

ORIGINAL ARTICLE

Acrossocheilus multistriatus, a new species of barbine fish (Teleostei: Cyprinidae) from the Zhujiang River basin, South China

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Abstract A new barbine cyprinid fish, *Acrossocheilus multistriatus* sp. nov., is described from the Zhujiang River (Pearl River) basin in South China. It is separated from all other barred congeners except *A. monticola* by its unique coloration pattern of 8–12 vs. 5–7 vertical dark bars on the dorsum and flank. Although 8 vertical black bars are also present in specimens of *A. monticola*, the new species is distinct from it by having a well-developed (vs. poor-developed) lower lip, with or without a median interruption (vs. with a median interruption which wider than 1/2 mouth width) on lower jaw, the lower jaw entirely covered (vs. uncovered) by the lower lip, body depth 22.57%–25.22% SL (vs. 25.64%–32.26% SL). Additional characteristics as follows: last simple dorsal-fin ray soft without serration; dark stripes on membranes between dorsal-fin rays; dark stripes absent on membranes between anal fin rays; maxillary barbels longer than eye diameter, extending to posterior edge of eyes.

Key words Cyprinidae, *Acrossocheilus*, new species, South China.

1 Introduction

The cyprinid genus *Acrossocheilus* was erected by Oshima (1919) with *Gymnostomus formosanus* Regan, 1908 as the type species. The genus is restricted to Southern China (southern China, north to the Huai-He Basin), and the northern part of Vietnam and Laos (Wu, 1977; Kottelat, 2001a, b; Shan *et al.*, 1984; Shan *et al.*, 2000). *Acrossocheilus* can be distinguished from other genera of the subfamily Barbinae by having the following characters: a rostral fold present; lips fleshy and continuous around corners of mouth; lower lip with a median interruption; mouth inferior; horny sheath on lower jaw; two pairs of barbels; last simple ray of dorsal fin osseous, with a serrated or smooth posterior margin (Kottelat, 2000).

Kottelat (2001) suggested that *Acrossocheilus* could be tentatively divided into two species-groups: a barred/striped group (plain or inconspicuous dark stripe running along the lateral line on the flanks) and a non-barred group. Species of the non-barred group include *A. ikedai* (Harada, 1943) from Hainan Island, *A. xamensis* Kottelat, 2000 from Northern Laos and Yunnan, *A. cf. xamensis* from the Mekong drainage, *A. yunnanensis* (Regan, 1904) from Yunnan and Guizhou, and

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should include *A. malacopterus* Zhang, 2005 from Guangdong, Guangxi, Guizhou and Yunnan (Yuan *et al.*, 2006). Other species in the genus have vertical dark bars on flanks and are assigned to the barred group (Yuan *et al.*, 2006).

Despite efforts to clarify the relationships among members of *Acrossocheilus*, in particular those forms of the barred-group (Yuan *et al.*, 2006; Wang *et al.*, 2010; Yuan & Zhang, 2010a, b), systematics of the genus remains unresolved (Kottelat, 2001; Zhang, 2005). Recent studies revealed *A. paradoxus* (Günther, 1868) as a senior synonym of two previously recognized species, *A. formosanus* (Regan) and *A. labiatus* (Regan) (Sung *et al.*, 1993), while *A. stenotaeniatus* Chu & Cui has been suggested to be immature specimen of *A. longipinnis* (Nichols & Pope) (Yuan & Zhang, 2012). Yuan and Zhang (2010a, b) also argued that *A. kreyenbergii* (Regan, 1908) is a senior synonym of *A. cinctus*, while the two hitherto subspecific populations of *A. hemispinus* (*A. h. hemispinus* and *A. h. cinctus*) should merit full species status: *A. hemispinus* and *A. kreyenbergii*. So far, the currently recognized 14 barred species as follows: *A. beijiangensis*, *A. clivosius*, *A. fasciatus*, *A. hemispinus*, *A. iridescens*, *A. jishouensis*, *A. kreyenbergii*, *A. longipinnis*, *A. monticola*, *A. paradoxus*, *A. parallens*, *A. spinifer*, *A. wenchowensis*, *A. wuyiensis*.

