

Letter to the editor

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## A new genus and species of disc-bearing Labeoninae (Teleostei: Cypriniformes) from Guangxi, China

### DEAR EDITOR,

*Guigarra cailaoensis* sp. nov., a new genus and species of Labeoninae, was collected from Guangxi Zhuang Autonomous Region, China. It differs from all other genera within Labeoninae by a unique combination of the following characters: (1) rostral cap smooth with posterior margin slightly serrated; (2) upper lip well developed and covering most of upper jaw; (3) gular disc present with crescentic torus, not forming horseshoe shape; (4) boundaries of torus, labrum, and pulvinus on gular disc inconspicuous; (5) posterior edge of labrum free, without notch. Molecular phylogenetic analysis of three gene datasets indicated that the new genus formed a monophyletic clade and was closely related to *Discogobio* and *Discocheilus*. Both morphological and molecular phylogenetic analyses indicated that *Guigarra cailaoensis* sp. nov. differs from all known labeonin genera and is thus described here as a new genus and species.

Labeoninae is one of the most diverse subfamilies of Cyprinidae, comprising about 40 genera and 400 species, widely distributed from Asia to Africa (Yao et al., 2018; Zhang et al., 2000). Most fish in this subfamily are specifically adapted to fast-flowing freshwater (Zhang et al., 2000), and therefore present highly divergent oromandibular structures, which are important for genus identification (Zhang et al., 2000; Zheng et al., 2012). To better understand its phylogenetic relationships and taxonomic status, various studies on Labeoninae morphology and molecular phylogeny have been conducted, verifying its monophyly (Chen et al., 1984; Stiassny & Getahun, 2007; Tang et al., 2009; Yang & Mayden, 2010; Yang et al., 2012, Zheng et al., 2010; 2012; 2016). The phylogenetic relationships have been further clarified with increasing species sampled, Yang et al. (2012) dividing Labeoninae into four major clades. Subsequent studies on character evolution of Labeoninae based on

molecular phylogeny have indicated that the oromandibular structures evolved in parallel several times (Zheng et al., 2012). As shown from molecular phylogeny, although morphological characters, especially oromandibular structures, cannot reflect genetic relationships, they can distinguish genera and species. (Zheng et al., 2012, 2016).

In the past few years, new freshwater fish species have been consistently described from the Guangxi Zhuang Autonomous Region in China, such as *Lanlabeo duanensis* (Yao et al., 2018). Recently, new specimens of Labeoninae with unique morphological characters were collected in this area. Both morphology and molecular phylogeny indicated that these specimens represented an undescribed genus and species, named *Guigarra cailaoensis* sp. nov., which is described herein.

Further details are provided in the Supplementary Materials and Methods. Counts and measurements followed Kottelat (2001), with some adjustments. Three genes (*COI*, *cyt b*, and *Rag 1*) were used to construct the phylogenetic tree in this study.

