

New Angarosphecidae (Insecta: Hymenoptera: Apoidea) from the Lower Cretaceous of Northeastern China

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Abstract—Two new species of the family Angarosphecidae, *Angarosphechus saxosus* sp. nov. and *Vitimosphex vividus* sp. nov., from the Lower Cretaceous Yixian Formation of northeastern China are described and illustrated. Generic diagnoses are revised. The genera *Palaeapis* Hong, 1984, *Mataeosphex*: Zhang, 1985, and *Calobaissodes* Zhang, 1992 are synonymized under *Angarosphechus* Rasnitsyn, 1975, and new combinations *Angarosphechus beiboziensis* (Hong, 1984), comb. nov., *Angarosphechus venulosus* (Zhang, 1985), comb. nov., and *Angarosphechus strigosus* Zhang, 1992, comb. nov. are proposed. The genus *Vitimosphex* Rasnitsyn, 1975 is found reaching northeastern China in its distribution. New morphological data are presented to complete characteristics of the genera concerned.

Keywords: Hymenoptera, Angarosphecidae, new species, new synonyms, Lower Cretaceous, China

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INTRODUCTION

The Angarosphecidae Rasnitsyn, 1975 are ancient spheciform wasps known from the deposits ranging from the Early Cretaceous to Eocene (reviewed by Rasnitsyn et al., 1998; Pulawski et al., 2000; Rasnitsyn and Martínez-Delclòs, 2000). These archaic, mainly Mesozoic wasps lack synapomorphies characteristic of living families and subfamilies and so may be paraphyletic with respect to other Apoidea, because they are not defined by any synapomorphies (Rasnitsyn et al., 1998, 1999). Nevertheless, for the present, we have to use the family name, because we cannot propose a way to split it into a series of monophyletic taxa without a paraphyletic residue. This family is considered to be the most abundant group among the Early Cretaceous Hymenoptera (Rasnitsyn et al., 1998).

Although plenty of angarosphechids have been reported from the Lower Cretaceous of eastern Asia, only a few species are known from China (Hong, 1984; Zhang, 1985, 1992; Ren et al., 1995). The reason is probably insufficient interest of students, which is in turn suppressed by the rather obscure taxonomy of the group. The problem is that the customary paleontological approach relies mainly on the wing venation, which is found less efficient for the aculeate wasps, whose venation is generally uninformative taxonomically. The body morphology may be of much help, but lots of efforts need to be invested before it will

become an efficient tool for taxonomic study the Cretaceous spheciform wasps.

The present report is the first result from a planned survey of the spheciform Aculeata of the Lower Cretaceous Yixian Formation of northeastern China. *Angarosphechus* Rasnitsyn, 1975, the type genus of Angarosphecidae, was established based on specimens from the Lower Cretaceous of Transbaikalia. Many species from the Early Cretaceous were described and some of them have been revised before (Rasnitsyn et al., 1998, Rasnitsyn, 1999). *Vitimosphex* Rasnitsyn, 1975 includes currently only the type species *V. incompletus* also described from the Lower Cretaceous of Transbaikalia. The new species described herein from the Yixian Formation of northeastern China are assigned to the genera *Angarosphechus* and *Vitimosphex*. Their discovery not only indicates that the genus *Vitimosphex* reached China in the Early Cretaceous, but also expands our knowledge of the morphology of these two genera, which in turn will help in exploring other fossil spheciform wasps in China and elsewhere.

MATERIAL AND METHODS

The present publication is based mainly on three specimens from the vicinity of the village of Huangbanjigou, Beipiao, Liaoning, and the village of Liutiaogou, Ningcheng, Inner Mongolia, China (Fig. 1). The specimen from the village of Huangbanjigou was