While examining the fish collection from Guangxi, South China, we found specimens of *Acrossocheilus* that not assigned to any described species. Further examination and comparisons of these specimens revealed them as a new species described herein.

2 Materials and methods

Specimens were fixed in 10% formalin, rinsed, and transferred to preservative 70% ethanol and deposited at the fish collection of the School of Life Science, South China Normal University (SCNU). Measurements were taken with dial calipers and recorded to 0.01 mm. When possible, counts and measurements were made on the left side of the specimens. Predorsal length is the horizontal distance between the tip of the snout and dorsal-fin origin. Standard length (SL) is the distance from the anteriormost tip of the snout to the end of the hypural plate. Head length (HL) is the distance from tip of the snout to the posteriormost margin of opercular; subunits of the head are expressed as proportions of HL. Body depth (BD) is the vertical measurement from the dorsal profile of the fish where its height is greatest to a straight line to the ventral profile. HL and measurements of body parts are expressed as proportions of the SL. All the measurements were taken following Chen *et al.* (1998).

3 Taxonomy

Acrossocheilus multistriatus sp. nov. (Figs 1–4)

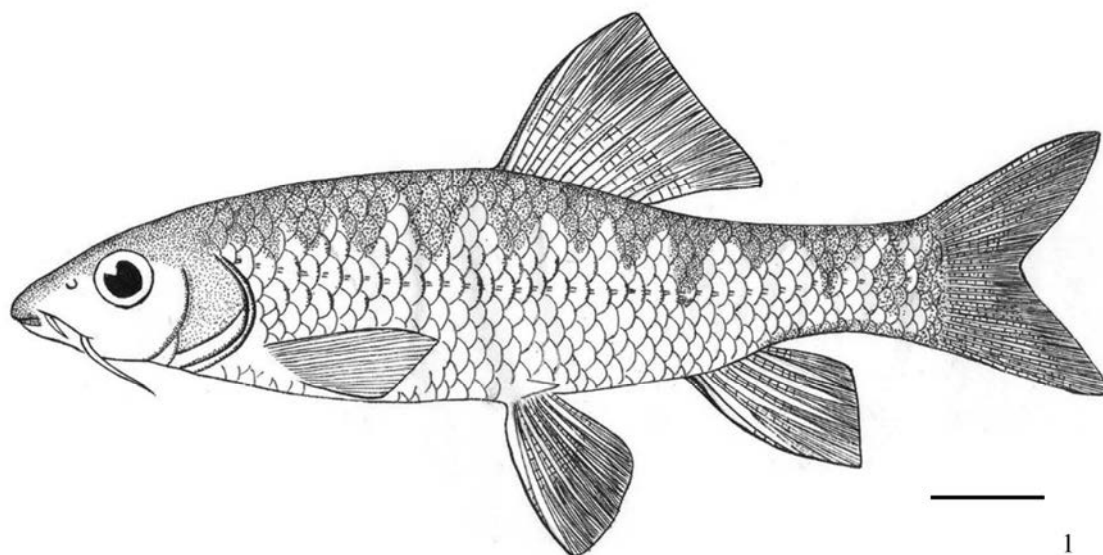
Holotype SCNU 1998080018, female, 80.63 mm, SL, 25°31'N, 109°50'E, Liujjiang drainage; Zhujiang (Pearl River) Basin, Longsheng County, Guangxi, China, Hong-Jing Li, August 1998.

Paratypes SCNU 1998080016, 1998080020, 1998080026, 1998080028–1998080029, 1998080033–1998080034, 1998080036, 8 specimens, 65.58–117.09 mm SL, same data as holotype.

Diagnosis. *A. multistriatus* sp. nov. is diagnosed from all other barred congeners except *A. monticola* by its unique coloration pattern of 8–12 vs. 5–7 vertical dark bars on the flank. Although 8 vertical black bars are also present in specimens of *A. monticola*, the new species is distinct from it by having a well-developed (vs. poor-developed) lower lip, with or without a median interruption (vs. with a median interruption which wider than 1/2 mouth width) on lower jaw, the lower jaw entirely covered (vs. uncovered) by the lower lip, body depth 22.57%–25.22% SL (vs. 25.64%–32.26% SL).

