



The first fossil Cydnidae (Hemiptera: Pentatomoidea) from the Late Mesozoic of China

YUNZHI YAO¹, WANZHI CAI^{1,2,3} & DONG REN^{2,3}

¹Department of Entomology, China Agricultural University, Yuanmingyuan West Road, Beijing 100094, China.
E-mail: caiwz@cau.edu.cn.

²Key Lab of Insect Evolution & Environmental Changes, Capital Normal University, Beijing 100037, China.
E-mail: rendong@mail.cnu.edu.cn

³Author for correspondence

Abstract

Two new genera and two new species of fossil amnestine burrower bugs, *Cilicydnus robustispinus* **gen. & sp. nov.** and *Orienicydnus hongii* **gen. & sp. nov.**, are described and illustrated. They were collected from the Late Mesozoic nonmarine sedimentary strata of Northeast China. This finding represents the first record of fossil cydnids from China. The fossil cydnid localities and the distribution of extant taxa are summarized in a map.

Key words: Heteroptera, Pentatomoidea, Cydnidae, Amnestinae, fossil, Late Jurassic — Early Cretaceous, Yixian Formation, China

Introduction

The subfamily Amnestinae, containing only one extant genus, *Amnestus* Dallas with 25 extant species, is distributed in the Western Hemisphere and Iran (Froeschner 1960, Lis 1998). Representatives of this subfamily are small (1.6–8 mm) and can be easily recognized by the presence of distinct claval commissure, an unusual feature in Pentatomoidea. Fossils of Amnestinae are represented by 7 species belonging to 5 genera (Pinto & Ornellas 1974, Popov 1986, 1990; Thomas 1988, 1994; Popov & Pinto 2000, Shcherbakov & Popov 2002). Recently we discovered three well-preserved fossil burrower bug specimens, including one part and counterpart from the Yixian Formation, in Chaomidian Village, Beipiao City, Liaoning Province, China. Because they cannot be assigned to any known genera, we erect two new genera to accommodate them.

The geological age of the Yixian Formation is still contentious, considered to be Late Jurassic (Ren *et al.* 1997, Zheng *et al.* 2003), the transition from Late Jurassic to Early Cretaceous (Chen *et al.* 2004, Wang *et al.* 2004), and the Early Cretaceous (Swisher *et al.* 1999, Li *et al.* 2001, Pang *et al.* 2002, Zhou *et al.* 2003). Recently, Wang *et al.* (2005) summarized and analyzed the geological age of the Yixian Formation by abundant fossil data and isotope data, and finally considered that the synthetic age of the Yixian Formation may be determined as Late Jurassic to Early Cretaceous. We accept this opinion and consider the age of the Yixian Formation as the transition from Late Jurassic to Early Cretaceous (Late Tithonian to the Berriasian).

Material and methods

All the type specimens of the new species are preserved at the Key Laboratory of Insect Evolution & Environ-

mental Changes, Capital Normal University in Beijing, China. Drawings were made with a camera lucida attached to a Leica MZ12.5 stereomicroscope. Basic terminology and the classification system follow Dolling (1981); cephalic chaetotaxy terminology follows Lis & Pluot-Sigwalt (2002). Body length was measured from the apex of the head to the apex of the hemelytron. Body width was measured at the maximal width of the body. The lengths of pronotum and scutellum were measured at the midline. The length of the fore wings was measured from the base of the hemelytron to its apex. All measurements are in millimeters.

Taxonomy

Order Hemiptera Linnaeus, 1758

Suborder Heteroptera Latreille, 1810

Infraorder Pentatomomorpha Leston, Pendergrast & Southwood, 1954

Superfamily Pentatomoidea Reuter, 1910

Family Cydnidae Billberg, 1820

Subfamily Amnestinae Hart, 1919

Genus *Cilicydnus* Yao, Cai & Ren, gen. nov.

Type species. *Cilicydnus robustispinus* Yao, Cai & Ren, sp. nov.

