Zootaxa 1096: 29–39 (2005)
www.mapress.com/zootaxa/

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

1096

A new species of *Jenynsia* (Cyprinodontiformes: Anablepidae) from northwestern Argentina and its phylogenetic relationships.

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Abstract

Jenynsia tucumana new species is described from the upper Río Salí basin, province of Tucumán, northwestern Argentina. The new species is diagnosed by the possession of a row of dark markings ranging from dots to small vertical stripes from the tip of adpressed pectoral fin to the posterior margin of the hypural. Also, the new species has a mandibular canal pore W and a symmetrical fifth anal-fin ray in adult males; whereas the females lack a urogenital swelling. According to a phylogenetic reanalysis of the genus, the new species is sister to most species of the subgenus *Jenynsia*, except for *J. onca* and possibly *J. sanctaecatarinae*.

Key words: *Jenynsia*, new species, Tucumán, Argentina, phylogeny

Introduction

The genus *Jenynsia* Günther is comprised of 11 species of small viviparous fishes, which are diagnosed by the possession of tricuspidate teeth in the outer mandibular series in adults, and an unscaled tubular gonopodium formed principally by anal-fin rays 3, 6, and 7 (Parenti, 1981). This genus is distributed in the Río de la Plata basin, coastal Atlantic drainages from Rio de Janeiro in Brazil to Río Negro Province in Argentina, and in the endorheic Río Salí–Dulce basin, in northwestern Argentina.

In his phylogenetic analysis of the family Anablepidae, Ghedotti (1998) recognized two clades within *Jenynsia*, which were formally recognized by him as the subgenera *Plesiojenynsia* and *Jenynsia*. Two new species have recently been described from southern Brazil, *Jenynsia weitzmani* Ghedotti, Downing–Meisner & Lucinda and *J. onca* Lucinda, Reis & Quevedo. According to the phylogenetic framework put forward by Ghedotti (1998); these species belong in the monophyletic subgenera *Plesiojenynsia* and *Jenynsia*, respectively.

Accepted by C. Gilbert: 21 Oct. 2005; published: 16 Dec. 2005

In Argentina four species of *Jenynsia* are represented, all in the subgenus *Jenynsia.* Of these, only *J. pygogramma* Boulenger and *J. maculata* Regan have their type localities within the country. In the upper Río Salí basin, in Tucumán, two species of this genus were cited as *Jenynsia* sp. A and *Jenynsia* sp. B (Butí & Miquelarena, 1995). The first of these species corresponds to the broadly distributed *Jenynsia multidentata* (Jenyns), and the latter is the new species herein described. The purpose of this paper is to describe *Jenynsia tucumana* n. sp. from the Río Vípos, Tucumán, Argentina, and to discuss its phylogenetic relationships.

Material and Methods

Material examined is deposited in the following collections: Fundación Miguel Lillo, Tucumán (CI–FML), and Asociación Ictiológica, La Plata (AI), both in Argentina; and in the Academy of Natural Science of Philadelphia (ANSP), USA. Specimens were cleared and counterstained (C&S) following Taylor & Van Dyke (1985). Nomenclature of sensory canal system follows Gosline (1949). Measurements are straight distances taken with caliper to the nearest 0.02 mm (Fig. 1); and expressed as a percentage of standard length (SL) in Table 1. Interorbital width is the shortest distance between the bony margins of the orbits. Following Ghedotti and Weitzman (1995) and Lucinda et al. (2002), the last two rays in the dorsal fin of all specimens and in the anal fin of females were counted as separate elements; gill rakers were counted from the ventral limb of first gill arch; and vertebrae were counted considering the hypural complex as one element. Numbers in brackets following the counts indicate the number of specimens for each count. An asterisk indicates holotype counts. In comparative material the number in brackets following the number of examples in each lot indicates the measured specimens.