Description. Body elongate and laterally compressed. Greatest body depth less than head length. Dorsal profile slightly convex. Head moderately large; interorbital space slightly convex. Eye moderately large and located dorsolaterally. Mouth subterminal and horse-shoe shaped. Rostral fold present, overlying base of upper lip. Upper lip thick, fully adnate to upper jaw, continuous with lower lip around corners of mouth. Lower lip well-developed, with or without a median interruption on lower jaw, separated from lower jaw by a groove extending along full length of lower jaw. Lower jaw bearing horny sheath on its arched cutting edge and covered by lower lip. The ventral view of the head showing mouthpart structures is shown in Fig. 4. Two pairs of barbels; rostral pair shorter than eye diameter, maxillary pair longer than eye

diameter and reaching posterior edge of eyes. Air bladder bipartite, anterior chamber oval, and posterior one slender and twice as long as anterior chamber. Gill rakers sparse, short and small, outer gill rakers on first gill arch 10–11; inner gill rakers on first gill arch 14–15.



Figs 1–3. *Acrossocheilus multistriatus* sp. nov. 2. Holotype, SCNU 1998080018, female, 80.63 mm SL. 3. Paratype, SCNU 1998080033, indistinct longitudinal stripe along lateral line. Scale bars =1 cm.



Fig. 4. *Acrossocheilus multistriatus* **sp. nov.**, ventral views of head showing mouthpart structures.

Dorsal fin with 3 simple and 8 branched rays, last ray split to base; last simple ray soft and with no serrations along posterior margin, distal margin moderately concave, origin closer to caudal-fin base than to snout tip, or anterior to origin of pelvic fin. Pectoral fin with 1 simple and 15–16 branched rays; adpressed fin nearly reaching origin of pelvic fin. Pelvic fin with 1 simple and 8 branched rays; adpressed fin reaching beyond midway to anal-fin origin, but not as far as to anus. Caudal fin deeply forked.

Scales moderately large; those immediately above or below lateral line larger. Lateral line complete, with 38–39 perforated scales, extending medially along caudal peduncle; scale rows above and below lateral line 5 and 4, respectively. Predorsal scales 12–14, almost of same size as those on flank and not embedded underneath skin. Circumpeduncular scales 16. Pharyngeal teeth in three rows, tooth pattern 2, 3, 5-5, 3, 2 (3); teeth with pointed, curved and compressed tips.

Morphometric data of *Acrossocheilus multistriatus* **sp. nov.** are provided in Table 1.

Coloration in formalin. Body pale brown dorsally and yellowish ventrally. Eight to twelve dark vertical bars on dorsum and flanks, each bar 1–3 scales in width. All bars positioned above or reaching to lateral line: first bar above base of pectoral fin, second and third above pectoral fin, fourth to base of last simple dorsal-fin ray or immediately anterior to origin of pelvic fin; subsequent bars in a series from below base of dorsal fin to base of caudal fin. Bars are irregular in coloration; some not distinct in some specimens of type series. Indistinct longitudinal stripe extending along lateral line (Fig. 3) (also absent in some specimens). Pectoral, pelvic, and anal fins yellowish. Caudal fin grayish. Dark stripes on membranes between dorsal fin rays.

Distribution. Currently known from Huaping National Nature Reserve, located in between Longsheng and Lingui Counties, Guangxi, China. The type locality is at the upper reach of the Liujiang River, a tributary of Xijiang River flowing into Zhujiang (Pearl River) basin, the largest catchment basin in Southern China draining into the South China Sea.

Ecology. *Acrossocheilus multistriatus* **sp. nov.** was collected from rapid streams clean, highly oxygenated water, and a boulder/pebble/gravel substrate. It coexists with other species such as *Acrossocheilus parallens*, *Opsariichthys bidens*, *Zacco platypus*.

Etymology. The specific name is derived from the Latin *multi* (many) and *striatus* (bar), in allusion to the high number of vertical black bars on the flank as compared with all other barred congeneric species.

