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A new species of *Silvinichthys* (Siluriformes, Trichomycteridae) lacking pelvic fins from mid-elevation localities of the southern Andes, with comments on the genus

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Silvinichthys huachi new species, is described from a stream along the lower slope of the Andean Cordillera in the Provincia de San Juan, Argentina. It shares the distinctive modifications characteristic of *Silvinichthys*, but is distinguished from the four previously described congeners by the combination of a lack of the pelvic fin and the pelvic girdle, details of pigmentation and various meristic and morphometric features. *Silvinichthys huachi* is apparently endemic to the type locality situated within an arid region of western central Argentina in the Andino Cuyana Province. Major gaps in the range of species of *Silvinichthys* may indicate that the origin of the genus predates the uplift events that subdivided drainages along the eastern slopes of the Andean Cordillera in west central Argentina. *Silvinichthys huachi* is hypothesized to be the sister species of *Silvinichthys bortayro*.

Key words: Andean Cordillera; Argentina; catfish; neotropic; southern South America; Trichomycterinae.

INTRODUCTION

Andean and cis-Andean piedmont regions of South America are characterized by multiple small isolated drainage basins which in many, if not all, instances have been minimally isolated since the last uplift episodes of these regions (Arratia, 1998). In the Andean piedmont of Argentina, this isolation compounded by aridity has resulted in depauperate ichthyofaunas. River systems in the region are inhabited by few or more often only one species of fish and the species are typically endemic to a single

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basin. Arratia *et al.* (1983) documented 14 species of fishes in the river systems in the Andean foothills across the expanse of the Provinces of Catamarca, La Rioja Mendoza and San Juan. Those authors noted that ten were members of the catfish family Trichomycteridae. Subsequent studies have documented that the prevalence of trichomycterids in the ichthyofauna of those provinces is even more pronounced, with nine additional species of that family reported from the area after 2000, most of which are endemic to individual small rivers and streams (Fernández & Vari, 2009).

Silvinichthys, a component of the subfamily Trichomycterinae, is endemic to this arid region with four species previously described from geographically distantly separated locations (Arratia, 1998; Fernández & de Pinna, 2005; Fernández *et al.*, 2011, 2013). The first of these species was described as *Trichomycterus mendozensis* by Arratia *et al.* (1978) from a location in the Andean piedmont of Mendoza, Argentina, at 1500–1700 m.a.s.l. Two decades later, Arratia (1998) proposed the monotypic *Silvinichthys* for *T. mendozensis* based on its possession of multiple unusual modifications, most notably having the entire skin surface perforated by pores of the ampullary organs, the absence of head and body pit lines and the reduction of the cephalic laterosensory canal system to the nasal portion of the supraorbital canal and the postotic canal. Fernández & de Pinna (2005) subsequently described a second species of *Silvinichthys*, *Silvinichthys bortayro*, from phreatic waters at 1258–1356 m.a.s.l. in Provincia de Salta, over 1100 km to the north-northeast of the location of *Silvinichthys mendozensis*. Fernández *et al.* (2011) described a third species of *Silvinichthys*, *Silvinichthys leoncitensis*, from a location at 1213 m.a.s.l. in Provincia de San Juan. Recently, Fernández *et al.* (2013) described the fourth species of *Silvinichthys*, *Silvinichthys gualcamayo*, from a location at 2300 m.a.s.l. in Provincia de San Juan. A fifth species of this unusual genus is described here based on the combination of the pelvic-fin loss, pigmentation, meristics and morphometrics that distinguish it from the four previously recognized species of *Silvinichthys*. With this description, the Trichomycteridae now accounts for 20 of the 25 species of fishes in the cis-Andean foothill drainages of the Provinces of Catamarca, La Rioja, Mendoza and San Juan in west-central Argentina.

