

A New Species of *Raiamas* (Teleostei: Cyprinidae) from the Lower Congo River, with a Phylogenetic Assessment of the Generic Limits of the Predatory Cyprinid Genera *Opsaridium*, *Raiamas*, and *Leptocypris*

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In the course of ongoing survey work in the lower Congo River, two collections of an undescribed species of the predatory cyprinid genus *Raiamas* have been made; one in the Congo main channel in the vicinity of Inga, and a second in the Inkisi River, a large south bank tributary of the Congo. Discovery of this new taxon has prompted a reexamination of potentially related taxa of adjacent regions and an attempt to provide generic diagnoses for the morphologically similar cyprinid genera *Leptocypris*, *Raiamas*, and *Opsaridium*. Based on a series of derived features of the neurocranium, pectoral girdle, jaws, and suspensorium, anatomical diagnoses for the three cyprinid genera are provided. We reassign *Opsaridium christyi* to *Raiamas* and *Raiamas weeksii* to *Leptocypris*. These two generic reassignments and the discovery of the new *Raiamas* bring the number of species of *Raiamas* confirmed from the lower Congo River to four: *R. salmolucius*, *R. buchholzi*, *R. christyi*, and the new species, *R. kheeli*, described herein. The reassignment of *Opsaridium weeksii* to *Leptocypris* raises the number of species of *Leptocypris* recorded from the region to four: *L. modestus*, *L. lujae*, *L. weynsii*, and *L. weeksii*.

HOWES (1980) referred all African species included in the catch-all genus *Barilius* Hamilton, 1822 to three genera: *Opsaridium* Peters, 1854, *Raiamas* Jordan, 1919, and *Leptocypris* Boulenger, 1900. The generic descriptions provided by Howes (1980) consist of a useful listing of osteological features and external anatomy seemingly characterizing each genus (see below), but explicit diagnoses based on derived features were not provided and generic assignment of species remains problematical and often unsupported by character data. While later studies (e.g., Howes, 1983; Howes and Teugels, 1989) have refined generic membership with the addition of new species and the reassignment of others (see also Skelton, 1996; Taverne and De Vos, 1997), ambiguities with regard to generic assignment remain. The discovery of a putatively undescribed taxon in the lower Congo River (the region of Pool Malebo, in the Democratic Republic of Congo and the Republic of Congo to the Atlantic Ocean, see Thieme et al., 2005) has prompted us to examine potentially related taxa from adjacent regions in an attempt to clarify the specific status of the new taxon and provide a rationale for its generic assignment. A review of anatomical characters discussed by Howes (1980, 1983), and additional features uncovered in the course of the present investigation, has led us to propose generic reassignments for two species from the Lower Congo region. These generic reassignments are justified in light of a series of anatomical features considered here to be diagnostic for each of the genera, and are discussed

briefly before the description of the new species of *Raiamas* is presented.

MATERIALS AND METHODS

Counts and measurements are depicted in Figure 1. Vertebral counts follow Howes and Teugels (1989) with a total vertebral count summing Weberian (4) + abdominal + caudal + fused PU1 and U1 centra. Visualization of scale rows and canal-bearing scales was aided by directing a fine jet of compressed air onto scales. Cleared-and-stained material was prepared following Taylor and Van Dyke (1985). For some comparative taxa we have relied on data culled from original and subsequent literature for morphometric and meristic ranges. Institutional abbreviations are as listed in Leviton et al. (1985), alc indicates alcoholic, and CS indicates cleared-and-stained materials.

In the following generic diagnoses, our observations are appended in parentheses to the characters considered by Howes (1980, 1983) and Howes and Teugels (1989). Character numbers are preceded by an asterisk in the accompanying illustrations. Based on outgroup comparison, use of superscript "1" indicates the hypothesized derived state and superscript "0" the plesiomorphic state for each figured character.

