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Re-description of the catfish species *Liobagrus kingi* Tchang, 1935 (Pisces: Amblycipitidae) from the upper Chang-Jiang basin, China

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Abstract

The identity and validity of *Liobagrus kingi* Tchang, 1935 remain contentious to date due to its inaccurate original description. A re-description is provided here for this species based on our examination on its type, hitherto deposited in ASIZB and available topotypic material. It is confirmed that *L. kingi* is a species with a serrated posterior edge of the pectoral-fin spine and distinct from the sympatrically existing species *L. nigricauda*. Comments on former recognitions of specimens from the upper Chang-Jiang basin as *L. kingi* are presented.

Key words: *Liobagrus*, type specimen, species identification

Introduction

Liobagrus kingi is an amblycipitid catfish so far known from the upper Chang-Jiang (Yangtze River) basin in Southwest China. It was initially described by Tchang (1935) on the basis of a single specimen collected from the southern part of Lake Dianchi at Tsingning (today's Jinning), Yunnan Province. This species was also recorded from the lake by Chu and Chen (1990) and Chen (1998). Ding (1994) also reported as *L. kingi* two specimens caught from a tributary flowing into the Jinsha-Jiang in Huidong County, Sichuan Province, as did Chu *et al.* 1999 for 11 specimens from Kunming City, Fumin and Yongren counties in Yunnan Province. The latest record of the species from the upper Chang-Jiang basin in Sichuan Province came from Jia *et al.* (2013), who determined its complete mitochondrial genome.

Nonetheless, the identity and validity of *L. kingi* remain contentious. The original description of this species stated that it possessed a smooth posterior edge of the pectoral-fin spine and a dorsal fin with a black median band and yellowish proximal and distal bands. In contrast, specimens identified by Chu and Chen (1990) under the name of *L. kingi* had a serrated posterior edge of the pectoral-fin spine. This is the case for specimens caught by Ding (1994) from the Jinsha-Jiang basin in Sichuan Province and also for those by Chu *et al.* (1999) from Kunming City, Fuming and Yongren counties. Chen (1994) questioned the validity of *L. kingi*, claiming that it, with a serrated posterior edge of the pectoral-fin spine, was a junior synonym of *L. nigricauda*, a species originally described by Regan (1904) based on two specimens of 64 and 96 mm in total length (TL) caught from the lake “Sea of Tien” (now Lake Dianchi), on the north shore of which the city of Yunnan Fu (today's Kunming City) is situated. Recently, Sun *et al.* (2013) regarded *L. kingi* as a valid species, but with a smooth posterior edge of the pectoral-fin spine, and concluded that the species currently recognized under the name of *L. kingi* did not fit the original description by Tchang (1935).

We examined the holotype of *L. kingi*, which is stored in the collection at the Institute of Zoology, Chinese Academy of Sciences in Beijing (ASIZB), and two topotypic specimens collected by Chu and Chen (1990) from Lake Dianchi. It is affirmed that *L. kingi* is a species with a serrated posterior margin of the pectoral-fin spine. The aim of the present study is to present a re-description of *L. kingi* and clarify the taxonomic confusion surrounding this species.

Material and methods

All measurements and counts were made on the left side of individuals whenever possible. Thirty-two measurements were made point-to-point with digital calipers and data were recorded to the nearest 0.1 mm. All fin-ray counts were made under a binocular dissecting microscope utilizing transmitted light, and the last two elements of each fin were counted as one ray. Measurements of parts of the head were expressed as percentages of the head length (HL). HL and measurements of other parts of the body were presented as proportions of the standard length (SL). The specimens examined in the present investigation are stored in the collections of the Institute of Zoology, Beijing (ASIZB), Kunming Institute of Zoology, Kunming (KIZ) and Institute of Hydrobiology, Wuhan (IHB).

Liobagrus kingi Tchang, 1935

(Fig. 1)

Liobagrus kingi Tchang, 1935: 95 (Tsingning, Yunnan Province); Chu and Chen, 1990: 169 (Lake Dianchi in Kunming City); Ding, 1994: 472 (Huidong County, Sichuan Province); Chen, 1998: 291 (Lake Dianchi in Haigeng County, Kunming City); Chu *et al.* 1999: 105 (Kunming City, Fumin and Yongren counties in Yunnan Province).

