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New Species of *Trichomycterus* (Teleostei: Siluriformes) from the Andean Cordillera of Argentina and the Second Record of the Genus in Thermal Waters

Luis Fernández^{1,2} and Richard P. Vari³



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***Trichomycterus minus*, new species, is described from an Andean stream in Provincia de Catamarca, Argentina. The new species is distinguished from congeners by the number of supraorbital pores, the form of the supraorbital canal within the frontal, the length of the lateral line canal, the shape of the supraorbital tendon bone, the size of the premaxilla, the form of the barbels, an absence of a thick layer of rugose fatty tissue on the head and body, the number and degree of exposure of odontodes on the interopercle, the limited compression of the caudal peduncle, details of pigmentation, the number of premaxillary tooth rows, and the head form from a dorsal view. *Trichomycterus corduensis* is recorded from thermal waters, the second locality known to be inhabited by members of the genus.**

***Trichomycterus minus*, nueva especie, es descrita para un arroyo andino en la Provincia de Catamarca, Argentina. La nueva especie se diferencia de los congéneres por el número de poros supraorbitales, la forma del canal supraorbital dentro del frontal, la longitud del canal de la línea lateral, la forma del hueso supraorbital, el tamaño del premaxilar, la forma de las barbillas, la ausencia de una gruesa capa de tejido graso sobre la cabeza y cuerpo, el número y grado de exposición de odontoides en el interopérculo, la ausencia de compresión del pedúnculo caudal, los detalles de pigmentación, el número de hileras de dientes premaxilares y la forma de la cabeza en vista dorsal. *Trichomycterus corduensis* es registrado para aguas termales, la segunda localidad conocida para los miembros del género.**

THE Andean fish fauna is miniscule relative to ichthyofauna of the South American lowlands, and with the exception of a few endemic genera (*Orestias*—Cyprinodontidae; *Astroblepus*—Astroblepidae; *Silvinichthys*, *Bullockia*, and the extinct *Rhizosomichthys*—all *Trichomycteridae*), the fishes of the uplands are all members of groups prominent across the lowlands of the Neotropics. This is particularly the case for *Trichomycterus*, which ranges from Costa Rica to Tierra del Fuego and as now defined is a speciose but questionably monophyletic and taxonomically poorly resolved assemblage of approximately 200 species (de Pinna, 1998; Ferraris, 2007; Wosiacki and de Pinna, 2008a). *Trichomycterus* is the most speciose genus of fishes in uplands along the Andean Cordillera where its members inhabit a remarkable variety of environments including temporary streams, subterranean drainages in caves, fossorial sandy settings, and warm thermal waters (Wosiacki and de Pinna, 2008b; Fernández and Vari, 2009; Barbosa and Costa, 2011).

The complex topography and diversity of habitats of Andean Argentina may account for the speciose trichomycterid fauna in the region including 16 species of *Trichomycterus*, eight of which (*T. belensis*, *T. catamarcensis*, *T. hualco*, *T. heterodontus*, *T. pseudosilvinichthys*, *T. ramosus*, *T. riojanus*, *T. yuska*) are endemic to the area, whereas the rest (*T. alterus*, *T. areolatus*, *T. barbouri*, *T. borellii*, *T. boylei*, *T. corduensis*, *T. roigi*, *T. spagazzinii*) are varyingly more broadly distributed. Supplementing the diversity of *Trichomycterus* are four species of the closely related *Silvinichthys* (*S. bortayro*, *S. leoncitensis*, *S. mendozensis*, and *Silvinichthys* sp.). We herein add to that total with the description of a new Andean species of *Trichomycterus* from a mid-elevation location in

northwestern Argentina. The field studies that yielded the type series of the new species also documented the second known occurrence of a species of *Trichomycterus* in thermal waters.

