



## A new species of *Proptychopterina* (Diptera: Nematocera: Ptychopteridae) from the Middle Jurassic of the Jiyuan Basin, China

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### Abstract

A new species of the dipteran family Ptychopteridae, *Proptychopterina jiyuanensis* sp. nov., is described based on a nearly complete forewing from the Middle Jurassic Yangshuzhuang Formation in the Jiyuan Basin of central China. This new discovery represents the second fossil record of Ptychopteridae from China. We also revise the morphological features of *Proptychopterina opinata* Lin & Lukashevich, 2006, a species previously documented from the Middle Jurassic Daohugou Beds of Inner Mongolia, north-eastern China. The present discovery further supports biostratigraphic correlation between the Daohugou and Jiyuan fossil localities.

**Keywords:** Yangshuzhuang Formation, Yanliao biota, central China, biostratigraphic correlation

### Introduction

The Jurassic was a crucial interval in the evolutionary history of insects. Several fossil insect assemblages across China are important for investigating Jurassic insect diversification; among these, the Middle Jurassic Yanliao entomofauna stands out. This fauna is mainly distributed in south-eastern Inner Mongolia, western Liaoning and northern Hebei in north-eastern China. To date, c. 800 insect species have been documented from the Daohugou locality (Lian *et al.*, 2021). In addition to the Yanliao biota, Middle Jurassic insect fossils have also been recovered from the Yan'an Formation of the Ordos Basin, the Yangshuzhuang Formation of the Jiyuan Basin, and the Shiti Formation at the Zhongshan Coal Mine of Guangxi. Furthermore, Jurassic insect remains have been

widely reported from various areas of southern China (Lin, 1986).

Insect fossils from the Jiyuan Basin were first documented but not described (Zhang, 2003). In recent years, diverse insect groups from this basin have been described. To date, a total of 13 insect orders has been identified from the Yangshuzhuang Formation: Ephemeroptera, Odonata, Blattodea, Orthoptera, Dermaptera, “Grylloblattodea”, Hemiptera, Mecoptera, Diptera, Coleoptera, Hymenoptera, Neuroptera, and Trichoptera.

Here, we report a new species of the genus *Proptychopterina* Kalugina, 1985, from the Yangshuzhuang Formation. This new specimen differs from *P. opinata* of the Daohugou biota in several forewing characters. The occurrence of this new species provides additional insights into the evolutionary history of the group and contributes to the biostratigraphic correlation of Jurassic strata in China.

### Geological setting

The Jiyuan Basin, located in north-western Henan Province, central China, is an east-west-trending basin situated west of the Kaifeng Depression. It is bounded to the south by the Qinling Orogenic Belt and connected to the Taihang Mountains (Wu *et al.*, 2002). During the late Middle Triassic, uplift of the North China Block strongly influenced the eastern basin, inducing intense tectonic activity (Wu *et al.*, 2002). The Mesozoic strata were deposited generally continuously (Yang, 2012).

