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Two new Paleogene insect fossil localities in southern Henan Province, central China

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Abstract

Paleogene insects in China are well documented from Eocene Fushun amber. In contrast, Paleogene insects preserved in sedimentary rock are poorly recorded, although they appear to represent a potentially rich resource, as evidenced by specimens from Eocene deposits in Tibet and the Paleocene Buxin Formation in Guangdong. Here, we report two new localities in southern Henan Province, central China. Relatively abundant insect fossils have been recovered from the middle–upper Eocene Hetaoyuan Formation near Tanghe City. In addition, both insect and plant fossils have recently been collected from the middle–upper Eocene Wulidun Formation near Tongbai County. These new discoveries highlight the significant potential of Eocene insect fossil resources in China.

Key words: Hetaoyuan Formation, Wulidun Formation, fossil insects, Eocene

Introduction

In China, insect fossil research has largely focused on the Mesozoic, with some attention to Paleozoic insects, whereas Cenozoic insect fossils have long been relatively neglected. The most significant studies on Cenozoic insects to date are derived from Eocene Fushun amber (Hong 2002a, b; Wang *et al*. 2014) and Miocene Shanwang diatomite deposits (Hong 1985). More recently, numerous bioinclusions have been discovered in Miocene Zhangpu amber, and research on these specimens is ongoing (Wang *et al*. 2021; Wang *et al*. 2023). Additionally, abundant Paleocene insects have been reported from the Buxin Formation in Sanshui District, Foshan City, Guangdong Province (Huang *et al*. 2022; Zhang *et al*. 2022), with related studies now underway. Eocene insects from Tibet are also of particular interest, as they may provide insights into the uplift history of the Tibetan Plateau (Cai *et al*. 2019; Xu *et al*. 2021; Huang *et al*. 2022; Xia *et al*. 2022). Overall, Eocene insect fossil resources in China appear highly promising, yet research on them remains comparatively limited compare with global research on Eocene fossils and amber, such as that on Baltic amber (*e.g*., Peyrot *et al*. 2023) and the Green River biota (*e.g*., Heads *et al*. 2023). For example, Eocene Longkou amber was recently discovered in Shandong Province, containing simple biological inclusions (Luo *et al*., 2025); further collection and screening of amber may reveal additional insect fossils.

Here, we report two new Eocene insect fossil localities in southern Henan Province. The first is the middle-upper Eocene Hetaoyuan Formation near Tanghe City, where outcrops were exposed during recent highway construction. Local enthusiast Yaqing Zheng first collected several well-preserved insect fossils, and additional specimens were subsequently collected by the ZJN. The second locality is the middleupper Eocene Wulidun Formation near Tongbai County. Initial insect fossils were discovered by ZJN at lake-side outcrops, followed by further insect and plant

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fossils collected by the DYH team. Insect fossils from this locality are relatively common but generally poorly preserved and difficult to identify. While other palaeontological fossils have previously been reported from these areas, insect fossils from these new outcrops are documented here for the first time.

