Cyprinus-like pharyngeal bones and teeth (Teleostei, Cypriniformes, Cyprinidae) from the Early–Middle Oligocene deposits of South China (Postprint)

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Abstract

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Full Text

Preamble

Cyprinus-like pharyngeal bones and teeth (Teleostei, Cypriniformes, Cyprinidae) from the Early–Middle Oligocene deposits of South China

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Abstract

Here we describe †*Nanningocyprinus wui* gen. et sp. nov., a fossil Cyprinus-like fish from the Early–Middle Oligocene deposits of Langdong, Nanning Basin, Guangxi Province, South China. †*Nanningocyprinus wui* is represented by a number of pharyngeal bones and teeth. It differs from all other cyprinid fishes in the following character combination: tooth formula $-3 \cdot 2 \cdot 1$, crushing molar-like A1 much larger than A2, only one groove on the grinding surface of A2 and B1 respectively, and the anterior angle of the pharyngeal bone triangular and prominent. The new-found Cyprinus-like fish, along with the previously known Late Eocene †*Eoprocypris maomingensis* (Procypris-like) and Oligocene †*Huashancyprinus robustispinus* (Cyprinus-like) from South China, further indicates an early branching and diversification of the Cyprininae (Cyprinidae) in this area.

Key words: Nanning Basin; Yongning Formation, Oligocene; Cyprinidae, pharyngeal bone and teeth

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Introduction

Many disarticulated bones of fishes and reptiles have been recovered from Early–Middle Oligocene deposits in Langdong, Nanning Basin, Guangxi, South China since 2000 (Chen et al., 2015a). Among these specimens are pharyngeal bones (enlarged fifth ceratobranchial) and teeth of a Cyprinus-like fish. Although fishes of *Cyprinus*, a genus of Cyprinidae that includes the Asian Common Carp, are very common in modern freshwater faunas, little is known about their early evolution. Only one genus with one species, †*Huashancyprinus robustispinus*, which is closely related to *Cyprinus*, has been found from the Paleogene (Chen and Chang, 2011). Therefore, the following description of new fossil materials of Cyprinus-like fish is needed to further our understanding of the morphology, diversification, distribution, and evolution of *Cyprinus* and even the family Cyprinidae, which is the most diversified and speciose freshwater fish group (Nelson et al., 2016).

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Materials and Methods

Fossil materials examined in this study were collected from Early–Middle Oligocene deposits in Langdong, Nanning, Guangxi, China, and are housed in the collection of the Natural History Museum of Guangxi Zhuang Autonomous Region (NHMG) under catalog numbers NHMG 033663–033672. Terminology of the pharyngeal bone and teeth follows Chu (1935). Tooth positions in the adult dentition are numbered according to Nakajima (1984). The most medial row is designated the main row (or row A), and lateral rows are named outer and most-outer rows (or rows B and C). Tooth position is numbered from anterior to posterior in each row. Thus, A1, A2, and A3 represent the first, second, and third teeth of the main row (row A), whereas B1 and C1 represent the first teeth of rows B and C respectively, and so on. Each tooth consists of an enameloid-coated crown and a dentine/predentine neck region, following the terms used by Sytchevskaya (1989). The tooth base at the proximal end of a pharyngeal tooth is ankylosed to a depression on the pharyngeal bone (tooth-base pit). The dagger symbol "†" is used to denote extinct taxa.

Systematic Paleontology

Superorder Ostariophysi Sagemehl, 1885
Order Cypriniformes Bleeker, 1860
Family Cyprinidae Bonaparte, 1840
Subfamily Cyprininae sensu Cavender & Coburn, 1992
Tribe Cyprinini sensu Yang et al., 2010

†*Nanningocyprinus* gen. nov.

Etymology: *Nanning*, the name of the locality where the specimens were collected; *cyprinus*, Latin genus name for carp.

Type species: †*Nanningocyprinus wui* gen. et sp. nov.

Diagnosis: Same as for the type and only known species.

†*Nanningocyprinus wui* gen. et sp. nov. (Fig. 1 [Figure 1: see original paper])

Etymology: The species name is dedicated to the late Prof. Hsianwen Wu, who made great contributions to the study of Chinese cyprinids.

Holotype: NHMG 033663 (Fig. 1a–b), a nearly complete right pharyngeal bone with pharyngeal teeth A1, A2, and B1.

Paratype: NHMG 033665 (Fig. 1e), a nearly complete left pharyngeal bone with pharyngeal teeth A1 and B1.

Referred materials: NHMG 033664 (Fig. 1c–d), an incomplete right pharyngeal bone with pharyngeal teeth A1 and B1; NHMG 033666, an incomplete left pharyngeal bone with pharyngeal teeth A1 and A2; NHMG 033667 (Fig. 1f), an incomplete left pharyngeal bone with pharyngeal teeth A1, A2, and B1; and NHMG 033668–033672, incomplete pharyngeal bones with pharyngeal tooth A1.

