

Austrolebias varzeae, a new annual fish from the upper rio Uruguay basin, southern Brazil (Cyprinodontiformes: Rivulidae)

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Austrolebias varzeae n. sp. is described from rio da Várzea floodplains, upper rio Uruguay basin, southern Brazil. It seems to be closely related to *A. carvalhoi* (Myers), with which it shares a similar color pattern of male and an apomorphic morphology of the autopalatine. The new species differs from *A. carvalhoi* by having more anal-fin rays in males and more caudal-fin rays. *Austrolebias varzeae* is distinguished from all other species of the genus by a unique color pattern, in which there are three distinctively darker and narrower bars on the anterior portion of male flank. Putative close relationships between *A. varzeae* and *A. carvalhoi* suggest a closely related biogeographic history between upper Uruguay and upper Iguazu River basins, corroborated by a biogeographic pattern of the anablepid genus *Jenynsia*.

Austrolebias varzeae sp. n. é descrita da várzea do rio da Várzea, bacia do rio Uruguai superior, sul do Brasil. Ela parece estar estreitamente aparentada a *A. carvalhoi*, com a qual compartilha um padrão de colorido similar e uma morfologia apomórfica do autopalatino. A nova espécie difere de *A. carvalhoi* por possuir mais raios na nadadeira anal de machos e mais raios na nadadeira caudal. *Austrolebias varzeae* se distingue de todas as espécies do gênero por um padrão de colorido exclusivo, no qual há três barras distintivamente mais estreitas e mais escuras na porção anterior do flanco do macho. As supostas estreitas relações de parentesco entre *A. varzeae* e *A. carvalhoi* sugerem uma história biogeográfica intimamente relacionada entre as bacias do rio Uruguai e do rio Iguazu superiores, corroborada por um padrão biogeográfico do gênero anablepídeo *Jenynsia*.

Key words: New species, killifishes, systematics, Neotropical.

Introduction

Austrolebias Costa was recently established to name a monophyletic assemblage of annual fishes endemic to northern and northeastern Argentina, Paraguay, southern Brazil, and Uruguay (Costa, 1998a). This genus is diagnosed by three synapomorphies: (1) basihyal cartilage more than 50% of basihyal length; (2) dorsal fin positioned anteriorly, origin at vertical between neural spines of vertebrae 7 and 10; and (3) female color pattern consisting of vertical rows

of dark spots on flank (Costa, 2002). *Austrolebias* comprises a total of 24 valid species, which inhabit temporary lagoons along floodplains of the middle and lower sections of the Paraguay, Parana, and Uruguay River basins, and the laguna dos Patos system (Costa, 1998a, 2002; Costa & Cheffe, 2001). One exception is *A. carvalhoi* (Myers), found in the highlands of the upper rio Iguazu floodplains, southern Brazil (Costa, 1998b). The new species herein described, was collected in another highland area, the upper rio Uruguay basin.

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Fig. 1. *Austrolebias varzeae*, holotype, MCP 29641, male, 33.7 mm SL; temporary lagoon close to the rio da Várzea, rio Uruguay basin, Carazinho, Rio Grande do Sul, Brazil.

Material and Methods

Measurements and counts are according to Costa (1995). All measurements are presented as percentages of standard length (SL). Counts of pelvic, pectoral, and caudal fin-rays and vertebrae were made only on cleared and counterstained specimens (c&s) prepared according to Taylor & Van Dyke (1985). The compound caudal centrum was counted as a single element in vertebrae numbers. Nomenclature for frontal squamation follows Hoedeman (1958) and terminology for cephalic neuromasts is according to Costa (2001). Selected osteological character states included in the description are those with some phylogenetic importance according to Costa (2002). Specimens examined of *Austrolebias carvalhoi* (9 specimens) are listed in Costa (1998b). Abbreviations for institutions are: MCP, Museu de Ciências e Tecnologia da Pontifícia Universidade Católica do Rio Grande do Sul, Porto Alegre, and UFRJ, Universidade Federal do Rio de Janeiro, Rio de Janeiro.

Austrolebias varzeae, new species

Fig. 1

Holotype. MCP 29641, male, 33.7 mm SL; Brazil: Rio Grande do Sul, temporary lagoon close to the rio da Várzea, Fazenda dos Branda, Carazinho, rio Uruguay basin, approximately 28°18'S, 52°48'W; M. N. Xavier, 26 Aug 1999.

Paratypes. MCP 23667, 7 males (1 c&s), 23.8-32.5 mm SL, and 2 females, 24.8-25.3 mm SL; UFRJ 5431, 1 male, 30.9 mm SL, and 1 female, 25.8 mm SL; UFRJ 5432, 1 male, 31.9 mm SL, and 1 female (c&s), 23.5 mm SL; all collected with holotype.