### Taxonomy

#### *Guigarra* gen. nov.

**Type species:** *Guigarra cailaoensis* sp. nov., new species (Figure 1A–C)

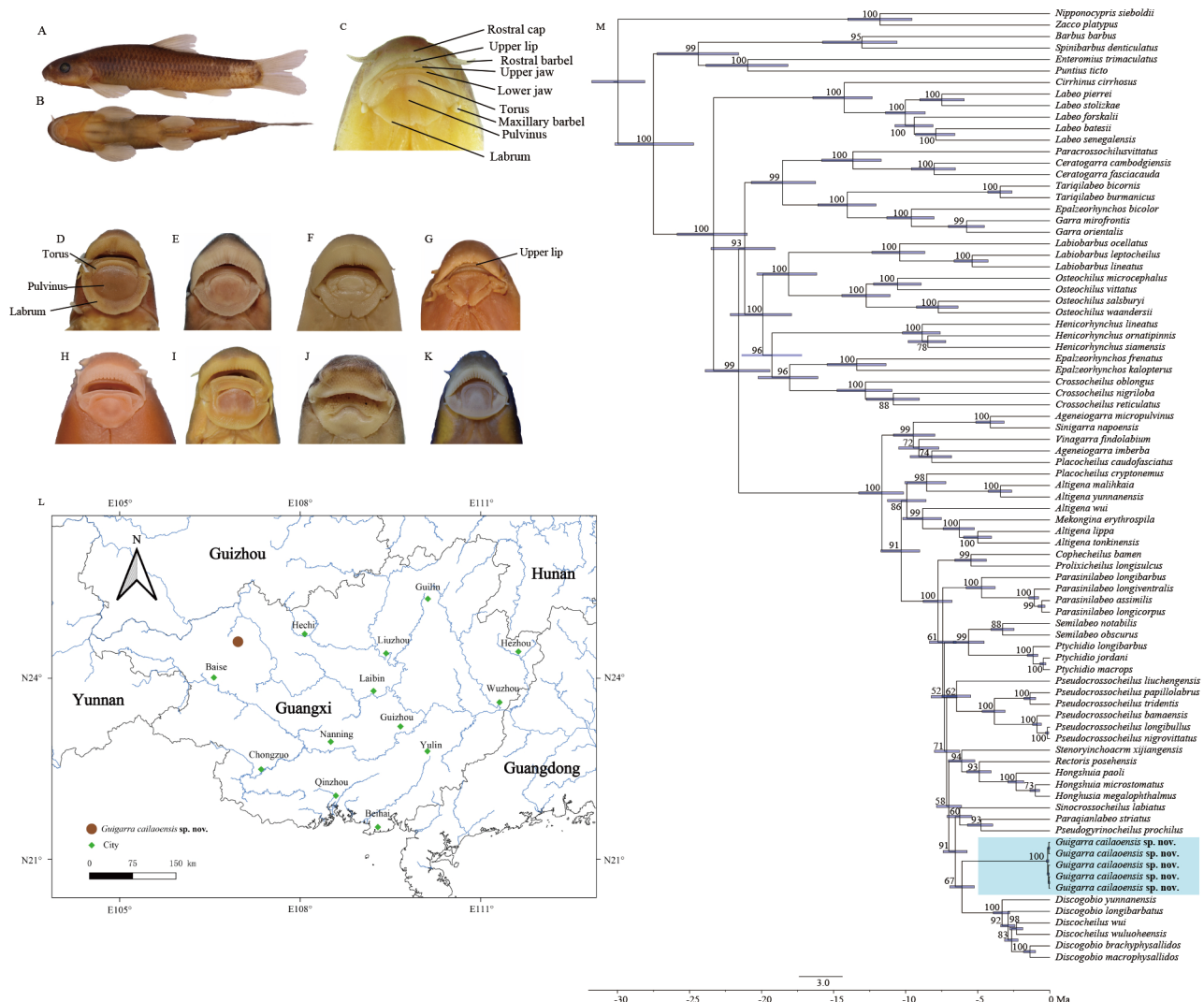
**Diagnosis:** *Guigarra* can be distinguished from all Labeoninae genera, except *Garra*, *Ageneiogarra*, *Ceratogarra*, *Vinagarra*, *Placocheilus*, *Discogobio*, *Discocheilus*, and *Sinigarra*, by possessing a gular disc. It can be distinguished from the above genera by well-developed and smooth upper lip; two pairs of barbels; rostral cap and torus of gular disc smooth or covered with small, inconspicuous papillae; boundaries of torus, labrum, and pulvinus on gular disc inconspicuous; anterior margin of gular disc modified into

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**Figure 1** Holotype, oromandibular structure, distribution, and phylogenetic relationships of *Guigarra cailaoensis* sp. nov., and comparison of oromandibular structures with other disc-bearing species