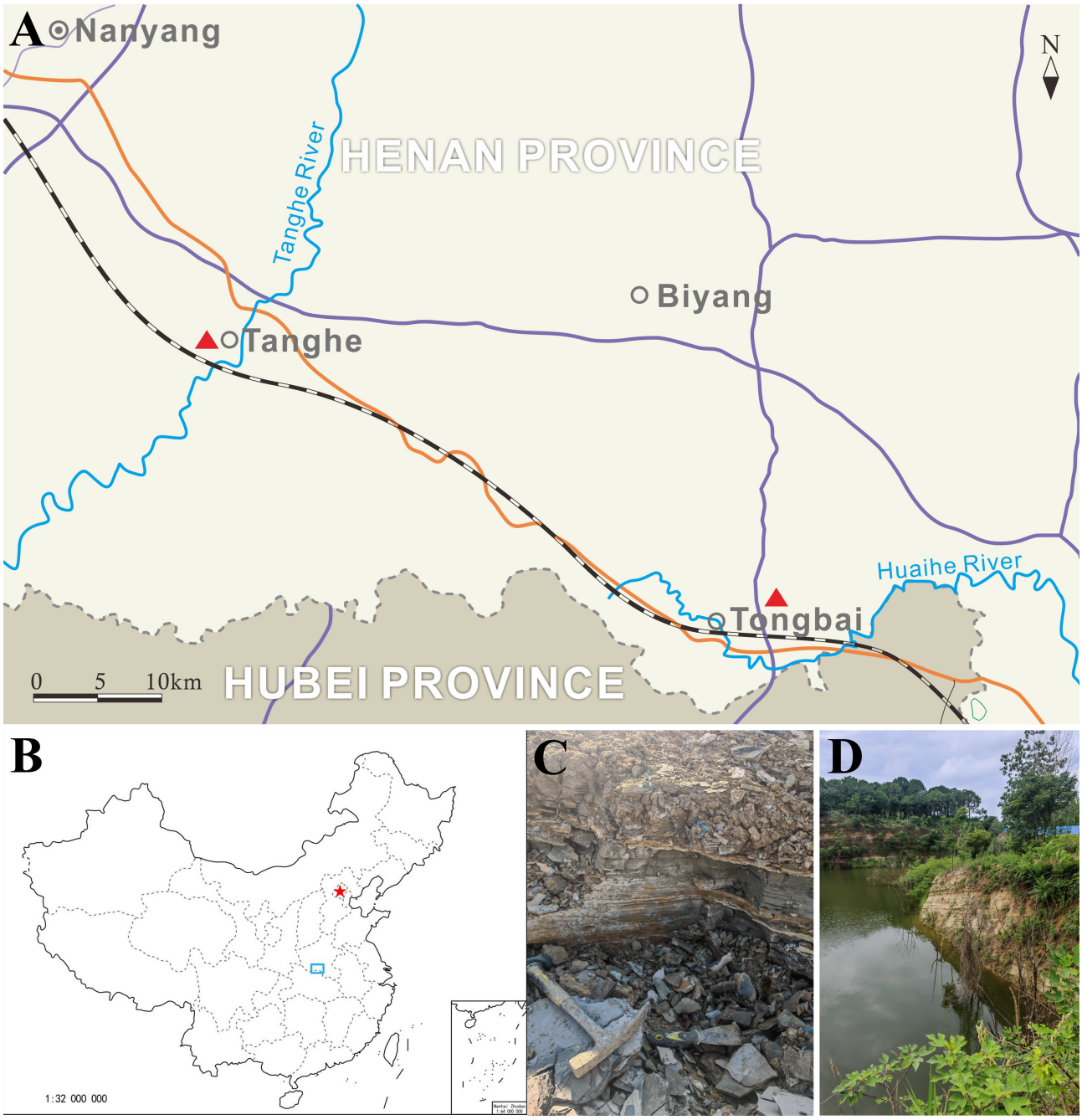

FIGURE 1. Maps of fossil localities and exposed outcrops. **A**, Fossil localities (indicated by red triangles). **B**, Location in China's map (in blue frame). **C**, Fossil insect outcrop of the Hetaoyuan Formation at Tanghe. **D**, Fossil insect outcrop of the Wulidun Formation at Tongbai.

Material and methods

Insect fossils were collected by Mr. Yaqing Zheng and ZJN from the green-gray shales of the Hetaoyuan Formation are preserved as brownish films (Fig. 1). Some insect fossils were collected by ZJN from the finely laminated oil shales of the Wulidun Formation also appear as brownish films. At the same Wulidun locality, DYH and his team

collected additional insect fossils co-occurring with abundant plant fragments from green-gray mudstones, which preserve a higher proportion of carbonized fossils (Fig. 1).

Photographs were taken using a Zeiss Discovery V16 stereomicroscope. To enhance contrast, some specimens were imaged under 70% ethanol. Certain fossils were borrowed from Mr. Yaqing Zheng, an amateur collector from Tanghe City, while other specimens are deposited at the Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences.