MATERIALS AND METHODS

Specimens were killed in the field by over-anaesthesia in benzocaine and were immediately fixed in 10% formalin. Morphometric and meristic data were taken following Tchernavin (1944). Measurements were taken on the left side of each specimen with digital callipers under a binocular microscope. Osteological preparations (CS) were made according to Taylor & Van Dyke (1985) and osteological terminology follows J. N. Baskin (unpubl. data) and de Pinna (1989). Counts of unpaired fin rays, vertebrae and ribs were taken from two CS and four radiographed specimens. The numbering system and terminology for laterosensory pores of the head follow Arratia & Huaquin (1995) and Arratia (1998). Counts of lateral-line pores follow the procedure proposed by Schaefer & Aquino (2000). One lot of specimens was not included in the paratype series due to incomplete meristic and morphometric data. Meristic values are followed by the number of specimens with that count in parentheses; meristic values for the holotype in the text are indicated (*). Institutional abbreviations in the text are as listed in Fricke & Eschmeyer (2013), with the exception of MCN which, here, refers to the Museo de Ciencias Naturales, Universidad Nacional de Salta, Salta, Argentina. Morphometric abbreviations are head length (L_H) and standard length (L_S).

RESULTS

SILVINICHTHYS HUACHI, NEW SPECIES

Holotype

MCN 1516 (30·2 mm L_S), Argentina, Provincia de San Juan, Departamento Jachal, Río Huerta de Huachi, 30° 01′ S; 68° 48′ W, 2000 m.a.s.l., 3 March 2009, E. Sanabria and L. Quiroga.

Paratypes

All collected with holotype: USNM 396057 (one specimen, 26·9 mm L_S), MCN 1517 (six specimens, 25·9–27·5 mm L_S), MCN 1515 (two specimens CS, 23·1–25·7 mm L_S).

Non-types

All collected at type locality: MCN 1563 (20 specimens, 16·1–40·0 mm L_S), 1 May 2009, E. Sanabria, L. Quiroga, R. Cortez and V. Marinero.

Diagnosis

Silvinichthys huachi differs from *S. bortayro* in the shape of the head from a dorsal view [triangular *v.* more rectangular (Fernández & de Pinna, 2005)], the number of opercular odontodes apparent in cleared and stained specimens (8–11 *v.* 2–4), the number of interopercle odontodes apparent in cleared and stained specimens (21–28 *v.* 9–12), the number of dorsal-fin rays (11–13 *v.* 9), the caudal-peduncle depth (8·8–10·9 *v.* 8·0–8·3% of L_S), the snout length (43·3–61·9 *v.* 38·2–40·5% of L_H) and body colouration. Specimens of *S. huachi* have broadly separated, dark, marmorated bands of pigmentation on the head and body with a more concentrated, but still diffuse, patch of darker pigmentation overlying the dorsal surface of the cranium and the dorsal portions of the pectoral girdle. It lacks a dark midlateral stripe on the caudal peduncle at all sizes. In comparison, *S. bortayro* lacks the dark marmorated pigmentation in larger individuals and the presence of a dark midlateral stripe in midsized specimens, and these differences are more apparent in live individuals. *Silvinichthys huachi* is distinguished from *S. gualcamayo* by the caudal-peduncle length (19·3–21·5 *v.* 22·0–23·9% of L_S) and the insertion point of the first proximal dorsal-fin pterygiophore (posterior to the neural spine of vertebra 21 *v.* 22). *Silvinichthys huachi* differs from *S. leoncitensis* by the number of vertebrae (37–39 *v.* 40), number of ribs (16–18 *v.* 20) and number of pectoral-fin rays (6–7 *v.* 8), the body depth (12·6–16·5 *v.* 8·4–12·2% of L_S), the caudal-peduncle depth (8·8–10·9 *v.* 6·6–8·6% of L_S) and the insertion point of the first proximal dorsal-fin pterygiophore (posterior to the neural spine of vertebra 21 *v.* 23). *Silvinichthys huachi* is readily distinguished from *S. mendozensis* by the condition of the pelvic fin and pelvic-fin girdle [fin and girdle absent *v.* present (Arratia *et al.*, 1978; Arratia, 1998)] and the number of interopercle odontodes apparent in cleared and stained specimens (21–28 *v.* 30–42).

