



Article

urn:lsid:zoobank.org:pub:11DCE264-A125-4EA0-A037-54B3B8953DB7

***Sinigarra napoense*, a new genus and species of labeonin fishes (Teleostei: Cyprinidae) from Guangxi Province, South China**

E ZHANG^{1,3} & WEI ZHOU²

¹*Institute of Hydrobiology, Chinese Academy of Sciences, Wuhan 430072, Hubei Province, P. R. China*

²*Faculty of Conservation Biology, Southwest Forestry College, Kunming 650224, Yunnan Province, P. R. China*

³*Corresponding author, E-mail: zhange@ihb.ac.cn*

Abstract

A new garrain genus and species are described from the Zuo-Jiang of the Zhu-Jiang (Pearl River) drainage in Guangxi Province, South China. *Sinigarra*, new genus, is characterized by having the lower lip modified into a mental adhesive disc posteriorly discontinuous with the mental region. It is distinguished from all other disc-bearing genera, namely *Garra*, *Placocheilus*, *Discocheilus* and *Discogobio*, by having the anterior edge of the mental adhesive disc not modified to form an anteromedian crescentic fold, an upper lip present, but separated from the upper jaw, and indistinct papillae scarcely scattered over the rostral cap and lower lip or absent.

Key words: Cypriniformes, Labeonini, Garraina, taxonomy

Introduction

The Labeonini is a monophyletic assemblage of Cyprinidae that comprises a large number of fish species broadly known from the freshwaters of tropical Africa and Asia (*sensu* Reid 1982; Stiassny & Getahun 2007). There are about thirty-five genera presently referred to the Labeonini, with the high diversity of this tribe at the generic-level rank concentrated in South China where twenty-six genera occur, accounting for about 72.2% of the total (Yang & Mayden 2010; Zhu *et al.* 2011). Unshared with all other cyprinid fish groups, the Labeonini exhibits a high degree of morphological modification in its oromandibular structures, which is the basis for recognition of most of the included genera (Zhang *et al.* 2000). As a result, the taxonomy of the Labeonini at the generic-level rank is poorly understood. This tribe is the subject of recent molecular phylogenetic analyses (Zheng *et al.* 2010; Yang & Mayden 2010). These investigations indicated that the monophyletic nature of some currently recognized genera, e.g. *Bangana*, *Cirrhinus*, and *Garra*, is not confirmed. Each of them should be split into several distinct genera. Evidently, generic classification of the Labeonini requires additional in-depth study.

In the past fifteen years, the first author and coauthors described five new labeonin genera from South China, i.e., *Pseudocrossocheilus* Zhang & Chen 1997, *Qianlabeo* Zhang & Chen 2004, *Akrokolioplax* Zhang & Kottelat 2006, *Hongshuia* Zhang *et al.* 2008, and *Cophecheilus* Zhu *et al.* 2011. The species currently referred to three genera, namely *Pseudocrossocheilus*, *Akrokolioplax* and *Hongshuia*, were assigned to other labeonin genera. These three taxa merit generic status as each of them has its own uniquely modified oro-mandibular structures, as do *Qianlabeo* and *Cophecheilus*. The validity of these five genera was verified by molecular phylogenetic analyses (Zheng *et al.* 2010; Zhu *et al.* 2011). Undoubtedly, our taxonomic works on Chinese labeonin species indicated that subtle distinctions in oro-mandibular structures provide sufficient evidence to define genera of this subtribe.

A fish field survey conducted in November 2009 into a tributary of the Zuo-Jiang flowing into the Zhu-Jiang (Pearl River) drainage, in Napo County, Guangxi Province, South China, yielded nine specimens that are referable to the Labeonini. These specimens, however, possess a lower lip modified into a mental adhesive disc whose posterior margin is discontinuous from the mental region. They have unique morphological modifications in the mental adhesive disc that do not allow their placement into any currently recognized disc-bearing genus, therefore representing an undescribed genus from South China. This paper provides a formal account of this genus, here named *Sinigarra*.

Materials and methods

All measurements were taken point to point with digital calipers connected directly to a data recording computer and data were recorded to the nearest 0.1 mm. Measurements and counts, made on the left side of individuals whenever possible, followed those of Kottelat (2001). Predorsal, prepectoral, prepelvic and preanal lengths were measured from the anteriormost tip of the snout to the dorsal-, pectoral-, pelvic- and anal-fin origins, respectively. Interorbital width was taken between the upper margins of the eyes. Abdominal vertebrae and caudal vertebrae were counted from radiographs following the method outlined by Roberts (1989). The Weberian and urostylar complex are included in the counts of the abdominal vertebrae and caudal vertebrae, respectively. The pharyngeal teeth were counted and presented in a formula using Hubbs and Lagler's (1947) method, and the formula 2, 3, 5–5, 3, 2 indicates that the pharyngeal bones of both left and right sides bear three rows, with five teeth in the inner, three in the middle, and two in the outer row. The number of specimens with a given meristic count is indicated in parentheses after the count. All values for the holotype are indicated by asterisks in the text. Measurements of parts of the head are presented as proportions of the head length (HL). The head length and measurements of other parts of the body are given as percentages of the standard length (SL).

