



## New Middle Jurassic kempynin osmylid lacewings from China

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**Kempyninae are a subfamily of osmylid lacewings whose extant representatives are restricted to the austral continents. Three new osmylids, *Jurakempynus sinensis* gen. et sp. nov., *J. bellatulus* gen. et sp. nov., and *J. epunctatus* gen. et sp. nov. are described from the Middle Jurassic Jiulongshan Formation of Daohugou Village, Inner Mongolia, China. The new genus *Jurakempynus* is assigned to the subfamily Kempyninae constituting its oldest known occurrence. It is allied to the Australian genus *Kempynus*, sharing two synapomorphies: extremely expanded MP space and distally forked MP<sub>2</sub> in the hindwing. The occurrence of *Jurakempynus* gen. nov. in China (Northern Hemisphere) implies a much wider geographic range of the Mesozoic osmylid lacewings in comparison to their modern counterparts.**

### Introduction

Up to now, all species of Kempyninae were reported from the Southern Hemisphere therefore the subfamily is considered as a strictly “austral” group of Osmylidae known to occur in Australia, New Zealand, and South America (Kimmins 1940; New 1983). The subfamily comprises five genera including four extant ones: *Australysmus* Kimmins, 1940, *Clydosmylus* New, 1983, *Euosmylus* Krüger, 1913, and *Kempynus* Navás, 1912, and one fossil genus, *Euporismites* Tillyard, 1916, sharing three synapomorphies: distal forked costal cross-veins in forewing, expanded MP region and complicated distal MP<sub>2</sub> forks in hindwing. Another Miocene genus *Lithosmylus* Carpenter, 1943 from North America was assigned to Kempyninae (Carpenter 1943), however, Lambkin (1987) redefined its type species and found out that actually it belongs to *Osmylus* (subfamily Osmylinae). A Cretaceous species (*Cretosmylus sibiricus* Makarkin, 1990) collected from the Lower Cretaceous of East Siberia with an incompletely preserved forewing, was also attributed to Kempyninae (Makarkin 1990). We consider it lacks the synapomorphy of kempynines, and exclude it from the subfamily pending new evidence.

The kempynin genera are typically restricted to a single biogeographic region, except for the genus *Kempynus*, which is known from Australia, New Zealand, and South America (Navás 1912; Kimmins 1940; Adams 1971; New 1983; Oswald 1994). The fossils of Kempyninae are rare and only one Palaeocene species (*Euporismites balli* Tillyard, 1916) from Queensland unambiguously belongs to this group. Herein we describe a new genus with three new species from the Jiulongshan Formation in Daohugou, Inner Mongolia, China.

*Institutional abbreviation.*—CNU-NEU-NN, specimen coding by Key Lab of Insect Evolution and Environmental Changes, the College of Life Sciences, Capital Normal University (CNU), Beijing, China.

*Other abbreviations.*—A1–3, anal vein; Cu, cubitus; CuA, the anterior branch of cubitus; CuP, the posterior branch of cubitus; MA, anterior media; MP, posterior media; Mp2, the second branch of the posterior media; R1, the first branch of radius; Rs, radial sector; r1–rs, cross-vein between R1 and Rs; Sc, subcosta; sc–r1, cross-vein between Sc and R1.

### Material and methods

The specimen was examined under a Leica MZ 7.5 dissecting microscope and illustrated with the aid of a drawing tube attachment. Line drawings were prepared with Corel-Draw 12 graphics software. The photographs were taken by AnyScan V70 scanner. All specimens are obtained from the Key Lab of Insect Evolution and Environmental Changes, the College of Life Sciences, Capital Normal University (CNU), Beijing, China. The terminology of wing follows New (1983).

### Systematic palaeontology

Order Neuroptera Linnaeus, 1758

Family Osmylidae Leach, 1815

Subfamily Kempyninae Krüger, 1913

*Included genera:* *Australysmus*, *Clydosmylus*, *Euosmylus*, *Kempynus* (extant genera), *Euporismites* (fossil, Palaeocene, Australia), *Jurakempynus* gen. nov. (fossil, Middle Jurassic, China).

