

A new species of *Roeboides* (Teleostei: Characidae) from Costa Rica and Panama, with a key to the middle American species of the genus

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A new species of *Roeboides* is described from the Pacific slope of Costa Rica and Panama. *Roeboides bussingi* differs from all other Central American *Roeboides* and all members of the *R. guatemalensis* species group by the following combination of characters: presence of 18-22 scales above the lateral line (vs. 12-16 in *R. dientito*); 15-22 scales below the lateral line (vs. 10-14 in *R. dientito*, and 20-24 in *R. loftini*); an inconspicuous, sometimes absent, crescent-shaped humeral spot (vs. a large round, conspicuous humeral spot in *R. carti*, *R. dayi*, *R. dientonito*, *R. ilseae*, *R. loftini*, and *R. occidentalis*); a small wedge-shaped spot that does not reach the lateral line (vs. a large spot crossing the lateral line in *R. guatemalensis*); a teardrop shaped caudal spot (vs. caudal spot triangle shaped in *R. bouchellei*); and a dark band at the distal tip of the anal fin (vs. dark band absent in *R. bouchellei*). A key to all Middle American species of *Roeboides* is also presented.

Uma espécie nova de *Roeboides* é descrita da vertente pacífica da Costa Rica e Panamá. *Roeboides bussingi* difere de todas as outras espécies de *Roeboides* da América Central e de todos os membros do grupo *R. guatemalensis* pela seguinte combinação de caracteres: presença de 18-22 escamas acima da linha lateral (vs. 12-16 em *R. dientito*); 15-22 escamas abaixo da linha lateral (vs. 10-14 em *R. dientito* e 20-24 em *R. loftini*); mancha umeral inconspícua, as vezes ausente, no formato de meia lua (vs. mancha humeral conspicua e arredondada em *R. carti*, *R. dayi*, *R. dientonito*, *R. ilseae*, *R. loftini* e *R. occidentalis*); pequena mancha em forma de cunha, não alcançando a linha lateral (vs. mancha grande, atravessando a linha lateral em *R. guatemalensis*); mancha do pedúnculo caudal em formato de gota d'água (vs. mancha caudal com formato triangular em *R. bouchellei*); banda escura na margem distal da nadadeira anal (vs. banda escura ausente em *R. Bouchellei*). Uma chave para todas as espécies de *Roeboides* da América Média é fornecida.

Key words: Central America, Characinae, Distribution, Freshwater, Pacific Slope.

Introduction

Roeboides Günther, 1864 includes 21 valid species (Eschmeyer, 2012). The genus has a wide distribution ranging from río Perros at Ixtepec in southern Mexico (Miller *et al.*, 2005) to the la Plata basin in northern Argentina (Lucena, 2007). Members of *Roeboides* are best known for their habit of tearing off and ingesting scales from other fishes (lepidophagy), which is presumably aided by conspicuous teeth on the external margin of the jaws

(Hahn *et al.*, 2000). The genus has its greatest species richness in South America (15 species), whereas in Central America only seven valid species are known, including the recently described *Roeboides loftini* Lucena, 2011. Six of these species are restricted to Lower Middle America (Costa Rica and Panama). *Roeboides bouchellei* is the only Middle American species with a large distributional range, extending from Panama to Southern Mexico (Miller *et al.*, 2005). Notably one third of all species of *Roeboides* have been described in the last decade.

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Lucena (1998) proposed that the species of *Roebooides* could be organized into four groups: the *R. dispar* group, the *R. guatemalensis* group, the *R. microlepis* group, and the *R. affinis* group. Those groups of species are defined by unique osteological synapomorphies (particularly of the jaws) as well as meristic traits (Lucena, 2000, 2003, 2007, 2011). All species of *Roebooides* from Central America (viz., *R. bouchellei*, *R. carti*, *R. dayi*, *R. guatemalensis*, *R. ilseae*, *R. loftini*, and *R. occidentalis*) belong to the *R. guatemalensis* group. *Roebooides dientonito*, from Guyana and Venezuela, is the only member of the *R. guatemalensis* group not found in Central America (Lucena, 2007).