The Chinese toponymy is utilized for the distribution data, and the international English toponymy, if available, is also given in parentheses following the Chinese river name when it first appears in the present paper. The data for the latitude and longitude coordinates of each locality were not provided in the original collection data, and are inferred by the authors based on the best information available. The examined specimens are preserved in the collection of the Institute of Hydrobiology (IHB), Chinese Academy of Sciences, Wuhan, Kunming Institute of Zoology (KIZ), Chinese Academy of Sciences, and Southwest Forestry College (SWFC), Kunming, China.

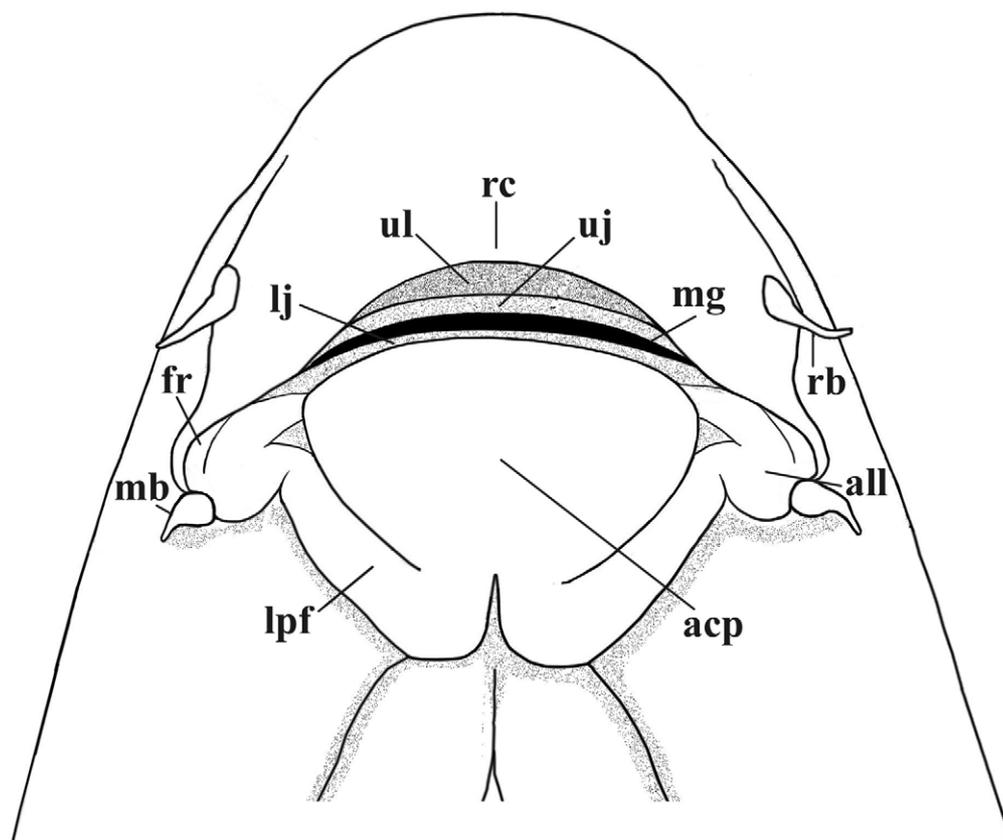


FIGURE 1. Diagrammatic illustrations of oromandibular structures in *Sinigarra*. acp = anteromedian callous pad of mental adhesive disc modified from lower lip; all = anterolateral lobe of mental adhesive disc; fr = frenum linking upper and lower lips; lj = lower jaw; lpf = lateroposterior flap of mental adhesive disc; mb = maxillary barbel; mg = mouth gap; rb = rostral barbel; rc = rostral cap; ul = upper lip; uj = upper jaw.

