

Two shark finspines (Hybodontoidae) from the Mesozoic of North China

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Abstract

Two hybodont finspines are described in this paper. An incomplete dorsal finspine from the Middle Jurassic Anting Formation of Shaanxi Province, northwest China, is thought to be from *Hybodus antingensis* as it is the only shark known in the deposit. It represents the first hybodont finspine to be found in association with teeth in China. A nearly complete dorsal finspine from the Lower Cretaceous Yixian Formation in Liaoning Province, northeast China, represents the first fossil shark to have been recorded from the Jehol Biota. It is identified as *Hybodontoidae* incertae familiae.

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1. Introduction

Hybodont sharks, formerly thought to be a typical Mesozoic group, first appeared in the Devonian (Zangerl, 1981). They began to decline from the Jurassic onwards and nearly became extinct by the end of the Cretaceous Period, with only one genus (*Asteracanthus*) surviving to the Palaeocene (Tate, 1894; Chapman and Pritchard, 1904). *Hybodus* lived from the Middle Triassic to the Late Cretaceous and is the best known genus of this group. It is represented by skeletons, isolated teeth, and cephalic and finspines from Asia, Europe, Africa and North America. Dorsal finspines of hybodont sharks, usually preserved as sections only a few centimetres long, are less common than teeth owing to their fragile nature and to destruction through transport to depositional sites.

The first Chinese hybodont shark (*Hybodus* sp.) was reported by Young (1935) from the Middle Jurassic Yaojie Formation of Yongdeng, Gansu Province, northwest China. This shark was represented by a section of a dorsal finspine with

its tip missing and the surface of the lower part somewhat damaged. Later, Young (1941) described a new species of the genus (*Hybodus houtienensis*) based on a middle part of a dorsal finspine and two other fragmentary pieces of spines from the Middle Jurassic Shanglufeng Formation of Houtien, Kunming, Yunnan Province, southwest China. He (1941, 1942) reported other hybodont (*Hybodus* sp.) spine sections from the Middle Jurassic Shanglufeng Formation of Lufeng, Yunnan and Late Jurassic Guanyuan Formation of Guanyuan, Sichuan, southwest China.

Hybodont teeth from China were first found in the lower part of Middle Jurassic Anting Formation of Ansai, Shaanxi Province (one isolated tooth) and in the lower part of the Triassic Yenchang Formation of Yangchang, in the same province (three detached teeth) (Liu, 1962). The former was named *Hybodus antingensis* and the teeth from Yangchang were named *Hybodus youngi* in honour of C. C. Yang for his pioneering work on hybodonts. Since then, five new species have been added to the list of Chinese hybodonts (*H. clavus*, *H. huangnidanensis*, *H. yohi*, *H. zuodengensis*, and *Polyacrodus tiandongensis*) based on isolated teeth (Wang, 1977; Xue, 1980; Wang et al., 2001).

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In recent years, new remains of hybodonts have been found in northern China including two teeth and two dorsal finspines. The teeth, which I collected, and an upper part of a spine, collected by Chen Jinhua of the Nanjing Institute of Geology and Palaeontology (NIGP), were encountered in the Anting Formation of Gaogoukou, Ansai, about 20 km north of the type locality of *Hybodus antingensis* at Zhuanyaowan. A pholidophorid fish, *Baleiichthys antingensis*, and a dinosaur footprint were also discovered at this locality. Based on morphological comparisons with the type specimen of *H. antingensis*, the teeth (Fig. 1A, B) are referred to the same species.

A finspine from the locality of Hejiixin in Yixian, Liaoning Province, is the most complete hybodont spine found in China so far. It was collected by a local farmer and presented to the Institute of Vertebrate Palaeontology and Palaeoanthropology, Chinese Academy of Sciences (IVPP). The fossil-bearing deposit is within the Yixian Formation (Wang and Zhou, 2003). The spine represents the first shark to have been encountered in the Jehol Biota.

The specimens studied were mechanically prepared and are deposited in the collection of IVPP.