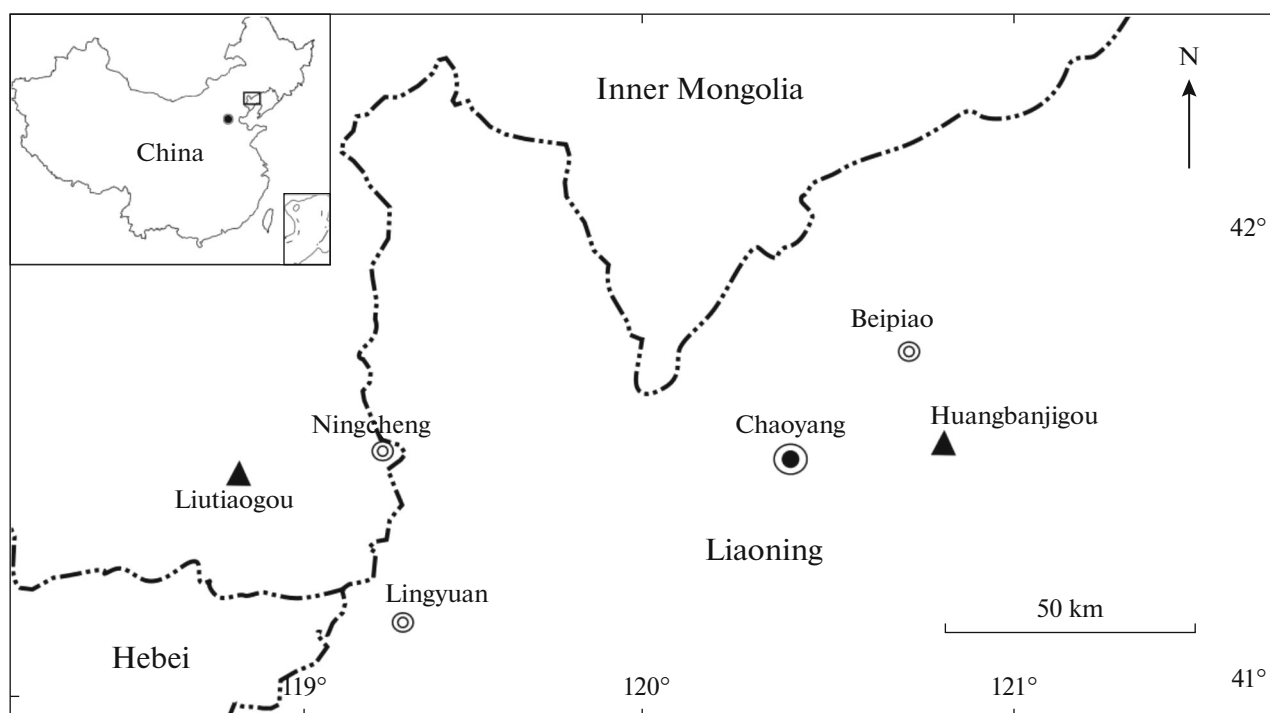


Fig. 1. Geographical position of fossil insect localities.

collected from the Lower Aptian Jianshangou Beds of the Yixian Formation, while the other specimen from the village of Liutiaogou was from the equivalent beds (Wang et al., 2011). All specimens are housed in the Nanjing Institute of Geology and Paleontology of the Chinese Academy of Sciences (NIGP). Examination of these specimens was performed under a NIKON SMZ1000 microscope with fiberoptics, dry and immersed in ethanol, and photographs were prepared with a digital camera (DXM1200) connected to the microscope at the State Key Laboratory of Paleobiology and Stratigraphy in Nanjing. Line drawings were made using CorelDraw X7.0 software. Wing venation terminology of Rasnitsyn (1969) and Rasnitsyn and Zhang (2010) is adopted herein.

SYSTEMATIC PALAEONTOLOGY

Order Hymenoptera Linnaeus, 1758

Suborder Apocrita Gerstaecker, 1867

Superfamily Apoidea Latreille, 1802
(=Sphecoidea Latreille, 1802)

INFORMAL GROUP SPHECIFORMES (*SENSU* BROTHERS, 1975)

Family Angarosphecidae Rasnitsyn, 1975

Genus *Angarosphe* Rasnitsyn, 1975

Angarosphe: Rasnitsyn, 1975, p. 110.

Palaeapis Hong: 1984, p. 38, syn. nov., (type species: *P. bei-boziensis* Hong, 1984).

Mataeosphe: Zhang, 1985, p. 32, syn. nov., (type species: *M. venulosus* Zhang, 1985).

Shandongodes: Zhang, 1985, p. 33, (type species: *S. lithodes* Zhang, 1985).

Calobaissodes strigosus Zhang, 1992 syn. nov. (Type species: *C. strigosus* Zhang, 1992).

Type species. *Angarosphe myrmicopterus* Rasnitsyn 1975; Lower Cretaceous, Zaza Formation of Baissa, Transbaikalia, Russia.