Sinigarra, new genus

Figure 1

Diagnosis. *Sinigarra* belongs in the disc-bearing group composed of four other garrain genera, namely *Garra*, *Placocheilus*, *Discogobio* and *Discocheilus*. These five genera possess a lower lip modified into a mental adhesive disc posteriorly discontinuous from the mental region. *Sinigarra* is distinguished by having the anterior margin of the mental adhesive disc not modified (vs. modified) into an anteromedian crescentic fold, an upper lip present (vs. absent) but separated from the upper jaw, and indistinct (vs. more prominent) papillae scarcely (vs. densely) scattered over the rostral cap and lower lip or absent (Fig. 1).

Type species. *Sinigarra napoense*, new species

Etymology. The generic name is made from a combination of the Latin word *Sinae* (Chinese) and *Garra*, a generic name used for a group of labeonin species usually with a lower lip modified into a mental adhesive disc and three rows of pharyngeal teeth, in allusion to the presence of a similar disc-like structure. Gender: feminine.

Sinigarra napoense, new species

Figures 2, 3; Table 1

Holotype. IHB 201001008, 87.3 mm SL, a tributary flowing into Zuo-Jiang of Zhu-Jiang (Pearl River) drainage at Napo County, Guangxi, South China; coll. Yu Zhu, July, 2010.

Paratypes. IHB 201001010–11, 201001015–6, 201001018–22, 9 specimens, 46.8–84.6 mm SL, same data as holotype.

Diagnosis. See generic diagnosis.

Description. Morphometric data for ten type specimens are given in Table 1. Body elongate, slightly compressed, more so towards caudal-fin base, with greatest depth at dorsal-fin origin and least depth of caudal peduncle slightly closer to caudal-fin base than to posterior end of anal-fin base (Fig. 2). Dorsal profile of head slightly convex, with a small hump immediately posterior to head. Profile of predorsal body straight or slightly convex; from dorsal-fin origin to origin of dorsal procurrent caudal-fin rays profile somewhat concave. Ventral profile from snout tip to anal-fin origin rounded; from there to origin of ventral procurrent caudal-fin rays nearly straight.



FIGURE 2. Lateral view of *Sinigarra napoense*, IHB 201001008, holotype.

Head relatively small, longer than wide. Eyes small with a wide, slightly convex interorbital space, dorsolaterally positioned in middle of head. Snout blunt in lateral view and pointed in dorsal view, with a shallow groove running along anteroventral border of lachrymal from rostral-barbel base to lateral extremity of rostral cap; no tubercle on its tip and anterior portion of lachrymal. Two pairs of tiny barbels; rostral barbel placed at anterior end of shallow sublachrymal groove on each side of snout and extending far away from anterior edge of eye; maxillary barbel rooted in corners of mouth, originating from exterior surface of confluence between anterolateral lobe of lower lip and lateral extremity of rostral cap, extending slightly beyond anterior edge of eye to opercle. Mouth inferior.

TABLE 1. Morphometric data for type specimens of *Sinigarra napoense*.

| Characters | Holotype | Paratypes (9) | | |
|-------------------------|----------|---------------|------|-------|
| | | Range | Mean | SD |
| SL (mm) | 87.27 | 46.8–87.3 | 65.1 | 14.81 |
| Percentage of SL | | | | |
| Body depth | 21.8 | 21.8–24.8 | 23.3 | 0.93 |
| Head length | 22.3 | 18.2–26.3 | 24.1 | 2.42 |
| Caudal-peduncle length | 22.2 | 17.6–24.5 | 21.4 | 2.06 |
| Caudal-peduncle depth | 12.4 | 11.5–13.8 | 12.4 | 0.73 |
| Dorsal-fin length | 18.6 | 19.3–23.6 | 20.5 | 1.41 |
| Pectoral-fin length | 17.3 | 16.0–18.8 | 17.5 | 1.03 |
| Ventral-fin length | 16.1 | 15.2–17.8 | 16.2 | 0.84 |
| Anal-fin length | 15.8 | 15.0–18.9 | 16.4 | 1.25 |
| Predorsal length | 46.6 | 46.5–52.6 | 48.7 | 1.87 |
| Prepectoral length | 19.9 | 20.8–25. | 22.4 | 1.74 |
| Preventral length | 49.0 | 50.7–53.4 | 52.0 | 1.36 |
| Preanal length | 68.9 | 69.6–74 | 71.3 | 1.74 |
| Percentage of HL | | | | |
| Head depth | 69.5 | 62.3–84.3 | 68.2 | 6.46 |
| Head width | 73.0 | 61.1–89.7 | 68.8 | 8.29 |
| Snout length | 45.5 | 39.2–59.5 | 45.0 | 5.46 |
| Interorbital width | 51.9 | 42.4–59.3 | 47.1 | 5.06 |
| Eye diameter | 19.4 | 17.6–26.8 | 21.8 | 3.06 |
| Mouth width | 29.9 | 28.3–36.4 | 31.6 | 2.62 |
| Rostral-barbel length | 8.8 | 6.7–13.2 | 9.7 | 2.35 |
| Maxillary-barbel length | 8.7 | 7.4–15.6 | 10.7 | 2.51 |