Diagnosis. A member of the species group of *Liobagrus* diagnosed by having a serrated posterior margin of the pectoral-fin spine. *Liobagrus kingi*, together with *L. chenghaiensis*, is distinguished from all other species of this group by having fewer anal-fin rays (10–12 vs. 13–19) (Table 1). *Liobagrus kingi* is distinct from *L. chenghaiensis* in having a rounded (vs. sub-truncate) caudal fin, vent positioned closer to the anal-fin origin than to the pelvic-fin insertion (vs. equidistant from the pelvic-fin insertion and the anal-fin origin), maxillary barbels not extending to (vs. reaching) the pectoral-fin insertion (Table 1).

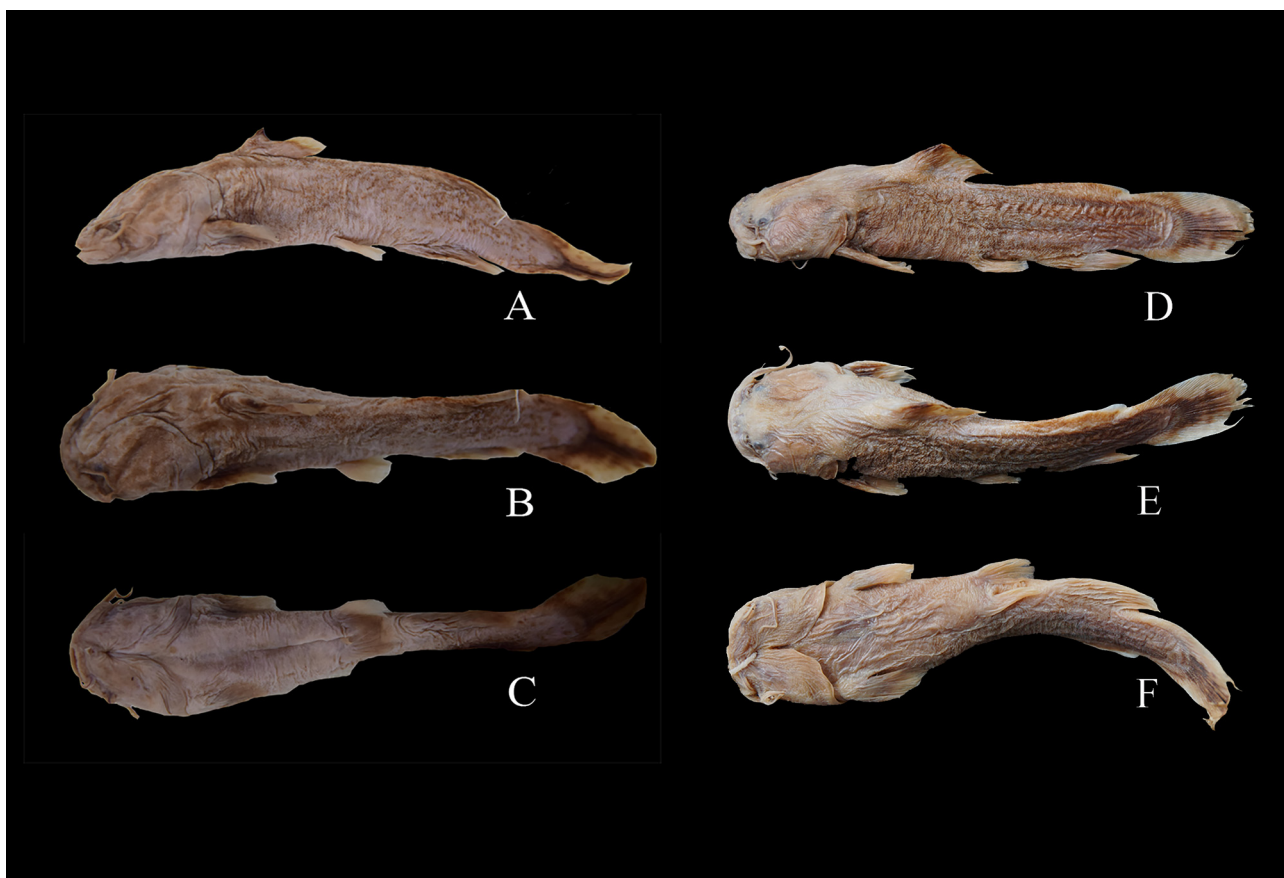


FIGURE 1. Lateral (A, D), dorsal (B, E) and ventral (C, F) views of *Liobagrus kingi*: ASIZB 19825 (11673) (ABC), holotype, 89.7 mm, China, Yunnan Province, Jinning County; KIZ 1960000612 (DEF), 67.6 mm, China, Yunnan Province.