Table 1. Morphometric data for *Acrossocheilus multistriatus* sp. nov. ($n=9$)

	Holotype	Range	Mean \pm SD
% SL			
Body depth	25.14	22.57–25.22	23.63 \pm 1.06
Caudal peduncle length	19.37	18.61–21.33	19.47 \pm 0.95
Caudal peduncle depth	10.98	9.69–10.98	10.27 \pm 0.41
Dorsal fin length	19.32	19.04–21.55	19.89 \pm 1.20
Pectoral fin length	19.83	18.43–22.47	20.23 \pm 1.32
Pelvic fin length	18.08	16.16–19.78	18.70 \pm 1.19
Anal fin length	20.79	16.78–22.29	19.86 \pm 1.83
Predorsal length	49.93	49.30–51.97	50.08 \pm 1.33
Prepectoral length	25.57	23.24–28.53	26.10 \pm 1.66
Prepelvic length	50.63	49.59–53.26	51.75 \pm 1.40
Preanal length	70.76	69.12–75.92	72.18 \pm 1.99
% HL			
Head depth	70.17	64.64–72.98	71.10 \pm 4.92
Head width	52.51	42.25–55.17	49.21 \pm 4.77
Snout length	28.88	28.44–40.23	31.74 \pm 3.57
Barbel length	33.95	21.13–41.58	31.48 \pm 5.70
Eye diameter	26.30	19.40–26.30	23.54 \pm 2.70
Interorbital distance	37.22	32.65–41.13	37.41 \pm 3.03

Comparative materials

A. parallens. SCNU 2009101028–2009101036, 2009101068–2009101078, China: Guangdong, Heping County, Dong Jiang drainage, Zhu Jiang Basin; SCNU 20100502020, 20100502042, 20100502047, 20100502055, 20100502060–20100502062, 20100502064, 20100502081, China, Guangdong, Shixing County, Bei Jiang drainage, Zhu Jiang Basin; SCNU20130822 (topotype), China, Guangdong, Liuxi drainage, Zhu Jiang Basin.

A. kreyenbergii. SCNU 2010081001–2010081002, 2010081006–2010081014, China, Hunan, Longhui County, Zi Jiang drainage, Yangtze River Basin; SCNU 2010090001–2010090020, China, Guangxi, Longsheng County, Liu Jiang drainage, Zhu Jiang Basin.

A. beijiangensis. SCNU 2003101001–2003101010, China, Guangdong, Guitou County, Bei Jiang drainage, Zhu Jiang Basin. SCNU20131427 (topotype), China, Guangdong, Yangshan County, Bei Jiang drainage, Zhu Jiang Basin.

A. hemispinus. 20120028 (topotype), China, Fujian, Nanping County, Min Jiang Basin; SCNU 2010060118, 2010060134, 2010060212–2010060213, 2010060230, 2010060233, 2010060260, 2010060280, 2010060285, 2010060298, China, Fujian, Shaowu County, Min Jiang Basin.

A. iridescens. SCNU 2009100011, 2009100117, 2009100138, 2009100313, 2009100322, 2009100341, 2009100359, 2009100413, 2009100552, 2009100560, China, Guizhou, Libo County, Liu Jiang drainage, Zhu Jiang Basin.

A. jishouensis. SCNU 201109001–201109010 (topotype), China, Hunan, Fenghuang County, Yuan Jiang drainage, Yangtze River Basin; SCNU 0407053–0407055, China, Guizhou, Shibing County, Yuan Jiang drainage, Yangtze River Basin.

A. paradoxus. SCNU 2010041001–2010041011, China, Taiwan, Gaoxiong City, Gaoping River.

A. spinifer. SCNU 2010062301–2010062309 (topotype), China, Fujian, Shanghang County, Ting Jiang drainage, Han Jiang Basin.

A. wenchowensis. SCNU 2010071002–2010071010, 2010071012, 2010071041, China, Zhejiang, Suichang County, Ou Jiang Basin.

Table 2. Diagnostic features distinguishing *Acrossocheilus multistriatus* sp. nov. from *A. parallens*, *A. kreyenbergii*, *A. jishouensis*, *A. hemispinus*, *A. fasciatus* and *A. wenchowensis*.

