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Recent Advances in Meso-Cenozoic Fish Research

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The research on Meso-Cenozoic fishes is mainly focused on the origin and early evolution of major fish groups, the biodiversities and the environmental evolvement, as well as the zoogeographic patterns and biostratigraphic problems in the Meso-Cenozoic Era. Recently, some remarkable progress has been achieved in the research programs on the Triassic marine fishes of South China and their zoogeographic patterns, the fish faunas of the Jehol Biota, and the Late Mesozoic and Cenozoic ichthyofaunas from China and the environmental background.

In China, Triassic marine fishes were first discovered in 1957. Afterwards in about 40 years, only a few fossils were sporadically found. Recently, many well-preserved Triassic marine fish fossils have been excavated in South China. Of these newly discovered materials, a small part have been preliminary reported, but most remain to be systematically studied. Because of the evident facies differentiation and variation in South China, the Early Triassic fishes are mostly distributed in the Middle and Lower Yangtze region to the east of Wuhan, and the Middle and Late Triassic fishes are mainly concentrated in southwestern Guizhou and eastern Yunnan of the Upper Yangtze region.

The Early Triassic fish fauna from the Middle and Lower Yangtze region is mainly composed of perleidids and parasemionotids, accompanied by saurichthyids and coelacanthids. In comparison with those intensively studied contemporaneous ichthyofaunas from Madagascar, Spitzbergen, East Greenland, *etc*., the diversification of this fish fauna is significantly lower if not for inadequate explorations. As for its nature, the predominant perleidid and parasemionotid fishes were formerly compared with or even referred to the related genera from Madagascar, and the fish faunas from these two regions were believed to be closely allied. In fact, the perleidids of this Early Triassic fish fauna are distinct from all other known forms of the family. The same should be true for the parasemionotids from the Middle and Lower Yangtze region. Moreover, in this region there is successive fossil record such as saurichthyids and coelacanthids near the Permian-Triassic boundary. Of those fishes from the uppermost Permian, *Eosaurichthys chaoi* is the earliest record of saurichthyids in the world. It seems that this region is probably the cradle of some Triassic fish groups subsequently flourishing in the Tethyan realm.

In contrast with the Early Triassic fish fauna from the Middle-Lower Yangtze region, the Middle-Late Triassic fish fauna from the Upper Yangtze region is much more diversified. It contains almost all of important Triassic fish forms, such as acrolepids, saurichthyids, birgeriids, perleidids, peltopleurids, luganoiids, eosemionotids, semionotids, marosemiids, parasemionotids, caturids, pholidophorids and elasmobranch ichthyoliths. This ichthyofauna is characterized by "subholosteans," and also includes the modern groups of halecomorphs and the predecessors of teleosts. On the other hand, most fishes of this fauna are closely related to those from Italy, Switzerland and Austria, and about one third can find their almost identical relatives in western Tethys. The close relationship between the fish faunas from South China and western Tethys indicates that these two regions must be closely related biogeographically during the Middle and early Late Triassic time.

Widespread nowadays in freshwater and coastal seas of the cold and temporal zones, lampreys are a jawless vertebrate group that has been in existence for more than 300 million years but left meagre fossil record. Only two fossil

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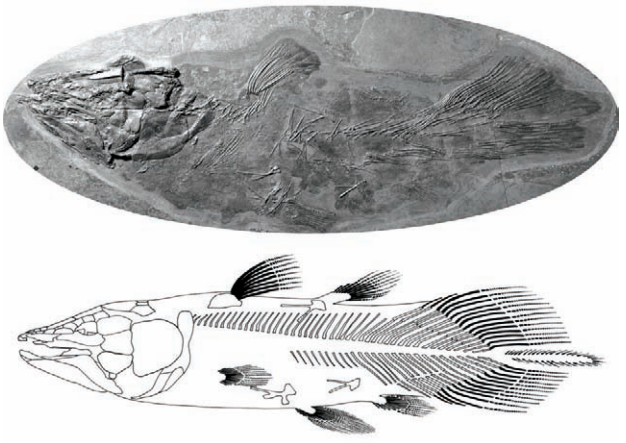

Fig. 1 *Guizhoucoelacanthus guanlingensis* Liu *et al*. 2006, a coelacanth from the Triassic seas of South China.

lamprey species have been recognized with certainty from North American Carboniferous marine deposits. *Mesomyzon mengae*, a newly found lamprey from the Cretaceous Jehol Biota of China, has a long snout, a well-developed sucking oral disk, a relatively long branchial apparatus showing branchial basket, seven gill pouches, gill arches and impressions of gill filaments, about 80 myomeres and several other characters that are previously unknown or ambiguous. The new finding not only indicates *Mesomyzon*'s closer relationship to extant lampreys but also reveals the group's invasion into a freshwater environment no later than the Early Cretaceous. The new material furthers the understanding of ancient lampreys, bridges the gap between the Carboniferous ones and their recent relatives, and adds to the knowledge of the evolutionary history of lampreys.