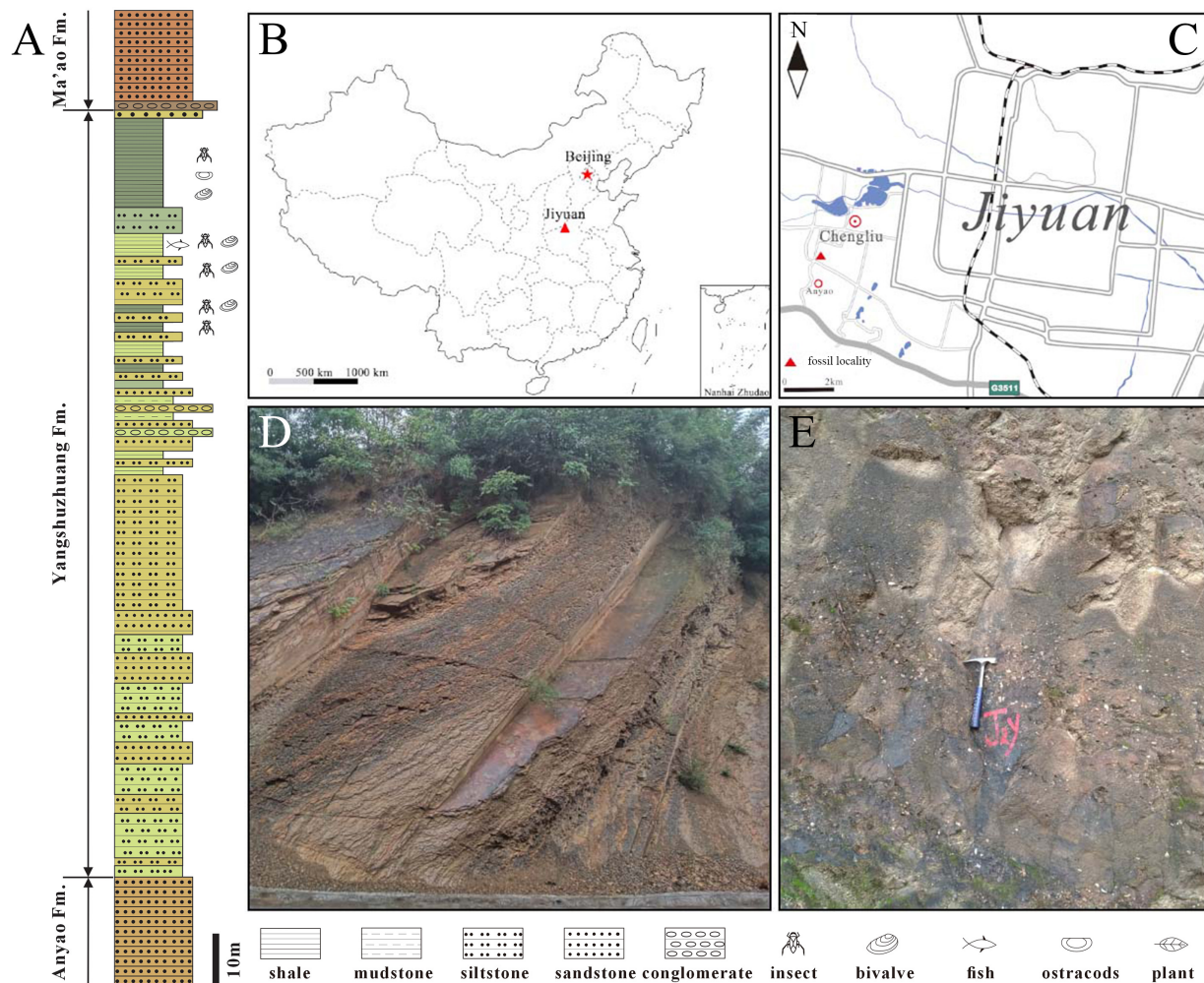
The Jurassic strata in the Jiyuan Basin are divided, from bottom to top, into the Anyao, Yangshuzhuang,

and Ma'ao formations. The Lower-Middle Jurassic Anyao Formation is separated from the Upper Triassic Tanzhuang Formation by a disconformity, marked by an alumina clay layer (Wu, 1985; Yang *et al.*, 2014; Huang *et al.*, 2021). The Lower Jurassic Anyao Formation represents deep lacustrine deposition and is characterized by thick-bedded, grey to yellowish sandstone interbedded with greyish-green, thin-bedded fine-grained sandstones, siltstones, and calcareous mudstones (Wu, 1985; Yang *et al.*, 2014). The Middle Jurassic Yangshuzhuang Formation records shallow lacustrine deposition and consists mainly of grey-green to greyish-yellow fine-grained sandstones, siltstones, sandy mudstones, and mudstones (Yang & Du, 2017). In the present section near Anyao Village, the Upper Jurassic Ma'ao Formation comprises, from bottom to top, brownish conglomerates and sandstone, yellow-green and purple-reddish clastic rocks, and topmost purple-reddish clastic rocks.

The Yangshuzhuang Formation was formerly included in the upper Anyao Formation and was later recognized as a separate formation, with a thickness of ca.

116 m (Yang, 2012). It exhibits a restricted geographical distribution and is well exposed near Anyao Village. The Yangshuzhuang Formation is deposited conformably on the Anyao Formation and is disconformably overlain by the Ma'ao Formation. Its upper boundary is likely close to the middle-late Jurassic transition. Consequently, using the International Chronostratigraphic Chart v2024-12, the Yangshuzhuang Formation is currently considered to be late Middle Jurassic in age (*e.g.*, Cohen *et al.*, 2025, Huang *et al.*, 2024).