*Emended diagnosis.*—Forewing elongated, outer margin occasionally with some modifications in some genera (*Kempynus* and *Euosmylus*); membrane commonly with some large fuscous spots exclusive of *Australysmus* (possessing fragmentary spots); costal cross-veins with many distal forked branches exclusive of *Euosmylus*; single cross-vein sc–r1 present at the wing base; cross-veins r1–rs numerous; Rs branches numerous, slightly sinuous close to the apex; cross-veins in radial area numerous, arranged irregularly, forming one row of gradate series at most; space between MP and Cu distinctly broadened in some genera (*Kempynus* and *Clydosmylus*). Hindwing: costal cross-veins generally simple except for *Australysmus*; base of MA well defined, sinuous; MP space extremely expanded exclusive



Fig. 1. Kempynin osmylid lacewing *Jurakempynus sinensis* gen. et sp. nov. **A.** Part (CNU-NEU-NN2010204-1). **B.** Counterpart (CNU-NEU-NN2010204-2).

of *Euosmylus*, forming 2–3 rows of cells (*Kempynus*, *Clydosmylus*, and *Jurakempynus* gen. nov.); base of  $MP_2$  with an additional vein (*Kempynus* and *Jurakempynus* gen. nov.), which is similar to the Spilosmylinae that  $MP_2$  with a short additional vein at base (Tjeder 1957);  $MP_2$  forming many forks in distal half of forewing.

**Remarks.**—The subfamily Kempyninae was considered as a primitive member of Osmylidae (Kimmmins 1940; New 1983), sharing many characters with other subfamilies (Osmylinae and Stenosmylinae). It is greatly similar to the subfamily Osmylinae in appearance, though the extant species of the both subfamilies are distinctly isolated in distribution i.e., Osmylinae belongs to an exclusively “northern group”, occurring in Europe and Asia. The two subfamilies share the following characters: dichotomic costal cross-veins in forewing; one row of gradate series at most species (also present in *Parosmylus* (Needham, 1909)); proximal  $MP$  fork in forewing; well-developed base of  $MA$  in hindwing. However, Kempyninae also possessed some features that can conveniently separate the two subfamilies: base of  $MP_2$  in hindwing with an additional vein in some genera of Kempyninae, while Osmylinae without the additional vein;  $MP$  space extremely expanded in hindwing, forming 2–3 rows of cells, while the space generally slightly expanded in Osmylinae, and only forming single row of cells;  $MP_2$  in hindwing branching complicatedly, while  $MP_2$  in Osmylinae usually simple. Kempyninae was allied to Stenosmylinae (New 1983), sharing with some characteristics: no more than one row of gradate series and  $MP_2$  forked distally in hindwing. However, Kempyninae can be differentiated from Stenosmylinae by following characters of wing: costal cross-veins forked distally in forewing, while Stenosmylinae commonly have simple cross-veins;  $MP$  forks close to wing base in forewing, while  $MP$  forks in Stenosmylinae beyond the half of wing;  $MA$  with a sinuous additional vein at base in hindwing, while Stenosmylinae generally without the additional vein.

### Genus *Jurakempynus* nov.

*Type species:* *Jurakempynus sinensis* sp. nov., see below.

*Etymology:* From *Jura* and *kempynus*, referring to age of the specimen (the Middle Jurassic). Gender is masculine.

**Diagnosis.**—Forewing: membrane with many fuscous fragmentary spots; costal cross-veins forked distally; one cross-vein  $sc-r_1$  close to the wing base, oblique; some fuscous spots resembling cross-veins distributed between  $Sc$  and  $R_1$ ;  $CuA$  forked in middle, and each branch with complicated pectinate branches;  $CuP$  forming some distal complicated branches;  $A_1$  well-developed, forming many pectinate branches. Hindwing: membrane hyaline, with fuscous spots on the outer margin;  $MP$  region expanded, forming two rows of cells;  $MP_2$  with a thin additional vein at base;  $CuA$  long,  $CuP$  as long as the half of  $CuA$ , with 3–4 pectinate branches.

**Remarks.**—*Jurakempynus* has forked costal cross-veins in forewing, which can differentiate it from most other subfamilies (Protosmylinae, Spilosmylinae, Stenosmylinae, Porisminae, Eidoporisminae and Gumillinae). The only subfamilies that *Jurakempynus* is likely assigned to are Osmylinae and Kempyninae. However, the new genus exhibits some kempynine-like features that are distinctly different from Osmylinae:  $MP$  space relatively expanded in hindwing, forming 2–3 rows of cells ( $MP$  space generally slightly broadened, but never forming multiple rows of cells in Osmylinae);  $MP_2$  branching complicatedly in distal half of hindwing ( $MP_2$  commonly simple, only with some distal simple branches in Osmylinae); base of  $MP_2$  with an additional vein (absence of the additional vein in Osmylinae). In Kempyninae three extant genera (*Kempynus*, *Clydosmylus*, and *Australysmus*) have the similar  $MP$  region in the hindwing, and  $MP$  region in *Clydosmylus* forms many rows of cells, highly similar to *Jurakempynus*.  $MP_2$  forms complicated distal forks, which is an autapomorphy of Kempyninae

(New 1989). Based on aforementioned characters that *Jurakempynus* shares with Kempyninae, we consider *Jurakempynus* should be assigned to Kempyninae instead of erecting a new high level taxon.

