

THE FIRST SKIFF BEETLE (COLEOPTERA: MYXOPHAGA: HYDROSCAPHIDAE) FROM EARLY CRETACEOUS JEHOL BIOTA

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ABSTRACT—The first skiff beetle fossil and earliest myxophagan, *Hydroscapha jeholensis* n. sp., is described and illustrated on the basis of a single specimen from the Lower Cretaceous Yixian Formation at Huangbanjigou of Beipiao City, Liaoning Province, Northeastern China. Based on the combination of diagnostic characters of this specimen (e.g., minute and fusiform body, short elytra, tapered abdomen, separated meso- and metacoxae, and 3-segmented tarsi), we suggest that it is a definitive representative of Hydroscaphidae belonging to the widespread hydroscaphid genus *Hydroscapha* LeConte, 1874. It also represents the only impression fossil of the beetle suborder Myxophaga. This find displays great significance for shedding light on the preservation of the minute aquatic beetles, since it is the first well-preserved impression fossil reported for the suborder, rather than amber inclusion.

INTRODUCTION

THE MYXOPHAGA is a small, obscure suborder of Coleoptera with 86 recent species placed in four families. Both adults and larvae are minute (many less than 2 mm in length). The myxophagan family Hydroscaphidae, or “skiff beetles,” is presently comprised of three genera: *Hydroscapha* LeConte, 1874, *Scaphydra* Reichardt, 1973, and *Yara* Reichardt and Hinton, 1976. These minute beetles somewhat resemble tachyporine staphylinids in superficial appearance. The presence of a distinct notopleural suture and aquatic habits, however, separates the two groups (Hall, 2000). Little about the fossil record of Myxophaga is known, with only two fossils being described. Kirejtshuk and Poinar (2006) described the first definitive member of this suborder from Cretaceous Burmese amber, which was later confirmed to belong to the family Lepiceridae (Ge et al., 2010). A second fossil Myxophagan in the family Sphaeriusidae was also recently described from Burmese amber (Kirejtshuk, 2009). However, until now no impression fossils of myxophagan beetles have been reported, probably because of their small body size and specialized habitat.

In recent years, we have collected abundant Mesozoic insects from the Lower Cretaceous Yixian Formation belonging to the famous Jehol Biota at the locality near the Huangbanjigou Village of Beipiao City, Liaoning Province. The Jehol Biota (ca. 125 Ma) has yielded exceptionally preserved feathered dinosaurs, mammals, beaked birds, flowering plants, and numerous insects with fine details (Chang, 2003). A considerably small beetle, bearing a spindle-like habitus and closely resembling some small-sized representatives of the subfamily Tachyporinae of rove beetles (Coleoptera: Polyphaga: Staphylinidae), was discovered from this biota. After detailed examination it is identified as a hydroscaphid.

MATERIALS AND METHODS

The single specimen was collected from the yellowish tuff of Yixian Formation near the Huangbanjigou Village of Beipiao City, Liaoning Province, northeastern China. The holotype is housed in the Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences. Observations and line drawing were made using Olympus SZX7 dissecting microscope. Photographs and measurements were taken with a digital camera attached to the Leica MZ16A microscope.

SYSTEMATIC PALEONTOLOGY

Order COLEOPTERA Linnaeus, 1758
Suborder MYXOPHAGA Crowson, 1955
Family HYDROSCAPHIDAE LeConte, 1874
Genus *HYDROSCAPHA?* LeConte, 1874
Hydroscapha? jeholensis new species
Figures 1–2

Etymology.—The name of the new species refers to the Jehol biota, from where the holotype was collected.

Type.—Only holotype (NIGP 152505) included, without counterpart. The original specimen was split through the gap between dorsal and ventral section of the body, of which only one piece is preserved. It mainly displays structure of the ventral side of the beetle from the inner view, with a small impression of the dorsal side. The fossil compressed as brownish film with somewhat three-dimensional preservation.

Occurrence.—Jianshangou Member of Lower Cretaceous Yixian Formation; Huangbanjigou of Beipiao City, Liaoning Province, northeastern China.

Diagnosis.—Distinguishable from all other representatives of *Hydroscapha* by the following two features: 1) antennae short, with at least six segments (likely 8); first basal antennomere large; at least apical antennomere forming a slight club, constituted by four segments with fusions displayed; and 2) elytra relatively short (EL/EW=1.12). Additionally, the new species is of Early Cretaceous age and distributed in China.

