

## ***Moema apurinan* sp. n. and *Aphyolebias boticarioi* sp. n. (Teleostei: Cyprinodontiformes: Rivulidae): two new annual killifishes from the Rio Purus basin, Brazilian Amazon**

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### **Abstract**

Two new annual fishes are described from the upper Rio Purus drainage, Amazonian basin, northern Brazil. *Moema apurinan*, new species, is similar to *M. staecki*, these two species distinguished from other congeners in having contact organs on scales of the flank in males, an acuminate caudal fin, fewer pectoral-fin rays, fewer vertebrae, and a narrower rostral cartilage. *Moema apurinan* differs from *M. staecki* in having a longer pectoral fin and a wider basihyal. *Moema apurinan* is distinguished from all other congeners by possessing fewer caudal-fin rays. *Aphyolebias boticarioi*, new species, differs from all other congeners by having a deeper body. It is similar to *A. rubrocaudatus*, *A. obliquus*, *A. claudiae* and *A. schleseri* in having a ventral marginal black stripe on the caudal fin in males. *Aphyolebias boticarioi* differs from these species by a combination of features including number of anal-fin rays, pectoral-fin rays, vertebrae and gill-rakers, and color patterns.

**Key words:** Annual Fish, Cyprinodontiformes, Rivulidae, *Moema*, *Aphyolebias*, Amazon, systematics, taxonomy, new species

### **Resumo**

Duas novas espécies de peixes anuais da drenagem do alto rio Purus, bacia Amazônica, são descritas. *Moema apurinan*, espécie nova, é semelhante a *M. staecki* e distingue-se dos outros congêneres por possuir órgãos de contato em escamas do flanco de machos, nadadeira caudal acuminada, menos raios na nadadeira pélvica, menos vértebras e cartilagem rostral mais estreita, diferindo dela pela nadadeira peitoral mais longa e basal mais largo; ela também se distingue de todas as outras espécies do gênero por possuir menos raios na nadadeira caudal. *Aphyolebias boticarioi*, espécie nova, difere de todos os outros congêneres por possuir corpo mais alto; ela é semelhante a *A. rubrocaudatus*, *A. obliquus*, *A. claudiae* e *A. schleseri* por possuir a margem ventral da nadadeira caudal negra em machos, e difere destas espécies por uma combinação de características, incluindo número de raios da nadadeira anal, raios da nadadeira peitoral, vértebras e rastros branquiais, e de padrões de colorido.

## Introduction

Six new species of the annual killifish genera *Moema* Costa and *Aphyolebias* Costa have been described from the Amazonian basin in recent years (Costa, 2003a–c). Species of both genera are found in temporary pools within the forest, often in sympatry.

*Moema* comprises ten nominal species, of which *M. heterostigma* Costa is endemic to the Brazilian Pantanal, Rio Paraguay basin (Costa, 2003d), and nine species are known from the Amazon: *M. piriana* Costa, the type species of the genus, from the coastal plains adjacent to Rio Amazonas estuary, Brazil, *M. staecki* (Seegers) from the central Amazon, Brazil, *M. portugali* Costa and *M. nudifrontata* from the Rio Branco basin, northern Amazon, Brazil, *M. hellneri* Costa from the Rio Napo basin, western Amazon, Peru, and *M. pepotei* Costa, *M. ortegai* Costa, and *M. quiii* Huber, from the Madre de Dios-Beni-Mamoré-Madeira river system in Peru, Brazil and Bolivia, southern Amazon (Costa, 1989, 1992, 2003a,b; Huber, 2003). *Moema ortegai* and *M. quiii* were described from the same locality (Tambopata, Río Madre de Dios drainage, Peru) and are morphologically identical, therefore considered synonyms. The name *Moema ortegai*, published in 24 November 2003 (Costa, 2003b), has priority over the name *Moema quiii*, published in December 2003 (Huber, 2003). *Aphyolebias* comprises seven species, all endemic to the Amazonian basin (Costa, 2003c): *A. peruensis* (Myers), *A. wischmanni* (Seegers), and *A. schleseri* Costa from Marañón-Ucayali-Amazonas river system, western Amazon, Peru, and *A. rubrocaudatus* (Seegers), *A. obliquus* (Costa, Sarmiento & Barrera), *A. claudiae* Costa, and *A. manuensis* (Costa) from the Madre de Dios-Beni-Mamoré-Madeira river system in Peru and Bolivia, southern Amazon.