Geological setting

The area with Hetaoyuan Formation is generally classified into the South China Stratigraphic Region. This formation consists of interbedded red-brownish and green-grayish mudstones, calcareous mudstones, white-grayish and green-grayish marlstones, with carbonaceous mudstones intercalated in the lower part and thin-bedded conglomerates in the upper part. Abundant vertebrate fossils, together with gastropods and ostracods, have been recovered from the Hetaoyuan Formation. Insect fossils represent the first record from this formation (Henan Provincial Bureau of Geology and Mineral Resources, 1997). The age of the Hetaoyuan Formation is contentious. Some authors assigned it to the Eocene (*e.g*., Henan Provincial Bureau of Geology and Mineral Resources, 1997; Zhao *et al*. 2012) and others suggest it is Oligocene (*e.g*., Wang *et al*. 1990; Dong *et al*. 2014). Here we follow the first opinion.

The area with Wulidun Formation is generally assigned to the North China Stratigraphic Region. Its basal part comprises variegated conglomerate, upwards passing into interbedded green-grayish and yellow-grayish siltstones, sandstones and shales with intercalated marlstones, and oil shales occurring in the middle-lower intervals. The formation bears abundant mammalian fossils, along with gastropods, bivalves, ostracods, plant fossils, fish fossil fragments, as well as the insect fossils documented in this paper (Henan Provincial Bureau of Geology and Mineral Resources, 1997). The age of the Wulidun Formation was considered as middle Eocene (Zhou *et al*. 2006) or upper Eocene (Henan Provincial Bureau of Geology and Mineral Resources, 1997). Synthesizing the above two viewpoints we attribute a middle-upper Eocene age for the Wulidun Formation.

Results

Relatively diverse fossil insects have been discovered from the Hetaoyuan Formation near Tanghe City including four insect orders: Orthoptera, Blattaria, Diptera, and Hymenoptera (Fig. 2). These insects are well preserved in the shales, with structural details such as ommatidia and fine setae clearly visible. Dipterans are the most abundant insects at this locality. Fossil insects from the Wulidun Formation are relative poorly preserved especially those in oil shale. At least Coleoptera, Diptera, and Hymenoptera were collected from this locality (Fig. 3). As for the Hetaoyuan Formation, dipterans are also the most common insects.

Conclusion

The flies in these two assemblages are predominantly Tipulidae, Chironomidae, and Sciaroidea, groups commonly associated with humid habitats, including species whose larvae develop in freshwater, consistent with expectations for lacustrine deposits from the Eocene–Oligocene (AN, pers. obs., in Oligocene lacustrine outcrops of France).

At present, the precise ages of the Paleogene insect-bearing horizons in southern Henan remain uncertain, and our understanding of the two insect assemblages reported here is preliminary. Both horizons were deposited in oil-shale-bearing sedimentary settings, offering new potential for research on the correlation and exploitation of energy-bearing strata. Moreover, they provide valuable data for studies of Paleogene, particularly Eocene, insect fossils and biotas in China.