Description.—Body: fusiform, elongate; minute in size. Head: subangular shape, wider than long. Eyes are moderately large, not protruding, laterally located. Antennae: relatively short, a little longer than head width, the first antennomere large, gradually narrowing proximad, central antennomeres poorly preserved, and their exact number and share are ambiguous, terminal antennomere slightly clubbed, slightly longer than the first antennomere, appearing formed by four segments with fusions visible. Mandible: not protruding; two sharp teeth visible on left mandible, one sharp tooth visible on right mandible. Head posteriorly inserted into pronotum.

Thorax: pronotum broader than head, widest between posterior angles, nearly as wide as elytra, processing obscure anterior angles; anterior margin excavated to receive head; lateral margins arcuate, posterior margin slightly arcuate; distinctly wider than long, distance between posterior angles



FIGURE 1—*Hydroscapha jeholensis* n. sp. (NIGP 152505). 1, holotype with normal light, showing the general habitus; 2, holotype with low-angular light, showing the outline of elytra; 3, enlargement of abdomen showing the hair arrangement; 4, enlargement of the head showing the details of mandible and antenna; 5, enlargement of middle and posterior legs, showing the right meso-tarsus and left meta-tarsus. Scale bars=500 μ m in 1–3; 200 μ m in 4, 5.

2.3 times the length of pronotum anterior to posterior margins medially. Mesoventrite relatively large, T-shaped, with a posterior process separating mesocoxae.

Elytra: Relatively short (length/width=1.12), rectangular in shape, covering first visible abdominal segment, lateral sides relatively straight, truncate posteriorly. Epipleura prominent, narrowing apically. Hind wings, if present, not visible.

Legs: All legs relatively short, uniform in shape and size, tarsi 3-segmented. Procoxae prominent, conical and nearly connected, profemora and tibia stout, tarsi obscure. Mesocoxal cavities rather large, oval shape, nearly vertical, distinctly separated, mesofemora fusiform and robust, mesotibia distinctly shorter than mesofemora, mesotarsi relatively elongate, first and second tarsomeres longer than wide, third tarsomere elongate, circa as long as the first two tarsomeres combined. Metacoxae transverse, broadly separated, subtriangular, metatrochanters visible, metafemora stout, broadest at basal section, metatibia robust, distinctly shorter than

metafemora, metatarsi long, first and second tarsomeres broad, first tarsomere larger than the second, the third tarsomere elongate; tarsal claw visible.

Abdomen: Relatively elongate, evenly tapered posteriorly; seven sternites visible, telescoped. Sternite IX subtriangular. Sternites covered with long and fine and pubescence, denser at median section of each segment.

Measurements.—Measurements in mm: body length (from anterior margin of the head to the apex of elytra) 0.91; head length 0.17, head width 0.31; pronotum length 0.22, pronotum width 0.52; elytra length 0.58, elytra width 0.52.

DISCUSSION

The new fossil specimen can be placed in myxophagan family Hydroscaphidae on the basis of the following diagnostic combination of character states: 1) minute size; 2) general habitus with fusiform body, short elytra, tapered abdomen and relatively short legs; 3) antenna relatively short, with first basal

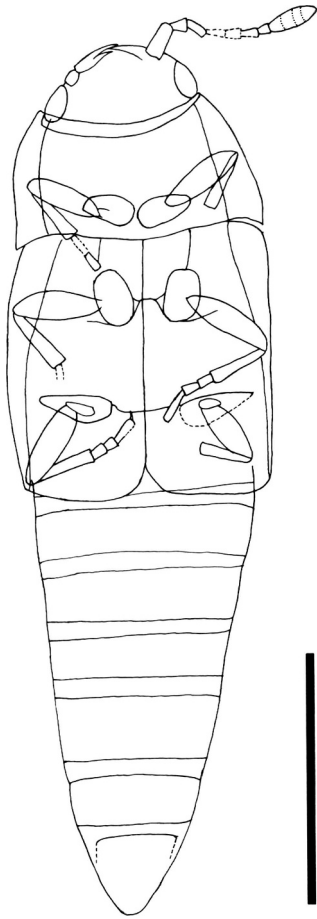


FIGURE 2—*Hydroscapha jeholensis* n. sp., line drawing of the holotype. Scale bar=500 μ m.

antennomere broad; 4) distinctly separated mesocoxae and metacoxae; 5) relatively elongate tarsi with three tarsomeres; and 6) pronotum sub-trapezoid, broad, and rather short.