Description

Morphometrics for the holotype and paratypes of *S. huachi* are presented in Table I. For general morphology, see Fig. 1. Body elongate, cylindrical overall in

TABLE I. Morphometric data for *Silvinichthys huachi*. Measurements are based on the holotype (MCN 1516) and seven paratypes (MCN 1517, USNM 396057) excluding two CS specimens. Range includes holotype

	Holotype	Range	Mean
Standard length (L_S) (mm)	30·2	23·1–30·2	26·5
Per cent of L_S			
Body depth	13·9	12·6–16·5	14·5
Caudal-peduncle length	21·4	19·3–21·5	20·6
Caudal-peduncle depth	8·8	8·8–10·9	9·9
Predorsal length	65·6	60·3–66·4	64·4
Preanal length	71·0	68·9–74·2	71·5
Dorsal-fin base length	12·1	10·5–12·4	11·6
Anal-fin base length	10·2	9·1–11·0	10·2
Head length (L_H)	19·3	16·9–19·3	17·8
Head width	16·5	14·2–18·0	16·3
Head depth	11·0	9·9–12·2	11·2
Per cent of head length			
Interorbital width	28·3	28·3–36·1	31·7
Snout length	43·7	43·3–61·9	49·5
Nasal barbel length	41·2	23·1–61·7	45·8
Maxillary barbel length	61·7	43·3–84·3	70·5
Rictal barbel length	36·0	26·0–55·0	37·8
Mouth width	30·9	28·8–43·4	36·0

trunk region and gradually but progressively becoming more compressed transversely towards caudal fin. Dorsal profile of head approximately straight overall. Dorsal profile of body slightly convex to point barely beyond vertical through tip of pectoral fin and then nearly straight to insertion of dorsal fin. Dorsal-fin base slightly posteroventrally aligned. Ventral profile of head and body distinctly concave to point approximately at vertical through midlength of adpressed pectoral fin; body profile then slightly convex to anus. Anal-fin base posterodorsally inclined. Caudal peduncle smoothly continuous with profile of trunk region. Dorsal and ventral profiles of peduncle approximately straight and parallel. Papillae-like structures absent on body. Lateral line short, with three pores.

Head triangular overall from dorsal view with broadly rounded margin along transversely narrower anterior portion. Head dorsoventrally flattened with eyes located on dorsal surface. Eyes circular and readily visible on surface of head. Skin covering eye thin, transparent and separate from surface of eyeball. Regions ventrolateral and particularly posterior of eyes somewhat expanded laterally as consequence of well-developed jaw muscles, but with degree of muscle development less pronounced in some smaller paratypes.

Anterior nostril slightly smaller than posterior nostril and surrounded by fleshy flap of integument medially and by barbel laterally. Posterior nostril partially surrounded anteriorly by flap of thin skin.

Mouth distinctly subterminal, with rictus directed posteriorly. Premaxilla rectangular and larger than maxilla and width of palatine. Premaxilla with two or three

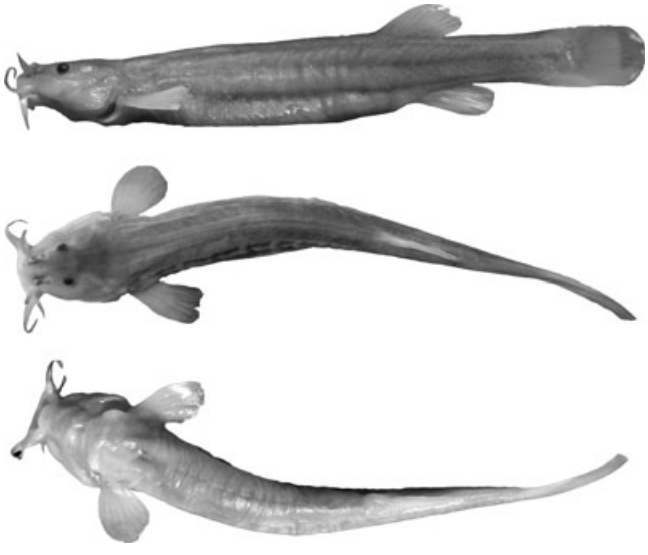

FIG. 1. *Silvinichthys huachi*, holotype, MCN 1516, 30·2 mm standard length, L_S: Argentina, Provincia San Juan, Departamento Jachal, Río Huerta de Huachi. Left lateral, dorsal and ventral views.

rows of teeth. Lower lip with prominent fleshy lobes along lateral limits; lobes situated internal to base of rictal barbels. Lower lip fleshy anteriorly with papilla-like structures covering anterior and to lesser degree anteroventral surfaces. Upper lip fleshy with numerous papillae.