Diagnosis: Body length ranging 5.9–6.1 mm, oval, dorsum of head, pronotum, scutellum, and corium with long dense setae. Head semicircular, wider than long, without primary setae on the margins of the head, shorter than pronotum; rostrum arising from apex of head, extending beyond posterior margin of pronotum, 4-segmented, first and second segments thickest, third nearly as long as fourth; eyes large, round, touching anterior margin of pronotum; antenna 4-segmented, shorter than head and pronotum combined, first segment shortest, second longest, third nearly as long as fourth, fourth fusiform, thickest. Pronotum trapezoidal, strongly transverse, anterior angles bulging forward, without collar; scutellum transverse, about 2 times as wide as long, slightly shorter than pronotum at midline; femora stout, distinctly thicker than corresponding tibiae, tibiae with dense stout spines, tarsus 3-segmented, tarsomeres subequal in thickness, first shortest, third longest; mid and hind coxae narrowly separated, coxa and trochanter rounded triangular, fore and mid femora subequal to corresponding tibiae in length, hind leg longer than mid leg, hind femur distinctly shorter than hind tibia; hemelytron macropterous, apical margin rounded, extending beyond tip of abdomen, corium with deep median fracture, clavus large, claval commissure shorter than scutellum. Abdomen wider than pronotum; ovipositor long, not projecting beyond last paratergites, extending through last two abdominal segments.

Distribution. China.

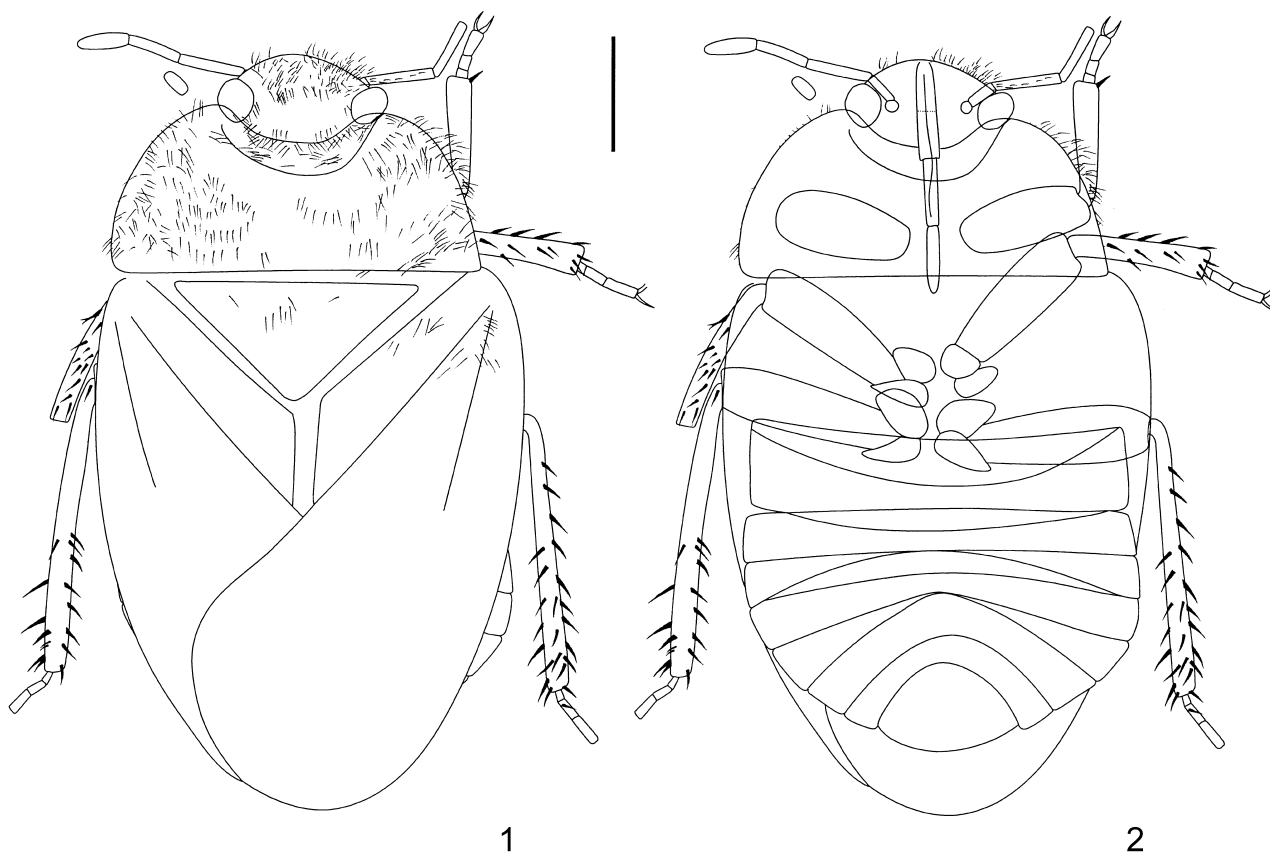
Etymology: The generic name is a combination of the Latin *cili* (“cilia”) and *Cydnus* (the type genus of Cydnidae).