Rostral cap slightly crenulated in median part of its distal margin, and laterally connected with lower lip around corners of mouth. Upper lip present, but separated from upper jaw, laterally connected by a frenum with rostral cap and lower lip. Upper jaw with a thick flexible horny sheath on its margin, and laterally discontinuous from lower lip at corner of mouth (Fig. 3). Lower lip modified into a mental adhesive disc posteriorly discontinuous with mental region; mental adhesive disc composed of an anteromedian callous pad, two anterolateral lobes and two lateroposterior lobes. Anteromedian callous pad large, coarsely inverted-triangular, anteriorly separated from lower jaw by a transverse groove, lateroposteriorly bordered in an oblique groove with lateroposterior lobe, and posteromedially confluent with lateroposterior lobe. Anterior edge of anteromedian callous pad slightly protruded, but not forming a distinctive anteromedian fold and central part slightly protruded; no clearly delineated boundary between them. Anterolateral lobe small, irregularly furrowed, and placed between maxillary barbel and anteromedian callous pad. Lateroposterior lobe elongate, with its anterior end confluent with anterolateral lobe and its posterior end anteriorly confluent with anteromedian callous pad and posteriorly free, separated from its counterpart by a median interruption that slightly intrudes into the anteromedian callous pad. Indistinct papillae sparsely scattered over ventral margin of rostral cap and lower lip. Lower jaw bearing a thick, flexible, horny sheath on its distal margin.



FIGURE 3. Ventral view of oromandibular structures in *Sinigarra napoense*, IHB 201001008, holotype.

Dorsal-fin with four simple and 8* (10) branched rays, last one split to base; origin slightly nearer to tip of snout than to caudal-fin base; last unbranched ray slightly shorter than HL; distal margin concave. Pectoral fin falcate, with one unbranched and 11* (6) or 12 (4) branched rays, inserted posterior to vertical through posterior-most point of opercle, extending beyond halfway to pelvic-fin insertion and as far as fourth or fifth scale anterior to pelvic-fin insertion. Pelvic fin with one unbranched and 8* (10) branched rays, inserted vertically posterior to first branched dorsal-fin ray base, but not extending to vent. Anal fin with three unbranched and 5*(10) branched rays, last one split to base; distal margin slightly concave or straight; origin closer to pelvic-fin insertion than to caudal-fin base. Caudal deeply forked; upper and lower lobes equal in length and shape.

Body scales moderately sized; chest and belly scaled, scales smaller than ones on flank, especially those on nearby mid-ventral region, embedded beneath skin. Lateral line complete, horizontal, with 38*(1), 40 (7) or 41(2) plus three scales on caudal-fin base; scale rows above lateral line 5* (10) and below 3 (5) or 4* (5). Predorsal scales 13 (2), 14*(4) or 15 (4), smaller than those on flank. Circumpeduncular scale rows 14 (4) or 16*(6). Axillary scale present at pelvic-fin base, extending slightly beyond base of last ray. Anus apart from anal-fin origin by two scales. Pharyngeal teeth triserial; tooth pattern 2, 3, 5–5, 3, 2 (1), with pointed and compressed tips. Gas bladder bipartite; anterior chamber oval, wider than posterior one; posterior one stick-like or elongate with an enlarged, rounded distal end, about twice as long as anterior one. Intestine long, forming many coils. Gill rakes on outer side of first gill arch, sparse, short and small.

Color pattern in formalin. Top of head, snout, cheek, opercle and subopercle brownish. Ventral surface of head yellowish-white. Ground color of body brownish dorsally and laterally, yellowish-white ventrally. Each scale on flank with dark chromatophores along exposed portion of its posterior margin forming a dark, crescentic, vertically-elongate mark; marks on scales above lateral line more prominent. Black mark on dorsal-fin base. Dorsal and caudal fins with dark chromatophores on fin rays, giving them a dusky appearance. Pectoral fins with dark chromatophores on anterior fin rays, giving them a dusky appearance. Pelvic and anal fins hyaline.

Distribution. Known only from a tributary of the Zuo Jiang of the Zhu Jiang drainage at Napo County, Guangxi Province, South China (Fig. 4).

Etymology. The specific epithet, used as adjective, is based on the type locality Napo County.