Diagnosis. Readily distinguished from all congeners by a unique color pattern of male, consisting of dark gray bars on

flank, the three anteriormost bars distinctively darker and narrower than posterior ones (Fig. 1). It is similar to *A. carvalhoi* and distinguished from all other species of the genus by the combination of pattern of bars on male flank and autopalatine with a prominent dorsomedial projection. It differs from *A. carvalhoi* by having more anal-fin rays in male (23-26 vs. 21-22) and consequently a longer anal-fin base length (38.1-40.9 % SL vs. 31.4-35.1 % SL), and more caudal-fin rays (28-29 vs. 25-26). Other features plesiomorphic for *Austrolebias* but useful to distinguish *A. varzeae* are the urogenital papilla of male not attached to anal fin, pelvic fins not united medially, 22-24 dorsal-fin rays in male and 16-18 in female, 18-19 anal-fin rays in female, and 28-30 scales in the longitudinal series.

Description. Morphometric data for holotype and seven paratypes given in Table 1. Male larger than female, reaching at least 33.7 mm SL. Dorsal profile concave on head, convex between snout and end of dorsal-fin base, approximately straight on caudal peduncle. Ventral profile convex from lower jaw to end of anal-fin base, nearly straight on caudal peduncle. Longest body depth on vertical through dorsal-fin origin. Body somewhat deep, compressed, body depth approximately 1.9 times body width in larger males. Snout blunt, jaw short.

Tip of dorsal and anal fins rounded. Anteromedian rays of anal fin of female not lengthened, anal fin shape approximately semicircular. Urogenital papilla of male not attached to anal fin. Caudal fin rounded. Pectoral fin elliptical, its posterior margin reaching vertical between pelvic-fin base and urogenital papilla in male, and reaching vertical through urogenital papilla in female. Tip of pelvic fin reaches base of second anal-fin ray. Pelvic-fin bases in close proximity, but fins not medially united. Dorsal-fin origin approximately on vertical through pelvic-fin base in male, and through

urogenital papilla in female. Anal-fin origin on vertical through base of second or third dorsal-fin ray. Dorsal-fin rays 22-24 in male, 16-18 in female; anal-fin rays 23-26 in male, 18-19 in female; caudal-fin rays 28-29; pectoral-fin rays 12; pelvic-fin rays 5.

Scales large, cycloid. Body and head entirely scaled, except on ventral surface of head. Frontal squamation F-patterned. No transverse row of scales on anal-fin base. Pectoral-fin base naked. Longitudinal series of scales 28-30, transverse series of scales 16-17, and scale rows around caudal peduncle 20. One discrete ctenii-like contact organ on each scale of ventral portion of body side of male. No contact organs on unpaired fins and outer surface of pectoral and pelvic fins. Rudimentary papillate contact organs on inner surface of three dorsalmost rays of pectoral-fin of male. Supraorbital neuromasts 15-22.

Jaw teeth gently bowed, with few larger fang-like teeth laterally. Slight concavity on anteromedial portion of premaxilla. Alveolar arm of premaxilla with prominent anterior process. Prominent rounded dorsomedial projection on autopalatine. Basihyal about triangular, its longest width about 80% of its total length; basihyal cartilage long, occupying about 65% of total basihyal length, and with pronounced lateral projections on its anterior portion. Anterior ceratohyal not elongated. Six branchiostegal rays. Urohyal deep. Three to five teeth on second pharyngobranchial. Gill-rakers on the first branchial arch 3+9. Lateral process of sphenotic narrow, without anterior expansion. Posterior arm of parasphenoid narrow. Lacrimal approximately straight in its dorsoventral axis. Dermosphenotic absent. Ventral process of posttemporal robust. Total vertebrae 27-28.

Color in alcohol. Male: Side of body light yellowish brown with nine to 11 dark gray bars; first three bars darker and narrower than posterior ones, their width about half or less interspace width; posterior bars about twice wider than interspace. Head light yellowish brown, with dark gray suborbital bar and triangular dark gray spot posterodorsally adjacent to orbit. Unpaired fins dark gray with light gray dots. Pectoral fin hyaline. Pelvic fin dark gray (Fig. 1). Female: Side of body light yellowish brown, with dark gray rounded spots; spots of anterocentral portion of flank darker. Head light yellowish brown, with faint suborbital bar and faint triangular gray spot posterodorsally adjacent to orbit. Unpaired fins hyaline, with faint small gray spots on basal portion of anal fin.

Distribution. Known only from the type locality (Fig. 2).