A, B: Lateral (A) and abdominal (B) view of *Guigarra cailaoensis* sp. nov., holotype KIZ 20210004, 47.0 mm SL. C: Oromandibular structure of *Guigarra cailaoensis* sp. nov., paratype KIZ 20210002, 51.6 mm SL. D–K: Oromandibular structures of *Garra qiaojensis*, KIZ 2006004476, 69.4 mm SL; *Ageneiogarra imberba*, KIZ 2010001942, 117.1 mm SL; *Ageneiogarra micropulvinus*, KIZ 2008008615, 76.2 mm SL; *Sinigarra napoensis*, KIZ 2012003907, 83.0 mm SL; *Ceratogarra cambodgiensis*, KIZ 202000630, 108.6 mm SL; *Placocheilus caudofasciatus*, KIZ 2007002789, 77.5 mm SL; *Discocheilus wui*, KIZ 2008007561, 67.0 mm SL; *Discocheilus yunnanensis*, KIZ 2010001341, 99.3 mm SL. L: Distribution of *Guigarra cailaoensis* sp. nov. M: Phylogenetic relationship inferred from concatenated sequences of three genes (*COI*, *cyt b*, and *Rag 1*); Node bars indicate 95% CI for clade age; Numbers denote ultrafast maximum-likelihood bootstrap values. Light blue rectangle shows position of *Guigarra cailaoensis* sp. nov.

crescentic torus; distal margin of labrum without notch; pulvinus connected with labrum; three rows of pharyngeal teeth.

**Etymology:** The generic name is a combination of *Gui*, the abbreviation of Guangxi, and *Garra*, which are small- to medium-sized Labeoninae fish that possesses a gular disc behind the mouth. The gender is feminine. The Chinese name of this genus is "桂墨头鱼属".

***Guigarra cailaoensis* sp. nov.** Wang, Chen & Zheng

Figure 1A–C; Supplementary Table S2.

**Holotype:** KIZ 20210004, 47.0 mm SL; China, Guangxi

Zhuang Autonomous Region, Fengshan County, Fengcheng Town; Cailao River (N24.61°, E106.97°; ~688 m above sea level (a.s.l.)).

**Paratypes:** KIZ 20210001–20210003, 20210005–20210008, 7 ex., 51.33–65.96 mm SL; same data as holotype.

**Diagnosis:** See generic diagnosis.

**Description:** Morphometric and meristic data are given in Supplementary Table S2. Body elongated, cylindrical anteriorly and compressed posteriorly, dorsal profile slightly convex from occiput to dorsal-fin origin, slightly declining to caudal-fin base. Abdomen smooth. Head rounded and

depressed as truncated cone, width shorter than length. Snout rounded and smooth, length shorter than postorbital length. Several small tubercles present on tip of snout. Eyes medium sized, slightly anterior to head. Two pairs of short barbels; rostral barbels located in anterior of shallow sublachrymal groove on each side of snout. Maxillary barbels present at corners of mouth.

Mouth inferior. Rostral cap smooth, very slightly serrated in posterior flange, connected with lips at lateral corners of mouth. Upper lip well developed and covering most of upper jaw. Lower lip thick, partly covering lower jaw. Crescentic torus smooth or with small papillae on surface, separated from lower lip by deep and transverse groove. Pulvinus connected with torus, joint forming shallow dent. Labrum of gular disc thin and short, smooth or sparsely covered by tiny papillae, around pulvinus.

Origin of dorsal-fin base roughly inserted in middle of body. Dorsal-fin profile slightly concave. Origin of anal-fin base nearer anus, fin tip not reaching caudal-fin base. Pelvic-fin origin slightly posterior than dorsal-fin origin in vertical orientation. Caudal fin forked, upper lobe relatively sharper and longer than lower lobe. Anus closer to anal-fin origin than to end of pelvic-fin base.

Intestine long and coiled (Supplementary Figure S2). Swim bladder bipartite, anterior oval and short; posterior slender, ~2.2 times longer than anterior.

**Color pattern in formalin:** Body dark brown dorsally and laterally, light brown ventrally. Each scale on back and flank with melanophores, forming triangular area. Several black spots at dorsal-fin ray base. All fins hyaline.

**Distribution:** Currently, this species is only known from the Cailao River, Fengcheng Town, Fengshan County, Guangxi Zhuang Autonomous Region, China, which drains into the Hongshui River, a tributary of the Pearl River (Figure 1L).

**Etymology:** The name of the new species, *cailaoensis*, is based on the Chinese name of the type locality, Cailao River. Its common name in Chinese is "才劳桂墨头鱼".