According to Bussing (1998), a preliminary molecular analysis provided evidence that an unidentified species of *Roebooides* from Costa Rica and Panama was distinct from other valid species of the genus. Bussing (1998) also noted that morphological evidence in favor of that distinction was lacking at the time. In January and April 2011, additional specimens of that species were collected from several localities in Costa Rica and Panama (Fig. 1). That new species of *Roebooides* is described herein, and a key to Middle American species of the genus is provided.

Material and Methods

Specimens examined are deposited in the Louisiana State University Museum of Natural Science (LSUMZ), Museo de Zoología, Universidad de Costa Rica (UCR), Florida

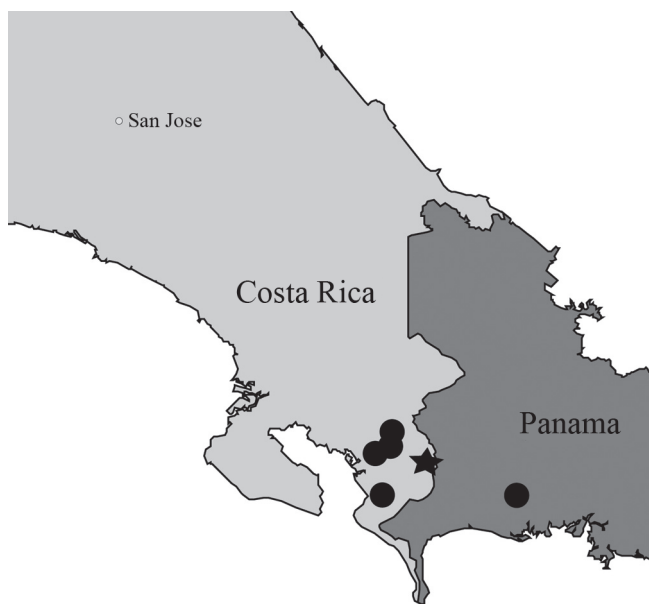


Fig. 1. Distribution of *Roebooides bussingi*. Holotype indicated by the star, circles represent paratypes.

Museum of Natural History (UF), and Tulane University (TU). Morphometric measurements were taken for 17 distances in 29 specimens of the species described herein. Comparative information on other valid species of *Roebooides* was obtained from Bussing (1985), Lucena (2000) and Lucena (2011) and from specimens listed in the Comparative Material. Measurements were taken following Fink & Weitzman (1974). Measurements were recorded to the nearest 0.1 mm using dial calipers, and include: standard length (SL), head length (HL), orbit diameter, snout length, maxillary length, bony interorbital length, greatest body depth, caudal peduncle depth, caudal peduncle length, pre-dorsal distance, pre-anal distance, pre-pectoral distance, pre-pelvic distance, height of the dorsal fin, height of the anal fin, pectoral-fin length, and pelvic-fin length. Morphometric measurements are presented as percentages of SL. Meristic counts include: anal-fin rays, pectoral-fin rays, pelvic-fin rays, caudal-fin rays, lateral line scales, scales above lateral line, scales below lateral line, and scales around caudal peduncle.

Results

Roebooides bussingi, new species Figs. 2a-b

Roebooides sp.; Bussing (1998)

Holotype. LSUMZ 14799, 74.9 mm SL, Costa Rica, Puntarenas Province, río Coloradito, about 6 km from the main road, tributary of the río Coto drainage, 08°34'12"N 82°51'33"W, W. A. Matamoros, C. D. McMahan, C. Garita, A. Angulo & P. Chakrabarty, 18 Feb 2011.

