

## Research Advances

## Charophytes from the Upper Cretaceous to probably Paleocene Jiaozhou Formation in the Jiaolai Basin (Eastern China)

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### Objective

The Cretaceous–Paleogene boundary (K–Pg boundary) marks the beginning of the Cenozoic, and is one of the most important geological boundaries. Charophytes are usually very abundant in the non-marine strata near the K–Pg boundary, and the change in the charophyte flora can help to recognize the K–Pg boundary. The position of K–Pg boundary in the Jiaolai Basin, eastern Shandong Province, China is still in dispute. The LK-1 borehole project, which was carried out by the Institute of Geology, Chinese Academy of Geological Sciences, produced a high-quality core in northern Jiaozhou, Shandong. In this core, lots of charophyte gyrogonites have been found from the Jiaozhou Formation for the first time. It is significant to study these charophytes, which further helps to find the K–Pg boundary in the Jiaolai Basin.

### Methods

The LK-1 borehole is 1600 m in depth, with lower part of the core mainly consisting of volcanic rocks. Nine hundred and forty-nine samples were collected according to the lithology, with one to three samples per meter taken from the core. For claystones and siltstones, three samples were taken systematically every one meter of thickness. Fifty grams of sediments per sample were processed. Fossils were picked out under a binocular microscope. As a result, fossils were obtained from 55 out of 949 samples including charophytes from 26 samples. Selected gyrogonites were observed and photographed with a scanning electron microscope (SU3500) at the Nanjing Institute of Geology and Palaeontology, Chinese Academy

of Sciences, China (Fig. 1).

### Results

Charophytes from the uppermost Campanian to uppermost Maastrichtian and probably Paleocene of the LK-1 borehole in the Jiaolai Basin were studied from the perspectives of taxonomy and palaeoecology. The Jiaolai charophyte flora is estimated in age by correlation with the Songliao flora calibrated with the GPTS (Deng et al., 2013; Li et al., 2018). During the latest Campanian, the charophyte flora was composed of *Mesochara biacuta*, *Microchara gobica* and *Lamprothamnium ellipticum* living in a freshwater lake. In the early Maastrichtian, the flora almost disappeared, similar to the phenomenon in the Songliao flora. In the late Maastrichtian, the flora is in recovery, with the appearance of *Microchara prolixa*, *Meso. biacuta*, and *Micro. gobica*. Into the latest Maastrichtian and probably the Paleocene, the charophyte flora was dominated by *Chara changzhouensis* and *Sphaerochara jacobii*, as well as other elements including *Sphaerochara parvula* and *Micro. prolixa*, living in a freshwater lake. The Jiaolai flora is similar to the coeval flora in the Songliao Basin northeast of the Jiaolai Basin, due to the similar depositional environment, even though the two floras are distributed relatively far away from each other (Li et al., in press). Under different depositional environments, the Jiaolai flora is different to the Pingyi flora even though they are relatively closer (Li et al., 2016). The Jiaolai flora in the LK-1 borehole lacks the brackish water species of *Feistiella anluensis* in the Late Cretaceous and the Pingyi flora lacks *Chara changzhouensis* found in the freshwater lake with terrigenous inputs in the latest Maastrichtian and Paleocene (Li et al., 2016).

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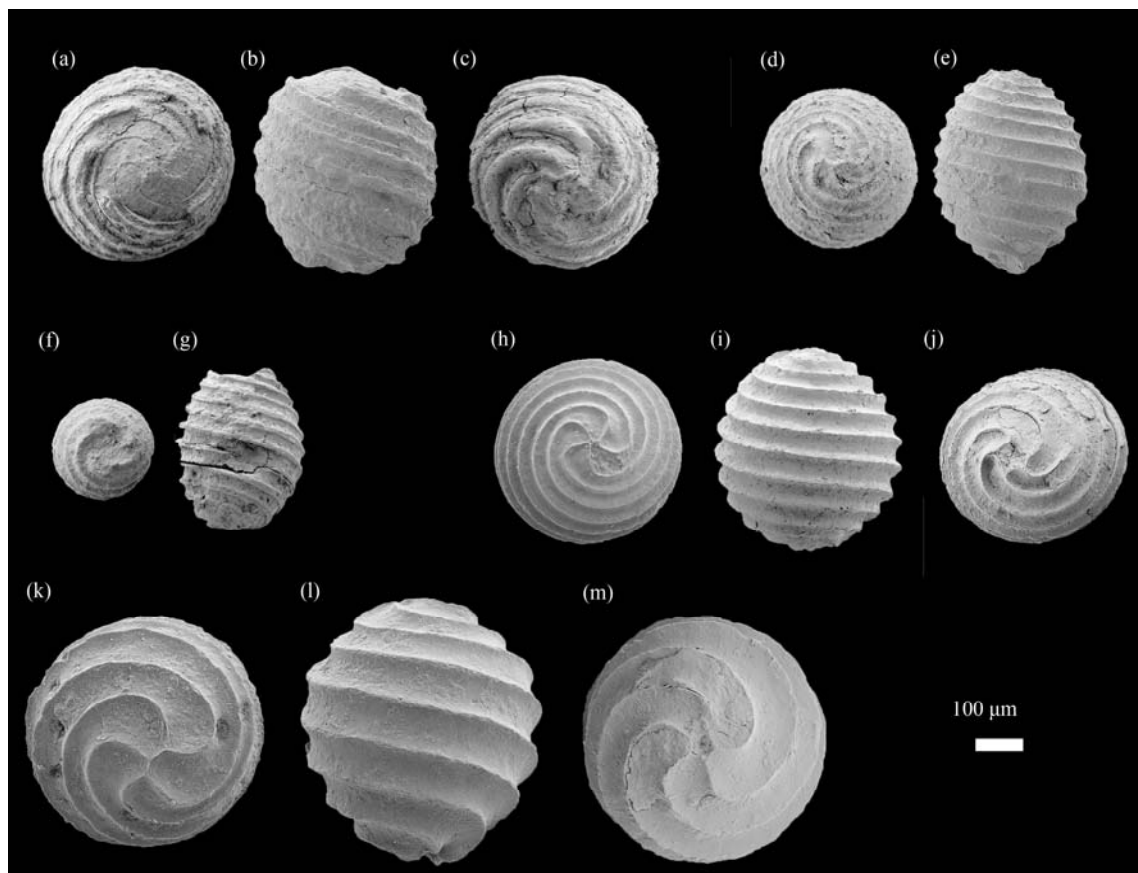


Fig. 1. Charophytes from the Jiaolai Basin.

(a–c), *Microchara gobica*; (a), Apical view; (b), Lateral view; (c), Basal view; (d–e), *Mesochara biacuta*; (d), Apical view; (e), Lateral view; (f–g), *Lamprothamnium ellipticum*; (f), Apical view; (g), Lateral view; (h–j), *Sphaerochara jacobii*; (h), Apical view; (i), Lateral view; (j), Basal view; (k–m), *Chara changzhouensis*; (k), Apical view; (l), Lateral view; (m), Basal view.

## Conclusion

Charophytes from the Jiaozhou Formation in the Jiaolai Basin are reported for the first time. The K–Pg boundary is supposed to be in the Jiaozhou Formation based on discovery of the charophyte *Chara changzhouensis* which appeared below the K–Pg boundary and cross the boundary in the Songliao Basin, north-eastern China. The Jiaolai flora is more similar to the Songliao flora due to the similar depositional environment.

## Acknowledgments

This is a contribution to projects funded by the National Nature Science Foundation of China (Grant Nos.

41602003 and 41688103).

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