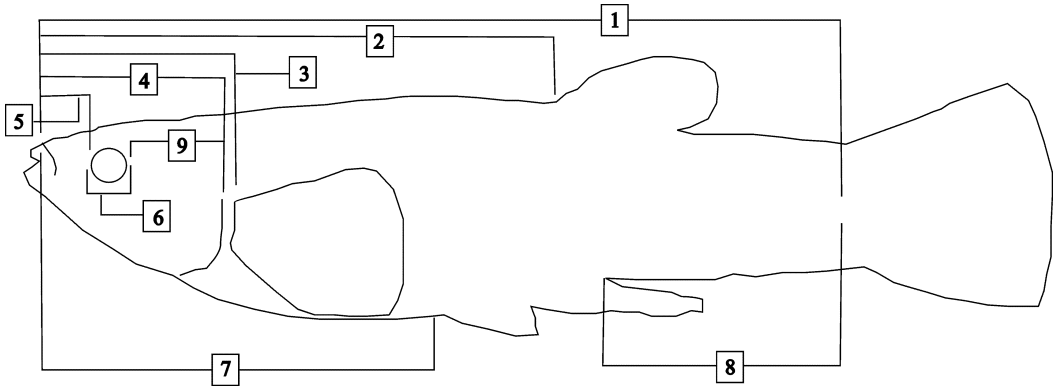

FIGURE 1: Diagrammatic representation of the morphometric measures taken: 1—Standard Length; 2—Predorsal length; 3-Snout to pectoral fin; 4—Head; 5—Snout; 6—Eye diameter; 7—Snout to pelvic fin; 8—Caudal peduncle; 9—Postorbital length.

TABLE 1. Descriptive morphometrics of specimens of *Jenynsia tucumana*

Morphometric measures	holotype	males (n=26)		females (n=20)	
		Mean	Range	Mean	Range
Standard length (mm)	30.7	26.9	20.4-30.8	36.1	27.6-44.5
Percents of standard length					
Head length	27.3	27.6	25.2-30.0	26.6	24.4-28.7
Snout length	7.4	7.1	6.3-8.3	7.4	6.6-8.2
Post orbital length	13.0	12.6	11.7-13.5	12.5	11.4-14.1
Eye diameter	9.7	9.1	8.3-9.9	8.1	6.9-8.8
Interorbital width	11.5	11.6	10.5-13.0	11.7	10.4-12.8
Predorsal length	62.7	64.2	58.7-71.3	67.2	62.0-71.9
Snout to pectoral fin	29.0	29.3	27.4-37.4	28.9	25.8-32.0
Snout to pelvic fin	51.2	52	49.6-56.9	52.9	49.9-55.5
Caudal peduncle	32.1	34.6	28.9-39.0	28.8	25.4-31.4

TABLE 2. Characters states for *J. tucumana* n. sp.

1-10	11-20	21-30	31-40	41-50	51-60	61-70	71
0000010011	0100001010	0101100000	0000?01002	1011021110	1111010100	0010000101	0

The new species was included in the phylogenetic framework proposed by Ghedotti (1998), Ghedotti et al. (2001), and Lucinda et al. (2002) (codification of the new species presented in Table 2). The multistate characters which states follow a logical sequence (i.e. could be interpreted as internested homologies) were considered to be additive (characters 19, 30, 40, 46 and 58 of Ghedotti's 1998 matrix); the additivity in this case only reflects degrees of similarity and is independent of any consideration on the sequence in which these characters evolved (Lipscomb, 1992; Goloboff, 1997). This treatment differs from the analyses of Ghedotti (1998), Ghedotti et al. (2001), and Lucinda et al. (2002), in which the authors neither ordered nor weighted differentially the characters. Character 46 (length of anal-fin ray five in adult male) was split because it involves two sequences of independent changes. This character was redefined as the length (character 46) and symmetry (character 71) of the fifth anal-fin ray in adult males as follows:

— Length of anal-fin ray five in adult male: (0) long, approximately as long as ray three; (1) intermediate, between one-quarter and three-quarters length of ray three; (2) short, less than one-quarter length of ray three.
— Symmetry of anal-fin ray five in adult male: (0) symmetric; (1) asymmetric, with one side short and the other side intermediate.

According to Ghedotti (1998), the males of *Jenynsia eigenmanni* (Haseman), *J. sanctaecatarinae* Ghedotti & Weitzman, and *J. alternimaculata* (Fowler) have an asymmetric fifth anal-fin ray. In these species, character 46 was codified as inapplicable (?) and character 71 as asymmetric (state 1); in the remaining species character 71 was codified as symmetric (state 0).