Opsaridium Peters, 1854

Diagnosis.—The presence of an expanded kinethmoid (variable, also expanded in *Raiamas*);

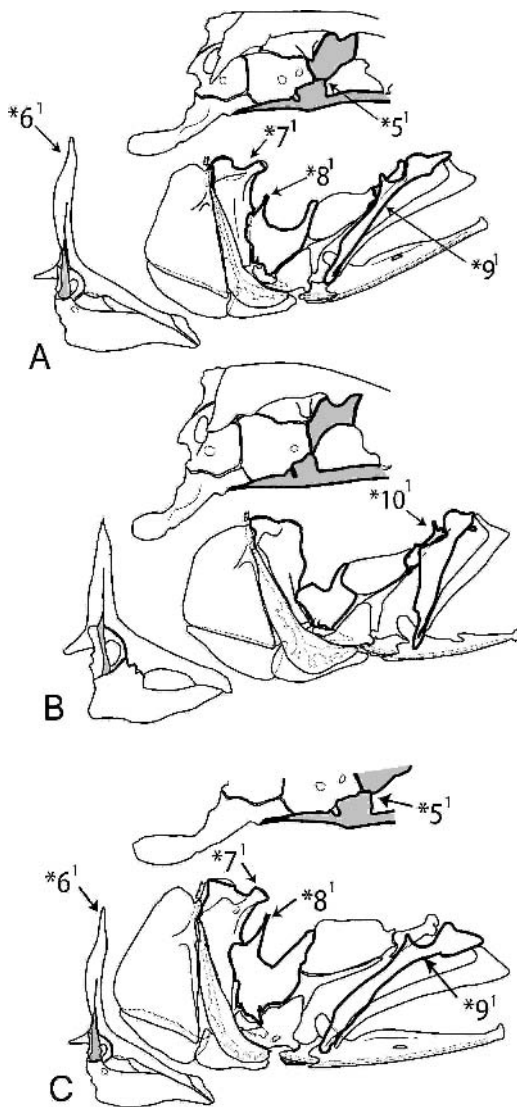


Fig. 3. Posterior neurocranium, pectoral girdle, suspensorium, and jaws. (A) *Raiamas christyi* AMNH 236349; (B) *Leptocypris weeksii* AMNH 236347; (C) *Raiamas kheeli*, new species AMNH 236354.

and *Leptocypris*); long shallow jaws (also in *Leptocypris*, see Fig. 2, *4¹ vs. *4⁰); extensive pterosphenoid-parasphenoid contact (a putative autapomorphy for the genus; see Fig. 2, *5¹ vs. *5⁰); small dilatator fossa (widespread among examined taxa); apophyseal platform formed partly from prootics (widespread among examined taxa); long post-parietal platform (unconfirmed by our study); broad mesocoracoid (also in *Opsaridium*); posteriorly extended cleithrum (slender, elongate cleithrum is a putative autapomorphy for the genus; see Fig. 2, *6¹ vs. *6⁰); elongate pectoral axial scales (widespread among

examined taxa); extensive development of the adductor mandibulae complex (widespread among examined taxa).

Additional characters considered here to represent putative synapomorphies for the genus include an anterior hyomandibular articular facet borne on a cylindrical process and widely separated from the posterior articular facet (see Fig. 2, *7¹ vs. *7⁰); extensive, spine-like metapterygoid posterior process (see Fig. 2, *8¹ vs. *8⁰); slender, elongate maxillary shafts (except in *R. senegalensis*; see Fig. 2, *9¹ vs. *9⁰).

Remarks.—Howes (1980) placed *Barilius christyi* Boulenger, 1920 in the genus *Opsaridium*, and subsequent authors have followed that assignment (see e.g., Lévêque and Daget, 1984). However, we find that “*Opsaridium*” *christyi* (Figs. 3A, 4A) lacks well-developed pectoral axial lobes and marked secondary sexual dimorphism in males, features considered by Howes (1980), Skelton (1996), and Taverne and De Vos (1997) to characterize *Opsaridium*. In contrast, the taxon shares the following character states hypothesized here to represent autapomorphies of the genus *Raiamas*: a broad zone of contact between the pterosphenoid and parasphenoid (see Fig. 3A, *5¹), the ascending arm of the cleithrum is elongate and slender (see Fig. 3A, *6¹), the anterior hyomandibular articular facet is borne on a cylindrical process and is widely separated from the posterior articular facet (see Fig. 3A, *7¹), the posterior metapterygoid process is extensive and spine-like (see Fig. 3A, *8¹), and the maxillary shaft is slender and elongate (see Fig. 3A, *9¹). Based on the anatomical features discussed herein we consider “*Opsaridium*” *christyi* to belong to the genus *Raiamas*.