Paratypes. Costa Rica: LSUMZ 14629, 6, 54.4-63.7 mm SL, same data as holotype; LSUMZ 14601, 4, 53.3-39.4 mm SL, Puntarenas Province, Puente Las Monjas at bridge in community of El Barrido, río Coto Drainage, 08°31'32"N 83°01'47"W, W. A. Matamoros, C. D. McMahan, C. Garita, A. Angulo & P. Chakrabarty, 17 Feb 2011; LSUMZ 14623, 1, 50.9 mm SL, Puntarenas Province, near city of río Claro, about 4 km from town of río Claro, río Claro drainage, 08°37'28"N 83°03'59"W, W. A. Matamoros, C. D. McMahan, C. Garita, A. Angulo & P. Chakrabarty, 17 Feb 2011; LSUMZ 14655, 2, 54.5-60.6 mm SL, Puntarenas Province, río Caracol, small bridge on main road, tributary of the río Claro, 08°40'48"N 83°00'25"W, W. A. Matamoros, C. D. McMahan, C. Garita, A. Angulo & P. Chakrabarty, 19 Feb 2011. **UCR** 0756, 20, 49.2-92.8 mm SL, Puntarenas Province, río Caracol on the Inter-American highway, río Coto Drainage, 7 km E of Pueblo río Claro, 08°39'55.96"N 83°01'34.4"W, W. A. Bussing, M. I. Bussing & E. Bussing, 27 Feb 1973. **Panama:** LSUMZ 14797, 1, 79.0 mm SL, Chiriquí Province, río San Pablo, near town of San Pablo, west of city of David, 08°25'44"N 82°29'45"W, W. A. Matamoros, C. D. McMahan & M. P. Davis, 10 Apr 2011; UCR 0450, 5, 46.2-68.5 mm SL, river of unknown name 30 km east of Paso Canoas, 1 km west of río Concepcion bridge at Inter-American Highway, W. A. Bussing & M. I. Bussing, 25 Jan 1971.



Fig. 2. Photographs of (a) *Roebooides bussingi* (LSUMZ 14629; 69.2 mm SL) depicting live coloration, and (b) preserved holotype (LSUMZ 14799; 74.9 mm SL).

Diagnosis. *Roebooides bussingi* differs from all other members of the *R. guatemalensis* group by the following combination of characters: the presence of 18-22 scales above lateral line (vs. 12-16 in *R. dientito*), 15-22 scales below lateral line (vs. 10-14 in *R. dientito*, and 20-24 in *R. lofini*), a small inconspicuous, sometimes absent, crescent-shaped humeral spot (vs. a large round, conspicuous humeral spot in *R. carti*, *R. dayi*, *R. dientonito*, *R. ilseae*, *R. lofini*, and *R. occidentalis*), and the presence of a small wedge-shaped spot that does not reach the lateral line (vs. a large spot crossing the lateral line in *R. guatemalensis*). *Roebooides bussingi* and *R. bouchellei* share a similar humeral spot, and both lack a wedge-shaped spot on the lateral line between the dorsal and anal fins. However, *R. bussingi* can be distinguished from *R. bouchellei* by an overall darker body coloration with many scattered melanophores (vs. a lighter colored body with few melanophores; most evident in preserved specimens and consistent across genders), by a dark band of melanophores at the distal tip of the anal fin (vs. distal band absent; melanophores scattered throughout anal fin; Fig. 3a and b), a darker, more developed teardrop shaped caudal spot with the rounded bulbous posterior end on the caudal fin (vs. a lighter, less developed triangular spot typically restricted to the caudal peduncle; Fig. 3c and d), and a lighter lateral band (vs. a darker, more developed lateral band; most evident in preserved specimens).

Description. Morphometric and meristic data for type specimens are summarized in Table 1. *Roebooides bussingi* is a laterally compressed characin with a strongly concave nape and a convex, hump-shaped nuchal region. Greatest body depth between dorsal- and anal-fin origins. Post-dorsal profile

straight, angling ventrally from the dorsal-fin origin to caudal-fin origin. Pre-anal profile rounded from tip of snout to anal-fin origin, post-anal profile straight along the anal fin, angling ventrally at the caudal peduncle.