Molecular phylogeny showed that the disc-bearing species of Labeoninae were clustered into six clades (Figure 1M). *Ceratogarra*, *Garra*, and *Guigarra* **gen. nov.** were all monophyletic. *Discocheilus* and *Discogobio* formed a monophyletic clade, consistent with previous studies (Yang et al., 2012; Zheng et al., 2012, 2016). Other disc-bearing genera exhibited a complicated phylogenetic relationship. The genera of *Sinigarra*, *Ageneiogarra*, and *Vinagarra* and *P. caudofasciatus* formed a clade, indicating that these genera and species were closely related. *Placocheilus cryptonemus* and *P. caudofasciatus* were located in two clades. These results suggest that taxonomic revision of these genera is warranted.

Yang et al. (2012) divided Labeonini (=Labeoninae of Zhang et al., 2000) into four subtribes (Labeoina, Garraina, Osteochilina, and Semilabeoina) based on molecular phylogenetic analysis. Zheng et al. (2016) defined one of the clades of Semilabeoina (*sensu* Yang et al., 2012) as a karst group, mainly consisting of genera distributed in the southwest karst region of China. Our phylogenetic relationships indicated that *Guigarra cailaoensis* **sp. nov.** was in the karst group

(Figure 1M). The karst group currently contains 17 genera, which are adapted to the unique karst environment and have therefore evolved different oromandibular structures. *Guigarra* **gen. nov.** is distinct from all other genera within the karst group, except for *Paraqianlabeo* and *Linichthys*, based on well-developed upper lip (vs. absent or vestigial). However, it differs from these two genera by disc in gular region (vs. without disc, lower lip divided into two lateral fleshy lobes and one central plate). It further differs from *Paraqianlabeo* by anterior and anterolateral edges of upper and lower lips smooth or covered by small inconspicuous papillae (vs. finely papillose) and gular groove absent (vs. present).

Our results also showed that *Guigarra cailaoensis* **sp. nov.** formed a sister clade to *Discogobio* and *Discocheilus* (Figure 1M), thus suggesting a close phylogenetic relationship. However, *Guigarra cailaoensis* **sp. nov.** can be distinguished from these two genera by a unique combination of morphological characters (see details in supplementary character comparison). Overall, based on morphological and molecular analyses, the validity of the new genus is supported.

Several new genera of Labeoninae have been reported in the karst region of southwestern China in recent years (Yao et al., 2018; Zheng et al., 2018). The karst region is characterized by a diverse and relatively isolated ecological environment, which has facilitated speciation (Zheng et al., 2012). Some species inhabiting the karst region, such as *Sinigarra napoensis* Zhang & Zhou, 2012 and *Garra incisorbis* Zheng, Yang & Chen 2016, are narrowly distributed species. This distribution pattern is shaped by the ecological environment of the karst region. *Guigarra cailaoensis* **sp. nov.** is only known from the Hongshui River, thus conforming to the species distribution pattern of the karst region.

Time to the most recent common ancestor (TMRCA) of *Guigarra* and the clade consisting of *Discogobio* and *Discocheilus* was estimated to be about 6 million years ago (Ma) (6.94–5.23 Ma), congruent with the end of the Miocene. *Guigarra cailaoensis* **sp. nov.** speciated about 0.15 Ma (0.25–0.06 Ma), coinciding with the Guxiang (Penultimate) Glaciation (Zheng et al., 2002). During this glacial period, the climate cooled, and hence the species returned to the karst caves with relatively stable temperature and environment and continued to diverge.

## NOMENCLATURAL ACTS REGISTRATION

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#### SCIENTIFIC FIELD SURVEY PERMISSION INFORMATION

Field collections followed the rules of the Fisheries Law of the People's Republic of China. All activities conformed to the Laboratory Animal Guidelines for the Ethical Review of Animal Welfare (GB/T 35892-2018).

#### SUPPLEMENTARY DATA

Supplementary data to this article can be found online.

#### COMPETING INTERESTS

The authors declare that they have no competing interests.

#### AUTHORS' CONTRIBUTIONS

L.P.Z. and X.Y.C. designed the study. Z.B.W. and L.P.Z. contributed to laboratory experiments, measurements, and data analyses. Z.B.W. wrote the manuscript with input from L.P.Z. and X.Y.C. Z.B.W. and L.P.Z. revised the manuscript. All authors read and approved the final version of the manuscript.

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