The inclusion of *Raiamas christyi*, and the discovery of a new *Raiamas*, brings the number of species of *Raiamas* confirmed as present in the lower Congo River to four: *R. salmolucius* (Nichols and Griscom, 1917; Fig. 4C), *R. buchholzi* (Peters, 1876; Figs. 4B, 6C), *R. christyi* (Boulenger, 1920; Figs. 4A, 6B), and a new species, *R. kheeli*, described herein. This new taxon is readily distinguished from the other *Raiamas* of the region, as well as from all nominal African species of the genus, and is formally described below.

Raiamas kheeli, new species

Figures 3C, 5, 6A; Table 1

Holotype.—AMNH 236352, 95.8 mm SL, Democratic Republic of Congo, small channel adjacent to main channel rapid, just below Inga intake canal, rotenone applied to complex of alternating pools and riffles, 5°27.76'S, 13°35.56'E, 14

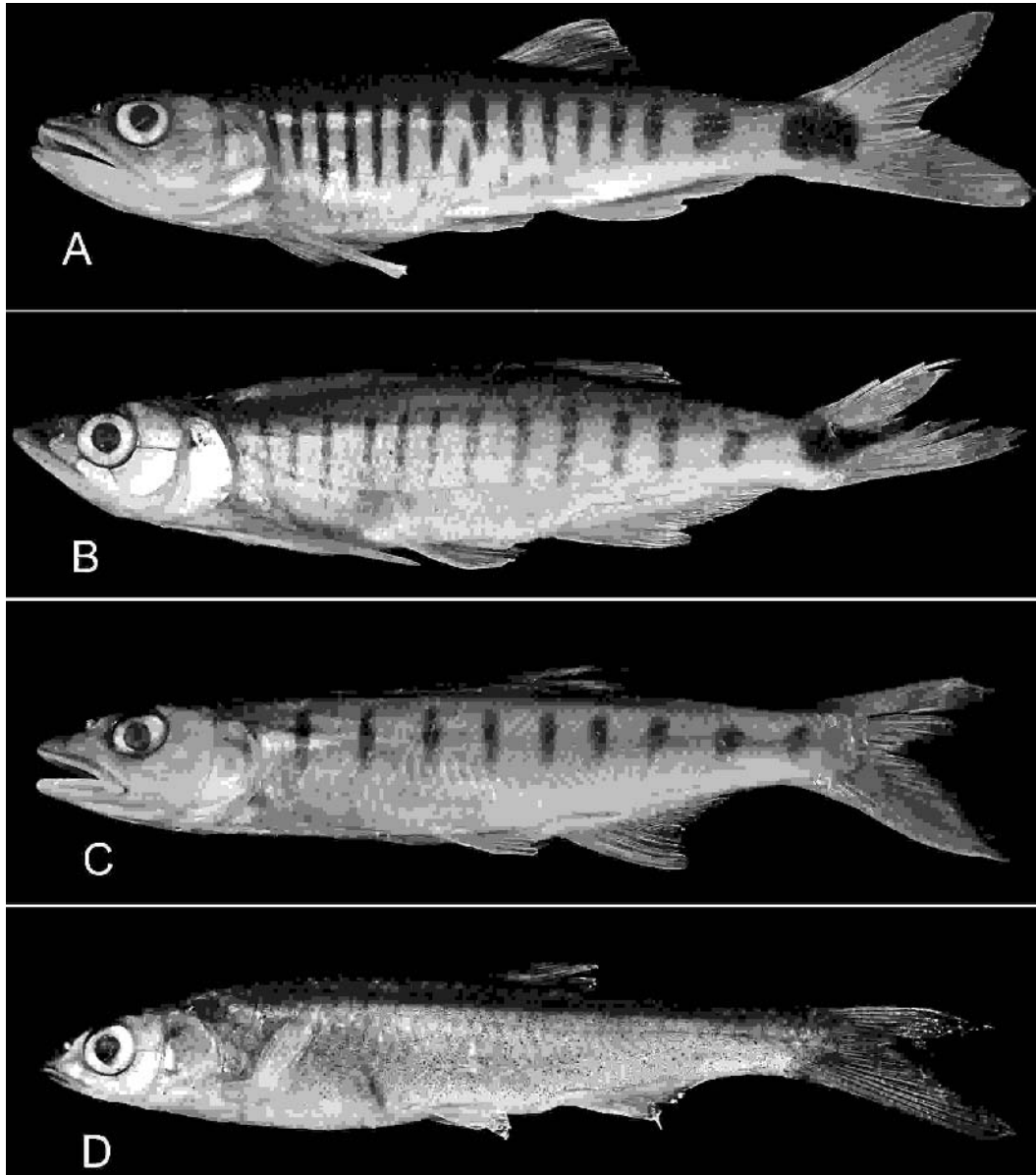


Fig. 4. (A) *Raiamas christyi* AMNH 236349; (B) *Raiamas buchholzi* AMNH 232380; (C) *Raiamas salmohucius* AMNH 227488; (D) *Leptocypris weeksii* AMNH 236347.

July 2005, R. C. Schelly, U. K. Schliewen, A. I. Zamba, S. Ifuta, and J. Punga.

Paratypes.—Nine specimens, 53.9–96.0 mm SL: AMNH 236353, 3, 67.3–96.0 mm SL, same data as holotype; ZSM 34134, 53.9 mm SL, same data as holotype; MNHN 2006-0782, 82.6 mm SL, same data as holotype; MRAC 2006-12-P-01, 79.5 mm, same data as holotype; AMNH 236354, 1 alc, 1 CS, 84.8–91.0 mm SL, Democratic Republic of Congo, Inkisi River, near Kilemfu, rotenone

applied to a rocky riffle ending in a pool, 2 m maximum depth, 45°6.24'S, 15°4.70'E, 22 July 2005, R. C. Schelly, U. K. Schliewen, A. I. Zamba, S. Ifuta, and J. Punga; ZSM 34135, 76.5 mm SL, same data as AMNH 236354.

