for the description. Eschmeyer et al. (2018) cite two lots as syntypes (BMNH 1867.6.13.46, 1 syntype, and BMNH 1867.6.13.58-59, 2 syntypes), and this material was examined in the present work.

Chirodon alburnus was succinctly described by Günther (1869) as belonging to the genus *Chirodon* Günther, 1864 because he overlooked the presence of maxillary teeth on the type specimens of *C. alburnus*. According to Maclaine (per. com.), Rosana Souza-Lima designated the specimens BMNH 1869.5.21.10 and BMNH 1869.5.21.11-13 as the lectotype and paralectotypes, respectively, of *Chirodon alburnus* in 2003, but that designation was never published. We concur, and so formally designate BMNH 1869.5.21.10 and BMNH

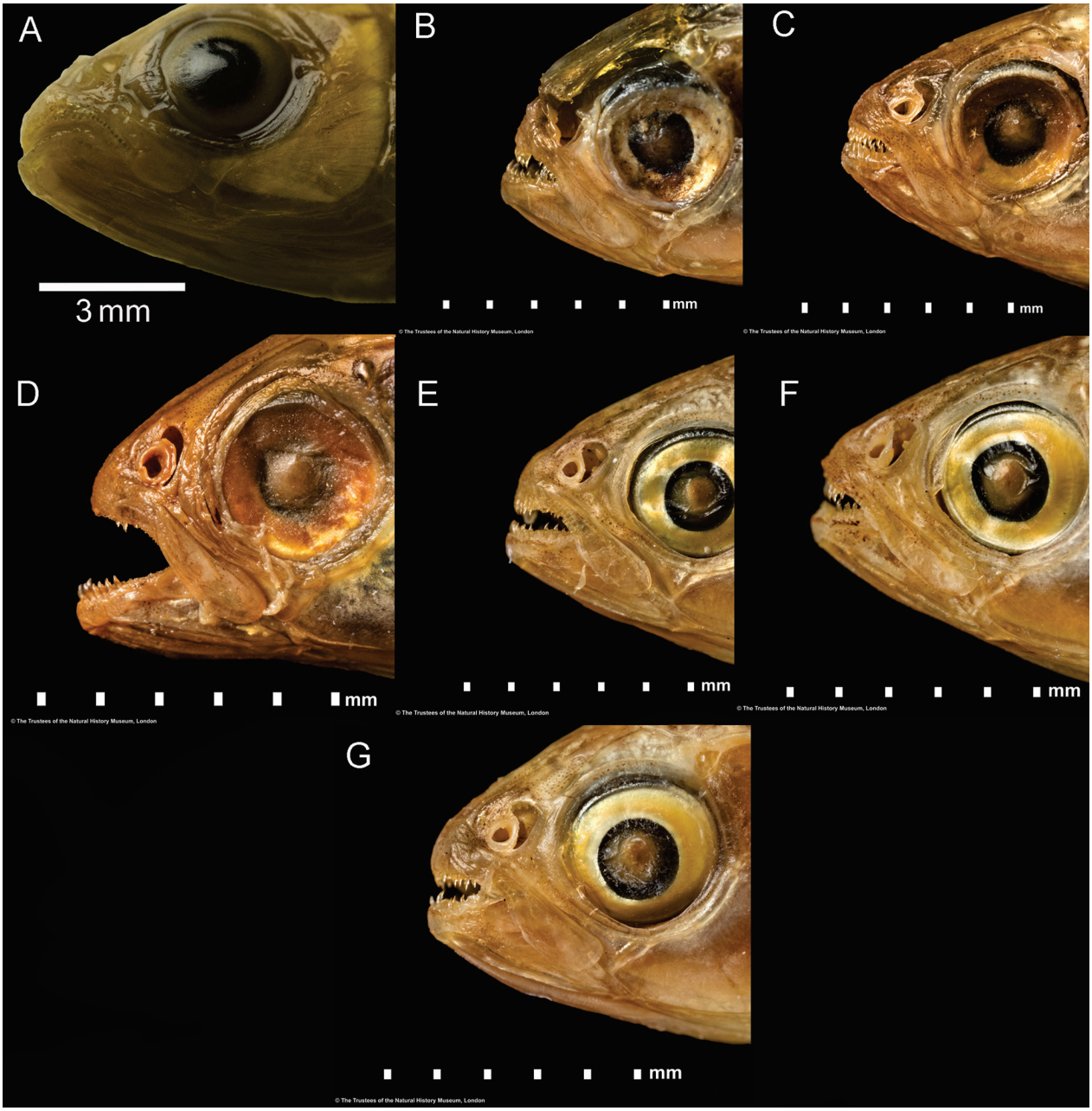

Figure 4. Maxillary teeth of: **A,** Holotype of *Aphyocharax avary*: ANSP 39217; **B,** Syntype of *Aphyocharax pusillus*: BMNH1867.6.12.46; **C, D;** Syntypes of *Aphyocharax pusillus*: BMNH 1867.6.13.58-59; **E,** Lectotype of *Chirodon alburnus*: BMNH 1869.5.21.10; **F, G,** two of the three paralectotypes of *Chirodon alburnus* (head damaged in a third): BMNH 1869.5.21.11-13. **A,** Photographed by Axel Katz; and **B-G,** Photographed by Kevin Webb.

1869.5.21.11-13 as the lectotype and paralectotypes, respectively, of *Chirodon alburnus*.

Based on the information presented here (type material examination, original descriptions, and the literature) we conclude that *Chirodon alburnus* is a junior synonym of *Aphyocharax pusillus* – as there are no clear diagnostic character states that distinguish those two species. Additionally, the type locality of *Chirodon alburnus* is imprecise ("Peruvian Amazon"), encompassing the type locality of *Aphyocharax pusillus*.

Aphyocharax avary Fowler, 1913