A cladistic parsimony analysis was performed with TNT (Goloboff et al., 2003a) by using implicit enumeration; this is the most exhaustive method, which compares all possible trees, applicable in this case given the small size of the matrix. This program was used because, according to a recent review (Meier & Ali, 2005), "TNT represents a milestone in parsimony analysis." Other reviews are equally favorable (Hovenkamp, 2004; Giribet, 2005).

The analysis was made under implied weighting (Goloboff, 1993), an improvement over the successive weighting method (Farris, 1969) implemented in Hennig86 (Farris, 1988), which was designed to down-weight characters according to its homoplasy. The aim of these procedures is to reach a classification that maximizes the influence of the more reliable characters at the expense of the more homoplastic ones. The fit of each character is calculated with a concave function of its number of extra steps (i. e. the more homoplastic, the less fit); the preferred tree(s) is(are) that(those) which maximizes the total fit. The weighting strength (i. e. how strongly homoplastic characters are down-weighted) is determined by modifying a concavity constant (K). We also performed an analysis under equal weighting in order to compare the results with previous papers. Nodal support was calculated with symmetric resampling (1000 replicates, with 10 addition sequences, saving up to 10 trees each) expressed as values of GC (groups present/contradicted), with a change probability of 0.33 (Goloboff et al. 2003b) and relative Bremer support (Goloboff & Farris, 2001), saving up to 5000 suboptimal trees.

As in previous papers (e. g. Lucinda et al., 2002), we performed both unconstrained and constrained analyses; the latter following the outgroup topologies of Parenti (1981) and Meyer & Lydeard (1993). Analyses were rooted in *Profundulus labialis* (Günther). As the resultant ingroup topology was the same, we present only the results of unconstrained searches.

Comparative material (SL in mm). *Jenynsia alternimaculata*: CI–FML 3831, 41 (10), 22.2–37.8 mm, Bolivia, Tarija, unnamed river in Acheralitos, which flows to Río Cambarí, Río Tarija basin. CI–FML 3825, 16 (4 C&S), 20.8–43.7 mm, Argentina, Salta, Dpto. Orán, Río Anta Muerta, tributary of Río Blanco, Río Bermejo basin. *Jenynsia* cf. *maculata*: CI–FML 3832, 10 (5), 21.0–30.2, Argentina, Catamarca, Fuerte Quemado, small tributary of Río Santa María. *Jenynsia* cf. *multidentata*: CI–FML 1081, 3, 23.0–23.8, Argentina, Tucumán, Dpto. Lules, Arroyo Calimayo (2 km from Ruta Nacional 38). CI–FML 3826, 15(10 measured, 2 C&S), 28.0–36.5 mm, Argentina, Tucumán, Dpto. Monteros, Río Mandolo, Río Salí basin. CI–FML 1440, 36 (10), 19.8–43.2, Uruguay, Dpto. Canelones, Canteras de Carrasco. CI–FML 1569, 11 (5), 20.1–43.2, Argentina,

Córdoba, Arroyo Las Mojarras, 2 km from Lago San Roque. *Jenynsia pygogramma*: CI–FML 2009, 288 (10), 21.8–54.7, Argentina, Catamarca, Hualfín, Los Nacimientos.

Non type material (SL in mm). *Jenynsia tucumana*, CI–FML 3841, 4 C&S, 20.4–38.5 mm, same data as for holotype. CI–FML 3842, 2 C&S, 33.3–42.6 mm, same locality as for holotype. CI–FML 1214, 19 (11), 21.6–51.6 mm, Argentina, Tucumán, Trancas, Río Vípos, Río Salí basin. CI–FML 1372, 23 (5), 17.0–31.7 mm, Argentina, Tucumán, Trancas, Río Vípos, Río Salí basin. CI–FML 3827, 1, 41.6 mm, Argentina, Tucumán, Tafí Viejo, El Siambón, Río Grande, Río Salí basin. CI–FML 3709, 541 (10), 23.9–43.9 mm, Argentina, Tucumán, Dpto. Burruyacu, Río Medina, Río Salí basin. CI–FML 3830, 4, 28.2–42.5 mm, Argentina, Tucumán, Dpto. Burruyacu, El Sunchal, Río Calera–Ayo. Artaza confluence, Río Salí basin. CI–FML 3006, 26 (5), 21.2–44.5 mm, Argentina, Tucumán, Dpto. Trancas, Río Tapia, Río Salí basin. CI–FML 1248, 76 (10), 28.0–46.1, Argentina, Salta, Dpto. Candelaria, Río La Candelaria. CI–FML 1086, 24 (10), 21.3–31.8, Argentina, Tucumán, Dpto. Burruyacu, Río Los Chorrillos. CI–FML 1091, 12 (10), 25.1–36.7, Argentina, Tucumán, Dpto. Burruyacu, Río Las Salas.