Charecters	Color pattern on dorsum and flanks	Mouthpart structure	Last simple dorsal-fin ray	CMDR*	CMAR**	Maxillary barbels	Body depth in SL (%)	Distribution
<i>A. multistriatus</i> sp. nov.	Eight to twelve vertical dark bars, above or reaching lateral line; with or without a longitudinal black stripe extending along the lateral line on each side of the body	Lower lip well developed, with or without a median interruption on lower jaw, with horny edge on lower jaw arched and covered by lower lip	Soft without serration along posterior edge	Dark stripes	Without dark stripes	Longer than eye diameter and reaching to posterior edge of eyes	22.36–25.22 (mean 23.63±1.06)	Liujiang River (draining into Xijiang River)
<i>A. parallens</i>	Six vertical dark bars, all above lateral line; with or without a longitudinal black stripe extending along the lateral line on each side of the body	Lower lip well developed, with or without a median interruption on lower jaw, without horny edge on lower jaw arched and exposed or uncovered by the lower lip	Soft with or without serration along posterior edge	Without dark stripes	Without dark stripes	Shorter than eye diameter and not reaching anterior edge of eyes	29.31–36.23 (mean 30.28±2.36)	Pearl River and Hanjiang River basins
<i>A. kreyenbergii</i>	With six vertical dark bars which all above lateral line of juveniles; with a longitudinal black stripe extending along the lateral line on each side of the body of adult	Lower lip well developed, with or without a median interruption on lower jaw, with horny edge on lower jaw arched and exposed or uncovered by the lower lip	Strong with serration along posterior edge	Dark stripes	Without dark stripes	Shorter than eye diameter and not reaching anterior edge of eyes	30.08–34.56 (mean 31.53±1.52)	Xijiang River, Xiangjiang River and Ganjiang River
<i>A. jishouensis</i>	Six vertical dark bars, all above lateral line; with or without a longitudinal black stripe extending along the lateral line on each side of the body	Lower lip well developed, with or without a median interruption on lower jaw, without horny edge on lower jaw arched and exposed or uncovered by the lower lip	Soft with serration along posterior edge	Dark stripes	Dark stripes	Shorter than eye diameter and not reaching anterior edge of eyes	27.12–31.15 (mean 29.05±1.88)	Yuanjiang River, Yangtze River System
<i>A. hemispinus</i>	Six vertical dark bars, all above lateral line in juveniles; without vertical dark bars and longitudinal black stripe extending along the lateral line on each side of the body of adult	Lower lip well developed, with or without a median interruption on lower jaw, without horny edge on lower jaw arched and covered by the lower lip	Strong with serration along posterior edge	Without dark stripes	Without dark stripes	Approximate to eye diameter and not reaching anterior edge of eyes	28.42–35.14 (mean 32.57±2.20)	Minjiang River and Qiantangjiang River

Table 2 (continued)

Characters	Color pattern on dorsum and flanks	Mouthpart structure	Last simple dorsal-fin ray	CMDR*	CMAR**	Maxillary barbels	Body depth in SL (%)	Distribution
<i>A. fasciatus</i>	Six vertical dark bars, all extend to the abdomen in both of male and female; with or without a longitudinal black stripe extending along the lateral line on each side of the body of adult	Lower lip well developed, with a median interruption on lower jaw, with strong horny edge on lower jaw arched and exposed or uncovered by the lower lip	Soft with or without serration along posterior edge	Dark stripes	Without dark stripes	Longer than eye diameter and not reaching anterior edge of eyes	28.40–30.99 (mean 29.62±0.94)	Minjiang River, Qiantangjiang River, Oujiang River and Lingjiang River
<i>A. wenchowensis</i>	Six vertical dark bars, all extend to the abdomen in female, six vertical dark bars, all above lateral line in male; with or without a longitudinal black stripe extending along the lateral line on each side of the body of adult	Lower lip well developed, without a median interruption on lower jaw, without horny edge on lower jaw arched and covered by the lower lip	Strong with serration along posterior edge	Dark stripes	Without dark stripes	Longer than eye diameter and not reaching anterior edge of eyes	24.22–30.72 (mean 27.56 ±1.67)	Oujiang River

* CMDR: Coloration on membranes between dorsal fin rays.