Remarks: The new genus can be assigned to the family Cydnidae by the following combination of features: head semicircular, more widened; anterior angles of pronotum bulging forward, tibiae with dense and stout spines. This genus can be easily placed in Amnestinae because of the distinct claval commissure. The new genus is distinguished from the extant amnestine genus *Amnestus* Dallas, in the dorsum of head, pronotum, scutellum, and corium with dense and long setae (vs. with a few setae), anterior margin of head without primary setae (vs. with primary setae).

Among all fossils of Cydnidae, the new genus is most closely related to *Laticutella* Pinto & Ornellas, 1974, but the new genus differs from the latter in ratio of first segment to second of antenna about 4:9 (vs. 5:14), dorsum of head, pronotum, scutellum, and corium with long dense setae (vs. without setae), pronotum about 3 times as wide as long (vs. about 2 times as wide as long), and scutellum very transverse, about 2 times as wide as long (vs. slightly wider than long).

***Cilicydnus robustispinus* Yao, Cai & Ren, sp. nov. (Figs. 1–5)**

Description: Body 1.6 times as long as wide. Head distinctly shorter than pronotum, 1.9 times as wide as long; antenna 2.4 times as long as head, second segment about 2 times as long as first, 1.1 times as long as third; eyes somewhat prominent, interocular space 2.8 times as wide as diameter of eyes in dorsal view. Pronotum 2.9 times as wide as long, anterior margin very concave, lateral margins convex, posterior margin straight, anterior angles rounded, posterior angles nearly rectangular; scutellum 2 times as wide as long, apex obtuse; all femora stout, more than 2 times as thick as corresponding tibiae, tibial spines nearly as long as diameter of tibia, fore leg shorter than mid, fore femur thicker than mid, fore tarsus 0.4 times as long as corresponding tibia, third tarsomere longest, almost 2 times as long as second and 4 times as long as first; mid tarsus 0.45 times as long as corresponding tibia, third tarsomere longest, 1.5 times as long as second and 4.5 times as long as first; hind tibia almost 1.5 times as long as hind femur, hind tarsus similar to fore and mid tarsi, third tarsomere longest, 1.4 times as long as second and 3.5 times as long as first. Fore wing 2.2 times as long as wide, extending beyond tip of abdomen by one-tenth of total length of hemelytron, costal margin slightly convex, median fracture 0.4 times of hemelytron in length; clavus nearly 4 times as long as wide, almost 0.5 times hemelytron in length.



FIGURES 1–2. *Cilicydnus robustispinus* gen. & sp. nov. Holotype, outline. ♂. CNU-HE-LB2006297-298. 1. dorsal view; 2. ventral view. Scale bar = 1 mm.