#### Key to species of *Jurakempynus* gen. nov.

1. Wing immaculate, base of  $MP_2$  connected without an additional vein in hindwing ..... *J. epunctatus* sp. nov.  
Wing distinctly spotted, base of  $MP_2$  with an additional vein in hindwing ..... 2
2. Hindwing:  $MP_2$  forming pectinate branches distally. .... *J. sinensis* sp. nov.  
Hindwing:  $MP_2$  with many dichotomic branches distally. .... *J. bellatulus* sp. nov.

#### *Jurakempynus sinensis* sp. nov.

Figs. 1, 2.

*Etymology*: The specific name *sinensis* refers to China.

*Type material*: Holotype: CNU-NEU-NN2010204-1 (part) (Fig. 1A), CNU-NEU-NN2010204-2 (counterpart) (Fig. 1B). The specimen consists of three well-preserved wings of which the left wings overlap partly. Paratype: CUN-NEU-NN2010205, CUN-NEU-NN2010206-1(-2). A hindwing with the apex lost.

*Type locality*: Daohugou Village, Shantou Township, Ningcheng County, Inner Mongolia, China.

*Type horizon*: Jiulongshan Formation, Aalenian–Bajocian boundary, Middle Jurassic.

*Diagnosis*.—Forewing with many fragmentary fuscous spots; some fuscous spots distributing on the space between Sc and R1; CuA forked close to middle, each branch forming many complicated pectinate branches; hindwing with large fuscous spot on the outer margin, but without any spots in centre; CuP relatively short, forming 4–5 pectinate branches.

*Description*.—Forewing is about 35.2 mm length as preserved, 11.7 mm width. Hindwing is about 32.3 mm length as preserved, 10.1 mm width (Fig. 1).

Forewing (Fig. 2A, B): membrane with many fragmentary fuscous spots; some fuscous spots present at the anterior margin; 5–7 spots resembling cross-veins present between Sc and R1; nygmata not detected; pterostigma fuscous, with hyaline patches; trichosors well defined on the margin; costal field relatively narrow, cross-veins forked distally; space between Sc and R1 relatively broad, with one oblique cross-vein; cross-veins r1-rs numerous; Rs branches numerous, each forming deep distal forks; cross-veins in radial area arranged irregularly, not forming the gradate series; MP forked with a short distance to the wing base, the both branches with simple distal forks; Cu forked at wing base; CuA long, biforked in middle, each branch forming complicated pectinate branches; CuP as long as the half of CuA, forming simple distal forks; A1 well developed, forming many pectinate branches; A2, A3 well defined, forming a large cell in base. Hindwing (Fig. 2C): membrane with large fuscous markings close to the outer margin, and possessing few spots in middle; nygmata present; trichosors well defined on the posterior margin; costal field narrow, cross-veins simple; base of MA fused with Rs;  $MP_1$  field forming two rows of cells, but the basal cells arranged irregularly;  $MP_1$  forming simple distal dichotomies,  $MP_2$  forming some