***Jenynsia tucumana*, new species**
(Fig. 2)

Holotype. CI–FML 3828, Male, 30.7 mm SL, Argentina, Tucumán, Dpto. Trancas, río Vípos (26°28'S; 65°20'W), 5 km from Ruta Nacional 9, G. Aguilera and M. Mirande, April 24, 2003.

FIGURE 2: *Jenynsia tucumana* sp. n., a—holotype, 30.7 mm SL, male; b—paratype, 39.8 mm SL, female.

Paratypes. CI–FML 3829, 4, 26.2–32.8 mm SL; AI 163, 6, 26.3–40.4 mm SL; ANSP 180781, 6, 20.4–33.0 mm SL; CI–FML 3840, 2 C&S, 28.3–36.0, collected with holotype.

Diagnosis. *Jenynsia tucumana* n. sp. is distinguished from other members of the genus by the possession of a row of dark markings ranging from dots to small vertical stripes, on the lateral surface, from the tip of the adpressed pectoral fin to the margin of hypural (Fig.2).

Among the remaining species of the genus only *Jenynsia alternimaculata* has vertical stripes, but its pattern is different from that of the new species (two occasionally three rows of dorsoventrally elongate markings on the lateral surface of body vs. one row of short vertical stripes or dots in the new species). These differences are further elaborated below under "Results and Discussion". *Jenynsia tucumana* may also be distinguished from *J. alternimaculata* by the possession of a mandibular canal pore W, a wide prootic bridge, and a symmetric fifth anal-fin ray of the tubular gonopodium; from *J. pygogramma* by the number of predorsal scales (15–16 vs. 19–25); from *J. multidentata*, *J. maculata* and *J. lineata* (Jenyns) by the absence of a swelling between the urogenital opening and the anterior base of the anal fin in females; from *J. sanctaecatarinae* by the absence of a rounded spot on dorsal pectoral-fin base; and from *J. onca* by the absence of a large dorsal convex expansion at subdistal segments of right half of sixth anal-fin ray of adult males. *Jenynsia tucumana* can be distinguished from *J. eirmostigma* Ghedotti and Weitzman, *J. weitzmani*, *J. eigenmanni*, and *J. unitaenia* Ghedotti and Weitzman by the absence of a long posterodorsal process of the lachrymal and a shorter fourth anal-fin ray in the gonopodium.

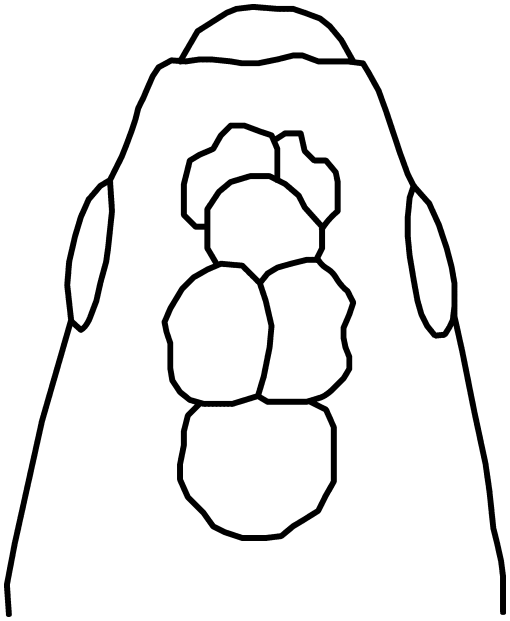

FIGURE 3: Diagrammatic representation of head scales.