Locality and horizon: Langdong, Nanning, Guangxi. Lower–Middle Oligocene, lower part of Yongning Formation.

Diagnosis: Dental formula $-3 \cdot 2 \cdot 1$, teeth molar-like, A1 about three to four times the size of A2, A2 and B1 with only one transverse groove on the grinding surface.

Description: The overall appearance of the pharyngeal bone and teeth resembles that of fishes in the genus *Cyprinus*. The pharyngeal bone is relatively broad and bent in the middle (NHMG 033663–033665). Its anterior limb is short. The surface ventral to the teeth is comparatively wide. The anterior angle is triangular and prominent, opposite to the anterior margin of A2. The anterior edentulous process is broad at the base and pointed at the tip. The pitted surface is wide and extends forward to the anterior limb. Some foramina are present on the pitted surface through which nerves and blood vessels pass (Fig. 1a, c). The dentigerous surface is moderately broad with three rows of teeth (Fig. 1d–f).

Two rows of pharyngeal teeth, including A1, A2, and B1, are preserved in the holotype (Fig. 1b). All preserved teeth are molar-like in shape. The teeth in row A are much larger than those in row B. A1 is the largest tooth, with its grinding surface smooth and slightly convex. A2 is much smaller than A1, about one-third its size. The length of A2 (distance in antero-posterior direction) is about half its width (distance in mesio-lateral direction). On the grinding surface of A2, there is a transverse groove. B1 is much narrower and shorter than A2, with its length slightly less than its own width. On its grinding surface, there is a groove extending mesio-laterally as in A2. The above shape and size pattern of A1, A2, and B1 is consistently observed in all specimens, except that B1 of the holotype is somewhat compressed rather than cylindrical as in the remaining specimens.

The pharyngeal dental formula is $-3 \cdot 2 \cdot 1$, recognized from NHMG 033664–033667 (Fig. 1d–f). Three large teeth, A1, A2, and B1, are generally well-preserved in all specimens. The crowns of A3, B2, and C1 are usually missing, whereas fragmentary tooth necks/bases and/or tooth-base pits are clearly visible.

3.1 Taxonomic Position of the New Form

The character combination of pharyngeal bone and teeth possessed by the new form †*Nanningocyprinus*—three rows of molar-like pharyngeal teeth with grooves on the grinding surface except A1—is only seen in cyprinid fishes be-

longing to the genus *Cyprinus* Linnaeus, 1758 or †*Huashancyprinus* Chen & Chang, 2011 prior to this study. Although †*Nanningocyprinus* resembles *Cyprinus* and †*Huashancyprinus* in having three rows of molar-like pharyngeal teeth, the pharyngeal tooth formula –3 • 2 • 1 of †*Nanningocyprinus* differs from that of *Cyprinus* and †*Huashancyprinus* (–3 • 1 • 1). While intraspecific variations in pharyngeal tooth formulae have been noted in some cyprinid fishes, the percentage of variation from formula 1 • 1 • 3–3 • 1 • 1 is significantly low. In a study of *Cyprinus carpio* by Eastman and Underhill (1973), the occurrence of two teeth on row B was only 3.7% based on observation of 380 pharyngeal bones with teeth. In other species of *Cyprinus*, as far as available references indicate, no B2 tooth has been reported (Chen and Huang, 1977; Wang, 1979; Zhou and Chu, 1986; Luo and Yue, 2000; etc.). In our sampled specimens, all three pharyngeal bones preserved with the portion to which B2 could possibly be ankylosed show either a tooth neck or tooth-base pit, thus confirming the –3 • 2 • 1 formula. If any intraspecific variation occurred in †*Nanningocyprinus* similar to that in extant cyprinids addressed by Eastman and Underhill (1973), the variation would not significantly affect recognition of the pharyngeal dental formula. Therefore, the pharyngeal tooth formula –3 • 2 • 1 of †*Nanningocyprinus* is distinguishable from that of *Cyprinus* and †*Huashancyprinus* (–3 • 1 • 1).