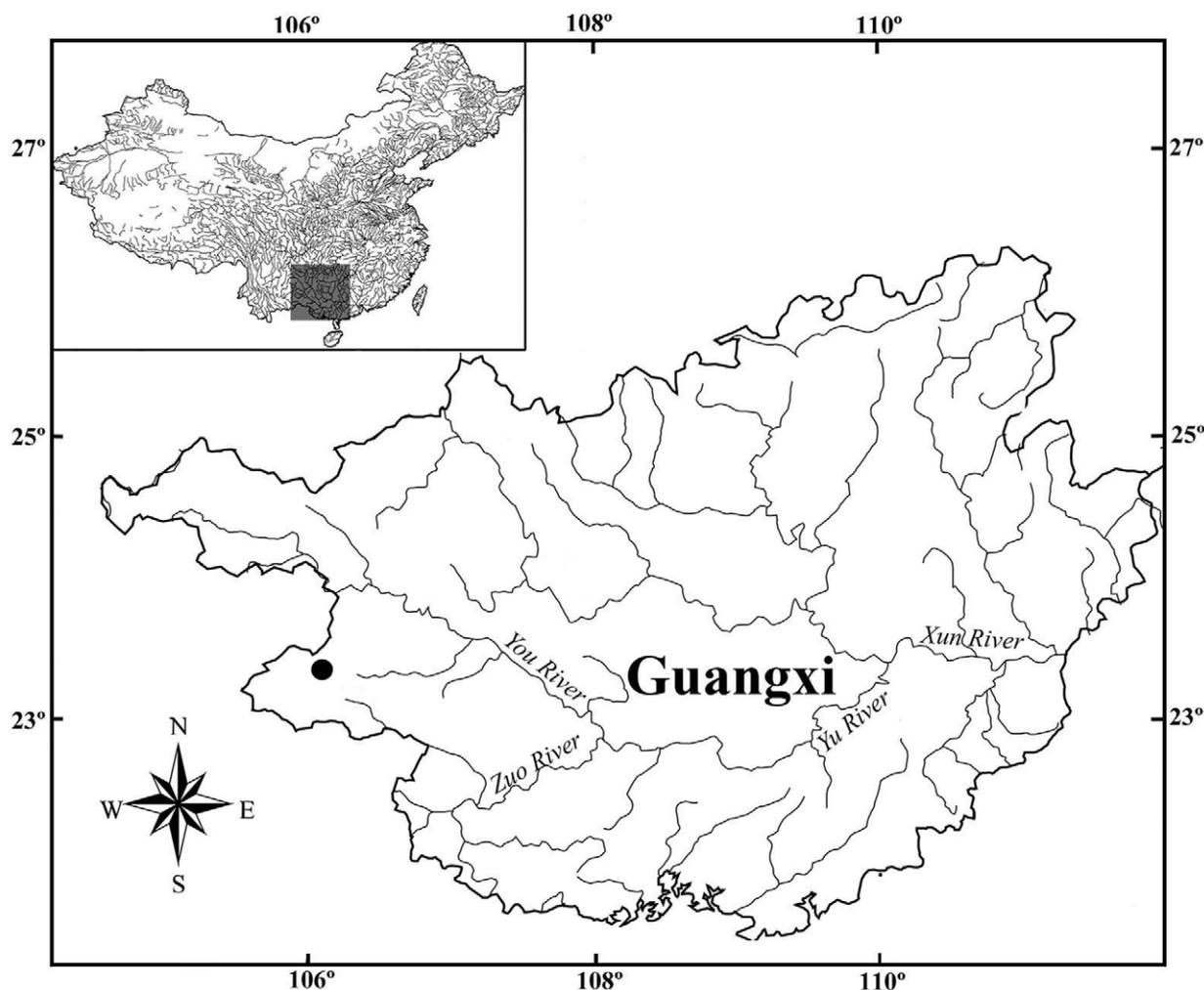


FIGURE 4. Distribution of *Sinigarra napaense* in South China.

Discussion

Sinigarra is temporarily assigned to the Garraina of the Labeonini as it shares most of the synapomorphic characters of these taxa. This subtribe is a monophyletic group delineated by having: (1) mediation of contact of neural complex with neurocranium; (2) fimbriate or invecked ventral margin of rostral cap; (3) antero-rostral position of rostral barbels; (3) papillae densely scattered over ventral margin of rostral cap and lower lip; (4) upper lip entirely regressed and absent medially, and (5) upper lip frenum attaching to lower lip and /or rostral fold cap is usually retained at lateral margin of lower jaw (Stiassny & Getahun 2007). *Sinigarra* has all of the above characters except for the third one. Indistinct papillae are sparsely scattered over the ventral margin of the rostral cap and lower lip in this new genus.