Until now three genera have been described within Hydroscaphidae: 1) *Hydroscapha* LeConte, 1874, distributed in most major biogeographic regions except Australia (Falamarzi et al., 2010; Fikáček and Šípková, 2009; Hall and Short, 2010); 2) *Scaphydra* Reichardt, 1973, distributed only in Brazil (Reichardt, 1973); and 3) *Yara* Reichardt & Hinton, 1976, found in Brazil, Panama and Venezuela (Short et al., 2010). Species of *Hydroscapha* and *Yara* bear 8-segmented antennae, while only five segments present in antennae of *Scaphydra*.

In general habitus and body size this new species is morphologically similar to the recent members of *Hydroscapha* and *Yara*. *Scaphydra* has a reduced number of antennal segments (to 5), and although the exact number of segments in the fossil is unclear, it is certainly more than this. By contrast to *Yara*, the terminal abdominal ventrite of the new species is slightly longer than wide, but it is normally much longer than wide in *Yara*. Unfortunately, most 'primary' diagnostic features for recognizing *Yara* (e.g., spines on metatrochanters, suture between mentum and submentum, shape of the femoral plate) are not visible in this fossil. Thus, we tentatively place this new species within the most common and widespread genus *Hydroscapha*.

The new species displays some resemblances to tachyporine staphylinids in superficial appearance, such as elongate body and short elytra. However, tachyporine staphylinids possess

longer antenna with eleven antennomeres and larger contiguous meso- and metacoxae (for details see Campbell, 1976 and Campbell, 1993). *Hydroscapha jeholensis* mostly resembles the extinct tachyporine rove beetle, *Mesotachyporus puer* Gusarov, 2000, a fossil species from the Late Cretaceous amber of Sayreville, New Jersey, U.S.A. (Gusarov, 2000). These similarities include: 1) body elongate and minute in size (*M. puer* is 2.3 mm long measured from the anterior margin of head to the apex of abdomen); 2) head transverse, narrower than pronotum, slightly inserted into pronotum; 3) elytra relatively short; and 4) abdomen armed with pubescence, gradually tapered. However, the new species could be readily recognized from *M. puer* by having specialized short antenna and 3-segmented tarsi.

Phylogenetic analysis based on larval and adult morphological characters support the monophyly of Myxophaga and inclusion of Hydroscaphidae (Beutel, 1999; Beutel et al., 1999). The branching pattern proposed by Beutel et al. (1999) suggests that the early representatives of Myxophaga (excluding Lepiceridae) were living in aquatic conditions with a preference for hygropetric habitats, and the tendency to live on rocks in running water and miniaturization have played an important role in myxophagan evolution. Since very few fossil records of Myxophaga have been reported so far, our newly described Mesozoic hydroscaphid species consequently plays a significant role in the phylogenetic analysis of this group. The Early Cretaceous fossil of *Hydroscapha jeholensis* suggests that the origin of Hydroscaphidae predated the Early Cretaceous, which broadens our knowledge of myxophagan beetles. Its general characters strongly resemble recent *Hydroscapha* including habitus and size. However, unlike all other recent members of the genus, the apical clubbed antennomere appears to be formed by the fusion of four segments.

ACKNOWLEDGMENTS

We are sincerely grateful to A. Y. Solodovnikov (Natural History Museum of Denmark, University of Copenhagen, Denmark), A. Nel (Muséum National d'Histoire Naturelle, France), A. Newton and M. Thayer (Field Museum of Natural History, U.S.A.) for helpful comments. Thanks also go to M. Fikáček for providing useful criticism and constructive suggestions that improved the manuscript. This research was supported by Chinese Academy of Sciences (grant no. KZCX2-YW-QN104), the National Natural Science Foundation of China (J0930006).