Although some species of *Moema* and *Aphyolebias* are among the largest species of South American killifishes, reaching about 150 mm in total length, all species of both genera, except *A. peruensis*, were described in the last 21 years. This is a consequence of the immense poorly explored Amazonian areas, where fishes inhabiting isolated temporary pools within forests were rarely sampled. This is the case for the Rio Purus, one of the largest Amazonian tributaries, with a main course of about 3,000 km, for which no rivulid fish was recorded until the present date. During a recent expedition directed at annual fish habitats to the upper section of the Rio Purus basin, one new species each of *Moema* and *Aphyolebias* were found, which are herein described.

## Material and methods

Measurements and counts follow Costa (1995). Measurements are presented as percentages of standard length (SL), except for those relative to head morphology, expressed as percentages of head length. Fin-ray counts include all elements; number of vertebrae, gill-rakers, and pectoral, pelvic and caudal-fin rays were recorded only from cleared and stained specimens; the compound caudal centrum was counted as a single element. Osteo-

logical preparations were made according to Taylor and Van Dyke (1985). Terminology for frontal squamation follows Hoedeman (1958), and for cephalic neuromast series Costa (2001). Osteological features presented in the descriptions are those considered phylogenetically informative in recent studies on rivulids (Costa, 1998). The abbreviation c&s means specimens cleared and stained for bone and cartilage. The material is deposited in UFRJ, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil.

***Moema apurinan* new species**

(Figs. 1–2)

**Holotype.** UFRJ 5980, male, 52.5 mm SL; Brazil: Estado do Acre: Porto Acre, temporary pool within forest, Rio Acre floodplains, Rio Purus drainage, Rio Amazonas basin (9°35'12.2"S 67°31'50.6"W; altitude 132 m); W. J. E. M. Costa, S. Lima and A. Pinto, 10 June 2003.



**FIGURE 1.** *Moema apurinan*, UFRJ 5980, male, holotype, 52.5 mm SL (one day after collection); Brazil: Acre: Porto do Acre: Rio Purus basin.

**Paratypes.** UFRJ 5981, 4 males, 50.2–55.4 mm SL, 5 females, 42.7–51.1 mm SL; UFRJ 5982, 4 males, 48.2–54.4 mm SL, 3 females, 46.8–47.9 mm SL (c&s); collected with holotype.

**Diagnosis:** The new species differs from all other species of the genus in having fewer caudal-fin rays (30–31, vs. 32–35). It is similar to *M. staecki* (Seegers), and distinguished from all other congeners by possessing contact organs on scales of the flank of the male (vs. contact organs absent), caudal fin acuminate (vs. rounded to subtruncate), fewer pectoral-fin rays (14, vs. 15–17), fewer vertebrae (33–35, vs. 36–39), and narrower rostral cartilage (width about 75–80% of rostral cartilage length, vs. 90–100% in the remaining species of the genus, except in *M. ortegai* Costa, about 145%). The new species differs from *M. staecki* by having a longer pectoral fin (tip reaching between the base of 8th and

13th anal fin rays, vs. reaching urogenital papilla), and wider basihyal (width about 75% of basihyal length, vs. 55 %).



**FIGURE 2.** *Moema apurinan*, UFRJ 5981, female, paratype, 44.4 mm SL (one day after collection); Brazil: Acre: Porto do Acre: Rio Purus basin.

**Description:** Morphometric data given in Table 1. Male larger than female, largest male 55.4 mm SL. Dorsal profile gently convex from snout to end of dorsal-fin base, approximately straight to slightly concave on caudal peduncle. Ventral profile slightly convex on head, almost straight from anterior portion of venter to end of anal-fin base, nearly straight on caudal peduncle. Body slender, subcylindrical anteriorly, deeper than wide, to compressed posteriorly. Greatest body depth at level of pelvic-fin base. Jaws long, snout pointed.