Diagnosis. Forewing with cells 3r apex acute, touching wing margin, 2rm and 1mcu little or not overlapping, 2r-m meeting RS distal of 2r-rs, 2m-cu meeting cell 3rm, cu-a antefurcal (basal of 1mcu cell).

Species composition. Fifteen species from the Early Cretaceous of Spain, England, Mongolia, Russia, China, and Brazil (see Table 1).

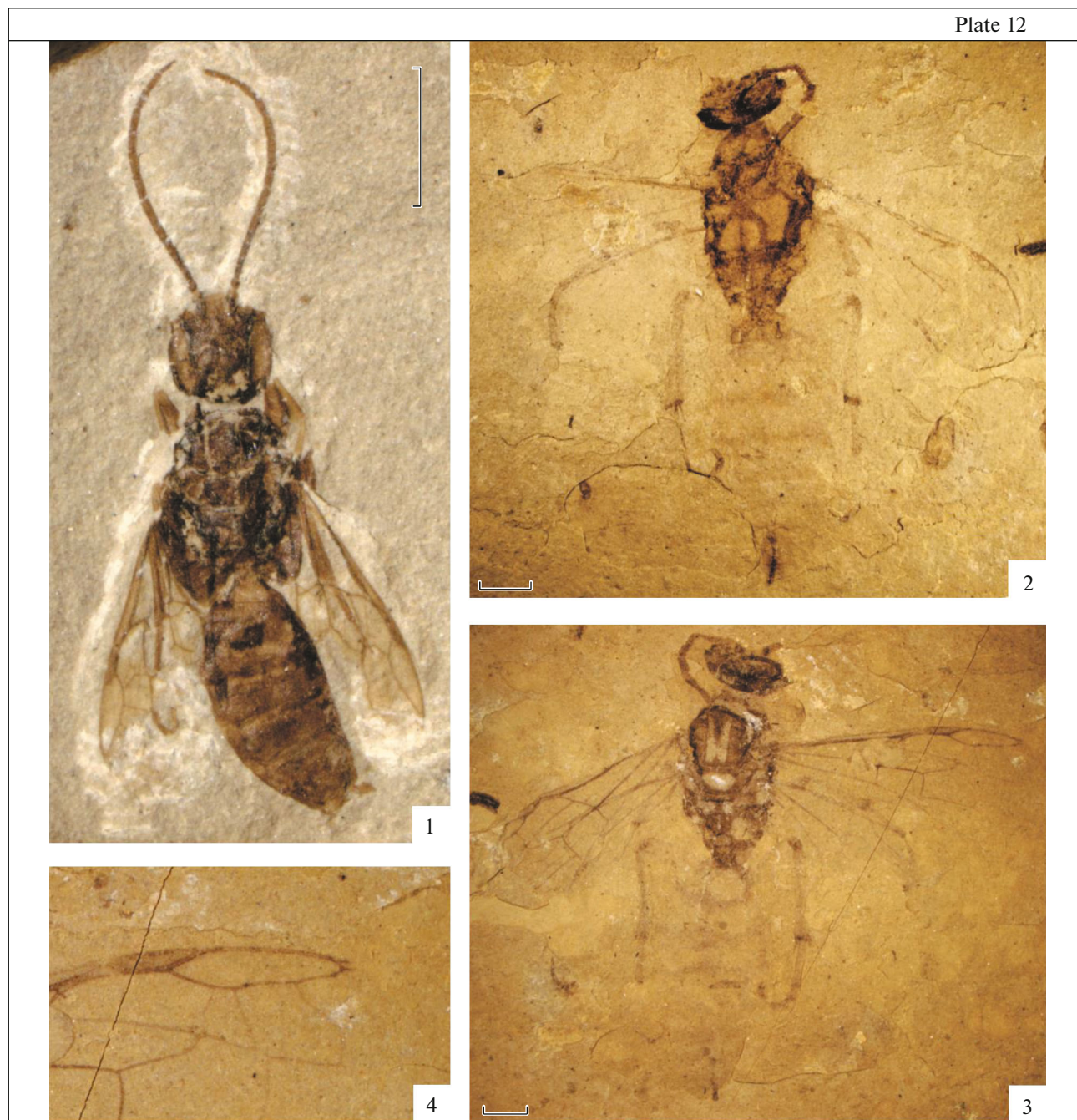
Remarks. The genera *Palaeapis* Hong, 1984, *Mataeosphe* Zhang, 1985, and *Calobaissodes* Zhang, 1992 are synonymized under *Angarosphe*, because they agree perfectly with its diagnosis, as it is outlined above.