REFERENCES

- BEUTEL, R. G. 1999. Phylogenetic analysis of Myxophaga (Coleoptera) with a redescription of *Lepicerus horni* (Lepiceridae). *Zoologischer Anzeiger*, 237:291–308.
- BEUTEL, R. G., D. R. MADDISON, AND A. HAAS. 1999. Phylogenetic analysis of Myxophaga (Coleoptera) using larval characters. *Systematic Entomology*, 24:171–192.
- CAMPBELL, J. M. 1976. Revision of Genus *Sepedophilus* Gistel (Coleoptera, Staphylinidae) of America North of Mexico. *Memoirs of the Entomological Society of Canada*, 99:1–89.
- CAMPBELL, J. M. 1993. A Revision of the Genera *Bryoporus* Kraatz and *Bryophacis* Reitter and two new related genera from America North of Mexico (Coleoptera, Staphylinidae, Tachyporinae). *Memoirs of the Entomological Society of Canada*, 166:3–85.
- CHANG, M. M. 2003. *The Jehol Biota: The emergence of feathered dinosaurs, beaked birds and flowering plants*. Shanghai Scientific and Technical Publishers, Shanghai, 208 p. (In Chinese)
- CROWSON, R. A. 1955. *The Natural Classification of the families of Coleoptera*. Nathaniel Lloyd and Co., London, 187 p.
- FALAMARZI, S., A. PÜTZ, M. HEIDARI, AND H. NASSERZADEH. 2010. Confirmed occurrence of *Hydroscapha granulum* in Iran, with notes on its biology (Coleoptera: Myxophaga: Hydroscaphidae). *Acta Entomologica Musei Nationalis Pragae*, 50:97–106.

- FIKÁČEK, M. AND H. ŠÍPKOVÁ. 2009. New Asian *Hydroscapha*, with comments on male-female association of co-occurring species (Coleoptera, Myxophaga, Hydroscaphidae). *Zootaxa*, 2286:31–48.
- GE, S. Q., F. FRIEDRICH, AND R. G. BEUTEL. 2010. On the systematic position and taxonomic rank of the extinct myxophagan dagger Haplochelus (Coleoptera). *Insect Systematics and Evolution*, 41:329–338.
- GUSAROV, V. I. 2000. *Mesotachyporus puer*, a new genus and species of Cretaceous Tachyporinae (Coleoptera: Staphylinidae) from New Jersey amber, p. 255–258. *In* D. A. Grimaldi (ed.), *Studies on Fossils in Amber, with Particular Reference to the Cretaceous of New Jersey*. Backhuys, Leiden.
- HALL, W. E. 2000. Hydroscaphidae LeConte, 1874, p. 27–29. *In* R. H. Arnett and M. C. Thomas (eds.), *American Beetles*. Vol. 1, Archostemata Myxophaga, Adephaga, Polyphaga: Staphyliniformia. CRC Press, Boca Raton.
- HALL, W. E. AND A. E. Z. SHORT. 2010. A new species of *Hydroscapha* LeConte from northwestern Venezuela (Coleoptera: Myxophaga: Hydroscaphidae). *Zootaxa*, 2358:49–56.
- KIREJTSHUK, A. G. 2009. A new genus and species of Sphaeriusidae (Coleoptera, Myxophaga) from Lower Cretaceous Burmese amber. *Denisia*, 26:99–102.
- KIREJTSHUK, A. G. AND G. POINAR. 2006. Haplochelidae, a new family of cretaceous beetles (Coleoptera: Myxophaga) from Burmese amber. *Proceedings of the Entomological Society of Washington*, 108:155–164.
- LECONTE, J. L. 1874. Descriptions of new Coleoptera chiefly from the Pacific slope of North America. *Transactions of the American Entomological Society*, 5:43–72.
- LINNAEUS, C. 1758. *Systema naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis*. Editio decima, reformata. L. Salvii, Holmiae, 1, 824 p.
- REICHARDT, H. 1973. A critical study of the suborder Myxophaga, with a taxonomic reversion of the Brazilian Torridincolidae and Hydroscaphidae (Coleoptera). *Arquivos de Zoologia*, 24:73–162.
- REICHARDT, H. AND H. E. HINTON. 1976. On the New World beetles of the family Hydroscaphidae. *Papéis Avulsos de Zoologia, São Paulo*, 30:1–24.
- SHORT, A. E. Z., L. J. JOLY, AND M. GARCIA. 2010. Discovery of the skiff beetle genus *Yara* Reichardt and Hinton (Coleoptera: Myxophaga: Hydroscaphidae) in Venezuela, with description of a new species. *Coleopterists Bulletin*, 64:151–156.

ACCEPTED 11 JULY 2011