Habitat notes. The type-specimens were collected in a temporary lagoon distant about 50 m from the rio da Várzea. The lagoon is shallow (maximum depth about 1.5 m) and vegetation is composed mainly of grasses, *Nymphaea* sp., *Ludwigia* sp., and a large volume of filamentous algae. The lagoon is temporarily connected to the river during flooding, when other fishes as *Astyanax* and *Oligosarcus* species are also found in the lagoon.

Etymology. *Austrolebias varzeae* is named after the river basin where it was collected, the rio da Várzea.

Discussion

Austrolebias varzeae possesses a prominent rounded dorsomedial projection on the autopalatine, a condition also found in *A. carvalhoi*, *A. nonoiuliensis* (Taberner, Fernandez & Castelli), *A. robustus* (Günter), *A. cinereus* (Amato), *A. nioni* (Berkenkamp, Reichert & Prieto), and *A. vazferrerae* (Berkenkamp, Etzel, Reichert & Salvia), which are hypothesized to be basal taxa within *Austrolebias* (Costa, 2002). That prominent projection of autopalatine is absent in all other species of *Austrolebias*, as well as in species of closely related genera such as *Megalebias* Costa and *Cynolebias* Steindachner (Costa, 2001; 2002), and thus interpreted as apomorphic. Among species of the above assemblage, *A. varzeae* is possibly more closely related to *A. carvalhoi*, with which it shares a similar male color pattern consisting of dark bars on body side. However, it is not clear if the color pattern shared by *A. varzeae* and *A. carvalhoi* is in fact an apomorphic condition, since bars on male flank are present in several other clades of cynolebiatines, including

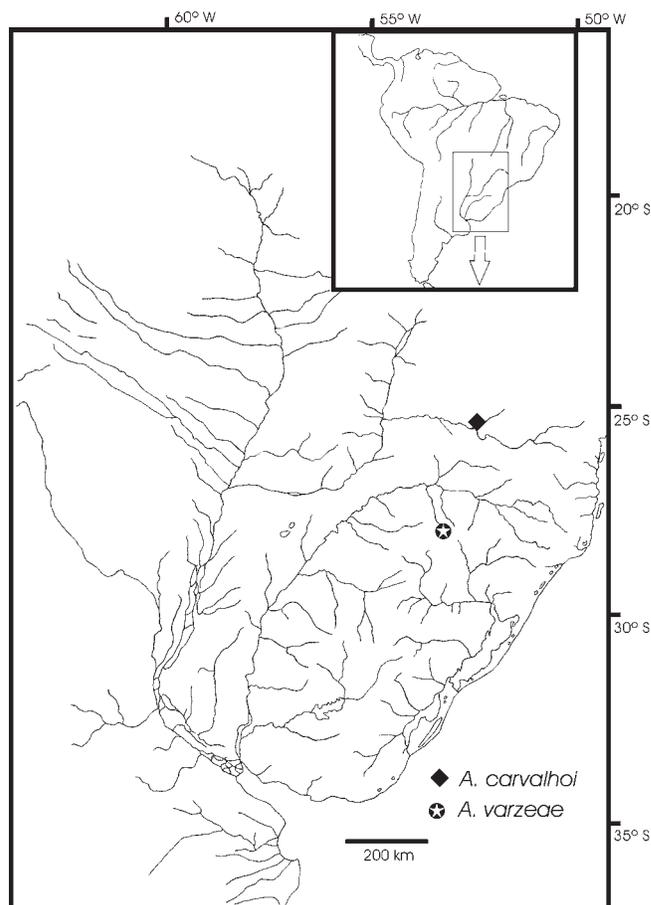


Fig. 2. Geographic distribution of *Austrolebias carvalhoi* and *A. varzeae*.

Table 1. Morphometric data of holotype (H) and seven paratypes of *Austrolebias varzeae*.

	Males					Females		
	H	Paratypes						
	MCP	MCP	UFRJ	MCP	MCP	UFRJ	MCP	MCP
	29641	23667	5431	23667	23667	5431	23667	23667
Standard length (mm)	33.7	32.5	30.9	30.3	28.0	25.8	25.3	24.8
Percents of standard length								
Body depth	38.1	34.8	38.8	38.9	35.0	32.9	36.1	36.6
Caudal peduncle depth	17.7	15.4	18.0	17.2	15.9	15.2	15.1	16.9
Predorsal length	50.8	50.5	52.2	51.6	51.9	60.0	62.0	59.4
Prepelvic length	52.1	52.8	55.1	53.8	52.9	57.6	54.9	57.8
Length of dorsal-fin base	41.3	40.2	40.9	40.6	39.0	28.5	27.7	28.4
Length of anal-fin base	39.7	38.1	40.9	40.0	39.7	25.7	23.2	23.0
Caudal-fin length	32.3	29.8	34.8	31.1	31.6	31.4	35.1	33.8
Pectoral-fin length	23.4	20.5	21.9	22.7	23.6	21.6	24.6	25.4
Pelvic-fin length	8.2	8.8	10.9	9.5	8.7	9.9	10.7	10.8
Head length	31.0	28.8	31.4	31.9	31.4	30.6	32.6	32.4
Head depth	33.2	31.0	31.8	33.1	30.7	29.7	33.1	32.5
Head width	20.3	19.8	21.8	20.1	19.9	19.7	21.5	22.2
Snout length	5.0	4.2	5.1	5.2	4.5	4.9	4.4	4.6
Lower jaw length	7.4	7.3	8.0	7.3	6.3	6.6	6.9	7.2
Eye diameter	8.4	7.5	8.8	8.8	8.6	9.3	9.3	9.9