Measurements (in mm): Body length 5.94 (♂), 6.09 (♀); maximal width of abdomen 3.38 (♂), 3.53 (♀); length head 0.76 (♂), 0.65 (♀), width 1.38 (♂), 1.09 (♀); length antennal segments I–IV: 0.24, 0.56, 0.44, 0.44 (♂); length rostrum segments I–IV: ?, ?, 0.56, 0.56 (♂); length pronotum 1.09 (♂), 0.9 (♀), width 3.18 (♂), 3.03 (♀); length scutellum 1.0 (♂), width 2.08 (♂); length hemelytron 4.94 (♂), width 2.2 (♂), length clavus 2.47 (♂), width 0.59 (♂); length fore leg: femur 1.09 (♂), tibia 1.0 (♂), tarsomeres I–III: 0.06, 0.12, 0.24 (♂); length mid leg: femur 1.26 (♂), 1.18 (♀), tibia 1.23 (♂), tarsomeres I–III: 0.06, 0.18, 0.26 (♂); length hind leg: femur 1.53 (♂), 1.47 (♀), tibia 2.35 (♂), tarsomeres I–III: 0.08, 0.18, 0.26 (♂).

Material: Holotype, ♂, CNU-HE-NN2006297-298 (part and counterpart); paratypes, 1 ♀, CNU-HE-NN2006299 (dorsoventrally compressed).

Locality and horizon: Huangbanjigou, Chaomidian Village, Beipiao City, Liaoning Province, China. Late Jurassic to Early Cretaceous, Yixian Formation.

Etymology: The name is derived from the Latin *robustispinus*, because of its tibiae with stout spines.



FIGURES 3–4. *Cilicydnus robustispinus* gen. & sp. nov., photograph. 3–4. Holotype, ♂. CNU-HE-LB2006297-298, part and counterpart. Scale bar = 2 mm.

Genus *Orienicydnus* Yao, Cai & Ren, gen. nov.

Type species. *Orienicydnus hongii* Yao, Cai & Ren, sp. nov.

Diagnosis: Body oval, dorsum of head, pronotum, scutellum, and corium with long dense setae. Head semi-circular, wider than long, subequal to pronotum in length, anterior margin with 9 primary setae; rostrum arising from apex of head, extending to posterior margin of pronotum, 4-segmented, segments subequal in thickness, first longest, basal 2/3 concealed between bucculae, second subequal to third, fourth distinctly longer than third; eyes moderately sized, subtriangular, contiguous to anterior margin of pronotum. Pronotum

trapezoidal, strongly transverse, anterior angles bulging forward, without collar; femora very stout, distinctly thicker than tibiae, tibiae with dense and stout spines, tarsi 3-segmented, tarsomeres subequal in thickness, first shortest, second nearly as long as third, mid and hind coxae narrowly separated, mid and hind coxae and trochanters rounded triangular, fore and mid femora subequal to corresponding tibiae in length, hind leg longer than mid leg, hind femur distinctly shorter than hind tibia. Abdomen wider than pronotum; ovipositor long, not projecting beyond last paratergites, extending through last two abdominal segments.

Distribution. China.

Etymology: The generic name is a combination of the Latin *oriens* (“orient”) and *Cydnus* (the type genus of Cydnidae).



FIGURE 5. *Cilicydnus robustispinus* gen. & sp. nov. Paratype, ♀, CNU-HE-LB2006299. Scale bar = 1 mm.

Remarks: This new genus is similar to *Cilicydnus* in dorsum of head, pronotum, scutellum, and corium having long dense setae, but *Oriencydnus* can be easily distinguished from *Cilicydnus* by head subequal to pronotum in length, anterior margin of head with 9 primary setae (vs. head shorter than pronotum, without primary seta); rostrum not extending to posterior margin of pronotum, rostral segments subequal in thickness,

fourth segment distinctly longer than third (vs. rostrum extending beyond posterior margin of pronotum, rostral segments differing in thickness, third segment subequal to fourth); eyes subtriangular, contiguous to anterior margin of pronotum (vs. eyes round, touching anterior margin of pronotum), and second tarsomere subequal to third (vs. shorter than third).