2. Systematic palaeontology

Class: Chondrichthyes Huxley, 1880
 Subclass: Elasmobranchii Bonaparte, 1838
 Superfamily: Hybodontoidea Zangerl, 1981
 Family: Hybodontidae Owen, 1846
 Genus *Hybodus* Agassiz, 1837

Hybodus antingensis Liu, 1962

Fig. 1

1962 *Hybodus antingensis* Liu, pp. 150–156, pl. 1, fig. 1.

1980 *Hybodus antingensis* Liu; Xue, pp. 9–14, pl. 1, fig. 4.

Material. One incomplete dorsal finspine, IVPP V 14146, from the Middle Jurassic Anting Formation of Gaogoukou, Ansai, Shaanxi Province, China.

Description. The spine fragment is 32 mm long (Fig. 1C, D). A large part of the base is missing as is the tip of the spine. The spine is laterally compressed and the overall profile shows a pronounced distal curvature in lateral view. On the anterior part of the lateral side, it is ornamented with three longitudinal ridges (costae) that fade away towards the tip. The posterior part of the lateral surface is smooth. Arranged in single series, 14 denticles are preserved on the posterior side. They are relatively large proximally and become very fine near the tip.

Discussion. Many genera and species have been erected on the basis of isolated finspines in the past; however, they could easily belong to the sharks already named based on isolated teeth. An association of spines with teeth is impossible to determine when they are found in isolation or when different genera and species of spines and teeth are encountered in

the same deposit. However, it seems certain that the spine described here is from *Hybodus antingensis* since this is the only shark known from the Gaogoukou deposit. It is the first hybodont finspine to have been found in association with teeth in China.

The posterior part of the lateral surface of the spine has no longitudinal ridges (costae). Similar ornamentation is seen on the spines of *Hybodus* sp. from the Middle Jurassic Yaojie Formation of Yongdeng, Gansu (Young, 1935), *H. fraasi* from the Late Jurassic Solnhofen Limestone of Bavaria, Germany (Maisey, 1986) and *Lonchidion* sp. from Weald clay of Surrey and Sussex, England (Patterson, 1966). The spine differs from these sharks in that its distal part is notably curved.

Hybodontoidea incertae familiae

Fig. 2

Material. A nearly complete dorsal finspine, IVPP V 12641, from the Lower Cretaceous Yixian Formation of Hejiixin, Yixian, Liaoning Province, China.

Description. The spine is almost complete with only a small part of the base missing. Although it is broken into several pieces, their positions have hardly changed. The preserved part is 140 mm long, but it may have reached 160 mm. It is nearly straight, showing only a slight curvature distally. It is ornamented with several longitudinal ridges (costae); seven at the base, but only five towards the apex. The ridges are equally spaced and the most anterior one forms a keel. The basal opening extends nearly to the lowest posterior denticles. The shape of the opening is unknown because the spine is compressed. Thirty alternating recurved denticles are preserved in double rows on the posterior wall of the spine, of which the four nearest the distal tip are fine and broken. The denticles are smooth and relatively small.

Discussion. The longitudinal ridges (costae), posterior denticles and general shape of the spine indicate that it is almost certainly from a hybodont (Maisey, 1978). No tubercles are known on the spine of *Hybodus houtieensis* (Young, 1941) and some other species of the genus (Maisey, 1978). Woodward (1889) argued that dorsal finspines do not appear to have constant specific characters. He found it impossible to distinguish the dorsal finspines of *Hybodus delabechei* from those of *H. medius* and *H. varicostatus*. He also observed that the dorsal finspines of *Hybodus reticulatus* (the type species of *Hybodus*) are not readily distinguishable from those of *Acrodus anningiae* (Acrodontidae). Maisey (pers. comm. 2004) has even seen an undescribed articulated specimen of an Upper Jurassic hybodont with a “*Hybodus*” finspine and *Asteracanthus* (Acrodontidae) teeth (usually *Asteracanthus* finspines are easily distinguished because they have large tubercles instead of ridges). Therefore, the dorsal finspine described here cannot be precisely identified and is only tentatively referred to the Hybodontoidea. Since no hybodonts have