TABLE 1. Comparisons of major diagnostic characters for species of *Liobagrus* with a serrated posterior edge of the pectoral-fin spine. Numbers of specimens examined are in parentheses.

Character	<i>L. marginatus</i>	<i>L. nigricauda</i>	<i>L. kingi</i>	<i>L. andersoni</i>	<i>L. chenghaiensis</i>
Upper/lower jaw in length	≤ 1	< 1 ^a	≤ 1	≤ 1	≤ 1
Marked incision at confluence between adipose and caudal fin	Present	Absent ^a	Present	Present	Present
Caudal-fin shape	Sub-truncate	Rounded ^a	Rounded	Sub-truncate	Sub-truncate
Serrations along posterior edge of pectoral-fin spine	3–4 (17)	>0 ^b	2–4 (3)	0–3 (4) ^f	2–5 (18) ^c
Post-Weberian Vertebrae	34–38 (17)	Unknown	Unknown	39–40 (27) ^d	35–39 (18) ^c
Anal-fin rays	13–16 (15)	15 ^a	11–12 (3)	15–16(5)	10–12 (18) ^c
Vent location	Equidistant from pelvic-fin insertion and anal-fin origin	Closer to pelvic-fin insertion than to anal-fin origin	Closer to anal-fin origin than to pelvic-fin insertion	Closer to anal-fin origin than to pelvic-fin insertion	Equidistant from pelvic-fin insertion and anal-fin origin
Maxillary barbels	Reaching pectoral-fin insertion or beyond	Unknown	Not extending to pectoral-fin insertion	Reaching pectoral-fin insertion or beyond	Reaching pectoral-fin insertion or beyond
Pectoral-fin spine length as %SL	6.8–11.3	Unknown	7.2–10.6	6.0–8.4	7.6–10.1
Dorsal-fin spine length as %SL	6.6–11.5	Unknown	8.0–12.3	8.1–9.5	7.0–10.8
Caudal-fin length as %SL	14.5–19.7	18.1–18.2 ^b	17.6–19.1	15.8–21.7	17.4–20.1

TABLE 1. (continued). Comparisons of major diagnostic characters for species of *Liobagrus* with a serrated posterior margin of the pectoral-fin spine.

Character	<i>L. mediadiposalis</i>	<i>L. obesus</i>	<i>L. somjinensis</i>	<i>L. hyeongsanensis</i>
Upper/lower jaw in length	> 1	= 1	> 1	> 1 ^f
Marked incision at confluence between adipose and caudal fins	Present	Absent	Present	Absent ^f
Caudal-fin shape	Sub-truncate	Rounded	Sub-truncate	Rounded ^f
Serrations along posterior edge of pectoral-fin spine	4–6 ^f	3–5 (15) ^d	4–6 (22) ^c	2–3 (21) ^f
Number of post-Weberian Vertebrae	40–44 (25) ^d	38–40 (15) ^d	38–44 (22) ^c	38–41 (21) ^f
Anal-fin rays	13–14 (5)	15–17 (4)	14–16 (4)	15–18 (21) ^f
Vent location	Closer to pelvic-fin insertion than to anal-fin origin	Closer to anal-fin origin than to pelvic-fin insertion	Closer to pelvic-fin insertion than to anal-fin origin	Unknown
Maxillary barbels	Reaching base of pectoral-fin spine	Reaching base of pectoral-fin spine	Reaching base of pectoral-fin spine	Reaching base of pectoral-fin spine ^f
Pectoral-fin spine length as %SL	7.3–10.2	9.0–11.1	11.0–12.5	3.7–6.5 ^f
Dorsal-fin spine length as %SL	8.8–11.5	8.0–10.4	10.8–12.5	3.2–6.8 ^f
Caudal-fin length as %SL	20.8–24.3	16.2–21.0	18.1–20.2	14.9–18.2 ^f

Notes: data from a, Regan (1904); b, Wright and Ng (2008); c, Sun *et al.* (2013); d, Son *et al.* (1987); e, Park *et al.* (2010); f, Kim *et al.* (2015).