Mouth terminal with strongly inclined gape. Upper jaw protrudes over lower jaw. Maxilla reaches slightly past vertical through midline of pupil. Premaxilla and dentary with unicuspid mammiliform teeth exposed on outer margin of lips. Largest mammiliform teeth larger than internal buccal teeth. Two large mammiliform teeth projecting from anterior margin of upper lip. Two small mammiliform teeth on the dentary directly below those on the margin of the upper lip. Buccal teeth unicuspid and conical, in single irregular row on both jaws (tooth morphology identical to other species of the *R. guatemalensis* group). Dorsal-fin origin slightly posterior to vertical through anal-fin origin. Pelvic-fin rays extending beyond anal-fin origin. Pectoral-fin rays not reaching origin of anal fin. Small bony hooks present in the segmented rays of the anal fin, as described by Lucena (2011) for *R. lofini*.

Color in life. Overall coloration silvery (transparent where scales are absent), with a greenish-silvery lateral band. All fins yellow to orange. Distal tips of anal and caudal fins with dusky distal margins. Conspicuous dark teardrop-

Table 1. Morphometric and meristic data of holotype (H) and paratypes (n =28) of *Roebooides bussingi*. Holotype is not included in the range, mean and standard deviation (SD).

Morphometrics	H	Mean	Range	SD
Standard length	74.9	59.2	44.2-79.5	9.5
Head length	26.9	15.9.9	11.7-21.3	2.1
Percentages of standard length				
Greatest body depth	35.3	34.9	32.3-37.5	1.6
Caudal peduncle depth	9.4	8.7	7.7-9.4	0.5
Caudal peduncle length	7.2	8.3	6.5-9.9	1.1
Predorsal length	51.3	48.1	44.0-51.3	1.7
Preanal length	45.4	45.6	42.0-48.8	2.2
Prepectoral length	23.4	26.5	23.3-45.1	5.5
Prepelvic length	30.9	31.4	21.9-35.4	4.1
Height of dorsal fin	27.6	26.5	20.7-30.5	2.6
Height of anal fin	14.6	15.6	12.7-19.5	2.1
Pectoral-fin length	19.6	20.4	17.1-24.8	2.3
Pelvic-fin length	18.7	18.1	11.5-20.7	2.7
Percentages of head length				
Orbit diameter	31.3	32.2	28-36	2.5
Snout length	23.6	25.3	20-51	5.5
Maxillary length	53.2	45.2	23-53	5.5
Bony interorbital length	24.1	27.0	21-31	2.4
Meristics	H	Mean	Range	Mode
Anal-fin rays	45 iv	44.0 iv	42-45 iv	45 iv
Pectoral-fin rays	13	13.0	13-14	13
Pelvic-fin rays	7	7.0	7	7
Dorsal-fin rays	9 ii	9 ii	9 ii	9 ii
Lateral line scales	83	80.3	72-85	81
Scales above lateral line	20	19.8	18-22	20
Scales below lateral line	21	20.0	15-22	20
Scales around caudal peduncle	24	24.7	22-27	24