MATERIALS AND METHODS

Measurements were taken from the left sides of the specimens with digital calipers under a binocular microscope following the methods outlined by Tchernavin (1944) and de Pinna (1992), supplemented by the body width at the pectoral-fin origin and the length of the pectoral and pelvic fins. Cleared-and-counterstained specimens (CS) were prepared following the procedure of Taylor and Van Dyke (1985) and osteological nomenclature follows Baskin (1973) and de Pinna (1989, 1998). Counts of dorsal- and anal-fin rays follow the methods proposed by de Pinna (1992) and were taken from radiographs and CS specimens. Values for the holotype are in brackets. Following de Pinna (1992), the vertebral counts exclude the vertebrae in the Weberian apparatus, with the compound caudal centrum counted as one element. Counts of caudal vertebrae follow Fernández and Schaefer (2003), with counts of vertebrae and ribs taken from two cleared-and-stained specimens. The numbering system and terminology for laterosensory pores of the head follow Arratia and Huaquin (1995) and Arratia (1998). Counts of lateral line pores follow the procedure proposed by Schaefer and Aquino (2000). Institutional abbreviations are as listed at <http://www.asih.org/node/204>, with the addition of MCN, Museo de Ciencias Naturales, Universidad Nacional de Salta, Salta, Argentina, and UNCa, Universidad Nacional de Catamarca, Catamarca, Argentina.

¹ CONICET, Fundacion Lillo, Miguel Lillo 251, 4000 Tucumán, Argentina; E-mail: (LF) luis1813@yahoo.com. Send reprint requests to this address.

² IBIGEO Instituto de Bio y Geociencias de Salta, Mendoza 2, 4400 Salta, Argentina.

³ Division of Fishes, Smithsonian Institution, P.O. Box 37012, National Museum of Natural History, WG-14, MRC-159, Washington, D.C. 20013-7012; E-mail: varir@si.edu.

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Fig. 1. *Trichomycterus minus*, new species, holotype, MCN 1528, 75.4 mm SL, lateral, ventral, and dorsal views; Argentina, Provincia de Catamarca, Departamento Belén, Arroyo Cuevas.

***Trichomycterus minus*, new species**

Figure 1, Table 1

Holotype.—MCN 1528, 75.4 mm SL, Argentina, Provincia de Catamarca, Departamento Belén, Río Cuevas, 27°04'S, 66°39'W, 2,318 m elevation, L. Fernández, 7 September 2006.

Paratypes.—9, 38.8–65.7 mm SL, collected with holotype: MCN 1529, 8, 38.8–65.7 mm SL (1 CS, 51.0 mm SL); USNM 405319, 1, 60.9 mm SL.

Diagnosis.—*Trichomycterus minus* is distinguished from its congeners, with the exception of *T. alterus*, *T. aguarague*, *T. belensis*, *T. boylei*, and *T. ramosus*, by the presence of supraorbital pore 3 (versus absence), the discontinuous supraorbital canal (versus continuous), the expanded supraorbital tendon bone (versus not expanded), and the premaxilla equal in size to, or smaller than, the maxilla (versus larger than the maxilla). *Trichomycterus minus* differs

from *T. alterus*, *T. aguarague*, *T. belensis*, *T. boylei*, and *T. ramosus* in the non-enlarged base of the maxillary barbel (versus enlarged), the absence of a thick rugose layer of fatty tissue on the head and body (versus the presence of such a layer), and the integument on the surface of the interopercle not covering the odontodes (versus covering the odontodes). *Trichomycterus minus* further differs from *T. alterus* in the only slightly compressed caudal peduncle (versus distinctly compressed), the presence of dark pigmentation on the area of the body anteroventral to the dorsal-fin origin (versus an unpigmented area in that region), and the profile of the head from a dorsal view which is not much wider posteriorly than anteriorly (versus much wider posteriorly). *Trichomycterus minus* additionally differs from *T. aguarague* in having four or five premaxillary tooth rows (versus two or three rows). *Trichomycterus minus* is further distinguished from *T. belensis* in the uniformly brown pigmentation on the body (versus darkly marmorated), and the lack of dark pigmentation on the basal portions of the caudal-fin rays (versus the dark pigmentation on the basal portions of the

Table 1. Morphometric Data for Holotype and Nine Paratypes of *Trichomycterus minus*, New Species. Standard length and head length are expressed in millimeters; measurements 1 to 13 are percentages of standard length; 14 to 20 are percentages of head length. Range, mean, and standard deviation (SD) include all specimens.