Austrolebias, and may be plesiomorphic for cynolebiatines as discussed by Costa (2002). Other characters would be necessary to clarify the phylogenetic position of *A. varzeae*, including live color patterns that are important to diagnose species assemblages within *Austrolebias* (Costa, 2002), but are not available for *A. varzeae* at the present.

Finally, besides similarities in the general morphology and color pattern, *A. varzeae* and *A. carvalhoi* inhabit parallel neighbor river basins (upper Uruguay and Iguaçú Rivers, respectively; Fig. 2), in biotopes inserted at higher altitudes (600-800 m), also suggesting close affinities. All other species of the clade *Austrolebias* plus *Megalebias* occur along the floodplains of the Parana-Uruguay-Paraguay system at lower altitudes (until about 150 m) or along coastal systems. Besides geographic proximity, a close biogeographic history among the upper Uruguay and upper Iguaçú basins has also been suggested in a recent phylogenetic study on another cyprinodontiform group. Within the anablepid genus *Jenynsia* Günther, which has a distribution pattern in much overlapping that of *Austrolebias*, *J. eigenmanni* (Haseman), endemic to the upper Iguaçú basin, is hypothesized to be the sister group to *J. eirmostigma* Ghedotti & Weitzman, endemic to the upper rio Uruguay basin and adjacent areas (Ghedotti, 1998; Ghedotti et al. 2001).

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Literature cited

- Costa, W. J. E. M. 1995. Pearl killifishes - the Cynolebiatinae: systematics and biogeography of the neotropical annual fish subfamily. Neptune City, TFH, 128p.
- Costa, W. J. E. M. 1998a. Phylogeny and classification of Rivulidae revisited: evolution of annualism and miniaturization in rivulid fishes (Cyprinodontiformes: Aplocheiloidei). *Journal of Comparative Biology*, 3(1): 33-92.
- Costa, W. J. E. M. 1998b. Rediscovery and redescription of *Cynolebias carvalhoi* (Cyprinodontiformes: Rivulidae). *Ichthyological Exploration of Freshwaters*, 9(3): 305-310.
- Costa, W. J. E. M. 2001. The neotropical annual fish genus *Cynolebias* (Cyprinodontiformes: Rivulidae): phylogenetic relationships, taxonomic revision and biogeography. *Ichthyological Exploration of Freshwaters*, 12(4): 333-383.
- Costa, W. J. E. M. 2002. Monophyly and phylogenetic relationships of the Neotropical annual fish genera *Austrolebias* and *Megalebias* (Cyprinodontiformes: Rivulidae). *Copeia*, 2002(4): 916-927.
- Costa, W. J. E. M. & M. M. Cheffe. 2001. Three new species of the genus *Austrolebias* from the laguna dos Patos system, southern Brazil, and a redescription of *A. adloffii* (Ahl) (Cyprinodontiformes: Rivulidae). *Comunicações do Museu de Ciências e Tecnologia da PUCRS, Série Zoológica*, 14(2): 179-200.

- Ghedotti, M. J. 1998. Phylogeny and classification of the Anablepidae (Teleostei: Cyprinodontiformes). Pp 561-582. In: Malabarba, L. R., R. E. Reis, R. P. Vari, Z. M. S. Lucena & C.A.S. Lucena (Eds.). Phylogeny and classification of neotropical fishes. Porto Alegre, Edipucrs, 603p.
- Ghedotti, M. J., A. D. Meisner & P. H. F. Lucinda. 2001. New species of *Jenynsia* (Teleostei: Cyprinodontiformes) from southern Brazil and its phylogenetic relationships. *Copeia*, 2001(3): 726-736.
- Hoedeman, J. J. 1958. Rivulid fishes of the Antilles. Studies on the Fauna of Curaçao and other Caribbean Islands, 32: 112-127.
- Taylor, W. R. & G. C. Van Dyke. 1985. Revised procedures for staining and clearing small fishes and other vertebrates for bone and cartilage study. *Cybio*, 9: 107-109.

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