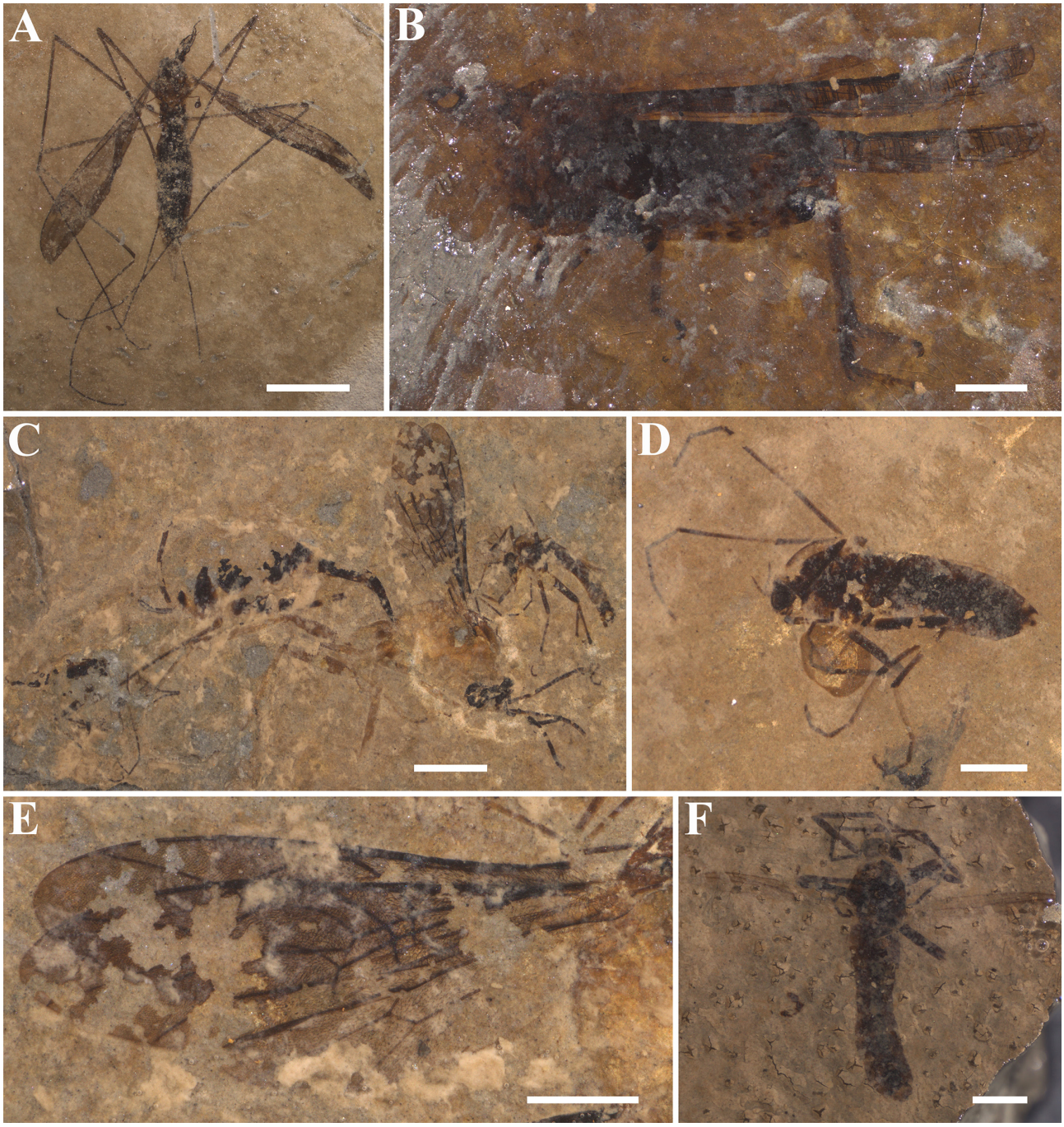

FIGURE 2. Insect fossils from the Hetaoyuan Formation. **A**, Tipulidae. **B**, Caelifera, probably belong to Acridoidea**. C**, Female Ichneumonidae with small male Chironomidae at its right**. D**, Sciarioidea, possibly a Cecidomyiidae. **E**, Enlarged from C, indicating venation and fine setae on wing surface. **F**, Probable Sciarioidea. Scale bars = 5 mm in **A**, 2 mm in **B**, **C**, 1 mm in **D**–**E**.