Sinigarra can be referred to the disc-bearing group (*sensu* Zhang 2005) as it has a lower lip modified into a mental adhesive disc whose posterior margin is discontinuous from the mental region. Currently, this group includes four genera, namely *Garra*, *Discogobio*, *Discocheilus* and *Placocheilus*. Their recognition is mainly based in Chinese literature on the morphology of the mental adhesive disc, and the number of pharyngeal tooth rows (Zhang *et al.* 2000; Zhang *et al.* 2002; Zhang 2005; Zhou *et al.* 2005; Li *et al.* 2008b; Chen *et al.* 2009). *Garra* shares with *Placocheilus* a crescentic anteromedian fold that is derived from the anterior margin of the mental adhesive disc, but it can be distinguished from that genus by having three (vs. two) rows of pharyngeal teeth. *Placocheilus* is similar to *Discogobio* and *Discocheilus* in possessing two rows of pharyngeal teeth, but both can be diagnosed by the shape of the anteromedian fold of the mental adhesive disc (Zhang 2005). This fold is horseshoe-shaped in *Discogobio*, but crescentic, flattened and more thickened in *Discocheilus*. Zhang's (2005)

morphologically based phylogenetic relationships among the disc-bearing genera demonstrated that they constituted a monophyletic clade where *Garra* is the basal lineage, and *Placocheilus* formed a subclade with the sister pair of *Discocheilus* and *Discogobio*. Recent hypotheses of phylogenetic relationships within the Labeonini or Labeoninae were based on molecular evidence (Li *et al.* 2008a; Yang & Mayden 2010; Zheng *et al.* 2010). These workers attempted to re-evaluate the validity of the disc-bearing genera in a phylogenetic context. Their results, though, disagree with each other in many aspects, or with those of morphological analyses. The resulting phylogenetic trees in Yang and Mayden's (2010) analysis demonstrated that, under their sampling scheme, species of *Garra* formed a monophyletic group. This is contrary to Zheng *et al.*'s (2010) study in which the monophyletic nature of Chinese *Garra* species was not supported. Zhang (2005) showed that *Discocheilus* was the sister taxon to *Discogobio*, and that the two genera were, respectively, monophyletic, but Zheng *et al.* (2010) showed that *Discocheilus* formed only as a terminal clade within the genus *Discogobio*. These facts clearly reveal that either morphological or molecular-based hypotheses are equally significant, and that one is not necessarily better than the other. The traditional or morphological-based recognition of the disc-bearing group at the generic rank is convenient, useful, and irreplaceable, awaiting a better generic classification of this group based on the combination of morphological and molecular evidence. This can explain why the new genus is described in this investigation despite current considerable controversies over the generic validity of the disc-bearing genera.

In *Sinigarra*, the mental adhesive disc modified from the lower lip has a long lateroposterior lobe extending posteromedially and separated from its counterpart by a median interruption which slightly intrudes into the anteromedian callous pad. In other words, the genus has a median interruption, notch, indentation or fissure on the posterior margin of the mental adhesive disc (or oral sucking disc). The structure of this kind is also present in three species currently included in *Garra*: *G. micropulvinus*, *G. findolabium*, and *G. laichowensis* (Zhou *et al.* 2005; Li *et al.* 2008b). *Garra micropulvinus*, according to Zhou *et al.* (2005), has three characters of the oral sucking disc (mental adhesive disc) atypical for *Garra*: a median indentation in the posterior edge, 2–7 small fleshy buds between the skin fold and the side of the central pad, and a reduced central pad. We fully agree with Zhou *et al.* that it possibly represents a distinct genus. Despite the shared possession of a median indentation or interruption on the posterior edge of the mental adhesive disc, *G. micropulvinus* is not regarded as congeneric with *Sinigarra napoense* as the former differs from the latter in having no upper lip (vs. lip present, but separated from the upper jaw and connected by a frenum with the lower lip around the corner of the mouth), more prominent (vs. indistinct) papillae densely (vs. scarcely) scattered over the rostral cap and lower lip; and the anterior edge of the mental adhesive disc modified (vs. not modified) into an anteromedian crescentic fold. These three characters are also unshared with *G. findolabium* on the basis of Li *et al.*'s (2008b) description and accompanying illustration. Moreover, the mental adhesive disc of this species has no anterolateral lobes and no barbels. Thereby, the species is also not considered as congeneric with *Sinigarra*; its genetic designation needs further study. No comments on the generic classification of *G. laichowensis* can be provided here due to inaccessibility to the type and other material of this species.