Barbels relatively short and tapering distally but not thread-like. Maxillary barbels extending posteriorly over interopercular odontodes to insertion of pectoral fin. Nasal barbels reaching posteriorly to posterior margin of eye. Origin of nasal barbel situated on posterolateral portion of skin flap running along margin of anterior naris. Submaxillary barbels shorter than maxillary barbels.

Seven or eight branchiostegal rays in two CS specimens. Interopercular patch of odontodes anteroposteriorly elongate with five to 15 odontodes apparent in whole specimens and 21 to 28 odontodes present in two CS specimens. Opercular patch of odontodes small, round and with three to six odontodes arranged in one or two irregular rows apparent in whole specimens and eight to 11 odontodes present in two CS specimens.

Distal margin of pectoral fin broadly convex. First pectoral-fin ray terminates at, rather than extends beyond, fin margin. Pectoral fin with one unbranched ray and 5 (2) or 6* (8) branched rays. Pelvic fins and pelvic girdle absent. Distal margin of dorsal fin semicircular when fin fully expanded. Dorsal fin with 3* (4), 4 (1) or 5 (1) unbranched rays followed posteriorly by 7 (2) or 8* (4) branched rays (in two CS and four radiographed specimens). Base of dorsal fin fleshy. Dorsal-fin origin located distinctly anterior to vertical through anterior limit of urogenital opening. First proximal dorsal-fin pterygiophore inserting posterior to neural spine of vertebra 21 (in two CS specimens). Anal fin with 2 (1), 3* (3) or 4 (2) unbranched rays followed by 6 (2) or 7* (4) branched rays (two CS and four radiographed specimens). Anal fin approximately same size as, to slightly smaller than, dorsal fin and slightly elongate

with distal margin gently rounded when fully expanded. Anal-fin origin located approximately at vertical through point one-third length of dorsal-fin base posterior of dorsal-fin origin. First proximal anal-fin pterygiophore inserting posterior to haemal spine of vertebrae 22–24 (in two CS specimens). Caudal-fin margin rounded overall. Principal dorsal caudal-fin rays either with 6 (3)* rays on fused third through fifth hypurals or three rays on fused fourth and fifth hypurals and three rays on separate third hypural (3) (in two CS and four radiographed specimens). Principal ventral caudal-fin rays 7 (6); rays attached to fused hypurals 1–2 and separate parahypural (in two CS and four radiographed specimens). Dorsal procurrent caudal-fin rays 11 (in two CS specimens). Ventral procurrent caudal-fin rays 10 (in two CS specimens). Total vertebrae 37 (1), 38* (4) or 39 (1) (in two CS and four radiographed specimens). Ribs on each side 16 (1) or 18* (5) (in two CS and four radiographed specimens).

Colour in ethanol

Overall ground colouration of head and body tan to light brown with irregular series of dark chromatophores forming barely apparent pattern of broad marmorated bands on dorsal and lateral surfaces of body. Diffuse darker pigmentation present on dorsal portion of head. Remainder of head with scattered dark chromatophores. Area immediately medial to anterior nostril very darkly pigmented. Opercular, but not interopercular, patch of odontodes with web-like pattern of dark pigmentation coursing around base of odontodes. All barbels with exception of submaxillary barbels covered with diffuse pattern of scattered dark chromatophores. Pigmentation overlying dorsal portions of pectoral girdle and adjoining areas somewhat darker than that of overall body pigmentation. Dorsal and anal fins hyaline. Dorsal surface of pectoral fin with scattered, irregular patches of dark pigmentation. Caudal-fin rays outlined by small dark chromatophores. Dark pigmentation forming obscure vertical bar at base of caudal fin.