Diagnosis.—Distinguished from all congeners, except *R. senegalensis* and *R. batesii*, by an elevated number of pored lateral-line scales (65–68 vs. 60 or fewer). *Raiamas kheeli* is readily distinguished from both *R. senegalensis* and *R. batesii* by a lower



Fig. 5. *Raiamas kheeli*, new species AMNH 236352, holotype, 95.8 mm SL, Democratic Republic of Congo, small channel adjacent to main channel rapid, just below Inga intake canal.

anal-fin ray count (iii,12–13 vs. iii,15). *Raiamas kheeli* is further distinguished from *R. senegalensis* by the presence of a large terminal black spot at the caudal-fin base (vs. terminal spot absent), and from *R. batesii* by the presence of vertical barring on the flanks (vs. no flank markings). *Raiamas kheeli* is diagnosed by a unique configuration of lateral barring, consisting of a dominant row of 15–17 short ovoid bars or spots passing a little above mid-body level, and a secondary row of somewhat less distinct ovoid spots or bars positioned over the lateral line. The two rows are completely separate in adults, but often remain merged in juveniles.

Description.—Maximum size 96.0 mm SL. Counts and proportional measurements given in Table 1. Elongate, gracile species, with dorsal body profile more-or-less straight, ventral body profile somewhat convex from opercle to anal fin, maximum body depth 22.6% SL. Jaws elongate; lower jaw prominent with a pronounced symphyseal process and an articulation in line with posterior border of orbit. Upper jaw narrow with distal maxillary tip extending just beyond center of eye. Head relatively large (24.7–28.6, mean 27.3% SL).