Sinigarra appears to have a more primitive mental adhesive disc compared to that of *Garra*, *Discogobio*, *Discocheilus* and *Placocheilus*. The mental adhesive disc found in Chinese species of these four genera is a soft-tissue complex that is usually composed of the following four components: an anteromedian fold, an anterolateral lobe, a central callous pad and a lateroposterior flap (Zhang *et al.* 2002). The mental adhesive disc present in *Sinigarra* has a large, roughly inverted-triangular anteromedian callous pad anteriorly separated from the lower jaw by a transverse groove, lateroposteriorly bordered in a shallow oblique groove with the lateroposterior flap, and posteromedially confluent with these flaps. Based on its structure and position, the anteromedian callous pad of *Sinigarra* is analogous to the central callous pad present in these four genera, especially in *Garra* and *Placocheilus*. However, it is larger than this central callous pad, probably because the anterior margin of the anteromedian callous pad stops short of evolving into the anteromedian fold seen in all other disc-bearing genera. This hypothesis needs to be re-evaluated in a phylogenetic context in future investigations. The discovery of *Sinigarra* brings the total number of Chinese labeonin genera to twenty-seven.

Comparative material

Garra imbera: SWFC 0412045-7, 3 type specimens, 63.1–70.6 mm SL, Jiangcheng, Yunnan, China. IHB 82V0343, 82V0346-8, 82V0350, 4 specimens, 64.0–133.5 mm SL, Dechang, Sichuan, China. *G. kempfi*: IHB 73VII0300, 73VII0169-70, 75VII0063-6, 73VII0284, 73VII0135, 8 specimens, 58.3–87.0 mm SL; Chayu, Tibet,

China. *G. micropulvinus*: SWFC 0111001-29, 26 type specimens, 63.5–133.0 mm SL; Xichou, Yunnan, China. *G. orientalis*: IHB 660755, 660757, 660841, 6600844, 4 specimens, 69.7–100.2 mm SL, Yangshan, Guangdong, China. *G. salweenica*: IHB 78IV1546, 78IV1549, 78IV1541, 78IV1536, 78IV1521, 90IV0119, 90IV291, 90IV0121, 90IV288-9, 10 specimens, 94.0–174.4 mm SL, Tengchong, Yunnan, China. *G. qiaojienensis*: IHB 60542, 78IV1051-2, 90IV0076-8, 78IV1052, 7 specimens, 92.3–162.4 mm SL, Tengchong, Yunnan, China.

Discogobio bismargairtus: KIZ 776563, 776579, 776568, 776587, 776582, 5 specimens, 58.0–108.0 mm SL, Guangnan, Yunnan, China. *D. branchyphysalloides*: KIZ 775784-5, 775795-6, 7757801, 5 specimens, 102.5–132.0 mm, Luoping, Yunnan, China. *D. elongates*: IHB 82100253, 82100286, 8810067-9, 8810088-9, 8810097, 8 specimens, 68.5–98.0 mm, Xuanwei, Yunnan, China. *D. laticeps*: IHB 87IV727, 87IV730-1, 87IV736-7, 5 specimens, 102.0–141.0 mm SL, Sandu, Guizhou, China. *D. longibarbatu*s: IHB 76XI068, 76XI029, 636548, 636501-2, 5 specimens, 65.0–105.0 mm SL, Lake Fuxian, Yunnan, China. *D. tetrebarbatu*s: IHB 75IV2036-7, 75IV2032, 75IV2326-7, 75IV2034, 83V0154, 7 specimens, 65.0–95.0 mm SL, Guiling, Guangxi, China.

Discocheilus multilepis: IHB 8950001, 8950228, 2 specimens, 31.2–99.1 mm SL, Congjiang, Guizhou, China. *D. wui*: IHB 85VIII068-70, 3 specimens, 36.5–44.5 mm SL, Tian'e, Guangxi, China

Placocheilus caudofasciatus: IHB 20005352-6, 20005985-6, 20005358-60, 10 specimens 49.1–87.3 mm SL, Jingping, Yunnan, China. *P. cryptonemus*: IHB 81X4311-2, 81X4303, 81X4308, 4 specimens 79.0–112.0 mm SL, Liuku Yunnan, China. *P. robustus*: IHB 601128-34, 7 specimens, 48.6–109.1 mm SL, Yuanjiang, Yunnan, China.

Acknowledgements

We thank Mr. Jia-Hu Lan (Fishery Bureau of Du'an County, Guangxi Province) for collecting the type specimens. This work was supported by two grants from the National Natural Sciences Foundation of China (NSFC No. 30970232 and No. 31160419).