†*Nanningocyprinus* also differs from *Cyprinus* and †*Huashancyprinus* in tooth size, shape, and position. First, A1 is much larger than A2, about three to four times its size in †*Nanningocyprinus* (Fig. 1), whereas A1 is usually slightly larger or even smaller than A2 in all known extant (Chen and Huang, 1977; Zhou and Chu, 1986; Luo and Yue, 2000; Chen and Chang, 2011:fig. 5e [Figure 5: see original paper]-f) and certain fossil *Cyprinus* (Lee, 2004:fig. 3 [Figure 3: see original paper]). In some fossil Cyprinus-like fish, A1 is about 1.5 times the size of A2 (Liu, 1985:fig. 1; Nakajima and Hattori, 1992:figs. 1-2), and in others, such as †*Huashancyprinus*, A1 is only slightly larger than A2 (Chen and Chang, 2011:fig. 5b). Second, the lateral wall of the A2 crown is smooth in the new form as in *Cyprinus*, whereas †*Huashancyprinus* bears numerous deep grooves on the lateral wall of the crown. Third, the new form has only one groove on the grinding surface of A2 and B1, resembling species referred to "C. (Mesocyprinus)" by Luo and Yue (2000), whereas species referred to "C. (Cyprinus)" by Luo and Yue (2000) have at least two grooves on the grinding surface of A2 and B1. Finally, regarding the pharyngeal bone, there are variations in anterior angle development among *Cyprinus* species. It is triangular and prominent in the new form, as in *C. carpio* (a "C. (Cyprinus)" species) (Pasco-Viel et al., 2010:fig. 3F) and †*Huashancyprinus*, but it is rounded in *C. fuxianensis* (Chen and Chang, 2011:fig. 5d), a so-called "C. (Mesocyprinus)" species. A summary comparing †*Nanningocyprinus wui* with *Cyprinus fuxianensis*, *C. carpio*, and †*Huashancyprinus* is presented in Table 1 . In conclusion, the new form is clearly distinct from any species of the genus *Cyprinus* and †*Huashancyprinus*, and should be assigned to a new genus and species.

3.2 Distribution of Cyprinus and Cyprinus-like Fishes and Its Implication

The Common Carp *Cyprinus carpio* exhibits a disjunct distribution in Europe and East Asia, whereas all other species of the genus *Cyprinus* are restricted to East Asia, particularly in the lakes of Yunnan Province and the Xijiang River of Guangxi Province, South China (Bănărescu, 1992; Chen and Huang, 1977). To date, numerous Neogene *Cyprinus* have been unearthed from Middle–Late Miocene to Pleistocene deposits in China (Liu and Su, 1962; Liu, 1985; Tao and Hu, 2001; Chang and Chen, 2008), South Korea (Lee, 2004), Japan (Nakajima, 1985; Nakajima and Hattori, 1992; Nakajima and Yue, 1995; Nakajima et al., 2001; Yasuno, 1986, 2003), Mongolia (Sytchevskaya, 1989), Russian Altai (Sytchevskaya, 1989), and India (Kotlia, 1985) (Fig. 2 [Figure 2: see original paper]). In Europe, *Cyprinus carpio* remains have been found at numerous Pleistocene and Paleolithic localities along the lower Don River valley in Russia (Lebedev, 1960) (Fig. 2). Recently, Kovalchuk (2013) reviewed *Cyprinus* fossils from Late Miocene to Holocene localities in Ukraine, and Gaudant et al. (2014) described *Cyprinus* sp. from Middle to Upper Miocene deposits in southern Spain (Fig. 2).

Interestingly, some pharyngeal teeth with one groove on the grinding surface, similar to those of living species *C. fuxianensis* and *C. yilongensis*, have been discovered in Nei Mongol (China) and Japan, completely outside the distribution range of these living species. Additionally, those *Cyprinus* fossils from Spain, Mongolia, Altai (Russia), and India do not overlap with the natural distribution of extant *Cyprinus* species. No *Cyprinus* species has been found in deposits older than Early Miocene. As for Cyprinus-like fishes from the Paleogene, two monotypic genera, †*Nanningocyprinus* and †*Huashancyprinus*, have been recovered from the Oligocene of Guangxi, South China. These two fishes bear pharyngeal teeth with only one groove on the grinding surface, resembling the aforementioned Neogene *Cyprinus* and living species *C. fuxianensis* and *C. yilongensis*.

In addition to fossil species of *Cyprinus* or Cyprinus-like cyprinids, the Paleogene Cyprinini (sensu Yang et al., 2010) fish †*Eoprocypris* (Procypris-like) has also been unearthed from South China (Chen et al., 2015b). All known fossil *Cyprinus* and related forms allow us to draw several conclusions: Cyprinins have been present in East Asia at least since the Late Eocene, and South China may have been the center of origin and diversification for this group; the Cyprinini had already diverged significantly during the Oligocene, and the molariform dental morphotype, especially those with one groove on the grinding surface, probably represents a plesiomorphic pharyngeal tooth type in cyprinids; and *Cyprinus* and closely related forms were widespread across Eurasia and had a much broader distribution during the Neogene than today. The absence of Cyprinus-like fish from most parts of the extant freshwater ecosystems of central and South Asia was likely caused by Cenozoic mountain-building activities in this region, similar to the pattern observed in *Cobitis* (Chen et al., 2010).

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Note: Figure translations are in progress. See original paper for figures.