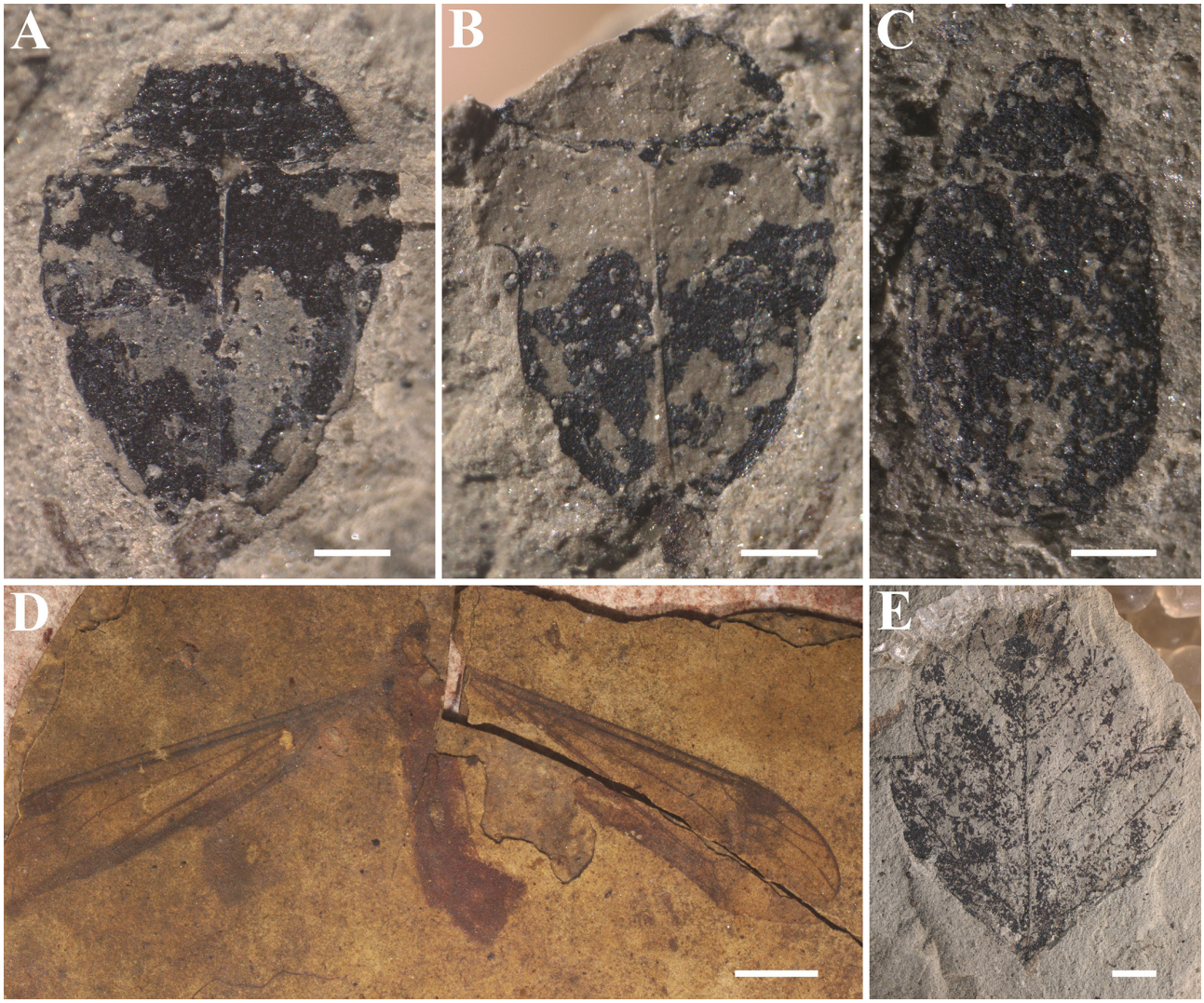

FIGURE 3. Insect and plant fossils from the Wulidun Formation. **A**, **B**, Unidentified beetle, part and counterpart. **C**, Another poorly-preserved beetle. **D**, Tipulidae. **E**, A leaf of angiosperm, possibly *Alnus* sp. Scale bars = 0.5 mm in **A**–**C**, 2 mm in **D**, **E**.

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