***Orienicydnus hongii* Yao, Cai & Ren, sp. nov. (Figs. 6–7)**

Description: ♀, Body 1.8 times as long as wide. Head 1.5 times as wide as long; eyes prominent, interocular space 6 times as wide as diameter of eyes in dorsal view. Pronotum 2.7 times as wide as long, anterior margin very concave, lateral margins convex, posterior margin nearly straight, anterior angles rounded, posterior angles rounded; all femora stout, more than 2 times as thick as corresponding tibiae, spines on tibia nearly as long as diameter of tibia, fore legs shorter than mid, fore tarsus 0.4 times as long as corresponding tibia, third tarsomere almost 4 times as long as first, mid tarsus 0.46 times as long as corresponding tibia, second tarsomere 2.5 times as long as first; hind tibia almost 1.6 times as long as femur, tarsi similar to fore and mid tarsi, third 2 times as long as first.

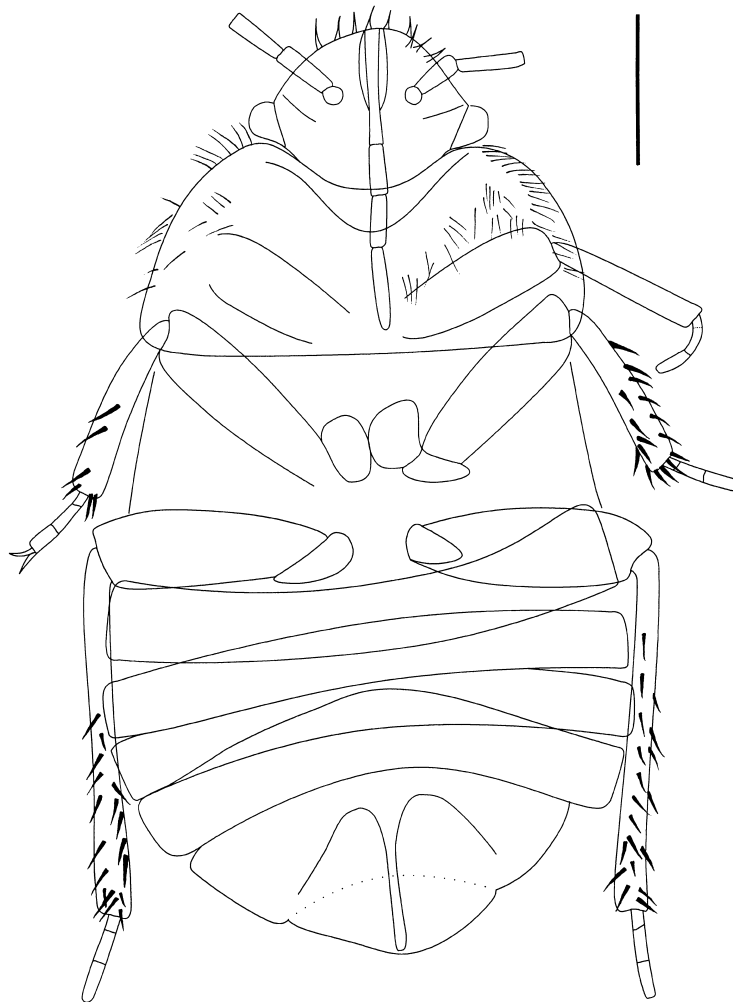


FIGURE 6. *Orienicydnus hongii* gen. & sp. nov. Holotype, outline. ♀. CNU-HE-LB2006300. Scale bar = 1 mm.

Measurements (in mm): Body length 6.15; maximal width of abdomen 3.47; length head 1.06, width 1.59; length antennal segments I–IV: 0.38, 0.44, ?, ?; length rostrum I–IV: 0.76, 0.32, 0.35, 0.53; length

pronotum 1.09, width 2.88; length fore leg: femur 1.12, tibia 1.0 (σ), tarsomeres I–III: 0.06, 0.18, 0.18; length mid leg: femur 1.29, tibia 1.26, tarsomeres I–III: 0.09, 0.23, 0.23; length hind leg: femur 1.47, tibia 2.35 (σ), tarsomeres I–III: 0.12, 0.24, 0.24.