The Songliao Basin is the largest Cretaceous oil-gas producing basin in China, with the giant Daqing Oilfield situated in its central part. In recent years, abundant and well-preserved fish specimens have been collected from the Nenjiang Formation of the central part of the basin. Among the findings, the osteoglossomorph fish was previously unknown from the Nenjiang Formation while the amiiform fish is the first occurrence found in the Late Cretaceous of the basin. Osteoglossomorphs are freshwater fishes except for the Eocene brackish *Brychaetus*. They bear important paleobiogeographic implications due to their Recent transoceanic distribution. The Late Cretaceous deposits in Songliao Basin were traditionally thought to be completely continental. According to the quite widely spread euteleosts from the Nenjiang Formation, the Songliao Basin might have had some influence by the sea. The new specimen probably represents the second brackish osteoglossomorph fish ever found and may indicate that the marine dispersal of this teleost group had occurred more commonly than previously expected.

Late Mesozoic and Cenozoic lacustrine deposits are widely spread in eastern China. From these deposits abundant fossil fishes have been discovered. Based on differences in their distribution and composition, the Early Cretaceous and Eocene freshwater fishes were divided into two assemblages, respectively. The Early Cretaceous fish fauna from northern China and adjacent areas of Mongolia and Siberia was considered as endemic at its time. On the contrary, the one of more or less the same age from southeastern part of China was thought to be related to those from northeastern South America and West Africa. The Eocene fish fauna from the region around the Bohai Gulf shows striking similarity to the contemporaneous one from the Green River area, western North America on the other side of the Pacific. The work on xenocyprinine mentioned the similarities between the Miocene and Pliocene ichthyofaunas from eastern China and Japan, and the differences between the Recent fish faunas of the two areas.

The distribution of the Early Cretaceous Paraclupeinae in West Africa, Northeast South America and Southeast China is suggested to be interpreted with a) the past existence of a widespread monophyletic group including Paraclupeinae, b) the Gondwana origin of the fish fauna from Southeast China, and c) the near shore habitat of, at least, some forms of the fish fauna. The "transpacific distribution of the Eocene fish faunas from the Bohai Gulf region, China and the Green River area, North America has been explained by the Pacifica theory and multiple origin of the members of the fish fauna. The many similar Neogene cyprinids shared by eastern China and Japan indicate that they formed a widespread ichthyofauna and the two areas were closely connected. After the separation of the two areas, the fish fauna split and differentiated into two. The one remaining on mainland East Asia shows more changes than the one on the Japanese Islands owing to greater environmental changes.

The Tibetan Plateau certainly represents an insulated natural habitat island from its surrounding areas because of its high altitude and resultant harsh environment. The rapid uplift of the Plateau caused by

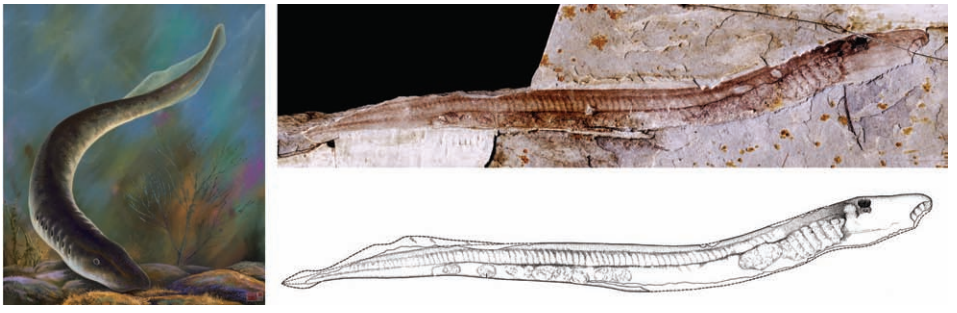

Fig. 2 *Mesomyzon mengae* Chang *et al*. 2006, a lamprey from the Cretaceous Jehol Biota of China.

the India-Asia plate collision during the late Cenozoic has profoundly influenced the geological, biological, and climatic changes in the region. Therefore, the Plateau turns out to be a laboratory for studying evolution in action. Recently, some research has been conducted on the evolution of Cenozoic schizothoracine fossils and the habitat fragmentation against the backdrop of tectonic uplift.