Angarosphe saxosus sp. nov.

Plate 12, fig. 1

Etymology. From the Latin *saxicole* (inhabiting or growing among rocks).

Holotype. NIGP165267 (LBSH02212), a female wasp in dorsal aspect. From the village of Huangbanjigou, town of Shangyuan, Beipiao, western



Explanation of Plate 12

Family Angarosphecidae, northeastern China; Yixian Formation, Lower Cretaceous.

Fig. 1. *Angarospheca saxosus* sp. nov., holotype NIGP165267, dorsal view.

Figs. 2–4. *Vitimospheca vividus* sp. nov., holotype NIGP165268: (2) part; (3) counterpart; (4) forewing apex counterpart. Scale bar, 2 mm.

Liaoning Province, China; Early Cretaceous (Early Aptian).

Description (Figs. 2a, 2b). The color pattern is dark. The head is medium-sized. The eye is large, ovate, occupying most of the head sides; the posterior ocelli are at a much more greater distance from each

other than from the anterior one. The antennae are composed of 12 segments, with the scape twice longer than wide; the pedicel is small, thickened apically and slightly longer than wide; the flagellum is basally and apically thin, gradually increasing in thickness towards its middle; the first flagellomere is thinner than the

Table 1. Occurrences of species of the genus *Angarosphex*

Species	Locality	Straton	Dating	Reference
<i>Angarosphex myrmicop-terus</i> Rasnitsyn, 1975	Baissa, Transbaikalia	Zazinskaya Formation	Early Cretaceous, Aptian	Rasnitsyn, 1975
<i>Angarosphex beiboziensis</i> (Hong, 1984), comb. nov.	Beipozi, Laiyang, Shandong, China	Laiyang Formation	Early Cretaceous, Aptian	Hong, 1984; Rasnitsyn et al., 1998
<i>Angarosphex lithodes</i> (Zhang, 1985) Rasnitsyn et Jarzembowski, 1998	Tuanwang, Laiyang, Shandong, China	Laiyang Formation	Early Cretaceous, Aptian	Zhang, 1985; Rasnitsyn et al., 1998
<i>Angarosphex venulosus</i> (Zhang, 1985), comb. nov.	Tuanwang, Laiyang, Shandong, China	Laiyang Formation	Early Cretaceous, Aptian	Zhang, 1985; Rasnitsyn et al., 1998
<i>Angarosphex pallidus</i> Rasnitsyn, 1986	Hurvan–Ereniy–Nuru, Gobi Altai Aymag, Mongolia	Gurvan–Eren Formation	Early Cretaceous, Aptian	Rasnitsyn, 1986
<i>Angarosphex magnus</i> (Darling, 1990) Rasnitsyn et Jarzembowski, 1998	Nova Olinda, Ceará State, Brazil	Santana Formation	Early Cretaceous, Late Aptian	Darling and Sharkey, 1990; Rasnitsyn et al., 1998
<i>Angarosphex niger</i> Rasnitsyn, 1990	Turga, Transbaikalia	Turga Formation	Early Cretaceous, Aptian	Rasnitsyn, 1990
<i>Angarosphex parvus</i> (Darling, 1990) Rasnitsyn et Jarzembowski, 1998	Nova Olinda, Ceará State, Brazil	Santana Formation	Early Cretaceous, Late Aptian	Darling and Sharkey, 1990; Rasnitsyn et al., 1998
<i>Angarosphex goldringi</i> Jarzembowski, 1991	Auclay Brickworks, Capel, Surrey, England	Upper Weald Clay Formation	Early Cretaceous, Early Barremian	Jarzembowski, 1991
	Bookhurst Tileworks, Cranleigh, Surrey, England	Upper Weald Clay Formation	Early Cretaceous, Late Barremian	Rasnitsyn et al., 1998
<i>Angarosphex strigosus</i> Zhang, 1992, comb. nov.	Nanlighezhuang, Laiyang, Shandong, China	Laiyang Formation	Early Cretaceous, Aptian	Zhang, 1992
<i>Angarosphex bleachi</i> Rasnitsyn et Jarzembowski, 1998	Clockhouse Rock Store, Clockhouse Brickworks, Capel, Surrey, England	Lower Weald Clay Formation	Early Cretaceous, Late Hauterivian	Rasnitsyn et al., 1998
<i>Angarosphex consensus</i> Rasnitsyn et Jarzembowski, 1998	Old pit, Clockhouse, Brickworks, Capel, Surrey, England	Lower Weald Clay Formation	Early Cretaceous, Late Hauterivian	Rasnitsyn et al., 1998
<i>Angarosphex lithographicus</i> Rasnitsyn et Ansorge, 2000	La Cabrú fossil-site, Montsec Range, Lleida Province, Spain	La Pedrera de Rubies Formation	Early Cretaceous, Early Barremian	Rasnitsyn and Ansorge, 2000
<i>Angarosphex penyalverí</i> Rasnitsyn et Martínez-Delclòs, 2000	Montsec Range, Lérida Province, Spain	La Pedrera de Rubies Formation	Early Cretaceous, Early Barremian	Rasnitsyn and Martínez-Delclòs, 2000
<i>Angarosphex saxosus</i> sp. nov.	Village of Huangbanjigou, town of Shangyuan, Beipiao, western Liaoning Province, China	Yixian Formation	Early Cretaceous, Early Aptian	This paper