Material: Holotype, ♀, CNU-HE-NN2006230 (dorsoventrally compressed).

Locality and horizon: Huangbanjigou, Chaomidian Village, Beipiao City, Liaoning Province, China. Late Jurassic to Early Cretaceous, Yixian Formation.

Etymology: This species is named in honor of Prof. Youchong Hong of the Beijing Museum of Natural History, Beijing, for his outstanding contributions to the study of the fossil insects of China.



FIGURE 7. *Orienicydnus hongii* gen. & sp. nov. Holotype, photograph. ♀. CNU-HE-LB2006300. Scale bar = 1 mm.

Discussion

The localities of all known and newly discovered fossil Amnestinae are summarized in a map (Fig. 8). During the Late Mesozoic, members of Amnestinae were widespread in all zoogeographical regions. Four known species of Early Cretaceous Amnestinae were described: *Pricecoris beckeri* Pinto & Ornellas, 1974, and *Laticutella santosi* Pinto & Ornellas, 1974, from the Codo Formation of Corda City, Maranhão State, Brazil; and *Clavicoris cretaceous* Popov, 1986, and *Meropachys dubius* Popov, 1986, from West Mongolia. In the Tertiary, the distribution of Amnestinae was reduced to the Western Hemisphere only. Three species of Tertiary *Amnestus* have been described from amber: *A. guapinolinus* Thomas, 1988, from the Oligo-Miocene of Chiapas, México; *A. electricus* Thomas, 1994, and *A. priscus* Thomas, 1994, from the Dominican Republic. The distribution of extant Amnestinae is shown as the shaded part in Fig. 8. According to this distribution pattern, the most parsimonious hypothesis is that the members of Amnestinae became abundant already in the Early Cretaceous; but later these bugs probably became extinct in the Old World due to climatic and environmental alterations during the Late Cretaceous. During the Tertiary, their distribution range became similar to that of extant Amnestinae, i.e., only in the New World, from which the subsequently spread into the Old World (e.g., Iran). The Amnestinae of the Late Mesozoic were longer than 5.5 mm, and a majority of species lacked pegs at the anterior margin of head, except for *Orienicydnus hongii*, which has these pegs. After the Late Cretaceous, the body of burrower bugs in this subfamily became smaller (only 1.6–4.5 mm), and all species now have pegs at the anterior margin of the head.