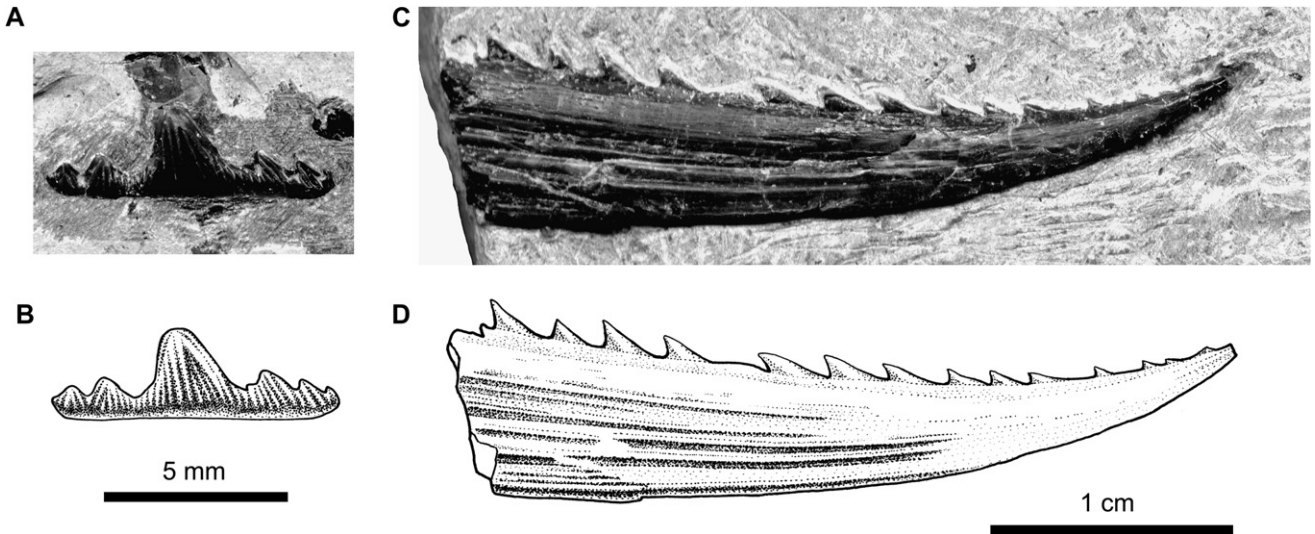


Fig. 1. *Hybodus antingensis*. A, photograph, and B, line-drawing of a detached tooth, IVPP V 14145·1. C, photograph, and D, line-drawing of a dorsal fin spine, IVPP V 14146.

been found in the Jehol Biota before, the spine cannot be associated with any known species.

3. Palaeoecology

Hybodont sharks fed on invertebrates and fishes. The majority of species of *Hybodus* possess a clutching-type dentition. Generally, this type characterizes a bottom or very near-bottom habitat (Cappetta, 1987). By increasing the size of the principal cusp, a tearing-type dentition is formed in some species, such as *H. basanus* (Maisey, 1983) and *H. ensis* (Patterson, 1966). Compared with those of *H. basanus* and *H. ensis*, the teeth of *H. antingensis* (Fig. 1A, B) have a relatively lower principal cusp, which suggests a clutching-type

dentition. *H. antingensis* may have fed on shelly invertebrates such as molluscs and crustaceans, and is most likely to have been a bottom-dweller. It is, of course, currently impossible to determine the diet and niche (benthic or nektonic) of the hybodont from Yixian.