Colour in life

On the basis of the photographs of just preserved specimens retaining life colouration. Dark pigmentation as described for preserved specimens, but with marmoration pattern on body much more pronounced. Dorsal surface of head and body with slight yellowish-reddish colouration. Ventral surface of body silvery from isthmus to slightly anterior of anus. Silvery colouration extending dorsally to ventral limit of marmoration pattern on lateral surface of body.

Etymology

The specific name, *huachi*, is in reference to the type locality of the species, the Río Huertas de Huachi. A noun in apposition.

Ecology

Water levels within the Río Huerta de Huachi fluctuate dramatically between seasons with maximum flow rates during and after the summer rainy period. Water flow in the main channel is significantly reduced during the dry season, with most of the inflow from a series of small, isolated springs scattered along the course of the main river. The collection location for the type series of *S. huachi* lies

within the Monte de sierras y bolsones ecoregion of Pol *et al.* (2006). This region has an arid climate, with a mean annual rainfall of 89 mm, which is concentrated during the summer, a mean annual temperature of 17·3° C, a mean annual maximum temperature of 25·7° C and a mean annual minimum temperature of 10·4° C (Cabrera, 1994). This region is considered a desert with summer precipitation climate of the Koppen climatic classification (G. A. Poblete & J. L. Minetti, unpubl. data). The dominant vegetation in this region is composed of *Larrea* spp. (jarillas), *Prosopis* spp. (algarrobos) and cacti such as *Opuntia* sp. and *Thrichocereus* sp. (Warner, 2004).

The type locality for *S. huachi* is a clear water stream 0·06–0·30 m deep and 1·5–2·0 m wide over a rock and cobble bottom with the water temperature 19·7° C. The stream is surrounded by limited riparian vegetation and located at an elevation of *c*. 2000 m.a.s.l. The stomachs of the two CS specimens contained dipteran larvae (Chironomidae) and sand indicating that the species feeds on autochthonous benthic macroinvertebrates, a diet shared with its congeners (Fernández & Vari, 2000). *Silvinichthys huachi* is nocturnally active with individuals observed swimming at night-time whereas during the day they hide among rocks on the stream bed. Breeding apparently takes place prior to April since observations during that month in 2009 revealed that the population of *S. huachi* at the sampling site contained larger numbers of juveniles than adults. The only other aquatic vertebrates captured at the type locality were tadpoles and adults of *Rhinella spinulosa* (Anura, Bufonidae) and *Odontophrynus cf. barrioi* (Anura, Odontophrynidae). Tadpoles of both species of amphibians co-occur with *S. huachi* in pools within the course of the stream.

Distribution

Silvinichthys huachi is only known from, and is the only species at, the type locality in the Río Huerta de Huachi (Fig. 2).

Conservations considerations

Fish faunas in drainage systems along much of the Andean Cordillera of Argentina are often drastically adversely affected by introductions of rainbow trout *Onchorhynchus mykiss* (Walbaum 1792). Water bodies in the region are often degraded by activities associated with mineral extraction and initial ore processing. Most problematic of these is the erosion associated with mining activities, with the increased sediment load in impacted rivers dramatically altering aquatic habitats (Fernández, 2005, 2009). Anthropogenic impacts on the stream inhabited by *S. huachi* are to date relatively minor. The human population living in the basin is limited and the primary agricultural activity is goat herding. Nonetheless, in light of the fact that the *S. huachi* is apparently endemic to the small Río Huerta de Huachi and is known from a restricted area within that basin, the introduction of predatory fish species and mining activities in that portion of the river basin would likely result in the extinction of the species.