Description. Morphometric data for the holotype and two topotypic specimens are summarized in Table 2. See Figure 1 for general body appearance. Body elongate; anteriorly wide and posteriorly increasingly compressed to caudal fin. Predorsal profile gradually sloping ventrally from dorsal-fin origin to occiput, becoming more convex and abruptly declining from occiput to posterior margin of eye; slope declining with profile becoming slightly convex from posterior margin of eye to snout tip. Ventral profile nearly straight from head to anal-fin origin and progressively sloping upwards along anal-fin base; slightly concave from posterior end of anal-fin base to origin of ventral procurent caudal-fin rays. Lateral line short with 5–6 pores, midlateral; extending to vertical through, or slightly behind, base of dorsal-fin spine.

Head depressed and broad, much wider than deep. Snout broadly rounded when viewed dorsally and subconical when viewed laterally. Anterior nostril tubular, rim with fleshy flap forming short tube; posterior nostril pore-like and located immediately anterior to eye; rim posteriorly confluent with nasal-barbel base. Eye small, dorso-laterally positioned immediately behind posterior nostril, subcutaneous and ovoid. Interorbital space flattened to slightly convex. Gill membranes narrowly joined at isthmus.

Mouth terminal. Lips thickened and papillated. Jaws covered by lips, upper and lower jaws of equal length. Premaxillary and mandibular toothpads broadly curved with villiform or setiform teeth. Four pairs of barbels; nasal pair small, thread-like, extending beyond posterior edge of eye, but not to pectoral-fin insertion; maxillary pair slender, not reaching pectoral-fin insertion; outer mental pair extending to pectoral-fin insertion, but not reaching posteriormost margin of preoperculum; inner mental barbels nearly half or two-thirds of outer mental-barbel length, approaching gill membrane margin at isthmus, but not pectoral-fin insertion.

Dorsal fin II, 6 (3); origin nearer to snout tip than to adipose-fin origin, above middle pectoral-fin spine or closer to pectoral- than to pelvic-fin insertion; distal edge convex; tip of depressed fin rays not reaching pelvic-fin insertion. Dorsal-fin spine covered by thick skin, straight, with a smooth anterior and posterior margin, nearly half of longest branched dorsal-fin ray, slightly longer than pectoral-fin spine. Adipose fin long at base, low in depth, posteriorly continuous with caudal fin, but with a marked incision at confluence; originating opposite to vent or anterior to vertical through tip of depressed pelvic-fin rays. Pectoral fin I, 7 (3), inserted slightly anterior to vertical through posterior margin of operculum, partially covered by opercular membrane; tip of depressed fin extending to middle of dorsal-fin base. Pectoral-fin spine having a smooth anterior and serrated posterior margin, sharp with deep grooves along shaft as well as dorsal-fin spine. Pelvic fin i, 5 (3), located posterior to vertical through tip of depressed dorsal fin; inserted closer to caudal-fin base than to snout tip; tip of depressed fin rays extending to vent, but not to anal-fin origin. Vent located closer to anal-fin origin than to pelvic-fin insertion. Anal fin with 11 (holotype) or 12 (topotype) rays; origin closer to pelvic-fin insertion than to caudal-fin base; tip of depressed fin rays reaching origin of ventral procurent caudal-fin rays; longer than dorsal fin in basal length, and shorter than adipose fin in basal length; distal margin rounded. Caudal fin rounded.

Coloration in preservative. In terms of original description, body greyish and marbled with black spots. Dorsal fin yellowish with a medial black band; pectoral fin black basally and yellowish distally; pelvic and anal fins yellowish, marbled with blackish spots; caudal fin black, but with yellowish upper, lower and posterior margins.

Distribution. Known only from the upper Chang-Jiang basin including Lake Dianchi (Fig. 2).

Material examined. *Liobagrus kingi*: ASIZB 19825 (11673), holotype, 89.7 mm SL, Lake Dianchi, Yunnan Province; KIZ 1960000611–2, topotypes (2) 67.6–75.9 mm SL.