Dorsal fin with ii–iii,7 rays, originating behind body center and in advance of anal-fin origin. Pectoral-fin tips extending almost to level of pelvic-fin insertion. Pelvic fins short, with I,8 rays, not reaching anal-fin origin. Anal fin with iii,13 (rarely 12) rays. Caudal fin deeply forked.

Gill rakers small and nub-like, becoming somewhat more elongate towards angle of arch. Usually 7–8 (occasionally 6) rakers on lower limb, invariably with an elongate raker in angle of arch, and one or two small epibranchial rakers.

Body scales relatively small. Pored scales in lateral line 65–68 (including scales extending on base of caudal fin), 12–13 scale rows between origin of dorsal fin and lateral line, 3–4 scale rows between lateral line and base of pelvic fin, 25–27 circumpeduncular scales. Pectoral axial scale

small, with acute border, measuring 26–28% of fin length. Pelvic axial scale, elongate, measuring 44–46% of fin length.

Coloration.—In life a colorful species (Fig. 6A). Base body coloration silvery, somewhat darkly counter-shaded with an orange sheen along the dorsal row of flank markings. Snout with an iridescent yellow spot. Iris uniformly silvery. Body with strongly marked lateral barring, consisting of a dominant row of 15–17 short ovoid bars or spots passing a little above mid-body level, and a secondary row of somewhat less distinct ovoid spots or bars positioned over the lateral line. The two rows are completely separate in adults, but often remain merged in juveniles. A large black terminal spot is present at the base of the caudal fin. Caudal fin yellowish along the margins of both lobes, dorsal fin slightly smoky grey, remaining fins pale and colorless. In preservation the base body coloration is creamy white ventrally, becoming darker dorsally. Infraorbital series and cheek silvery, iris white.

Osteology.—*Raiamas kheeli* exhibits all derived character states considered here to be diagnostic for the genus. These include an extensive pterosphenoïd-parasphenoïd contact (Fig. 3C, *5¹), an elongate and slender cleithrum (Fig. 3C, *6¹), an anterior hyomandibular articular facet borne on a cylindrical process, and widely separated from the posterior articular facet (Fig. 3C, *7¹), a posterior metapterygoid process that is extensive and spine-like (Fig. 3C, *8¹), and a slender and elongate maxillary shaft (Fig. 3C, *9¹). The infraorbital bones are of the “*Raiamas* type” (Howes and Teugels, 1989) with the third and fourth covering the cheek and leaving only a narrow naked area along the posteroventral border of the third infraorbital. Total vertebral number is 42–43 (4+17+21+1, 4+17+20+1, or 4+16+21+1).

Distribution and habitat.—Currently, *Raiamas kheeli* is known only from the type series collected at



Fig. 6. Coloration (immediately after capture). (A) *Raiamas kheeli*, new species; (B) *Raiamas christyi*; (C) *Raiamas buchholzi*; (D) *Leptocypris weeksii*.

two widely separated localities in the Lower Congo (Fig. 7), although continued collecting in the region will probably extend this range. Both collections were made in complex habitats composed of alternating riffles and pools. Near Inga, such habitat was part of a small channel connected to the mainstream Congo, flowing

through a large boulder-field. Near Kilemfu, a similar habitat was formed in the main channel of the Inkisi River at an isolated riffle formed by a short stretch of rocky substrate. In both cases, *R. kheeli* was captured in deeper stretches of open water in relatively fast-flowing waters.

TABLE 1. MORPHOMETRIC AND MERISTIC DATA FOR HOLOTYPE AND NINE PARATYPES OF *Raiamas kheeli*, NEW SPECIES.