DISCUSSION

The fish fauna of the Andean piedmont region across the Provinces of Catamarca and Mendoza in Argentina is relatively depauperate, a generality also applying to the

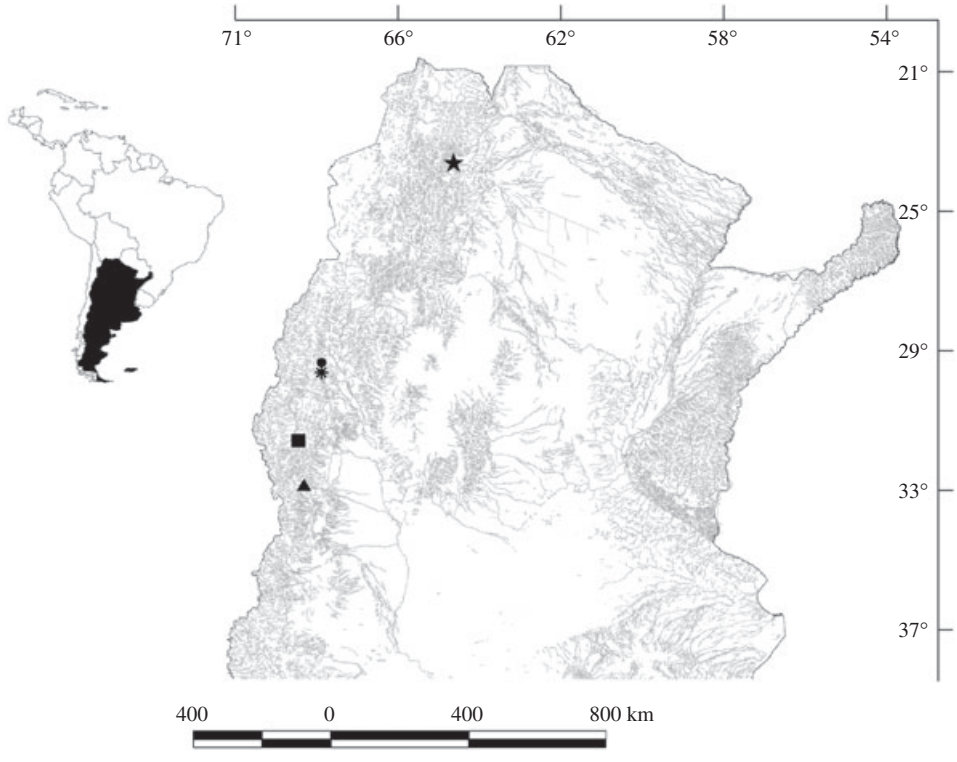

FIG. 2. Map of central and northern Argentina and adjoining regions showing type localities of *Silvinichthys huachi* (✳), *Silvinichthys bortayro* (★), *Silvinichthys gualcamayo* (●), *Silvinichthys leoncitensis* (■) and *Silvinichthys mendozensis* (▲).

ichthyofauna of San Juan Province which includes the type locality of *S. huachi*. The known ichthyofauna of San Juan Province consists of 17 species, of which six are members of the Trichomycteridae: *Hatcheria macraei* (Girard 1855), *Trichomycterus corduvensis* Weyenbergh 1877, *S. gualcamayo*, *S. leoncitensis*, *S. huachi* and one undescribed species of *Silvinichthys*. The continuing discovery of members of the genus indicates that our state of knowledge of the group is far from complete and other species probably await discovery. The gaps may, at least in part, be the result of unrepresentative sampling. The regions where species of *Silvinichthys* are found are difficult to sample and often neglected in survey work. In addition, the fishes are secretive and difficult to capture. The pronounced separation of many of these populations, and the fact that drainages are quite isolated from each other, however, does suggest the possibility that the genus predates the uplift and desiccation of these regions with the resultant separation of the streams in that area, a phenomenon previously highlighted by Arratia (1998).

As noted by Fernández & de Pinna (2005: 105), the subfamilial assignment of species with the defining attributes of *Silvinichthys* is of necessity provisional in the light of the apparent non-monophyly of the Trichomycterinae. Those authors, nonetheless, lay out a series of characteristics in support of the assignment of *Silvinichthys* to the Trichomycterinae, a practice followed here. The assignment of the

new species to *Silvinichthys* is based on its possession of the synapomorphies for the genus, specifically the perforation of the entire skin surface by the pores of the ampullary organs, the reduction of the laterosensory canal system with the portion of that system on the head reduced to the postotic canal and the nasal portion of the supraorbital canal, the narrow and elongate opercle, the unossified gill rakers and a urohyal with two foramina (Arratia, 1998; de Pinna, 1998; Fernández & de Pinna, 2005; Fernández *et al.*, 2011).