Discussion

The original description of *L. kingi* stated that the holotype was deposited in the Zoological Museum of Fan Memorial Institute of Biology. It seemed to Chen (1994) that the type of this species was unable to be tracked down because of the dissolution of this institution. The type specimen of *L. kingi* is actually deposited in the fish collection in the Institution of Zoology, Chinese Academy of Sciences, in Beijing, one of several descendant institutions from the Fan Memorial Institute of Biology, and its catalogued number is ASIZB 19825 (11673) (Ye *et al.* 2016).

Liobagrus kingi, in terms of the original description, had a smooth posterior edge of the pectoral-fin spine. However, Chen (1994) assumed that the smooth pectoral-fin spine of this species was an observation error. Most

Chinese workers regarded *L. kingi* as a species with a serrated pectoral-fin spine (Chu & Chen 1990, Ding 1994, Chen 1998, Chu *et al.* 1999). Sun *et al.* (2013) followed the original description to insist that *L. kingi* had a smooth pectoral-fin spine. The first author's examination on the holotype of *L. kingi* found that it has a serrated posterior edge on the pectoral-fin spine, confirming that the original description of *L. kingi* was inaccurate.

TABLE 2. Morphometric data of *Liobagrus kingi*

Character	Holotype	Topotypes (n=2)	
	ASIZB19825 (11673)	KIZ1960000611	KIZ1960000612
Standard length (mm)	89.7	75.9	67.6
% of standard length			
Body depth	18.7	21.6	15.8
Head length	27.2	27.7	28.9
Predorsal length	35.7	34.8	36.3
Prepectoral length	22.9	22.8	25.3
Prepelvic length	51.2	53.8	54.6
Preanal length	64.0	68.2	69.0
Dorsal- to adipose-fin origin	33.4	28.1	27.7
Pectoral-fin insertion to anal-fin origin	40.9	46.7	46.0
Pelvic-fin insertion to anal-fin origin	12.6	14.0	15.5
Pelvic-fin insertion to caudal-fin origin	48.9	47.2	47.7
Dorsal-fin base length	13.5	12.9	14.8
Anal-fin base length	15.6	18.5	15.3
Adipose-fin base length	25.2	23.6	24.9
Caudal-peduncle length	17.3	15.3	15.3
Caudal-peduncle depth	11.9	11.4	10.4
Pelvic-fin insertion to vent	5.6	7.0	9.2
Vent to anal-fin origin	5.2	6.1	6.6
Dorsal-fin spine length	8.8	8.0	12.3
Pectoral-fin spine length	8.2	7.2	10.6
Caudal-fin length	17.6	17.8	19.1
% of head length			
Head width	90.0	93.3	85.4
Head depth	59.1	55.9	45.8
Snout length	28.7	28.1	20.6
Mouth width	56.5	46.9	47.8
Interorbital width	31.9	32.7	35.8
Nasal-barbel length	46.5	48.5	47.7
Maxillary-barbel length	49.6	46.4	66.6
Inner mandibular barbel length	35.8	37.8	36.7
Outer mandibular barbel length	54.0	54.2	69.9
Width between anterior nares	19.0	16.5	19.4
Width between postoral nares	29.0	33.2	28.9

Prior to the discovery of *L. kingi* by Tchang (1935) from Lake Dianchi, Regan (1904) described two specimens from this lake as a new species: *L. nigricauda*. No mention was made in its original description about whether the posterior edge of the pectoral-fin spine was smooth or serrated. Chen's (1994) examination of the type specimens

of *L. nigricauda* determined that it has a serrated posterior edge of the pectoral-fin spine. He further proposed that *L. kingi* was a junior synonym of *L. nigricauda* because no prominent differences were found between both based on the original description and illustration of the former and the type material of the latter. Although the type of *L. nigricauda* (BMNH 1904.1.26.42) was not directly examined in this study, examination of its photographs available on the ACSI website (<http://acsi.acnatsci.org/base/getthumbnail.php?mode=original&target=132174>) showed that this species has a more posteriorly positioned anus closer the posterior end of the pelvic-fin base than to the anal-fin origin. In addition, the original description of *L. nigricauda* clearly showed that the adipose fin was confluent with the caudal fin (or the dorsal pre-current rays of the caudal fin) and had 15 branched anal-fin rays. By contrast, *L. kingi*, on the basis of our examination of the type and two available topotypic specimens, has a striking incision at the confluence between the adipose and caudal fins, 11–12 branched rays of the anal fin, and a vent located closer to the anal-fin origin than to the posterior end of the pelvic-fin base. No doubt, *L. kingi* is a species distinct from *L. nigricauda*.