	Holotype	Range	Mean	SD
Total length	86.4	45.6–86.4	64.5	12.6
Standard length	75.4	38.8–75.4	55.7	11.2
1. Body depth	12.4	11.8–15.8	13.5	1.2
2. Caudal peduncle length	24.0	22.7–27.6	24.9	1.4
3. Caudal peduncle depth	8.7	8.2–9.6	9.0	0.4
4. Predorsal length	62.5	60.8–63.5	62.2	0.8
5. Preanal length	68.0	65.9–70.6	68.5	1.5
6. Prepelvic length	52.1	50.8–55.6	53.5	1.5
7. Dorsal-fin base length	9.3	9.3–11.2	10.4	0.5
8. Anal-fin base length	6.9	6.9–8.8	7.9	0.5
9. Head length	17.3	17.3–22.4	20.2	1.7
10. Head width	16.6	16.6–20.0	18.4	1.0
11. Head depth	8.6	8.6–11.7	10.3	0.9
12. First pectoral fin	16.4	13.9–18.9	17.3	1.3
13. First pelvic fin	7.4	7.4–9.4	8.5	0.4
Head length	13.1	8.7–13.1	11.1	1.4
14. Interorbital width	26.1	23.4–28.5	26.0	1.5
15. Snout length	41.1	36.6–41.1	39.5	1.4
16. Nasal barbel length	42.1	33.3–52.1	44.6	6.3
17. Maxillary barbel length	42.4	42.4–63.9	55.0	7.8
18. Rictal barbel length	38.4	27.8–38.5	34.1	3.8
19. Mouth width	45.1	33.0–45.1	38.1	3.4
20. Eye diameter	10.2	8.9–11.0	10.3	0.7

caudal-fin rays forming a slightly anteroventrally angled vertical bar). *Trichomycterus minus* additionally differs from *T. boylei* in the profile of the head from a dorsal view which is not much wider posteriorly than anteriorly (versus much wider posteriorly) and from *T. ramosus* in the distally unbranched barbels of variable width along their length (versus some or all barbels distally branched one or more times but of a constant width along their length).

Description.—Morphometrics of holotype and paratypes of *Trichomycterus minus* presented in Table 1. Body elongate, approximately cylindrical overall, but distinctly compressed somewhat transversely along dorsal portion of body in trunk region; gradually and progressively becoming more compressed transversely across entire vertical extent of body toward caudal fin. Dorsal and ventral profiles of trunk region ranging from nearly straight to slightly convex. Caudal peduncle smoothly continuous with dorsal and ventral profiles of trunk. Papillae-like structures present on body. Urogenital opening closer to anal-fin origin than to pelvic-fin insertion and covered by adpressed pelvic fins.

Head profile nearly rectangular from dorsal view, with adductor musculature of cheek well developed and obvious. Head dorsoventrally flattened; eye located on dorsal surface of head and not visible from lateral view. Eye ovoid and slightly anteroposteriorly elongate. Skin covering eye thin, transparent, and separate from surface of eyeball. Anterior nostril slightly smaller than posterior nostril and bordered medially by fleshy flap and laterally by base of nasal barbel. Flap and base of barbel continuous and forming short tube. Anterior margin of posterior nostril bordered by flap of thin skin. Infraorbital canal incomplete with segment between pores Io3 and Io10 absent. Posterior portion of infraorbital canal situated posterior to rim of orbit and arising from

temporal canal running within sphenotic. Posterior portion of infraorbital canal and infraorbital pores Io10 and Io11 present. Supraorbital canal segment not continuous, with pores So1 and So2 on anterior portion and pores So3 and So6 on posterior section. Postotic canal with two pores, with pterotic branch present at junction of pterotic and post-temporo-supracleithrum. Laterosensory canal along midlateral portion of trunk reduced, with three pores on anterior-most portion of lateral line.

Mouth subterminal, with rictus directed posteriorly. Premaxilla approximately equal in size to maxilla from ventral view. Teeth incisiform with distal portions of dentition in each jaw narrowing. Premaxilla bearing 4 or 5 rows of elongate teeth with 7 teeth in outer tooth row and total of 37 to 40 teeth. Dentary with 3 rows of teeth with 11 teeth in outer row. Lower lip fleshy anteriorly with anterior, and to lesser degree, anteroventral surfaces covered with papillae. Lower lip with prominent lobes along lateral limits; lobes situated medial to base of rictal barbels and covered by papillae. Upper lip fleshy and bearing numerous papillae.