	Holotype	Paratypes	Mean	SD
Standard length [mm]	95.8	53.9–96.0	78.1	
Percents of standard length				
BD, body depth	22.1	20.4–22.6	21.4	0.7
HL, head length	28.6	24.7–28.6	27.3	1.2
PdL, predorsal length	57.5	53.6–57.6	56.0	1.5
DL, dorsal-base length	10.3	9.9–11.5	10.6	0.6
AL, anal-base length	17.3	16.6–17.8	17.5	0.4
Percents of head length				
SnL, snout length	28.1	25.5–29.1	27.2	1.1
EyL, eye diameter	23.0	23.0–27.0	24.5	1.6
PoL, postorbital length	48.5	45.2–50.8	48.3	1.6
IoW, interorbital width	25.9	25.7–27.5	26.4	0.6
UjL, upper-jaw length	54.0	47.9–55.3	51.9	2.5
LjL, lower-jaw length	63.1	58.9–64.3	62.5	1.8
CpL, caudal-peduncle length	54.0	53.9–62.6	57.6	3.1
CpW, caudal-peduncle width	31.4	31.1–35.5	32.6	1.7
Vertebrae (total)	43	42 (3), 43 (6)		
LtL, lateral-line scales	68	65 (2), 66 (2), 67 (3), 68 (2)		
LtL-D, scales above LtL	13	12 (2), 13 (7)		
LtL-Pv, scales below LtL	3	3 (6), 4 (2)		
PdSc, predorsal scales	28	26 (1), 27 (3), 28 (3), 30 (1)		
CpSc, circumpeduncular scales	25	25 (6), 27 (2)		
Anal-fin rays	iii,13	iii,12 (2), iii,13 (7)		
Dorsal-fin rays	iii,7	iii,7 (9)		
Gill rakers, lower limb first arch	8	6 (1), 7 (4), 8 (3)		

Etymology.—This species is named in honor of Theodore W. Kheel in recognition of his enduring support for nature conservation and sustainable development around the globe.

MATERIAL EXAMINED

Barilius barna AMNH 13794 (CS); *Chelaethiops bibie* AMNH 226475 (alc, CS); *Chelaethiops elongatus* AMNH 6212 (alc, CS); *Danio albolineatus* AMNH 54630 (CS); *Danio malabaricus* AMNH

97548 (CS); *Leptocypris modestus* AMNH 5850 (alc, CS), AMNH 6049 (alc); *Leptocypris weeksii*, AMNH 227603 (alc, CS), AMNH 236347 (alc, CS), AMNH 227444 (alc, CS); *Leptocypris niloticus* AMNH 233696 (alc, CS); *Leptocypris lujae* AMNH 227476 (alc, CS); *Opsariichthys bidens* AMNH 10943 (CS); *Opsariichthys uncirostris* AMNH 227872 (CS); *Opsaridium microcephalum* AMNH 17871 (CS); *Opsaridium ubangiense* AMNH 232363 (alc, CS), AMNH 12411 (CS); *Opsaridium zambezense* AMNH 41586 (alc); *Raiamas ansorgii* ANSP 37923–25 (alc); *Raiamas bola* ANSP 90520 (alc); *Raiamas buchholzi* AMNH 232267(alc), AMNH 230749 (CS), AMNH 211408 (alc), AMNH 232380 (alc, CS); *Raiamas christyi* AMNH 236348 (alc), AMNH 236349 (alc, CS), AMNH 236350 (alc), AMNH 236351 (alc); *Raiamas guttatus* AMNH 13762 (alc); *Raiamas moorii* AMNH 217409 (alc); *Raiamas nigeriensis* AMNH 215357 (alc); *Raiamas salmolucius* AMNH 227488 (alc, CS), AMNH 227482 (alc); *Raiamas senegalensis* AMNH 226551 (alc), AMNH 226539 (CS); *Raiamas steindachneri* AMNH 32794 (alc).

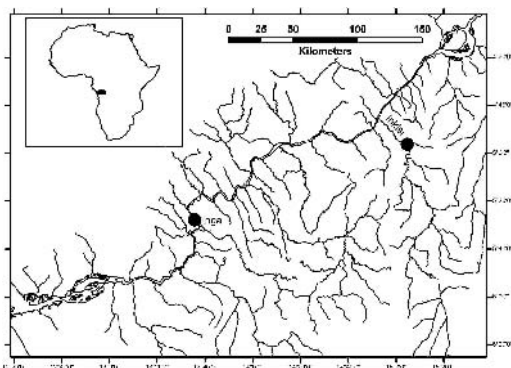


Fig. 7. Map of the lower Congo River drainage network with collection localities of *Raiamas kheeli*, new species indicated with black circles.

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