Silvinichthys bortayro, *S. gualcamayo*, *S. huachi* and *S. leoncitensis* share the absence of the pelvic girdle and pelvic fin (*v.* the presence of both structures in *S. mendozensis* and most trichomycterids). Absence of the pelvic fin and girdle has been observed elsewhere in the Trichomycteridae in *Eremophilus mutisii* Humboldt 1805, *Listrura camposi* (Miranda Ribeiro 1957), *Trichomycterus catamarcensis* Fernandez & Vari 2000, *Trichomycterus candidus* (Miranda Ribeiro 1949), *Trichomycterus tropeiro* Ferrer & Malabarba 2011, the Glanapteryginae, the Tridentinae and some specimens of *Ituglanis parahybae* (Eigenmann 1918) (Costa & Bockmann, 1993; Barbosa & Costa, 2003; Ferrer & Malabarba, 2011). de Pinna (1989) documented minimally three independent losses of the pelvic fin within the Trichomycteridae; a pattern perhaps reflecting an underlying propensity for the loss of this system in this family. Nonetheless, given the synapomorphies which define *Silvinichthys*, it is reasonable to assume that the absence of the pelvic fin and girdle in *S. bortayro*, *S. gualcamayo*, *S. huachi* and *S. leoncitensis* is a synapomorphy supporting the hypothesis of the monophyly of a clade consisting of those four species and homoplastic relative to the absence of those structures in various other members of the Trichomycteridae. Further supporting that hypothesis is the reduction to between nine and 28 interopercle plate odontodes within those four species (*v.* 30–42 in *S. mendozensis* and other trichomycterins). Within that clade (*S. bortayro*, *S. gualcamayo*, *S. huachi* and *S. leoncitensis*), the reduction in the numbers of branched pectoral-fin rays (five or six in *S. bortayro* and *S. huachi v.* seven to nine in three congeners and most trichomycterins) is hypothesized to be a synapomorphy supporting the hypothesis of a sister group relationship between *S. bortayro* and *S. huachi*.

COMPARATIVE MATERIAL

Comparative material examined in this study is that cited in Fernández & Vari (2009) and Schaefer & Fernandez (2009) with the addition of the following specimens. *Silvinichthys gualcamayo*: MCN 1518 (holotype 51·0 mm L_S); MCN 1532 (paratype 31·9 mm L_S, CS). *Silvinichthys leoncitensis*: MCN 1511 (holotype 58·2 mm L_S); MCN 1512 (paratype 35·8 mm L_S, one CS); *S.* sp A: MCN 1562 (two specimens, 34·5–40·9 mm L_S); *S.* sp B: uncat. (three specimens, 50·7–58·2 mm L_S). *Trichomycterus alterus*: FML 2085 (nine specimens, 43·6–49·1 mm L_S, one CS). *Trichomycterus belensis*: FML 2531 (10 paratypes 25·5–58·7 mm L_S, one CS). *Trichomycterus catamarcensis*: USNM 357449 (one paratype 31·6 mm L_S); FML 2510 (10 of the 14 specimens, 25·0–31·5 mm L_S, two CS). *Trichomycterus corduvensis*: FML 1215 (four specimens, 39·0–93·1 mm L_S, one CS). *Trichomycterus hualco*: USNM 383794 (four paratypes 52·7–59·6 mm L_S, one CS). *Trichomycterus minus* MCN 1529 (four paratypes 38·8–65·7 mm L_S, one CS). *Trichomycterus pseudosilvinichthys*: USNM 374759 (four paratypes 43·5–52·9 mm L_S, one CS). *Trichomycterus ramosus*: FML 2071 (five of the 11 paratypes 58·9–66·8 mm L_S,

two CS). *Trichomycterus yuska*: FML 1132 (five of the 12 paratypes, 15·5–61·5 mm L_S, two CS).

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