Tip of dorsal fin pointed, with short filamentous ray in male, rounded to slightly pointed in female. Anal fin approximately rectangular, longer than deep; tip pointed, long, reaching vertical through middle of caudal fin in male, rounded and short in female. Caudal fin long, acuminate, with short posterior filamentous rays in male, short and elliptical in female. Pectoral fin lanceolate, terminating in long tip, reaching between base of 8th and 13th anal fin rays in male, slightly pointed and short, reaching between pelvic-fin base and anus in female. Pelvic fin rounded, tip reaching between base of 1st and 3rd anal-fin rays in male, and between anus and urogenital papilla in female. Pelvic-fin bases in close proximity. Dorsal-fin origin on vertical through base of 9th or 10th anal-fin ray, and between neural spines of 20th and 22nd vertebrae. Anal-fin origin between pleural ribs of 16th and 17th vertebrae. Dorsal-fin rays 10–11; anal-fin rays 16–17; caudal-fin rays 30–31; pectoral-fin rays 14; pelvic-fin rays 7.

Scales large, cycloid. Body and head entirely scaled, except anterior ventral surface of head. Body scales extending over caudal-fin base; no scales on dorsal and anal fins. Fron-

tal squamation E-patterned; E-scales not overlapping medially; scales arranged in irregular circular pattern around A-scale without exposed margins. Longitudinal series of scales 34–35; transverse series of scales 8; scale rows around caudal peduncle 16. Ctenii-like contact organ on each scale of median ventral portion of male flank. Supraorbital neuromasts 3 + 3.

**TABLE 1.** Morphometric data of *Moema apurinan*. H: holotype.

	males					females				
	H	paratypes (UFRJ 5981)								
Standard length (mm)	52.5	55.4	53.8	53.3	50.2	51.1	46.3	45.3	44.4	42.7
<b>Percents of standard length</b>										
Body depth	21.0	21.5	21.7	21.7	21.4	22.9	22.1	23.1	21.4	22.1
Caudal peduncle depth	14.1	15.2	15.2	14.9	14.7	13.7	13.8	14.5	13.2	14.0
Predorsal length	73.5	69.9	71.9	71.6	73.8	73.6	73.5	75.4	75.8	74.9
Prepelvic length	48.6	49.2	50.7	50.9	50.1	52.1	50.8	53.1	52.7	52.3
Length of dorsal-fin base	11.7	11.1	10.6	9.9	10.6	9.1	9.2	9.2	8.4	9.7
Length of anal-fin base	21.2	22.2	22.6	21.7	21.9	18.6	19.7	18.5	18.7	19.0
Caudal-fin length	52.7	-	64.6	62.2	58.2	41.1	42.8	44.7	44.3	41.5
Pectoral-fin length	41.7	-	46.6	37.8	48.1	26.4	25.0	25.7	29.6	24.5
Pelvic-fin length	14.4	15.0	15.9	14.6	15.7	12.9	12.3	12.5	13.6	11.8
Head length	26.3	25.8	25.9	25.0	25.4	25.9	26.7	26.9	28.5	26.8
<b>Percents of head length</b>										
Head depth	66.0	69.6	67.6	67.9	67.5	70.7	65.3	68.1	63.3	67.3
Head width	63.1	66.8	65.5	65.3	67.0	72.7	69.9	70.9	66.7	70.3
Snout length	15.0	14.5	16.0	15.8	15.1	14.5	14.0	14.2	13.5	12.3
Lower jaw length	25.9	23.6	25.1	25.1	25.0	23.9	23.0	24.0	23.4	23.8
Eye diameter	31.6	32.2	32.1	32.2	33.3	33.0	35.3	35.0	32.1	34.4

Interhyal vestigial, not ossified. Rostral cartilage longer than wide, width 75–80% length. Basihyal subtriangular, width 75% length; basihyal cartilage 45% basihyal length. Six branchiostegal rays. Second pharyngobranchial with no, one or two small teeth. Gill-rakers of first branchial arch 1 + 10. Vomerine teeth 4–11. Ventral process of posttemporal present. Total vertebrae 33–35.