The present study affirms previous recognitions of materials from the upper Chang-Jiang basin as *L. kingi* by most Chinese authors. Although Tchang's (1935) original description of this species was inaccurate in its description of the posterior margin of the pectoral-fin spine, its accompanying illustration showed that there was a prominent incision at the confluence between the adipose and caudal fins, a rounded caudal fin and an anus situated closer to the anal-fin origin than to the posterior end of the pelvic-fin base. These characters were considered as diagnostic for *L. kingi* by Chinese researchers such as Chu and Chen (1990), Ding (1994), Chen (1998) and Chu *et al.* (1999). Sun *et al.* (2013), misled by the original description and their observation error, incorrectly considered *L. kingi* as a species with a smooth posterior margin of this spine, but their diagnosis of *L. nigricauda* contrasted with that of these authors. As delimited by Sun *et al.* (2013) and also in the present study, *L. nigricauda* is endemic to Lake Dianchi, but known only by its original account. Specimens from the upper Chang-Jiang basin exclusive of the lake were misidentified. Further study is urgently needed to determine the taxonomic status as specimens from this basin become available.

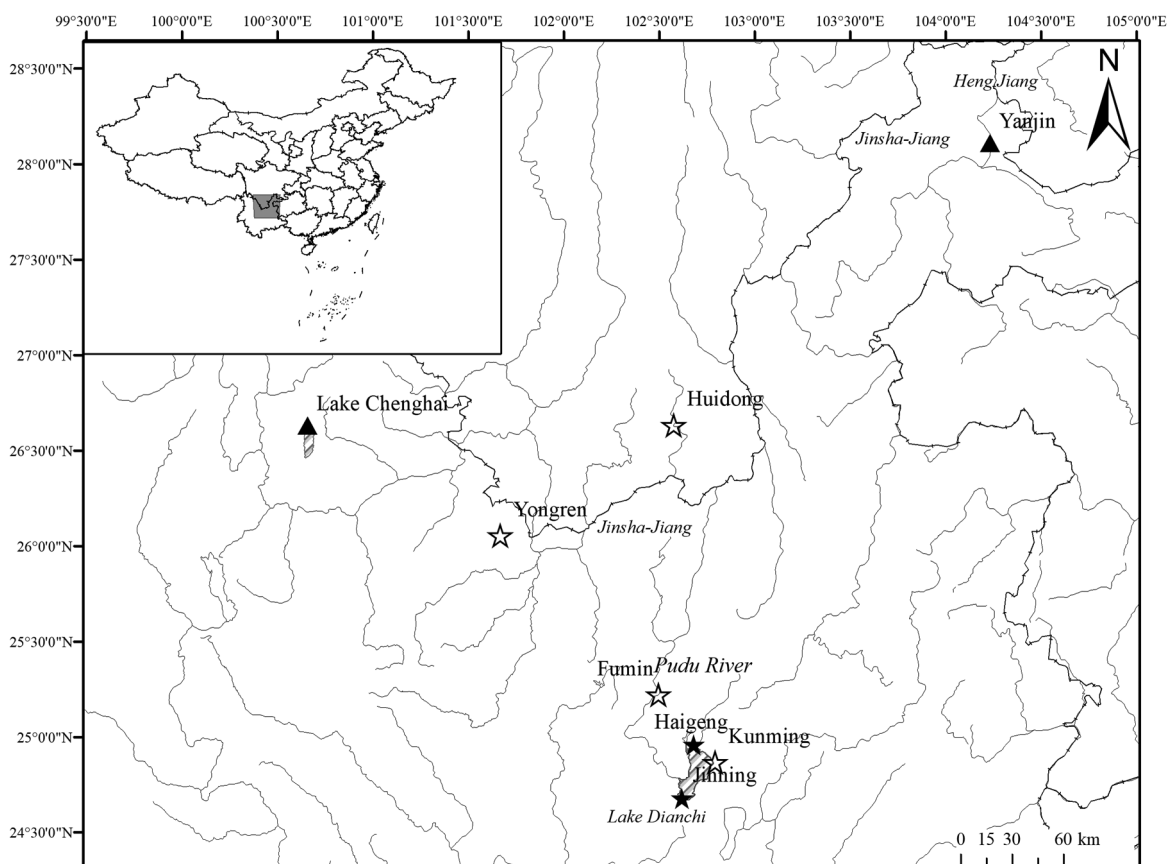


FIGURE 2. Distribution of *Liobagrus kingi* (★, ☆) and *Liobagrus chenghaiensis* (▲) in China. ▲ and ▲, localities of examined specimens; ☆, historical records (Chen 1998, Chu & Chen 1990, Ding 1994).