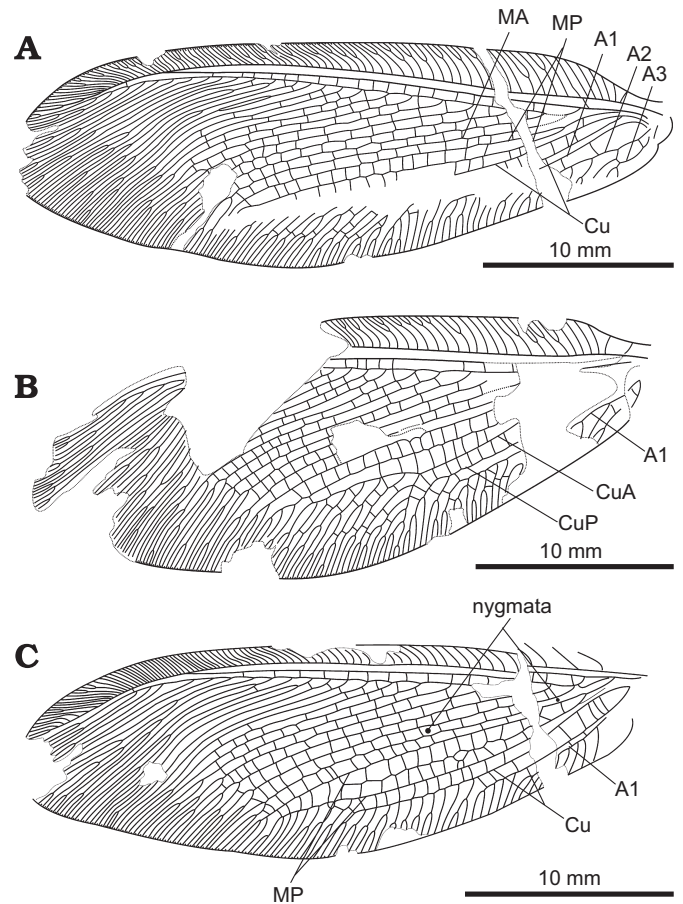


Fig. 2. Line drawings of kempynin osmylid lacewing *Jurakempynus sinensis* gen. et sp. nov.; left forewing (A), right forewing (B), left hindwing (C).

pectinate branches; Cu forked at wing base, CuA long, forming many pectinate branches, CuP as long as the half of CuA, with 4–5 pectinate branches; A1 well developed, forming some pectinate branches; A2 short, with 2–3 branches.

#### *Jurakempynus bellatulus* sp. nov.

Fig. 3.

*Etymology*: The specific name *bellatulus* refers to the delicate hindwing of new species.

*Holotype*: CNU-NEU-NN2010207 (Fig. 3A). A hindwing with the apex lost.

*Type locality*: Daohugou Village, Shantou Township, Ningcheng County, Inner Mongolia, China.

*Type horizon*: Jiulongshan Formation, Aalenian–Bajocian boundary, Middle Jurassic.

*Diagnosis*.—Hindwing with large brown spots; the cells of  $MP$  region arranged regularly; CuP with 7–8 pectinate branches.

*Description*.—Only hindwing preserved, about 28.7 mm long, 11.2 mm wide (Fig. 3A). Membrane hyaline, with fuscous markings on the margin, forming triangular hyaline region on posterior margin; trichosors present on posterior margin and part of anterior margin, two nygmata distinct; costal region relatively narrow, cross-veins simple; Sc and R1 fused distally, cross-vein sc-r1 undetected; cross-veins r1-rs numerous; Rs

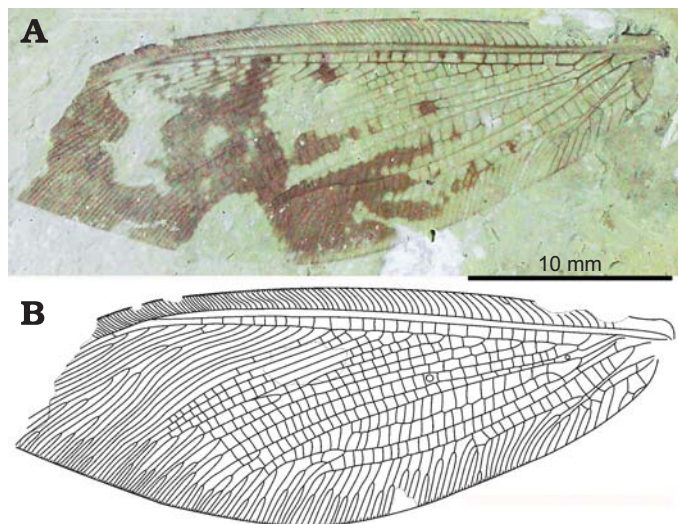


Fig. 3. Kempynin osmylid lacewing *Jurakempynus bellatulus* sp. nov. A. Photo of CNU-NEU-NN2010207. B. Line drawing of CNU-NEU-NN2010207.

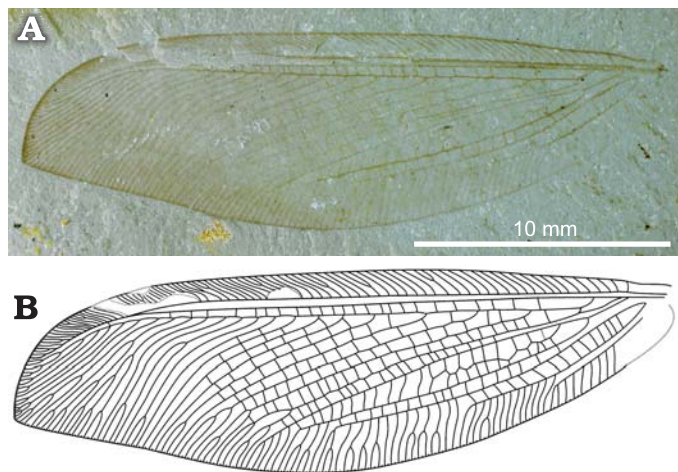


Fig. 4. Kempynin osmylid lacewing *Jurakempynus epunctatus* sp. nov. A. Photo of CNU-NEU-NN2010208. B. Line drawing of CNU-NEU-NN2010208.