**Coloration:** Male: Side of body greenish golden, with three purplish brown stripes alternating with narrow dark golden stripes; dark red crimson dots simultaneously arranged both in longitudinal rows, on two dorsalmost purplish brown stripes, and in oblique rows crossing flank. Dorsum light brown with brown dots, venter white. Side of

head greenish golden with dark brown blotches. Jaws light brown. Infraorbital region and ventral surface of head white. Iris yellowish green, with dark brown bar crossing center of eye. Dorsal fin pale greenish yellow with small dark reddish brown spots. Anal fin light greenish yellow, basal region light blue, with small dark reddish brown spots. Caudal fin pale greenish yellow with small dark reddish brown spots on dorsal portion and short brown stripes or dots parallel to fin rays on median portion; broad light orange stripe with bright yellow dorsal contour, dorsally outlined by dark brown stripe, on ventral margin of fin. Pelvic fin light greenish yellow, with transverse rows of small brown spots. Pectoral fin yellowish hyaline.

Female: Side of body light metallic green, with six longitudinal rows of brown dots. Dorsum light brown with brown dots, venter white. Side of head pale metallic green with faint brown spots. Jaws gray. Infraorbital region and ventral surface of head white. Iris yellow, with pale brown bar crossing center of eye. Dorsal and anal fins pale greenish yellow with small dark brown spots. Caudal fin pale greenish yellow with small dark brown spots on dorsal portion, and faint small gray spots on middle. Paired fins hyaline.

**Distribution:** Known only from the type locality, Rio Acre floodplains, Rio Purus drainage, Rio Amazonas basin, northwestern Brazil (Fig. 3).

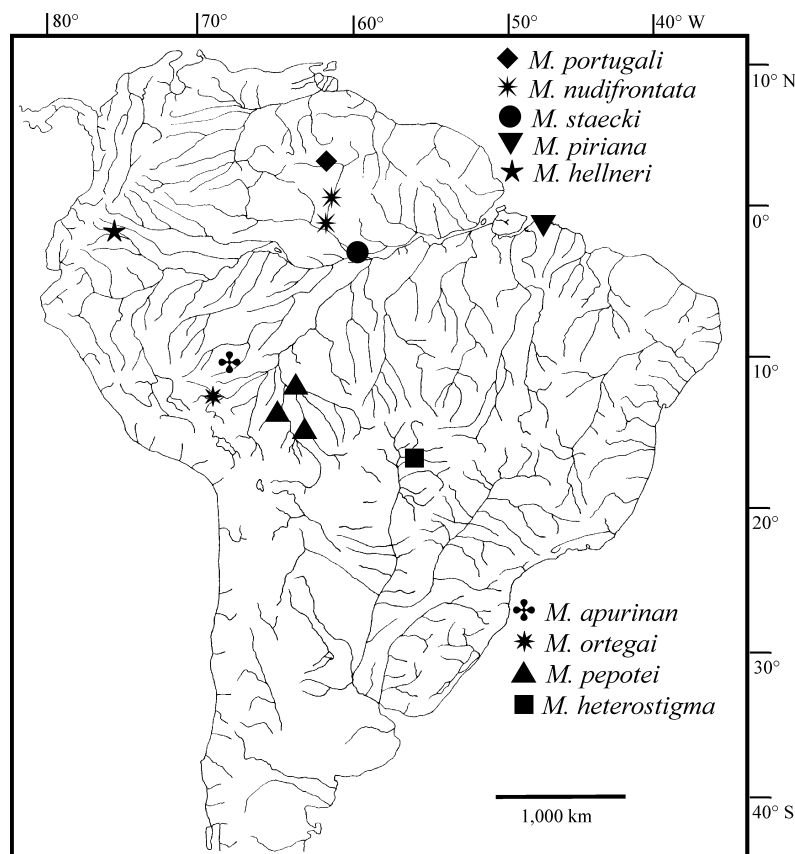


FIGURE 3. Geographic distribution of species of the genus *Moema*.

**Habitat notes:** The type series was collected in a temporary pool within the forest. The pool was small, about 7 m of long and about 3 m wide, shallow, about 0.40-0.60 m deep. The water was dark brown. No aquatic vegetation.

**Etymology:** The specific name *apurinan* (Apurinã) is the Portuguese name of an indigenous tribe of people, also known as Ipurinã, Poppingaré and Kangitê, with own language derived from the linguistic group Aruak, inhabiting lands drained by the Rio Purus basin in the region of the type locality of the new species.