Jia *et al.* (2013) determined the complete mitochondrial genome sequence of the sample identified by them as *L. kingi* from the upper Chang-Jiang basin, but without precise location. In Huang *et al.*'s (2017) Bayesian inference phylogenetic tree based on mitogenome sequence for *L. stanyi* and other eight congeneric species, *L. kingi* was sister to *L. marginatus*, a widely distributed species from the upper Chang-Jiang basin. This pair was recovered in our phylogenetic trees inferred from COI and *cyt. b* genes (not shown here). The pairwise genetic distance between both species was 0.4% and 4.0%, respectively, for these two genes. Thereby, it is not easy to determine if the sample previously identified as *L. kingi* by Jia *et al.* (2013) is conspecific with *L. marginatus* or not, particularly when this sample is inaccessible to us.

Liobagrus chenghaiensis was originally described from Lake Chenghai, an inner lake that has a historical connection with the Jinsha-Jiang (Sun *et al.* 2013). In terms of its original description, this species also has a serrated posterior margin of the pectoral-fin spine, and a free apex on the posterior margin of the adipose fin. Our examination found that these two characters are present in six specimens identified by Chu and Chen (1990) as *L. marginatus* from the Jinsha-Jiang at Yanjin County, Yunnan Province; so these specimens are conspecific with *L. chenghaiensis*. Evidently, this species and *L. kingi* overlap in their distributions (see Fig. 2). *Liobagrus kingi* differs from *L. chenghaiensis* in having a rounded (vs. sub-truncate) caudal fin, a vent positioned closer to the anal-fin origin than to the pelvic-fin insertion (vs. equidistant between the pelvic-fin insertion and the anal-fin origin), and maxillary barbels not extending to (vs. reaching) the pectoral-fin insertion.

Comparative material

Liobagrus kingi: ASIZB 19825 (11673) (1) 89.7 mm SL; 1933.11; China: Yunnan Province, Jinning County, Lake Dianchi, about 103°E 25°N; KIZ 1960000611–0612 (2) 67.6–75.9 mm SL, 1960; China: Yunnan Province, Haigeng County, Lake Dianchi, about 103°E 25°N.

Liobagrus marginatus: IHB 2013083083–3084, 3087, 3091, 3094–3097, 3099 (10) 74.7–99.2 mm SL, 2013.08; China: Chongqing Municipality, upper Chang-Jiang basin; IHB 2013083117–3134, 2013083074–3082 (26) 67.1–125.8 mm SL, 2013.08; China: Sichuan Province, Ya'an City, Min-Jiang of upper Chang-Jiang basin.

Liobagrus chenghaiensis: IHB 81?2802–2803, 2805–2808, 2811, 2813–2816, 2818 (12) 67.6–79.9 mm SL, 1981.08; China: Yunnan Province, Lake Chenghai, about 101°E 27°N; KIZ 1982002784–2785, 2792, 2794, 2797, 2801 (6) 51.1–101.2 mm SL, 1982; China: Yunnan Province, Yanjin County, Jinsha-Jiang, upper Chang-Jiang basin.

Liobagrus obesus: IHB1986V10001–4 (4) 65.6–90.2 mm SL, 1986.05.10; South Korea: Okcheon-gun, Chungcheongbuk-do, Geum River.

Liobagrus mediadiposalis: IHB 1989IV27001–5 (5) 69.9–86.5 mm SL, 1989.04.04; South Korea: Bonghwa-gun, Gyeongsangbuk-do, Nakdong River.

Liobagrus somjinensis: IHB 1988III27001–4 (4) 83.4–87.8 mm SL, 1988.03.27; South Korea: Sunchang-gun, Jeonla buk-do, Somjin River.

Liobagrus andersoni: IHB 1981?9001–5 (5) 73.3–91.4 mm SL, 1987.07.09; South Korea: Pyeongchang-gun, Gangwon-do, Han River.

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