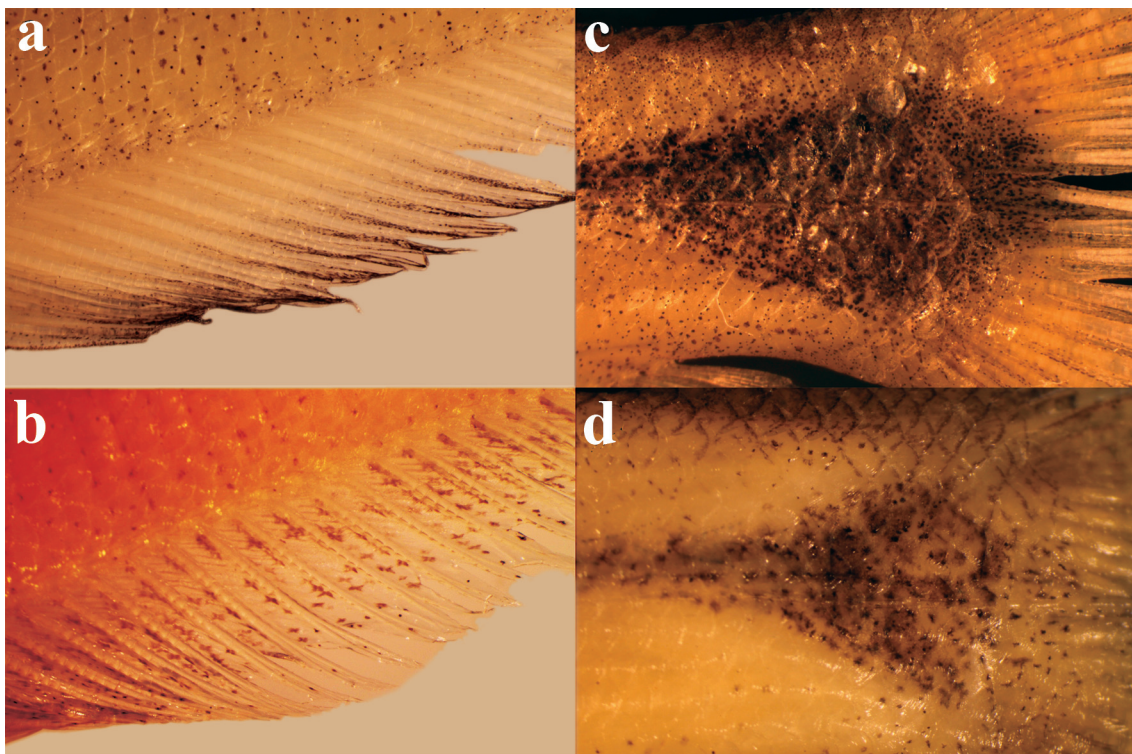


Fig. 3. (a) Anterior portion of the anal fin of *Roeboides bussingi* (LSUMZ 14797, 79.0 mm SL; paratype) showing concentration of melanophores forming a dark band at the edge of the fin. (b) Same region of anal fin of *R. bouchellei* (LSUMZ 14798, 72.2 mm SL) showing scattered melanophores, without a distinctive dark band. (c) Caudal region of *R. bussingi* showing the teardrop-shaped spot that extends onto the caudal fin. (d) Caudal region of *R. bouchellei* showing a lighter and triangle-shaped spot, largely restricted to the caudal peduncle. Also note the densely distributed melanophores on the body of *R. bussingi* and the lighter body coloration and fewer melanophores in *R. bouchellei*.

shaped spot on caudal peduncle that extends to the caudal fin (rounded end on caudal fin). Dark, crescent-shaped humeral spot present (Fig. 2a), inconspicuous or absent in some specimens.

Color in alcohol. Ground color yellowish-tan. Dorsal head and flank with melanophores loosely dispersed but more concentrated than below lateral line. Dark gray mid-lateral band extending from anterior margin of opercle to black teardrop-shaped spot on caudal peduncle and base of middle rays of the caudal fin. Humeral spot dark brown, crescent-shaped when present. Dorsal and caudal fins whitish to transparent and with dusky distal margins, anal fin with concentrated melanophores at distal margin. Paired fins opaque (Fig. 2b, 3a).

Distribution. *Roeboides bussingi* is known from the Pacific slope of Costa Rica and Panama, including tributaries of the río Coto drainage in Costa Rica to the río San Pablo west of the city of David in western Panama (Fig. 1).

Etymology. The species is named after William Bussing, an

exceptional ichthyologist who has devoted his professional career to the understanding of the Costa Rican and Central American ichthyofauna. He was the first to suggest that the species described herein was new to science (Bussing, 1998).