***Aphyolebias boticarioi* new species**

(Figs. 4–5)

**Holotype.** UFRJ 5986, male, 42.1 mm SL; Brazil: Estado do Acre: Porto Acre, temporary pool within forest, Rio Acre floodplains, Rio Purus drainage, Rio Amazonas basin (9°35'14.8"S 67°31'57.0"W; altitude 133 m); W. J. E. M. Costa, S. Lima and A. Pinto, 10 June 2003.



**FIGURE 4.** *Aphyolebias boticarioi*, UFRJ 5986, male, holotype, 42.1 mm SL (one day after collection; caudal and anal fins damaged); Brazil: Acre: Porto do Acre: Rio Purus basin.



**FIGURE 5.** *Aphyolebias boticarioi*, UFRJ 5987, female, paratype, 32.4 mm SL (one day after collection; pectoral, caudal and anal fins damaged); Brazil: Acre: Porto do Acre: Rio Purus basin.

**Paratypes.** UFRJ 5987, 4 males, 36.2–45.3 mm SL, 7 females, 32.4–47.1 mm SL; UFRJ 5988, 2 males, 43.1–44.7 mm SL, 2 females, 38.6–43.3 mm SL (c&s); collected with holotype.

**Diagnosis:** The new species is distinguished from all congeners in having a deeper body (body depth 23.4–26.5% SL, vs. 20.2–23.6% SL). Similar to *A. obliquus*; both are distinguished from all other species of the genus by possessing dark brown spots on the pectoral fin in males (vs. spots absent). The new species differs from *A. obliquus* by having fewer anal-fin rays (14–16 vs. 16–18) and fewer pectoral-fin rays (13–14 vs. 15–16). *Aphyolebias boticarioi* is similar to *A. rubrocaudatus*, *A. obliquus*, *A. claudiae* and *A. schleseri*, but is distinguished from *A. peruensis*, *A. wischmanni* and *A. manuensis* by having a black stripe on the ventral margin of the caudal fin in males (vs. black stripe absent); distinguished from *A. rubrocaudatus*, *A. obliquus*, *A. claudiae* and *A. schleseri*, by having dark brown spots restricted to the posterior portion of the anal fin in males (vs. brown spots on the entire fin), and by the absence of a distal black stripe on the anal fin (vs. presence in males). The new species is also distinguished from *A. rubrocaudatus* by having an orange stripe only on the ventral portion of the fin in males (vs. an orange stripe on the ventral portion, and another similar stripe on the dorsal of the caudal fin); from *A. claudiae* by the absence of a black humeral blotch in males (vs. presence) and fewer anal-fin rays (14–16 vs. 16–19), and from *A. schleseri* by possessing more vertebrae (33–34, vs. 32) and more gill-rakers on first branchial arch (2 + 10, vs. 1 + 8).

**Description:** Morphometric data given in Table 2. Male usually larger than female, but largest specimen, female 47.1 mm SL. Dorsal profile gently convex from snout to end of dorsal-fin base, approximately straight on caudal peduncle. Ventral profile slightly convex between lower jaw and end of anal-fin base, nearly straight on caudal peduncle. Body somewhat deep, subcylindrical anteriorly, deeper than wide, to compressed posteriorly. Greatest body depth at level of pelvic-fin base. Jaws short, snout slightly pointed.

Tip of dorsal fin slightly pointed. Anal fin rectangular, with short pointed tip in male, longer than deep in male, wider than long in female. Caudal fin subtruncate; short filaments on dorsal portion of posterior edge, and pointed ventral extension in male. Pectoral fin lanceolate, tip reaching vertical between anus and anal-fin origin in male, between pelvic-fin base and anus in female. Pelvic fin pointed, tip reaching between base of 1st and 4th anal-fin rays in male, and between urogenital papilla and base of 2nd anal-fin ray in female. Pelvic-fin bases in close proximity in male, and separated by small interspace, about half pelvic-fin base, in female. Dorsal-fin origin on vertical through base of 9th or 10th anal-fin ray, and between neural spines of 20th and 21st vertebrae. Anal-fin origin between pleural ribs of 14th and 15th vertebrae. Dorsal-fin rays 8–10; anal-fin rays 14–16; caudal-fin rays 26–28; pectoral-fin rays 13–14; pelvic-fin rays 7.