with 23 branches, distal branches distinctly sinuous; cross-veins in radial area numerous, arranged irregularly; MA originating from the base of Rs-stem as most osmylids, base connected with a sinuous vein (Tjeder 1957); MP forks close to wing base, with a thin additional vein before the fork which is detected in extant *Kempynus* (Kimmins 1940); MP region dilated, forming two rows of cells; MP<sub>1</sub> simple, MP<sub>2</sub> bifurcated distally; Cu forked at base; CuA long, with pectinate branches from middle to terminal end; CuP short, bifurcated in middle, the longer branches forming pectinate branches, ending close to the middle of CuA; A1 short, with 3 branches; A2 with two branches; A3 single branch (Fig. 3B).

**Remarks.**—*Jurakempynus bellatulus* sp. nov. is separated from *Jurakempynus sinensis* sp. nov. based on the following characters: spots of *J. bellatulus* sp. nov. present on whole apex in hindwing, while spots in *J. sinensis* sp. nov. only restricted to

the margin; MP<sub>2</sub> with many distal dichotomic branches in *J. bellatulus* sp. nov., while MP<sub>2</sub> of *J. sinensis* sp. nov. forming many pectinate branches; CuP with 7 pectinate branches in *J. bellatulus* sp. nov., while CuP in *J. sinensis* sp. nov. has 4–5 pectinate branches.

### *Jurakempynus epunctatus* sp. nov.

Fig. 4.

**Etymology:** The specific name *epunctatus* refers to the immaculate hindwing of the new species.

**Holotype:** CNU-NEU-NN2010208 (Fig. 4a). Well preserved hindwing.

**Type locality:** Daohugou Village, Shantou Township, Ningcheng County, Inner Mongolia, China.

**Type horizon:** Jiulongshan Formation, Aalenian–Bajocian boundary, Middle Jurassic.

**Diagnosis.**—Only hindwing preserved; membrane hyaline, immaculate; cells in MP region arranged irregularly; CuP with 12 pectinate branches.

**Description.**—Only the hindwing preserved, 25.2 mm long, 7.5 mm wide (Fig. 4A). Membrane hyaline, nearly immaculate; pterostigma pale brown, nygmata not detected; trichosors well-defined in the posterior margin of wing; costal cross-veins simple; Sc and R1 entering the margin before the apex; cross-veins r1-rs numerous; Rs originated from R1, with 20 branches, distal branches slightly sinuous; cross-veins in radial area numerous, arranged irregularly; MA originated from Rs-stem as most osmylids; MP forks close to the wing base, MP region greatly broadened, forming two rows of cells, cells in MP region arranged irregularly, cross-veins slightly sinuous from middle to termination; MP<sub>1</sub> and MP<sub>2</sub> forming simple pectinate distal branches; CuA long, with 13 pectinate branches; CuP short, as long as the half of CuA, with 12 pectinate branches; A1 well-developed, with 7 pectinate branches (Fig. 4B).

**Remarks.**—*Jurakempynus epunctatus* sp. nov. is conveniently separated from other species by the following characters: hindwing immaculate, while other species commonly have large spots on margin; cells in MP region arranged irregularly, only forming two rows of cells in middle, while other species generally forming two rows of cells on the whole MP region.

## Concluding remarks

The described herein new genus with three new species from the Jiulongshan Formation in Daohugou, Inner Mongolia, China are the oldest-known representants of Kempyninae. They display the following apomorphies of the subfamily: (i) costal cross-veins forked distally in forewing; (ii) MP fork close to wing base in forewing; (iii) MP region extremely expanded, forming more than two rows of cells in hindwing; (iv) MP<sub>2</sub> with many complicated distal forks in hindwing. Occurrence of *Jurakempynus* gen. nov. in China stands in opposition to the traditional concept that kempynines belong to an exclusively “austral” group. It shows that kempynines were present in the Northern Hemisphere during the Middle Jurassic (165 Mya) and were apparently much more widely distributed than at present. Nev-

ertheless due to the scarcity of the fossil record (only two other fossil species were known up to date) it is premature to argue on the actual origin of the kempynines. Nevertheless, we anticipate that true fossil kempynins are to be found from America in the future.

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