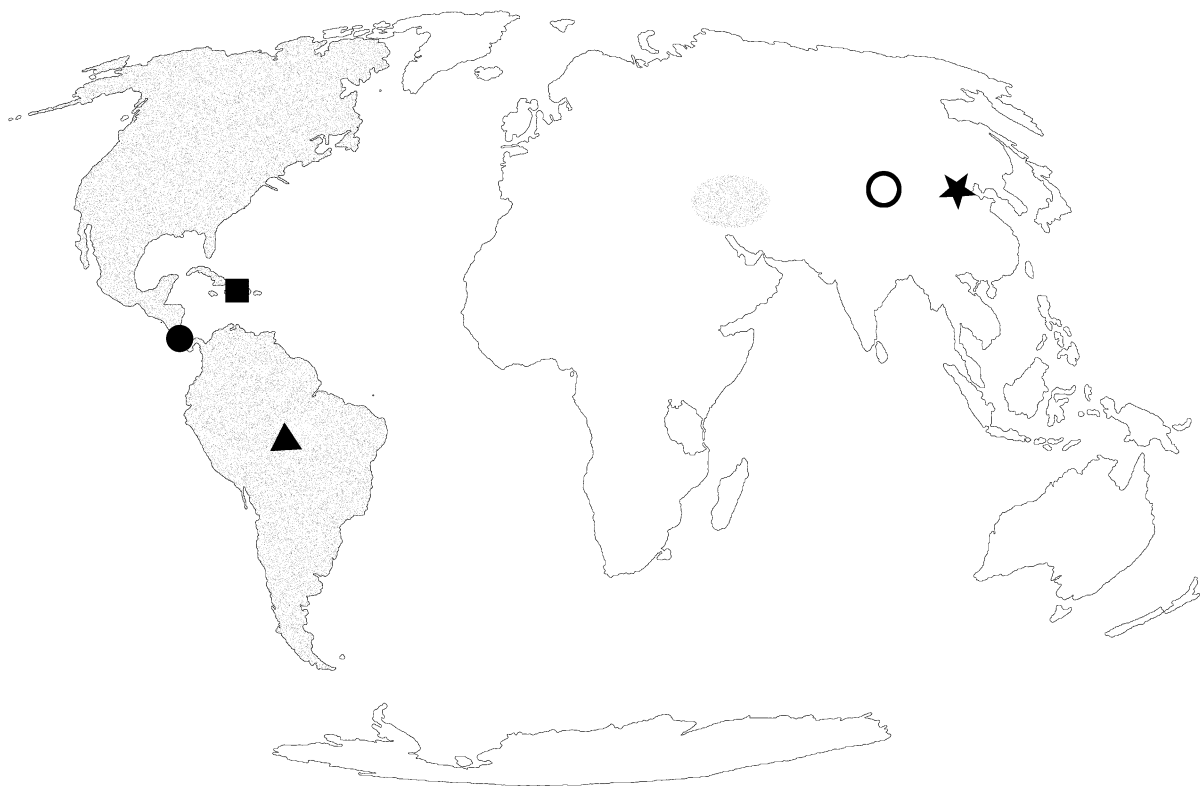


FIGURE 8. Sketch map with fossil localities and the distribution of extant taxa of Amnestinae. ★, The Yixian Formation, in Chaomidian Village, Beipiao City, Liaoning Province in China, Late Jurassic to Early Cretaceous; ○, West Mongolia, Early Cretaceous; ▲, Codo Formation of Corda City, Maranhao State, Brazil, Early Cretaceous; ■, Dominican Republic, Tertiary; ●, Chiapas, Mxico, the Oligo-Miocene. Shaded part is the distribution of extant Amnestinae.

Acknowledgements

We sincerely thank Prof. Carl W. Schaefer (University of Connecticut) for a critical reading of, and helpful comments on, the manuscript. We are grateful to Dr. Chung-Kun Shih (Capital Normal University, Beijing) for his improvement of an earlier draft of the manuscript, and to Ms. Ming Liu for practical help. This research is partly supported by grants from the National Natural Science Foundation of China (Nos. 30370161, 30370184, 30430100), the Beijing Natural Science Foundation Program (No. 6042014), the Scientific Research Key Program (KZ200410028013), and the PHR Project of Beijing Municipal Commission of Education.