Hybodus may reach 2.5 m in length. With a fin spine about 160 mm long, the Liaoning shark was probably over 1 m in length. Hybodonts were predominantly marine, with specialized freshwater lineages that diverged from them. First appearing in the Triassic of Africa, freshwater hybodonts became abundant in the Early Cretaceous and survived until the Late Cretaceous (Maisey, 1996). The successful invasion of fresh water seems not to have been permanent in the Early Cretaceous, because some specialized forms also inhabited brackish

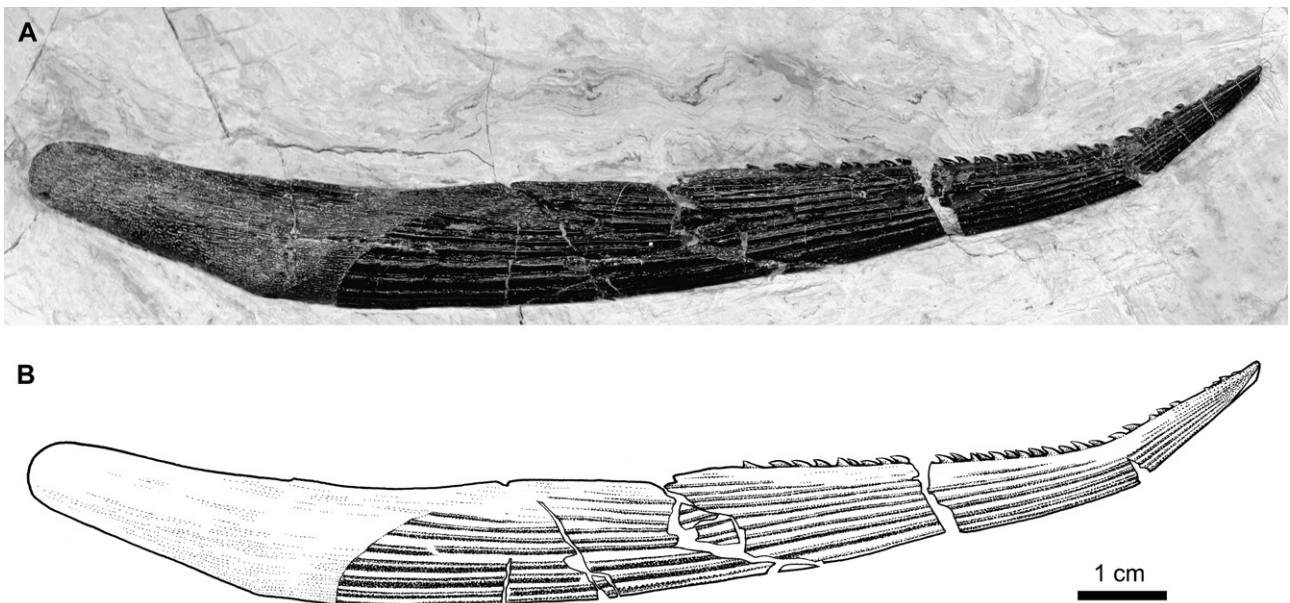


Fig. 2. A nearly complete hybodont fin spine, IVPP V 12641. A, photograph; B, line-drawing.

water and the marine realm at the end of Wealden deposition in southern England (Patterson, 1966). All Chinese hybodonts have been discovered in terrestrial deposits apart from *Hybodus yohi*, *H. zuodengensis* and *Polyacrodus tiandongensis* from the Lower Triassic Luolou Formation of Guangxi Province, which lived in the open sea (Wang et al., 2001). That the water bodies in which these sharks lived were possibly connected to the sea was first proposed by Young (1935) and then supported by Wang (1977) and Xue (1980). The lacustrine environment in which the Anting and Yixian formations were deposited was probably also under marine influence. During the Early Cretaceous, marine transgressions produced an extensive shallow bay in eastern Heilongjiang, northeast China, which opened into the Palaeo-Pacific (Sha et al., 1994, 2002; Gu et al., 1997). This embayment may have reached Yixian and nearby areas of Liaoning Province.