Scales large, cycloid. Body and head entirely scaled, except anterior ventral surface of head. Body scales extending over caudal-fin base; no scales on dorsal and anal fins. Frontal squamation E-patterned; E-scales not overlapping medially; scales arranged in irregular



circular pattern around A-scale without exposed margins. Longitudinal series of scales 33–35; transverse series of scales 8; scale rows around caudal peduncle 16. Minute ctenii-like contact organs on scales of median portion of male flank. Supraorbital neuromasts 3 + 3.

Interhyal vestigial, not ossified. Rostral cartilage longer than wide, width 70% length. Basihyal subtriangular, width 60% length; basihyal cartilage 35% basihyal length. Six branchiostegal rays. Second pharyngobranchial with one or two small teeth. Gill-rakers of first branchial arch 2 + 10. Vomerine teeth 3–4. Ventral process of posttemporal present. Total vertebrae 33–34.

**TABLE 2.** Morphometric data of *Aphyolebias boticarioi*. H: holotype.

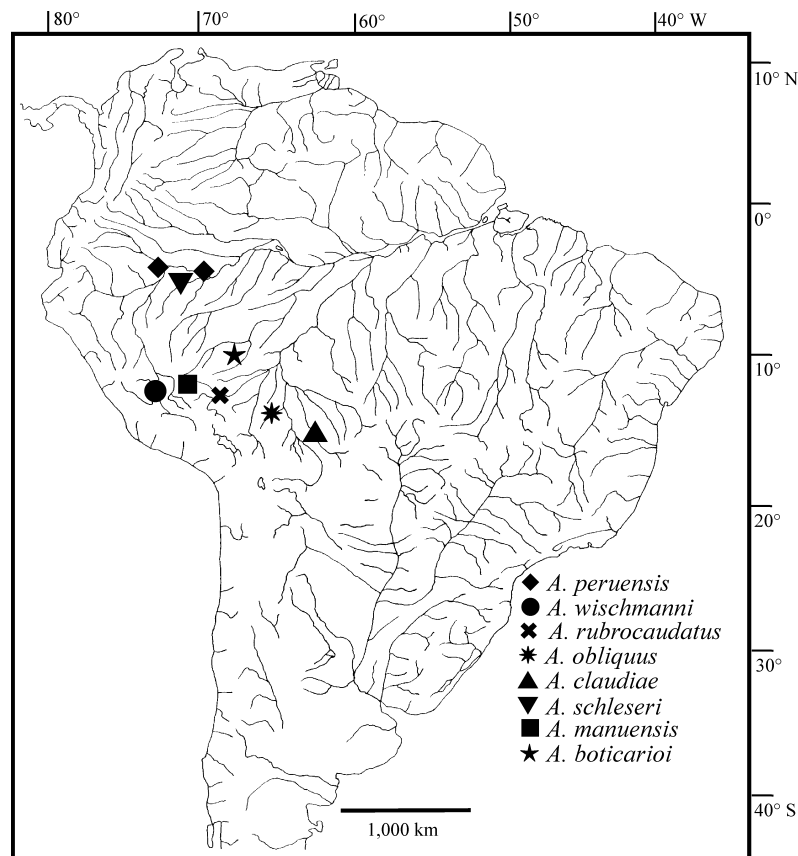
	males					females				
	H	paratypes (UFRJ 5987)								
Standard length (mm)	42.1	45.3	43.5	38.1	36.2	47.1	38.3	35.7	34.6	34.1
<b>Percents of standard length</b>										
Body depth	23.6	23.7	23.4	23.9	26.1	25.6	25.8	26.5	26.5	25.4
Caudal peduncle depth	15.6	15.0	14.5	15.0	15.6	15.3	14.4	14.1	14.6	13.0
Predorsal length	74.8	73.1	75.8	76.0	74.2	74.3	75.3	77.4	76.8	76.4
Prepelvic length	52.3	50.3	49.7	52.8	52.3	52.1	54.6	53.3	56.0	52.8
Length of dorsal-fin base	13.1	12.3	-	12.0	12.0	10.7	10.3	9.9	12.1	10.7
Length of anal-fin base	22.6	20.3	23.7	22.1	23.3	19.4	20.8	19.0	20.5	20.0
Caudal-fin length	-	-	-	43.2	41.6	38.8	39.9	39.5	41.6	40.8
Pectoral-fin length	-	-	30.1	30.5	30.5	25.2	26.0	25.8	27.3	26.4
Pelvic-fin length	15.3	15.0	15.7	14.9	14.6	13.5	15.8	14.7	16.5	14.2
Head length	26.4	26.3	26.9	27.5	27.2	25.7	27.2	27.2	28.1	26.5
<b>Percents of head length</b>										
Head depth	78.2	76.1	70.3	71.8	78.2	79.3	78.7	77.7	72.7	78.0
Head width	76.7	77.5	73.4	73.8	71.1	76.6	76.9	77.2	77.9	79.2
Snout length	14.6	13.4	14.8	14.7	14.7	14.5	13.2	13.3	13.1	15.0
Lower jaw length	23.9	23.9	21.4	20.8	22.7	20.3	18.4	19.0	16.8	19.2
Eye diameter	35.6	33.9	31.7	35.9	38.2	34.1	36.5	36.2	36.3	38.5