References

- Chen, P.J., Wang, Q.F., Zhang, H.C., Cao, M.Z., Li, W.B., Wu, S.Q. & Shen, Y.B. (2004) Discussion on the stratotype of Jianshangou of Yixian Formation. *Science in China, Series D*, 34, 883–895. (In Chinese with English abstract).
- Dolling, W.R. (1981) A rationalized classification of the burrower bugs (Cydnidae). *Systematic Entomology*, 6, 61–76.
- Froeschner, R.C. (1960) Cydnidae of the Western Hemisphere. *Proceedings of the United States National Museum*, 111, 337–680.
- Li, P.X., Cheng, Z.W. & Pan, Q.Q. (2001) The horizon and age of the Confuciusornis in Beipiao, western Liaoning. *Acta Geologica Sinica*, 75, 1–13. (In Chinese with English abstract).
- Lis, J.A. (1998) *Amnestus raunoi* n. sp. from Iran, the first Old World representative of the New World subfamily Amnestinae (Hemiptera: Heteroptera: Cydnidae). *Entomologica Fennica*, 9, 5–7.
- Lis, J.A. & Pluot-Sigwalt, D. (2002) Nymphal and adult cephalic chaetotaxy of the Cydnidae (Hemiptera: Heteroptera), and its adaptive, taxonomic and phylogenetic significance. *European Journal of Entomology*, 99, 99–109.
- Pang, Q.Q., Li, P.X., Tian, S.G. & Liu, Y.Q. (2002) Discovery of ostracods in the Dabeigou and Dadianzi Formations at Zhangjiagou, Luanping County, northern Hebei Province of China and new progress in the biostratigraphic boundary study. *Geological Bulletin of China*, 21, 329–336. (In Chinese with English abstract)
- Pinto, I.D. & Ornellas, L.P. (1974) New Cretaceous Hemiptera (Insecta) from Codó Formation —Northern Brazil. *Anais 28th Congresso Brasileiro de Geologia*, 289–304.
- Popov, Yu.A. (1986) Peloridiina (=Coleorrhyncha) et Cimicina (=Heteroptera). In: *Insects in Early Cretaceous ecosystems of western Mongolia. Transactions of the Joint Soviet-Mongolian Paleontological Expedition*, 28, 47–84. (In Russian).
- Popov, Yu.A. (1990) Description of fossil insects. True bugs. Cimicina. In: *Late Mesozoic insects of Eastern Transbaikalia. Transactions of Paleontological Institute of Academy Sciences of the USSR*, 239, 20–39. (In Russian).
- Popov, Yu.A. & Pinto, I.D. (2000) On some Mesozoic burrower bugs (Heteroptera: Cydnidae). *Paleontological Journal*, 34, 298–302.
- Ren, D., Guo, Z.G., Lu, L.W., Ji, S.A., Tang, F., Jin, Y.G., Fang, X.S. & Ji, Q. (1997) A further contribution to the knowledge of the Upper Jurassic Yixian Formation in Western Liaoning. *Geological Review*, 43, 449–459. (In Chinese with English abstract).
- Shcherbakov, D.E. & Popov Yu.A. (2002) Superorder Cimicidea Laicharting, 1781. Order Hemiptera Linne, 1758. The bugs, cicads, scale insects, etc. In: Rasnitsyn A.P. & Quicke D.L.J. (eds.) *History of insects*. Kluwer Academic Publishers, Dordrecht, pp. 143–157.
- Swisher, C.C., Wang, Y.Q., Wang, X.L., Xu, X. & Wang, Y. (1999) Cretaceous age for the feathered dinosaurs of Liaoning, China. *Nature*, 400, 58–61.
- Thomas, D.B., Jr. (1988) Fossil Cydnidae (Heteroptera) from the Oligo-Miocene amber of Chiapas, Mexico. *Journal of the New York Entomological Society*, 96, 26–29.
- Thomas, D.B., Jr. (1994) Fossil Cydnidae (Heteroptera) in the Dominican amber. *Journal of the New York Entomological Society*, 102, 303–309.
- Wang, W.L., Zhang, L.J., Zheng, S.L., Ren, D., Zheng, Y. J., Ding, Q.H., Zhang, H., Li, Z.T. & Yang, F.L. (2005) The age of the Yixian stage and the boundary of Jurassic-Cretaceous—the establishment and study of stratotypes of the Yixian stages. *Geological Review*, 51, 234–242. (In Chinese with English abstract).
- Wang, W.L., Zhang, L.J., Zheng, S.L., Zheng, Y.J., Zhang, H., Li, Z.T. & Yang, F.L., (2004) A new study on the stratotype and biostratigraphy of the Yixian Stage in Yixian-Beipiao Region, Liaoning—establishment and study of stratotypes of the Yixian Stage. *Acta Geologica Sinica*, 78, 433–447. (In Chinese with English abstract).

- Zheng, S.L., Zheng, Y.J. & Xing, D.H. (2003) Characteristics, age and climate of Late Jurassic Yixian flora from western Liaoning. *Journal of Stratigraphy*, 27, 233–241. (In Chinese with English abstract).
- Zhou, Z.H., Barrett, P.M. & Hilton, J. (2003) An exceptionally preserved lower Cretaceous ecosystem. *Nature*, 421, 807–814.