Remarks. A reduced or absent humeral spot clearly distinguishes *R. bussingi* from all other Lower Middle American species of *Roeboides* with the exception of *R. bouchellei*, which is nevertheless distinct from *R. bussingi* in terms of color pattern. Examination of more than 300 specimens of *R. bouchellei* revealed that the differences in coloration described in the diagnosis of *R. bussingi* are consistent, strongly indicating that the species are distinct. In addition, Bermingham *et al.* (1997) concluded that specimens of *Roeboides* from the río Coto and Western Panama are genetically distinct from other *R. bouchellei*. That might be interpreted as additional circumstantial evidence for the distinction of *R. bussingi* among congeners, given that *R. bussingi* is the only species of the genus known to occur in the río Coto.

Key to species of *Roeboides* from Middle America, adapted from Lucena (2000).

- 1a. Presence of a small dark wedge-shaped spot at the lateral midline of body, located between the verticals through the anterior and posterior bases of the dorsal fin; humeral spot absent *R. guatemalensis*
- 1b. Small dark wedge-shaped spot at the lateral midline of body absent; humeral spot absent or present (usually present) 2
- 2a. Humeral spot absent (or very small, covering less than 4 scales) 3
- 2b. Humeral spot well developed and covering 4 or more longitudinal scales and 6 or more vertical scales in adults 4
- 3a. Body coloration light (most obvious in preserved specimens); distal tip of anal fin without dark band of melanophores; triangular caudal spot typically restricted to the caudal peduncle; 15 to 19 scales above lateral line; 14 to 20 scales below lateral line *R. bouchellei*
- 3b. Body coloration dark, with densely distributed melanophores (most obvious in preserved specimens); distal tip of anal fin with dark band of melanophores; teardrop-shaped caudal spot extending beyond the caudal-fin peduncle, reaching the caudal fin; 18 to 22 scales above lateral line; 15 to 22 scales below lateral line *R. bussingi*
- 4a. Scales in the lateral line 83 to 104 5
- 4b. Less than 82 scales in lateral line 6
- 5a. Maximum body depth 31.8 to 36.1% of SL; predorsal length 49.1 to 51.9% of SL *R. loftini*
- 5b. Maximum body depth 36.9 to 38.8% of SL; predorsal length 51.4 to 55.9% of SL *R. ilseae*
- 6a. Scales in lateral line 60 to 73; 13 to 18 scales below lateral line; anterior border of the gap between the two branches of the parasphenoid, in ventral view, close to the line between the basioccipital and preopercle *R. dayi*
- 6b. Scales in lateral line 69 to 81; 17 to 22 scales below lateral line; anterior border of the gap between the two branches of the parasphenoid not in the position as described above 7
- 7a. Posterior margin of humeral spot usually not reaching the vertical through the origin of the anal fin, and extending through 6 or more scales beyond the dorsal-fin origin *R. occidentalis*
- 7b. Posterior margin of humeral spot elongated in adults, extending posteriorly beyond the vertical through the origin of the anal fin, and extending through less than 4 scales beyond the dorsal-fin origin *R. carti*

Comparative material. *Roeboides bouchellei*. Costa Rica: LSUMZ 14681, 47, 23.7-34.7 mm SL, Guanacaste Province, río Congo, small shallow stream under bridge Pan-American Hwy, río Barranca drainage, 10°14'29.8"N 84°59'29.8"W; LSUMZ 14696, 3, 54.8-80.3 mm SL, Guanacaste Province, Road from Umpala to