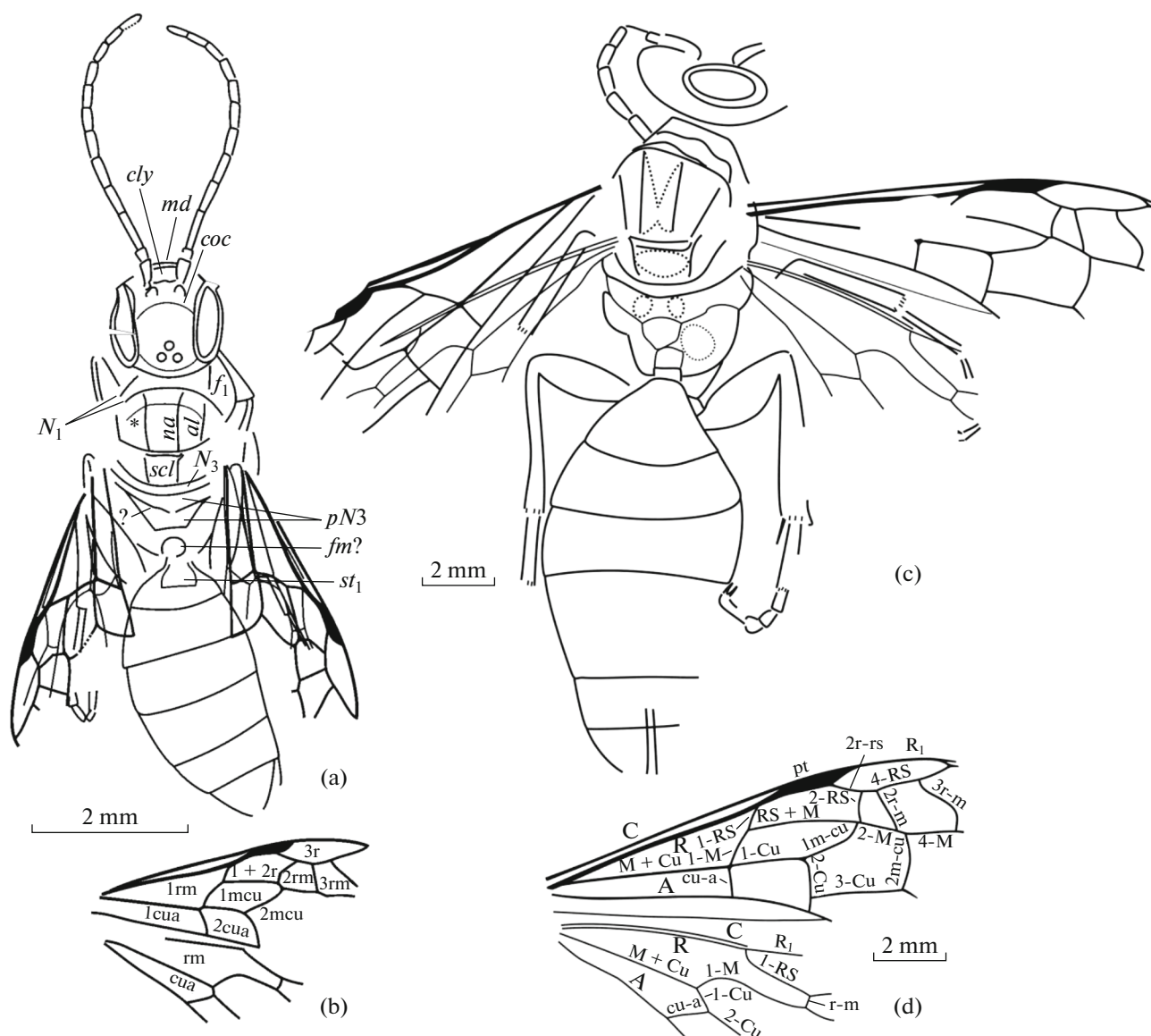


Fig. 2. New species of Angarosphecidae from the Early Cretaceous of northeastern China: (a) *Angarosphecx saxosus* sp. nov., holotype NIGP165267, dorsal view; (b) the same, wings; (c) *Vitimosphecx vividus* sp. nov., holotype NIGP165268b, dorsal view; (d) the same, wings. Explanation of symbols: (al) adlateral line, (cly) clypeus, (coc) occipital carina, (f₁) fore femur, (fm?) possible metasomal articular orifice, (md) mandible, (N₁) pronotum, (N₃) metanotum, (na) notaulus, (pN₃) metapostnotum (propodeal enclosure), (scl) scutellum, (st₁) first metasomal sternum, (*) line of posteriormost reach of pronotum, (?) lines of obscure nature (possibly hind margin of the metapostnotum, but rather some internal structures). Symbols of wing cells in (b) and veins in (d) are standard.

pedicel apex; the second to fifth gradually increase in thickness and decrease in length apically; succeeding flagellomeres are approximately equal in length and shorter than the fifth, becoming thinner apically; the terminal flagellomere is rounded apically.

The mesosoma is slightly broader than the head; the pronotum is very short (its hind, thin part might be not preserved). The mesonotum is broad, with a complete notauli and adlateral lines (parapsides), with an arched line indicating the possible position of the hind pronotal margin. The metanotum is very short, with

an undeveloped or lost metascutellum. The propodeum is long, with a trapezoid metapostnotum (propodeal enclosure) and two oblique lines of obscure nature (possibly representing some internal structures; less likely, these delimit true metapostnotum). The legs are small, with a basally thick forefemur; the tibia is longer than it. The hind femur is comparatively thin, as long as the hind tibia; the hind tarsus is thin, much longer than the tibia.