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References

- Cappetta, H., 1987. Chondrichthyes II, Mesozoic and Cenozoic Elasmobranchii. *Handbook of Paleichthyology* 3B, 1–192.
- Chapman, F., Pritchard, G.B., 1904. Fossil fish remains from the Tertiaries of Australia. Part I. *Proceedings of the Royal Society of Victoria, New Series* 17, 267–297.
- Gu, Z.-W., Li, Z.-S., Yu, X.-H., 1997. Lower Cretaceous Bivalves from the Eastern Heilongjiang Province of China. Science Press, Beijing, 301 pp.
- Liu, H.-T., 1962. Two new *Hybodus* from north Shensi (Shaanxi), China. *Vertebrata Palasiatica* 6, 150–152 (in Chinese, English summary).
- Maisey, J.G., 1978. Growth and form of finspines in hybodont sharks. *Palaeontology* 21, 657–666.
- Maisey, J.G., 1983. Cranial anatomy of *Hybodus basanus* Egerton from the Lower Cretaceous of England. *American Museum Novitates* 2758, 1–64.
- Maisey, J.G., 1986. Anatomical revision of the fossil shark *Hybodus fraasi* (Chondrichthyes: Elasmobranchii). *American Museum Novitates* 2857, 1–16.
- Maisey, J.G., 1996. *Discovering Fossil Fishes*. Henry Holt and Company, New York, 223 pp.
- Patterson, C., 1966. British Wealden sharks. *Bulletin of the British Museum (Natural History). Geology* 11, 251–305.
- Sha, J.-G., Cai, H.-W., He, C.-Q., Gu, Z.-W., Jiang, J.-H., Yin, D.-S., Zhao, X.-F., Liu, Z.-X., Jiang, B.-Y., 2002. Studies on the Early Cretaceous Longzhaogou and Jixi groups of eastern Heilongjiang, northeast China, and their bearing on the age of supposedly Jurassic strata in eastern Asia. *Journal of Asian Earth Sciences* 20, 141–150.
- Sha, J.-G., Fürsich, F.T., Grant-Mackie, J.A., 1994. A revised Early Cretaceous age for the Longzhaogou and Jixi groups of eastern Heilongjiang, China, previously considered Jurassic: palaeogeographic implications. *Newsletters on Stratigraphy* 31, 101–114.
- Tate, R., 1894. Unrecorded genera of the older Tertiary fauna of Australia, including diagnoses of some new genera and species. *Proceedings of the Royal Society of New South Wales* 27, 167–197.
- Wang, N.-Z., 1977. Jurassic fishes from Lingling–Hengyang, Hunan and its stratigraphical significance. *Vertebrata Palasiatica* 15, 233–243 (in Chinese).
- Wang, N.-Z., Yang, S.-R., Jin, F., Wang, W., 2001. Early Triassic Hybodontoides from Tiandong of Guangxi, China. *Vertebrata Palasiatica* 39, 237–250 (in Chinese, English summary).
- Wang, X.-L., Zhou, Z.-H., 2003. Mesozoic Pompeii. In: Chang, M.-M., Chen, P.-J., Wang, Y.-Q., Wang, Y., Miao, D.-S. (Eds.), *The Jehol Biota*. Shanghai Scientific and Technical Publishers, Shanghai, pp. 19–36.
- Woodward, A.S., 1889. *Catalogue of the Fossil Fishes in the British Museum (Natural History)*. I. Elasmobranchii. British Museum, London, 474 pp.
- Xue, X.-X., 1980. New materials of Hybodontidae in Gansu and Shaanxi, China. *Vertebrata Palasiatica* 18, 9–14 (in Chinese, English summary).
- Young, C.-C., 1935. On a dorsal fin-spine of *Hybodus* from northwestern Kansu. *Bulletin of the Geological Society of China* 14, 53–54.
- Young, C.-C., 1941. On two new fossil fishes from southwestern China. *Bulletin of the Geological Society of China* 21, 91–95.
- Young, C.-C., 1942. Fossil vertebrates from Kuangyuan, N. Szechuan. *Bulletin of the Geological Society of China* 22, 293–308.
- Zangerl, R., 1981. Chondrichthyes I, Paleozoic Elasmobranchii. *Handbook of Paleichthyology* 3A, 1–115.