Description. Body elongate, slightly compressed laterally; greatest body depth at vertical between pectoral and pelvic fins; mouth terminal, slightly oblique; tricuspid teeth in premaxilla and dentary. Dorsal-fin origin at vertical through or just behind first anal-fin ray insertion. Sexual dimorphism present, males much smaller than females, with tubular intromittent organ formed by 8 first anal-fin rays; length of gonopodium 1.3–1.5 in caudal peduncle; posterior two anal-fin rays not forming part of tubular intromittent organ and extending approximately two-thirds of gonopodium length. Females without swelling between urogenital opening and anterior base of anal fin. Head squamation pattern as in figure 3; anterior branch of supra-orbital sensory canal formed by pores 1 and 2a; middle part by 2b, 3, 4a, and posterior branch by 4b, 5, 6, 7; preopercular canal continuous, with 7 pores; infraorbital canal formed by 4 pores; mandibular canal with pores X, Ya, Yb, Z and W.

Morphometric measurements expressed as percents of standard length in table 1. Counts of 47 specimens, including the holotype: lateral scale series 31[11], 32[17], 33*[15], 34[4]; predorsal scales 14[5], 15[20], 16*[21]; circumpeduncular scales 16*[47]; dorsal-fin rays 7*[11], 8[36]; anal-fin rays in females 10[19], 11[1]; pectoral-fin rays 15[8], 16[26], 17*[13]; pelvic-fin rays 6*[47]; caudal-fin rays 16[10], 17[15], 18*[22]. Counts in C&S specimens: gill rakers 10[5], 11[4], 12[1]; vertebrae 31[3], 32[5]; gonopodium 10[5].

Coloration in alcohol: Body background color grading from brown dorsally to cream ventrally. Dark chromatophores in center of scales, present on dorsal part of body to fifth row of scales. Mid-dorsal stripe of dark chromatophores from posterior part of head to first dorsal-fin ray insertion; base of dorsal fin light brown; mid-dorsal stripe continued on upper portion of peduncle to anterior procurrent caudal-fin rays. Concentration of chromatophores present on two scales anterior to dorsal-fin origin. Mid-lateral row of dark markings ranging from dots to small vertical stripes, from adpressed tip of pectoral fin to posterior margin of hypural. Anterior part of this row with dark dashes irregularly distributed. Two rows of rounded dark dashes posteriorly directed in dorsal view, from vertical through pectoral-fin insertion, turning to dorso-lateral at vertical through pelvic-fin insertion, and reaching 4/5 of peduncle length. Some specimens with third row of dark dashes under mid-lateral row, reaching 4/5 of peduncle length. Isthmus unpigmented. All fins with scattered chromatophores in membranes, surrounding some rays. Diffuse subdermal stripe ventrally, from posterior anal-fin insertion to half caudal peduncle length. Dark chromatophores scattered over entire surface of gonopodium.

Head brown dorsally, cream ventrally; a dark brown blotch on postero-dorsal surface of the head, extending anteriorly between the eyes. Dark brown dashes between anterior branch of supra-orbital sensory canal and posterior nares. Dark chromatophores scattered over premaxilla, lower jaw and pre-orbital canal area. Upper part of opercle with a horizontal strip. Branchiostegal membranes unpigmented.

Distribution. *Jenynsia tucumana* n. sp. is known from Río Vípos, Río Calera, and Río Grande; all of which are in the upper Río Salí basin (Fig. 4).