Aphyocharax avary Fowler, 1913:532. Type locality: Madeira River, about 200 miles east of Long. 62°20'W., Brazil. Holotype: ANSP 39217.

Material examined. ANSP 39217, 41.7, 1 (Holotype), Madeira River, about 200 miles east of 62°20'W, Brazil, Sept 1912, Edgar A. Smith.

Diagnosis. *Aphyocharax avary* differs from all of its congeners, except *A. pusillus*, by having black or dark brown

Figure 5. Holotype of *Aphyocharax avary*: ANSP 39217, 41.7 mm SL. Photographed by Axel Katz.

Table 2. Meristic data of *Aphyocharax avary.*

Measurements	ANSP 39217
Pored lateral-line sclaes	13+1
Longitudinal scales	38
Transverse scales	11
Dorsal-fin rays	11 or 12
Pectoral fin-rays	13
Pelvic-fin rays	7
Anal-fin rays	19
Premaxillary teeth	6 or 7
Maxillary teeth	14
Dentary teeth	13 or 14
Vertebrae	34

middle caudal-fin rays (Fig. 5; Fowler, 1913, fig. 8). It can be distinguished from *A. pusillus* by having more teeth on the maxillary, spread along 2/3 of the bone's extension (Fig. 4A) [vs. fewer teeth on the maxillary, spread along only the proximal half of the bone (Fig. 4B–G)].

Morphological notes. Meristic data of the holotype are presented in Table 2.

Body slightly compressed. Dorsal profile slightly convex in the snout region, somewhat flat in the anterior limit of the nasal bone to the extremity of the supraoccipital spine; convex from that point to the dorsal-fin origin; straight through dorsal-fin base; slightly convex after dorsal fin; slightly concave through caudal peduncle. Ventral profile slightly convex from snout to pelvic-fin insertion; straight from this point to the anal-fin origin and through that fin base; slightly concave through caudal peduncle. Snout rounded; eye large compared to the head and snout length; mouth terminal; lower maxilla slightly shorter than upper one. Lateral line interrupted; last scale on caudal-fin base.