The fish fossils from the Oligocene Lower Ganchaigou Formation of Wulan Husentu, Lulehe area in Qaidam Basin are the earliest Cenozoic fossil fish thus far found from the Tibetan Plateau. The fossil pharyngeal bones indicate that the fish belongs to Barbinae or primitive Schizothoracinae; and the Recent representatives of these groups live in the peripheral areas of the Plateau. The fish fossils are found outside the distribution area of their living relatives.

The excellently preserved fossil fish from the early Pliocene Shizigou Formation of Yahu area in Qaidam Basin was reported as a new form, *Hsianwenia wui*, which was referred to the subfamily Schizothoracinae. It is of great interest because all specimens of this fish show extraordinarily thickened bones. The ribs are so thick that there seems hardly any room for muscles to attach. Even the intermuscular bones, usually needle-thin in all other teleosts, became extremely thickened and acquired unrecognizable odd shapes. This kind of overall thickening of skeleton has not yet been found in any living fish. The only similar case was known from the fossil record, a marine cyprinodont *Aphanius crassicaudus* found in the evaporites exposed along the margins of the Mediterranean Sea. It lived during the late Miocene Messinian desiccation period. This fish shows similarly thickened skeleton and occurred in similar rocks that are rich in marl and gypsum as *Hsianwenia wui* did, providing evidence for a high concentration of calcium in the water. It is considered that highly concentrated calcium in the water was the crucial chemical element causing the bone thickening in both fishes and linked *Hsianwenia wui* to the aridification of the Qaidam Basin.

The Kunlun Pass Basin is possibly the world's highest fish fossil locality. The fish fossils from the late Pliocene Lower Member of the Qiangtang Formation of this locality consist exclusively of disarticulated bones, and some can be confidently referred to the genus *Gymnocypris*, a highly specialized schizothoracine fish. It is suggested that the water systems in the areas of the present Golmud River and the upper reaches of the Yellow River must have been in communication during late Pliocene. The disintegration of this water body happened after the Qiangtang stage. It is also estimated that the amplitude of uplift in the East Kunlun area is approximately 1,000 m since late Pliocene, based on the comparison between the height span of Recent *Gymnocypris* and the elevation of the fossil locality.

Fig. 3 *Hsianwenia wui* Chang *et al*. 2008, an extraordinarily thick-boned fish linked to the aridification of the Qaidam Basin, northern Tibetan Plateau.

The research on fossil schizothoracines shows that the earlier fossil schizothoracines are primitive and have been uplifted to the central area of the Tibetan Plateau at high elevation, outside the distribution area of their living relatives. The later fossil schizothoracines are highly specialized whose living representatives now live in the central area of the Plateau at high altitude. Thus, the temporal distribution pattern of the fossil schizothoracines approximately mirrors the spatial distribution pattern of their living counterparts, which reflects the biological responses to the stepwise uplift of the Tibetan Plateau. The consistency in independent lines of evidence between extant and extinct fishes illustrates the beauty of Darwinism. Through ascent with modification, the fossil schizothoracine fishes demonstrate how their own group has adapted to the ever-changing environment.

References

Chang M M and Chen Y Y, 2000. Late Mesozoic and Tertiary ichthyofaunas from China and some puzzling patterns of distribution. *Vert PalAsiat,* 38: 161–175.

Chang M M, Zhang J Y and Miao D S, 2006. A lamprey from the Cretaceous Jehol biota of China. *Nature,* 441: 972–974.

Chang M M, Wang X M, Liu H Z *et al*., 2008. Extraordinarily thick-boned fish linked to the aridification of the Qaidam Basin (northern Tibetan Plateau). *Proc Natl Acad Sci USA,* 105: 13246–13251.

Jin F, 2006. An overview of Triassic fishes from China. *Vert PalAsiat,* 44: 28–42.