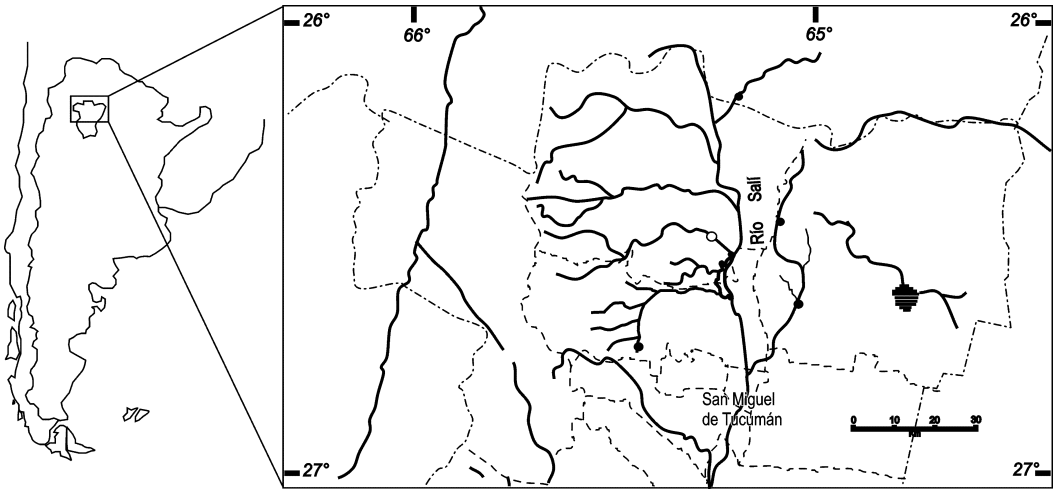

FIGURE 4: Distribution of *Jenynsia tucumana*. Open dot indicates type locality.

Etymology. The specific epithet *tucumana* means "from Tucumán" province in Argentina, where the type locality is situated.

Remarks. This species mainly inhabits moderate to slow flowing streams with rocky bottom and algae on the substrate, where it is sympatric with *Jenynsia multidentata*.

Results and Discussion. *Jenynsia tucumana* shares two uniquely derived characters with the members of the subgenus *Jenynsia* (Ghedotti 1998): the lack of segmentation on the proximal and distal quarters of sixth anal-fin ray in adult males and the vertically inclined proximal radials associated with the first six anal-fin rays in the gonopodium.

The unique coloration pattern distinguishes the new species from the remaining species of the genus. Although the pattern in *J. tucumana* resembles that of *Jenynsia alternimaculata* (i.e. vertical stripes on lateral surface of body), the former species has only one row of markings vs. two or three in the latter (see Fig. 4 in Ghedotti & Weitzman, 1996). In addition *J. alternimaculata* has the left and right halves of anal-fin ray five asymmetric; this apomorphy, shared with *J. sanctaecatarinae*, is absent in *J. tucumana* in which both halves are similar in size. *Jenynsia alternimaculata* also has, as an autoapomorphic condition, a narrow prootic bridge, which is an additional character to distinguish this species from *J. tucumana* and from the remaining species of the genus.

A single, most parsimonious tree of 147 steps was obtained with concavity constants (K) ranging from 0.0001 to 6 (Fig. 5b), and in concavities from 7 to 100, the most parsimonious tree, with 146 steps, is one of the four most parsimonious trees under equal weights (Fig. 5a,c). Low concavity constants and equal weighting (or high concavity constants) represent opposite extreme cases in which the homoplastic characters are

almost ignored, or are considered as reliable as the perfectly hierarchic ones respectively. Since the results produced by either extreme are very similar, those results clearly do not depend entirely on decisions of whether (or how strongly) to weight characters.

Regardless of weighting strength, *Jenynsia tucumana* belongs to the subgenus *Jenynsia*. The relationships of the new species vary slightly between the analyses performed due to differing relationships of *J. sanctaecatarinae*, as in the analysis of Lucinda *et al*. (2002). The latter species is the sister group of *J. alternimaculata* under concavities 0.0001 to 6, and the sister group of *J. onca* under concavities 7 to 100; under equal weights, *J. sanctaecatarinae* collapses basally to *J. tucumana*. Thus, position of the new species is basal to the remaining species of the subgenus *Jenynsia*, except *J. onca* and, for concavities below 7, also *J. sanctaecatarinae*.