In the forewing, 1-RS is shorter than 1-M, distant from the pterostigma for more than its length and less

than the pterostigma length. The pterostigma is elongate, widened slightly distally, issuing 2r-rs slightly beyond its midlength; 2r-rs is longer than the pterostigmal height. 2-Rs is angled, lacks 1r-rs rudiment, shorter than 3-RS and 4-RS; 2r-m is straight; 3r-m is very oblique, meeting Rs much closer to 2r-m than to the apex of 3r, although it is shifted from the latter by less than its length. Cell 2rm is shorter than cell 3rm. The Rs + M fork is located slightly more distally than the level of the pterostigma midlength; 1m-cu adjoins M distal to the bifurcation of Rs + M. The upper side of 1mcu is shorter than its lower side; 2m-cu meets cell 3r-m near 2r-m; cu-a is antefurcal.

In the hind wing, 1-Rs is at least four times as long as r-m; 1-M is greatly bent; cu-a is distad of divergence of M + Cu, and 1-Cu is slightly shorter than r-m.

The metasoma is spindle-like, with six segments, widest in the third segment; the first segment is thin basally, gradually broadened apically, and twice wider than long distally; the second to fourth are approximately equal in length; the fifth is shorter than the fourth.

Measurements in mm. Head length, 1.5; width, 1.5; antennal length, 4.0; mesosomal length, 2.3; forewing (as preserved) length, 3.6, width, 1.3; hind wing (as preserved) length, 2.6; width, 1.1; metasomal length, 3.6.

Comparison. The new species differs from all congeners in its small size (the forewing length is less than 4 mm).

Material. Holotype.

Genus *Vitimosphex* Rasnitsyn, 1975

Type species. *Vitimosphex incompletus* Rasnitsyn, 1975 (Fig. 3A), Lower Cretaceous, Zaza Formation of Baissa, Transbaikalia, Siberia.