**Coloration:** Male: Side of body pale bluish green; dark red crimson dots irregularly scattered over flank, barely aligned in oblique or longitudinal rows. Dorsum gray with brown dots, venter white. Side of head greenish golden, usually with dark reddish brown blotches on preopercle and postorbital area. Jaws light brown. Ventral surface of head white. Iris yellowish green, with dark brown bar crossing center of eye. Dorsal fin pale greenish yellow with small dark reddish brown spots. Anal fin light orangish yellow, basal region light blue, with small dark reddish brown spots on posterior portion. Caudal fin

with alternating light blue and red small spots, forming chessboard-like pattern; ventral margin of fin with broad orangish red stripe with bright yellow dorsal and ventral contour, dorsally outlined by dark reddish brown stripe, ventrally outlined by black stripe. Pectoral fin yellowish hyaline with dark reddish brown dots. Pelvic fin light orangish yellow with small brown spots.

Female: Side of body pale green, sometimes with faint brown dots. Dorsum light brown with brown dots, venter white. Side of head pale metallic green with faint brown spots. Jaws gray. Infraorbital region and ventral surface of head white. Iris greenish yellow, with pale brown bar crossing center of eye. Dorsal and anal fins hyaline with small dark brown spots. Caudal fin hyaline, with faint gray spots on dorsal region and narrow dark gray stripe on ventral margin. Pectoral fin hyaline. Pelvic fin hyaline with small brown spots.

**Distribution:** Known only from the type locality, Rio Acre floodplains, Rio Purus drainage, Rio Amazonas basin, northwestern Brazil (Fig. 6).



**FIGURE 6.** Geographic distribution of species of the genus *Aphyolebias*.

**Habitat notes:** All specimens were collected in a single small (about 5 m long and about 3 m wide) and shallow (about 0.30-0.40 m deep) temporary pool, with dark brown water, within the forest close to the Rio Acre. No aquatic vegetation.

**Etymology:** The name *boticarioi* after the Fundação O Boticário de Proteção À Natureza, in recognition to the support provided to studies on diversity and conservation of annual killifishes.

## Discussion

Relationships among species of *Moema* and *Aphyolebias* are still unclear. Most characters used to diagnose species (*e.g.*, number of vertebrae, number of anal and pectoral-fin rays, caudal-fin shape, presence of organs of contact on male scales, width of the basihyal and the rostral cartilage, and color patterns) are variable among potential outgroups to both genera (*i.e.*, putative closely related genera, *Micromoema* Costa, 1998, *Renova* Thomerson & Taphorn, 1995, *Trigonectes* Myers, 1925, *Neofundulus* Myers, 1924, *Pterolebias* Gorman, 1895, *Gnatholebias* Costa, 1998) (Costa, 1998, 2003b, d). For example, the reduced number of vertebrae in *Moema apurinan* and *M. staecki*, with a total of 33–35 vertebrae, is within the range of most species of closely related genera, which have 29–34 vertebrae, but contrasts with the remaining species of *Moema* which possess 36–39 vertebrae. This suggests that all species of *Moema* except *Moema apurinan* and *M. staecki* form a monophyletic unit defined by higher vertebra counts.

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