Humeral spot conspicuous and middle caudal-fin rays black or dark brown (Fig. 5; Fowler 1913, fig. 8).

Remarks. *Aphyocharax avary* was described by Fowler (1913) based on a single specimen collected by Edgar A. Smith in September 1912 in the Madeira River, approximately 200 miles East of 62°20'W. This collection site is located between the municipalities of Novo Aripuanã-AM and Borba-AM, in the lower Madeira River Basin. The number of maxillary teeth was cited as 4 in the original inscription, although our examination of the holotype counted 14.

Based on the information presented here, we conclude that *A. avary* is a valid species, distinguishable from *A. pusillus* mainly by the number of teeth on the maxillary and their different distributions along that bone (14 maxillary teeth spread along 2/3 of the bone extension vs. 7–8 maxillary teeth spread along the proximal half of the bone) (Fig. 4).

Comparative material

Aphyocharax anisitsi: CICCAA 00867, 14, 25.1–27.9 mm SL, Brazil, Mato Grosso do Sul state, Rio Verde municipality. CICCAA 01267, 6 C&S, 22-26.9 mm SL, Brazil, Mato Grosso do Sul state, Rio Verde municipality. CAS 59697, 1, 41.0 mm SL, Paraguay, Asuncion municipality (Radiograph and photograph of Holotype. ***Aphyocharax dentatus***: ANSP 128718, 21, 25.4–34.9 mm SL, Colombia, Lake Mozambique; UFRJ 5571, 2, 23.3–26.0 mm SL, Brazil, Mato Grosso state, Poconé municipality. CAS 59722, 1, 71.0 mm SL, Paraguay, Asuncion municipality, Laguna del Río Paraguay (Radiograph and photograph of Holotype). ***Aphyocharax erythrurus*** **Eigenmann, 1912**: FMNH 53406, 1, Guyana: Rockstone sandbank (Photograph of paratype). ***Aphyocharax nattereri***: UFRJ 5783, 2, Brazil, Mato Grosso State, Poconé municipality. ***Aphyocharax pusillus***: ANSP 178013, 4, 33.1–54.8 mm SL (photographs of recently preserved specimens), Peru, Loreto, Rio Napo (Amazon river basin), right bank just upstream from mouth of Mazan river, near town of Mazan (3°29'10"S, 73°6'24''W). ***Aphyocharax rathbuni***: CAS 76467, 1, 26.0 mm SL, Paraguay, Arroyo Chagalalina, Paraguay basin. Paraguay (Radiograph and photograph of a Holotype). ***Aphyocharax yekwanae***: FMNH 109278, 1, Venezuela, Bolivarian Republic of (Radiograph of paratype). ***Aphyocharax*** **sp.**: CICCAA 00865, 11, 29.9–36.2 mm SL, Brazil, Mato Grosso State, Pontes e Lacerda municipality. CICCAA 2330, 4 C&S, 27.3–32.4, Brazil, Mato Grosso State, Pontes e Lacerda municipality.

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Webb, the photographer of *A. pusillus* type specimens; Mark Sabaj Perez for providing photographs of *A. pusillus*; Rosana Souza-Lima for providing photographs and x-ray images of *A. avary*; Pedro Bragança for the assistance with the photographs and examination of *A. avary* type material; Paulo Buckup, Cristiano Moreira, James Maclaine, Wilson Costa, and Mark Sabaj Perez for allowing us to examine material in their care; Donald Taphorn and Roy Funch for the grammatical revision; and Paulo Petry, Antonio Machado Allison, Francisco Provenzano, Oscar Miguel Lasso, and Elias Costa Araujo Junior for providing useful literature. This paper benefited from suggestions provided by Peter Bartsch and Donald Taphorn.

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