Barbels relatively short and tapering distally, but not thread-like or with distal branching. Tip of maxillary barbel falling short of vertical through anterior limit of patch of opercular odontodes in some specimens but extending somewhat posterior of that point in other individuals. Submaxillary barbel shorter than maxillary barbel and falling short of vertical through anterior limit of opercular patch of odontodes. Nasal barbel extending posteriorly distinctly beyond posterior margin of eye.

Branchiostegal rays 6. Interopercular odontode patch elongate, straight, and bearing 50 to 54 odontodes not deeply embedded in fleshy covering over interopercle. Interopercular odontode patch with maximum of 4 irregular rows. Opercular odontode patch small and rounded; odon-

todes straight overall. Opercular odontode patch bearing up to 14 odontodes arranged in up to 3 irregular rows; odontodes not embedded in fleshy tissue covering of opercle.

Dorsal-fin rays obvious in whole specimens 11 [11], with 4 unbranched rays and 7 branched rays. Total of 14 rays apparent in CS specimens, with 5 unbranched rays and 9 branched rays. Distal margin of dorsal fin semicircular in expanded fin. Dorsal-fin origin located distinctly anterior to vertical through anterior limit of vent. First proximal dorsal-fin pterygiophore inserting posterior to neural spine of vertebra 17. Anal-fin rays 9 or 10 [9], with 4 unbranched rays and 5 or 6 branched rays. Anal fin relatively elongate; equal in size to, or slightly smaller than, dorsal fin with distal margin slightly rounded. Anal-fin origin located approximately at vertical through posterior portion of dorsal-fin base. First proximal anal-fin pterygiophore inserting posterior to haemal spine of vertebra 21. Dorsal-fin base either terminating at vertical through insertion of anal fin or overlapping anal-fin base for distance of up to 2 vertebrae. Pectoral-fin rays 9 or 10 [9], with lateralmost ray unbranched. Distal margin of pectoral fin straight to slightly convex. First pectoral-fin ray terminating at fin margin without forming distal filament. Pelvic-fin rays 5 [5], with 1 unbranched and 4 branched rays plus small splint. Second and third pelvic-fin rays longest. Tip of pelvic fin extending posterior of anal opening but falling short of anal-fin origin. Distal margin of caudal fin nearly straight or slightly convex. Principal caudal-fin rays 6+7. Three caudal-fin rays attaching to fused fourth plus fifth hypurals and 3 rays attaching to third hypural. Dorsal procurrent caudal-fin rays 11. Ventral procurrent caudal-fin rays 10. Total vertebrae 36, with 7 precaudal and 29 caudal vertebrae. Ribs on each side of body 15. No externally obvious sexual dimorphism present in examined population samples.

Color in alcohol.—Head and body with distinct, albeit faint, marmoration formed by patches of small, dark chromatophores on dorsal and dorsolateral surfaces of head and trunk and all but ventralmost portion of caudal peduncle. Ventral surface of head ranging from hyaline to slightly darkly pigmented. All barbels darkly pigmented to some degree. Dorsal, anal, and pectoral fins with irregular, dark pigmentation on rays and membranes usually more intense along rays. Variation in intensity of dark dorsal-fin pigmentation sometimes in form of indistinct transverse bar. Caudal-fin membranes irregularly darker than those of dorsal and anal fins. Pectoral fin hyaline to slightly dusky ventrally, with irregular dark pigmentation on dorsal surface that becomes less intense distally. Pelvic fin hyaline to slightly darkly pigmented. Opercular and interopercular odontodes and oral dentition unpigmented.

Ecology and endemism.—The type locality is a small, silt-laden stream flowing along a small rocky canyon into the Río Belén basin. When sampled, the stream was approximately 0.2 to 1.0 m deep and 1.0 to 2.5 m wide over a sand and rock bottom without aquatic vegetation, had a flow rate of 0.037 m³/s, a temperature of 20°C, conductivity 0.614 mS/cm, salinity 0.02%, turbidity 10, pH 8.43, and dissolved oxygen 4.96 mg/l. The drainage lies within an endorheic system that experiences torrential hydrological conditions associated with scarce but intense summer rains. All captured specimens were hiding under rocks, the usual habit for fishes in other streams in the Altiplano. Stomachs

of two cleared-and-stained specimens of *Trichomycterus minus* contained autochthonous benthic macroinvertebrates (dipteran larvae [Chironomidae and Ceratopogonidae] and Ephemeroptera). The one other species of fish collected at that site was *T. alterus*. Many Andean drainage systems are impacted by mining operations including mountain mining/valley fill practices primarily for extraction of various minerals. The resultant siltation, mercury pollution, changes in water chemistry, and modifications of the physical aspects of drainage systems (Oliveira Ribeiro et al., 1996) put the native aquatic fauna, including endemic catfishes such as *T. alterus*, *T. boylei*, *T. corduvensis*, and *T. minus*, at risk.