Revised diagnosis. Forewing with 2r-rs at junction with widest point of pterostigma; first abscissa of Rs shorter than that of M; cell 3r apex narrowly rounded at some distance from forewing margin; free section of Rs present beyond 3r apex; 2rm shorter to slightly longer than high, quadrangular; 3r-m arched, rarely sinuate, distant from cell 3r apex for less than its length; second abscissa of Rs bent basad near its beginning; 1m-cu at or near base of cell 2rm; 2m-cu meeting cell 3rm near 2r-m; cell 1mcu longer than cell 2cua; cu-a before cell 1mcu base. Hind wing with first abscissa of Rs originating distad of M + Cu fork, several times longer than r-m; cu-a meeting Cu (not M + Cu). Metasoma with first segment thin basally but not distinctly petiolate.

Species composition. *Vitimosphex incompletus* Rasnitsyn, 1975 and new species described below. Siberia and China; Early Cretaceous.

Vitimosphex vividus sp. nov

Plate 12, figs. 2–4

Etymology. From the Latin *vividus* (vivid).

Holotype. NIGP165268 (NNDL0086) (part and counterpart), a nearly complete female wasp in dorsal aspect, with antennae, wings and legs damaged, from the village of Liutiaogou, town of Dashuangmiao, Ningcheng County, Chifeng City, Inner Mongolia; Lower Cretaceous Yixian Formation (Lower Aptan).

Description. The head, antenna, and mesosoma are moderately dark; the mesosoma has abundant pale markings: two wide lines mesad of notauli connected to each other at the third quarter of its length, most of the scutellum, two small spots on the metapostnotum, at least two spots on the pronotum, and possibly hind (not preserved) half of the pronotum. The legs are pale, with darkened knees and less so the tibial apices, possibly also the apices of tarsal segments. The metasoma is pale, with slightly darkened hind tergal margins and with dark sting sheaths.

The head is medium-sized, with ovoid eyes and short temples. The antennae are thin, with a moderately long scape; the pedicel is short; flagellar segments are about 2.5 times as long as wide. The mesosoma is suboval. The pronotum is partially preserved, probably medially about one-fourth as long as the mesoscutum. The mesonotum has long notauli and adlateral lines; the scutellum is half as long as the scutum. The metanotum is short; metapostnotum is apparently triangular, but its hind part looks separated and might not belong to it, along with the propodeum about as long as the mesoscutum. The hind legs have femora swollen at the middle; the tibiae are thin, with one apical spur visible; the mid and hind tibial apices have a row of spines; the tarsus is thin, slightly longer than the tibia and possesses two short claws, with the basitarsomere half as long as the tibia. The forewing has a nearly parallel-sided pterostigma, issuing 2r-rs subapically; the Rs base is distant from the pterostigmal base by almost half the pterostigmal length; 2-Rs is slightly arched, subvertical, three times longer than 3-RS; 2r-rs about half as long as the pterostigmal length; 2r-m is straight; 3r-m is oblique, sinuate, slightly closer to the cell 3r apex than to 2r-m, and removed from the 3r apex by less than its length; the cell 3r apex is narrowly rounded and departs from the forewing margin; cell 2rm is short, half as long as 3rm; the upper side of cell 1mcu is much longer than the lower side; 2m-cu meets cell 3rm near 2r-m; cu-a meets the M + Cu fork. In the hind wing, Rs originates well distad of the M + Cu fork; r-m is short and straight; M curves strongly basally; cu-a is distinctly distad of the M + Cu fork, nearly four times as long as r-m. The metasoma is thick and ovoid, with six segments; the first segment is thin basally, nearly conical, 1.5 times as long as wide distally and four times as broad distally as basally; the second and third seg-

ments are half as long as the first; the third is broadest; the fourth is slightly longer than the first; the fifth is as long as the last segment and both are shorter than the second. The sting sheaths are short and slightly protrude beyond the metasomal apex; the sting is not preserved.

Measurements in mm. Head length, 2.0; mesosomal length, 7.0; metasomal length, 11.3; forewing (as preserved) length, 11.3; width, 3.9; hindwing (as preserved) length, 7.6; width, 3.1.

Comparison. The new species conforms to the diagnosis of *Vitimosphex* in its forewing with a unique 3r cell and differs from its congeners in the forewing with a short cell 2rm, half as long as cell 3rm, the oblique and straight 2r-m, and 1m-cu terminating short of cell 2rm.

Material. Holotype.

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