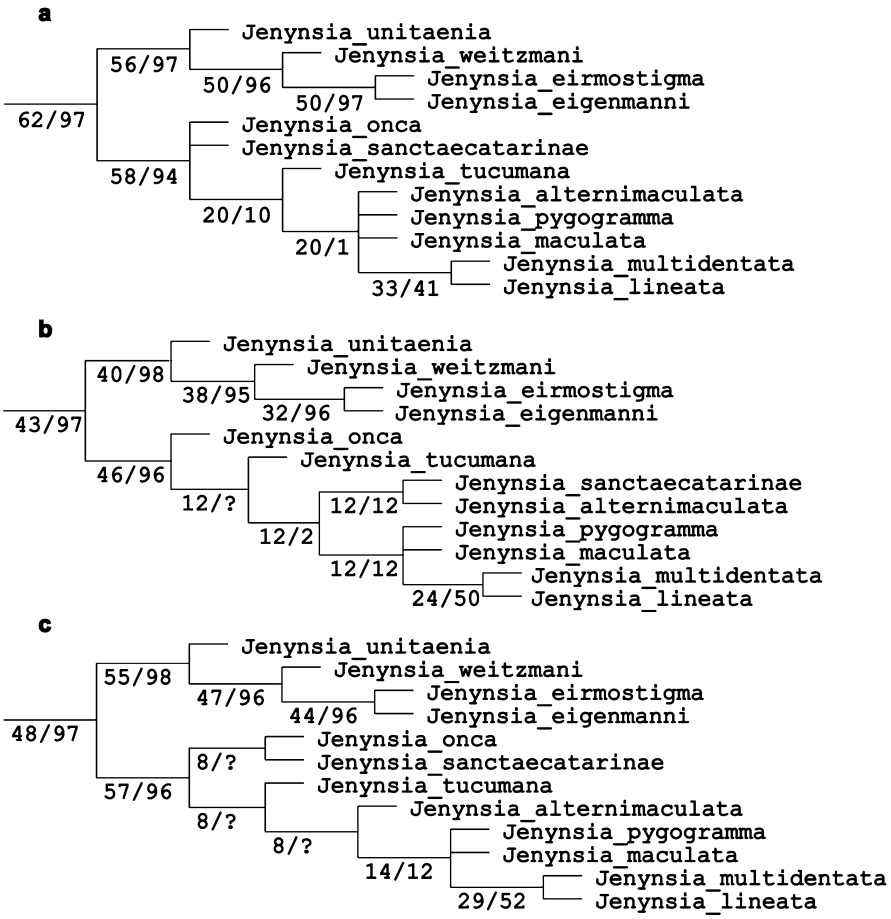

FIGURE 5: Topologies of most parsimonious trees and relative bremer support/GC values under **a**—equal weights (strict consensus of 4 trees), **b**—concavities K=0.0001 to 6 (with supports measured under K=4) and, **c**—concavities K=7-100 (with supports measured under K=8) are shown. Question marks in GC values represent negatives values, which are an artifact of the method, assigned to weakly supported nodes. Unsupported nodes are shown as collapsed. The relationships of outgroups and genera of the family are consistent which those proposed in previous studies, therefore *Anableps*, *Oxyzygonectes*, and outgroups are not shown.

Five species of *Jenynsia* are present in Argentina: the widely distributed *J. multidentata* and the exclusively northwesterly distributed *J. alternimaculata, J. maculata*, *J. pygogramma* and *J. tucumana*. *Jenynsia multidentata* was considered to occur in lowlands (Ghedotti & Weitzman, 1996 and Ghedotti, 1998), but we have found it together with *J. tucumana* in highland streams at 1200 meters above sea level. The distribution of the genus in northwestern Argentina coincides with the proposed extension of the Paranean Sea, in the Middle-Upper Miocene (Aceñolaza & Sprechmann, 2002); this sea would have extended westward on the Brazilian/Uruguayan platform, flooding a big area of central-northern Argentina and central Paraguay, and may have acted as a barrier between southeastern Brazilian–Uruguayan and northwestern Argentine populations/ species (compare fig. 1 of Aceñolaza & Sprechmann, 2002 with fig. 29 of Ghedotti, 1998). Also, the northwestern Argentina species (or its ancestor/ancestors) probably was/were coastal species before the recession of the Paranean Sea and now are restricted to highlands. Nevertheless, this is only a hypothesis that could be corroborated or refuted only with additional information on the systematics and evolutionary history of the genus.

Acknowledgements

We thank C. Butí for collection help and valuable comments on the new species identity; F. Cancino for making some specimens available; M. Suárez and M. Quoirín for help in collecting expeditions; CONICET and Fundación Miguel Lillo partially supported this study. We also thank V. Abdala, M. M. Azpelicueta, H. R. Fernández, P. A. Goloboff, and C. Szumik for manuscript reviews. M. Ghedotti and R. Reis improved significantly this paper with their valuable comments and suggestions.

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