** CMAR: Coloration on membranes between anal fin rays.

4 Discussion

Among the barred species of *Acrossocheilus* there are remarkable differences in the number of vertical black bars on the flank, a character that can be used with some degree of confidence to distinguish its species. The barred group can be divided into four sub-groups by Yuan *et al.* (2006) based on the vertical black bars: (1) five bars in *A. clivosius* (Lin, 1935) and *A. beijiangensis* (Wu & Lin) (each bar 3–5 scales in width), or the *A. iridescens* complex (each bar 6–8 scales in width); (2) five or six bars, each bar two scales in width in *A. fasciatus*, *A. hemispinus* (in juveniles only), *A. jishouensis*, *A. kreyenbergii*, *A. paradoxus*, *A. parallens*, *A. spinifer*, *A. wenchowensis*, and *A. wuyiensis*; (3) seven or eight bars, each bar 1–3 scales in width in *A. monticola*. The new species shows a new pattern, (4) eight to twelve bars, each bar 1–3 scales in width.

Further distinguished from the other barred species by the following characters: more slender (body depth 22.57%–25.22% SL vs. 29.31%–36.23% SL in *A. parallens*, 30.08%–34.56% SL in *A. kreyenbergii*, 24.22%–30.72% in *A. wenchowensis*, 27.12%–31.15% in *A. jishouensis*, 28.42%–35.14% in *A. hemispinus*, 28.40%–30.99% in *A. fasciatus*, see Table 2; 26.32%–31.25% in *A. iridescens* and 27.03%–33.33% in *A. beijiangensis*, see Shan *et al.*, 2000); maxillary barbels longer than eye diameter, extending to posterior edge of eyes (vs. shorter or approximate to eye diameter in *A. parallens*, *A. iridescens*, *A. beijiangensis*, *A. kreyenbergii*, *A. fasciatus*, *A. paradoxus*, *A. jishouensis*, *A. spinifer* and *A. wenchowensis*; extending to the leading edge of preoperculum in *A. wuyiensis*); with horny edge arched on lower jaw (vs. without horny edge arched on lower jaw in *A. parallens*, *A. jishouensis*, *A. hemispinus*, *A. wenchowensis*, *A. wuyiensis*, *A. spinifer*); the lower jaw entirely covered by the lower lip (vs. the lower jaw exposed or uncovered by the lower lip in *A. parallens*, *A. kreyenbergii*, *A. jishouensis*, *A. hemispinus*, *A. fasciatus*, *A. paradoxus*, *A. wuyiensis*, *A. iridescens*, *A. monticolus*).

Acrossocheilus multistriatus **sp. nov.** resembles *A. parallens* morphologically in the possession of a soft last simple dorsal-fin ray, and vertical bars that do not extend below lateral line; and to *A. parallens*, *A. kreyenbergii*, *A. jishouensis*, *A. fasciatus*, *A. wenchowensis* in with or without a longitudinal black stripe extending along the lateral line on each side of the body; and to *A. hemispinus*, *A. jishouensis*, *A. fasciatus*, *A. wenchowensis* in dark stripes on membranes between dorsal fin rays. Table 2 summarizes diagnostic features of *A. multistriatus* **sp. nov.** relative to *A. parallens* and *A. kreyenbergii*, *A. jishouensis*, *A. hemispinus*, *A. fasciatus*, *A. wenchowensis*.

Conventionally, the distance between the lobes of the lower lip, color pattern and serrations and stiffness of the last simple dorsal-fin ray have been used to distinguish species of the genus *Acrossocheilus*. However, more recent studies have shown that serration and stiffness of dorsal-fin rays undergo ontogenic changes could not be used for diagnosis of species (Sung *et al.*, 1993; Kottelat, 2001; Yuan, 2005; Yuan *et al.*, 2006; Wang *et al.*, 2010; Yuan & Zhang, 2010a, b). While the present new species can readily be identified by its distinct color pattern, our understanding of the systematic relationships and their diagnosis from other species with less distinctive characters may be greatly augmented with the aid of molecular studies in combination with conventional taxonomic methods.

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