Distribution.—*Trichomycterus minus* is known only from the type locality. The species is the ninth in the genus apparently endemic to water systems of the southern Andes in Chile (*T. chungaraensis*, Arratia, 1983; *T. laucaensis*, Arratia, 1983) and Argentina (*T. ramosus*, Fernández, 2000; *T. catamarcensis*, Fernández and Vari, 2000; *T. belensis*, Fernández and Vari, 2002; *T. yuska*, Fernández and Schaefer, 2003; *T. pseudosilvinichthys*, Fernández and Vari, 2004; and *T. hualco*, Fernández and Vari, 2009).

Etymology.—The specific name, *minus*, in reference to the English word, mine, is in allusion to the mining activities common in the portion of the Province of Catamarca in which the species was captured.

Extremophile environment: thermal waters.—*Trichomycterus therma* and *T. tiraquae* were recorded in a small thermal stream in Miraflores, north of Potosí, Bolivia (Fernández and Miranda-Chumacero, 2007). Thermal water sources are common in the geologically active Andean cordillera of northwestern Argentina and are often used by local human populations for spa therapy and bathing (Menni et al., 1998; Gonzo et al., 2011). Ichthyological explorations near the type locality of *T. minus* revealed a population of *T. corduvensis* in a stream at Los Nacimientos (27°09'S, 66°45'W; 2,126 m asl) utilized by the local inhabitants as a hot bath thermal. At that site *T. corduvensis* (MCN 1530, 4 specimens) inhabits a portion of a small thermal pH 7.9, oligo to mesohaline creek in 29°C waters. This clear water creek ranges between 0.30–0.60 m wide and 0.30–0.50 m deep and flows slowly for approximately 3 m over a clay and sand substrate before ending at what during higher flow rates would be a 2 m high waterfall.

DISCUSSION

Relationships.—The inadequate understanding of the species-level diversity within *Trichomycterus* parallels the incomplete state of knowledge of intrageneric phylogenetic relationships. This complicates the evaluation of similarities between *T. minus* and putative congeners, but three derived features are informative as to the relationships of the species. Most species of *Trichomycterus* have an approximately rectangular premaxilla larger than the maxilla (e.g., *T. roigi* and *T. duellmani*, Arratia and Menu-Marque, 1984:figs. 3a and 12b, respectively; *T. nigricans*, Arratia, 1998:fig. 1; *T. corduvensis*, Fernández, 2001), conditions which occur elsewhere in the Trichomycterinae in outgroups *Bullockia* (Arratia et al., 1978:fig. 2b), *Eremophilus* (Eigenmann, 1918:fig. 40a), *Hatcheria* (Arratia and Menu-Marque, 1981:fig. 11), *Rhizosomichthys* (Schaefer and Fernández, 2009:fig. 2a–c), and *Silvinichthys* (*S. mendozensis*, Arratia, 1998:fig. 8a; *S. bortayro*, Fernández and de Pinna, 2005:fig. 5; *S. leoncitisensis*, Fernández et al., 2011:229).