Caño Negro, small stream near farm, río San Juan drainage, 10°51'07.9"N 84°42'55.29.5"W; LSUMZ 14705, 1, 80.5 mm SL, Alajuela Province, drainage ditch off road to Caño Negro, surrounded by farm, río San Juan drainage, 10°58'16.8"N 84°42'58.8"W; LSUMZ 14720, 2, 33.5-37.4 mm SL, Alajuela Province, marsh in town of Medio Queso, río Sarapiquí drainage, 11°01'51.6"N 84°41'21.1"W. **El Salvador:** LSUMZ 14798, 26, 62.0-71.7 mm SL, Department of Santa Ana, Lago Guija, río Lempa drainage, 14°14'52.5"N 89°29'03"W, W.A. Matamoros, C. D. McMahan, 6 June 2011. **Honduras:** TU 187481, 94, 35.5-78.4 mm SL, Department of Valle, Nacaome River drainage. **Nicaragua:** TU 24219, 146, 25.4-94.4 mm SL, Departamento de Rivas, Sapoa River, Lake Nicaragua, Suttkus, DeAbate, Vieto and Jimenez. **Guatemala:** UF 115557, 15, 44.2-68.1 mm SL, Department of Escuintla, Azuchio River, Marialinda River Drainage, 23.5 km south of Escuintla on CA-2-Oriente.

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Literature Cited

- Bermingham, E., S. McCafferty & A. Martin. 1997. Fish biogeography and molecular clocks: perspectives from the Panamanian Isthmus. Pp. 113-138. In: Kocher, T. D. & C. Stepien (Eds). *Molecular Systematics of Fishes*. Academic Press, NY.
- Bussing, W. A. 1985. *Roeboides ilseae*, n. sp., a new scale-eating characid fish from Costa Rica. *Revista de Biología Tropical*, 33: 45-50.
- Bussing, W. A. 1998. Peces de las aguas continentales de Costa Rica/Freshwater fishes of Costa Rica. Universidad de Costa Rica, San Jose, Costa Rica.
- Fink, W. L. & S. H. Weitzman. 1974. The so called cheirodontin fishes of Central America with descriptions of two new species (Pisces: Characidae). *Smithsonian Contributions to Zoology*, 172: 1-46.
- Eschmeyer, W. N. 2012. *Catalog of Fishes*. California Academy of Sciences. (<http://research.calacademy.org/research/ichthyology/catalog/fishcatmain.asp>). Electronic version accessed Sep 2012.
- Hahn, N. S., C. S. Pavanelli & E. K. Okada. 2000. Dental development and ontogenetic diet shifts of *Roeboides paranensis* Pignatelli (Osteichthyes, Characinae) in pools of the upper Rio Paraná floodplain (State of Parana, Brazil). *Revista Brasileira de Biologia*, 60: 93-99.
- Lucena, C. A. S. 1998. Relações filogenéticas e definição do gênero *Roeboides* Günther (Ostariophysi: Characiformes: Characidae). *Comunicações do Museu de Ciências e Tecnologia da PUCRS, Série Zoologia*, 11: 19-59.

- Lucena, C. A. S. 2000. Revisão taxonômica e filogenia das espécies transandinas do gênero *Roeboides* Günther (Teleostei: Ostariophysi: Characiformes). Comunicações do Museu de Ciências e Tecnologia da PUCRS, Série Zoologia, 13: 3-63.
- Lucena, C. A. S. 2003. Revisão Taxonômica e Relações Filogenéticas das espécies de *Roeboides* grupo-*microlepis* (Ostariophysi; Characiformes; Characidae). Iheringia, Série Zoologia, 93: 283-308.
- Lucena, C. A. S. 2007. Revisão taxonômica das espécies do gênero *Roeboides* grupo-*affins* (Ostariophysi, Characiformes, Characidae). Iheringia, Série Zoologia, 97: 117-136.
- Lucena, C. A. S. 2011. A new species of *Roeboides* from Panama (Characiformes: Characidae). Revista de Biología Tropical, 4: 1663-1667.
- Miller, R. R., W. L. Minckley & S. M. Norris. 2005. Freshwater Fishes of Mexico, University of Chicago Press, Chicago.

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