References

- Chen, Z.M., Zhao, S. & Yang, J.X. (2009) A new species of the genus *Garra* from Nujiang River basin, Yunnan, China (Teleostei: Cyprinidae). *Zoological Research*, 30, 438–444.
- Hubbs, C.L. & Lagler, K.F. (1947) Fishes of the Great Lakes region. *Bulletin of the Cranbrook Institute of Sciences*, 26, 1–186.
- Kottelat, M. (2001) *Fishes of Laos*. Wildlife Heritage Trust Publications, Colombo, 198 pp.
- Li, J.B., Wang, X.Z., Kong, X.H., Zhao, K., He, S.P. & Mayden, R.L. (2008a) Variation patterns of the mitochondrial 16S rRNA gene with secondary structure constraints and their application to phylogeny of cyprinine fishes (Teleostei: Cypriniformes). *Molecular Phylogenetics and Evolution*, 47, 472–487.
- Li, F.L., Zhou, W. & Fu, Q. (2008b) *Garra findolabium*, a new species of cyprinid fish (Teleostei: Cypriniformes) from the Red River drainage in Yunnan, China. *Zootaxa*, 1743, 62–68.
- Reid, G.M. (1982) The form, function and phylogenetic significance of the vomero-palatine organ in cyprinid fishes. *Journal of Natural History*, 16, 497–510.
- Roberts, T.R. (1989) The freshwater fishes of Western Borneo (Kalimantan Barat, Indonesia). *Memoirs of the California Academy of Sciences*, 14, 1–210.
- Stiassny, M.L.J. & Getahun, A. (2007) An overview of labeonin relationships and the phylogenetic placement of the Afro-Asian genus *Garra* Hamilton, 1922 (Teleostei: Cyprinidae), with the description of five new species of *Garra* from Ethiopia, and a key to all African species. *Zoological Journal of the Linnean Society*, 150, 41–83.
- Yang, L. & Mayden, R.L. (2010) Phylogenetic relationships, subdivision, and biogeography of the cyprinid tribe Labeonini (sensu Rainboth, 1991) (Teleostei: Cypriniformes), with comments on the implications of lips and associated structures in the labeonin classification. *Molecular Phylogenetics and Evolution*, 54, 254–265.
- Zhang, E. (2005) Phylogenetic relationships of labeonine cyprinids of the disc-bearing group (Pisces: Teleostei). *Zoological Studies*, 44, 130–143.
- Zhang, E. & Chen, J.X. (1997) Revision of the genus *Crossocheilus* in China, with the description of a new genus *Pseudocrossocheilus*. *Acta Zootaxonomica Sinica*, 22, 321–326. [In Chinese]
- Zhang, E. & Chen, Y.Y. (2004) *Qianlabeo striatus*, a new genus and species of Labeoninae from Guizhou Province, China (Teleostei: Cyprinidae). *Hydrobiologia*, 527, 25–33.
- Zhang, E., He, S.P. & Chen, Y.Y. (2002) Revision of the cyprinid genus *Placocheilus* Wu, 1977 in China, with description of a new species from Yunnan. *Hydrobiologia*, 487, 207–217.
- Zhang, E. & Kottelat, M. (2006) *Akrokolioplax*, a new genus of Southeast Asian labeonine fishes (Teleostei: Cyprinidae). *Zootaxa*, 1225, 21–30.

- Zhang, E, Xin, Q. & Lan, J.H. (2008) Description of a new genus and two new species of labeonine fishes from South China (Teleostei: Cyprinidae). *Zootaxa*, 1682, 33–44.
- Zhang, E, Yue, P.Q. & Chen, J.X. (2000) Labeoninae. In: Yue, P.Q. *et al.* (Eds), *Fauna Sinica (Osteichthyes: Cypriniformes III)*. Science Press, Beijing, pp. 172–272. [In Chinese]
- Zheng, L.P., Yang, J.X., Chen, X.Y. & Wang, W.Y. (2010) Phylogenetic relationships of the Chinese Labeoninae (Teleostei, Cypriniformes) derived from two nuclear and three mitochondrial genes. *Zoologica Scripta*, 39, 559–571.
- Zhou, W., Pan, X.F. & Kottelat, M. (2005) Species of *Garra* and *Discogobio* (Teleostei: Cyprinidae) in Yuanjiang (upper Red River) drainage of Yunnan Province, China with description of a new species *Zoological Studies*, 44, 445–453.
- Zhu, Y., Zhang, E, Zhang, M. & Han, Y.Q. (2011) *Cophecheilus bamen*, a new genus and species of labeonine fishes (Teleostei: Cyprinidae) from South China. *Zootaxa*, 2881, 39–50.