Contrarily, *Trichomycterus minus* has an approximately triangular premaxilla equal in size to, or smaller than, the maxilla, derived attributes common to a set of congeners from cis-Andean northwestern Argentina (*T. alterus*, *T. belensis*, *T. boylei*, Arratia and Menu-Marque, 1984:fig. 12a, and *T. ramosus*, Fernández, 2000:fig. 3). Most species of *Trichomycterus* have a cylindrical supraorbital tendon bone (=frontolachrymal or sesamoid supraorbital; e.g., *T. roigi* and *T. duellmani*; Arratia and Menu-Marque, 1984:figs. 3 and 12b, respectively), an apparently plesiomorphic morphology occurring elsewhere in the Trichomycterinae in *Eremophilus mutissii*, *Hatcheria macraei*, *Bullockia maldonadoi* (Arratia et al., 1978:fig. 2, Arratia, 1998:fig. 14b–d, f), *Silvinichthys bortayro* (Fernández and de Pinna, 2005:fig. 4), and *Rhizosomichthys totae* (Schaefer and Fernández, 2009:fig. 10). A laterally expanded supraorbital tendon bone characterizes *T. minus* along with *T. alterus*, *T. aguarague*, *T. belensis*, *T. boylei* (Arratia and Menu-Marque, 1984:fig. 12a), *T. pseudosilvinichthys* (Fernández and Vari, 2004:fig. 2), *T. ramosus* (Fernández, 2000:fig. 3), *T. yuska* (Fernández, 2006:fig. 1), and *Silvinichthys mendozensis* (Arratia et al., 1978:fig. 10; Arratia, 1998:figs. 7, 8a, 14f). Whereas the supraorbital canal in most trichomycterids is continuous, the canal in *Trichomycterus minus* lacks the segment between pores So2 and So3. This derived condition is also present in *T. alterus*, *T. aguarague*, *T. areolatus*, *T. belensis*, *T. boylei*, *T. gracilis*, *T. megantoni*, *T. punctulatus*, *T. ramosus*, and *T. rivulatus* (Arratia, 1998:figs. 3b, 4a–b, 5b–c, 14a). Thus, three features considered derived under present hypotheses of relationships within the Trichomycteridae occur repeatedly in *T. minus* and *T. alterus*, *T. belensis*, *T. boylei*, and *T. ramosus*, providing support for the hypothesis of a close relationship of the new species with these four species.

Trichomycteridae in the ichthyofauna of Catamarca.—The depauperate ichthyofauna of the Provincia de Catamarca consists of only 24 species of native fishes, ten of which are members the Trichomycteridae. Among these, *Trichomycterus belensis*, *T. catamarcensis*, *T. ramosus*, and *T. yuska* are endemic to Catamarca, whereas *T. alterus*, *T. barbouri*, *T. borellii*, *T. boylei*, *T. corduvensis*, and *T. spegazzinii* range beyond the boundaries of that province. Although Berg (1895:143) followed by Liotta (2005:285) reported *Pygidium* (= *Trichomycterus*) *areolatum* from “República Argentina (Catamarca)”, repeated ichthyological sampling across that province failed to confirm the presence of *T. areolatus* in Catamarca. Rather, the known distribution of the species is Chile and further south in Argentina, with the most northern confirmed record being in Mendoza Province. Berg (1897:266) described *Pygidium schmidti* from Río Belén in Catamarca, with this species now considered a synonym of *Trichomycterus borellii* (de Pinna and Wosiacki, 2003). Examination of the types of *T. schmidti* and *T. borellii* revealed differences in the shape of the papillae between the species, and further analysis is necessary to determine whether *T. schmidti* is a valid species, thereby increasing the prominence of *Trichomycterus* within the depauperate ichthyofauna of Catamarca.

MATERIAL EXAMINED

Additional material is that cited in Schaefer and Fernández (2009) and Fernández and Vari (2009).

Hatcheria macraei: MCN 1521, 1 CS; MCN 1561, 2.

Silvinichthys leoncitis: MCN 1511 holotype; MCN 1512, 1 CS; ILPLA 2171, 1 paratype.

Silvinichthys sp. A: MCN 1515, 2 CS; MCN 1516, 5.

Silvinichthys sp. B: MCN 1518, 2; MCN 1532, 1 CS.

Trichomycterus areolatus: MCN 1370, 1.

Trichomycterus barbouri: MCN 48, 3; MCN 1163, 6; MCN 1178, 3; MCN 1376, 1.

Trichomycterus boylei: MCN 795, 2.

Trichomycterus corduvensis: MCN 1372, 4; MCN 1375, 1; MCN 1530, 4; UNCa 66, 4.

Trichomycterus hualco: MCN 1467, 1 paratype; USNM 383794, 4 paratypes.

Trichomycterus roigi: MCN 757, 2; MCN 994, 5.

Trichomycterus spegazzinii: MCN 321, 3; MCN 356, 5; MCN 815, 1.

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