The middle-upper sections of the Yangshuzhuang Formation contain abundant plant fossils belonging to the assemblage of the *Coniopteris-Phoenicopsis* flora, characteristic of northern China and originally defined in the Yan'an Formation, dated to the early Middle Jurassic (Si & Zhou, 1962). *Euestheria* was previously reported in the Yangshuzhuang and Ma'ao formations (Deng *et al.*, 2003). However, a detailed study of the conchostracans from the Ma'ao Formation revealed that they actually belong to the genus *Triglypta* (Liao *et al.*, 2017). Huang *et al.* (2019) further proposed that the conchostracans in the



**FIGURE 1.** Stratigraphic column and location map of the Yangshuzhuang Formation at Anyao Village, Chengliu Town, Jiyuan City. **A**, Stratigraphic column. **B**, **C**, Fossil location maps (red triangle). **D**, Upper section of the Yangshuzhuang Formation showing insect fossil-rich layers. **E**, Boundary of the Yangshuzhuang and Ma'ao formations.

Yangshuzhuang and Ma'ao formations represent the lower and upper assemblages of the *Triglypta ziliujingensis* fauna, corresponding to the late Middle Jurassic and the early Late Jurassic, respectively. Additionally, the Yangshuzhuang Formation yields bivalve fossils that constitute the *Margaritifera–Ferganconcha* assemblage, a typical biozone from the late Early Jurassic to the early Middle Jurassic (Deng *et al.*, 2003). Ostracods, gastropods, and fish scales are also commonly found in the Yangshuzhuang Formation.

In recent years, 550 insect fossils have been collected from the Yangshuzhuang Formation in the Jiyuan Basin, Henan Province, central China. A total of 15 genera and 17 species have been reported to date: *Orthophlebia quadrimacula* Lin, 1982, *Eotrichocera (Archaeotrichocera) ephemera* Zhang, 2006, *Jurocercopsis grandis* Wang & Zhang, 2009, *Kisa fasciata* Shcherbakov, 2012, *Jurathemis incompletus* Huang, Fu, Gao & Nel, 2018, *Qibinius maculatus* Fu & Huang, 2020, *Eoptychoptera jiyuanensis* Liu & Huang, 2020, *Crenoptychoptera gaoi* Liu & Huang, 2021, *Cicadocoris henanensis* Xu & Huang, 2023, *?Mailotrichocera jiyuanensis* Azar & Lian, 2024, *Oxfordgompus trescellulae* Huang & Nel, 2024, *Turanopteron sinensis* Huang & Nel, 2024, *Jiyuanphlebia incompleta* Lian, 2024, *Orthophlebia picta* Lian, 2024, *Protorthophlebia curvata* Lian, 2024, *Protorthophlebia gracilis* Lian, 2024, *Quadrivena jiyuanensis* Lian, 2024 (Huang *et al.*, 2018; Liu & Huang, 2020, 2021; Fu & Huang, 2020, 2021; Fu *et al.*, 2023; Xu & Huang, 2023; Azar & Lian, 2024; Huang *et al.*, 2024; Huang & Nel, 2024; Lian, 2024). Collectively, these advances highlight the Yangshuzhuang entomofauna as a prominent Jurassic biota in China.

## Material and methods

A single specimen was collected from the uppermost horizons of the Yangshuzhuang Formation near Anyao Village, Chengliu Township, Jiyuan City, Henan Province, central China. The fossil is preserved as a brown film on greenish-grey lacustrine mudstone. Additionally, the holotype (NIGP133708) of *Proptychoptera opinata* Lin & Lukashevich, 2006 from the Daohugou locality was re-examined for comparative morphological analysis. Specimens were prepared using a sharp knife. Photographs were taken with a digital camera attached to a Zeiss Discovery V16 stereomicroscope. Specimens were moistened with 70% ethanol to reveal fine details (Fig. 3). The new material is housed in the Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, Nanjing.

We followed the wing venation nomenclature from Lukashevich (1998).

## Systematic palaeontology

### Order Diptera Linnaeus, 1758

### Suborder Nematocera Latreille, 1825

### Family Ptychopteridae Osten-Sacken, 1862

### Subfamily Proptychopterinae Lukashevich, 1995

### Genus *Proptychoptera* Kalugina, 1985

**Type species.** *Proptychoptera handlirschi* Kalugina, 1985.

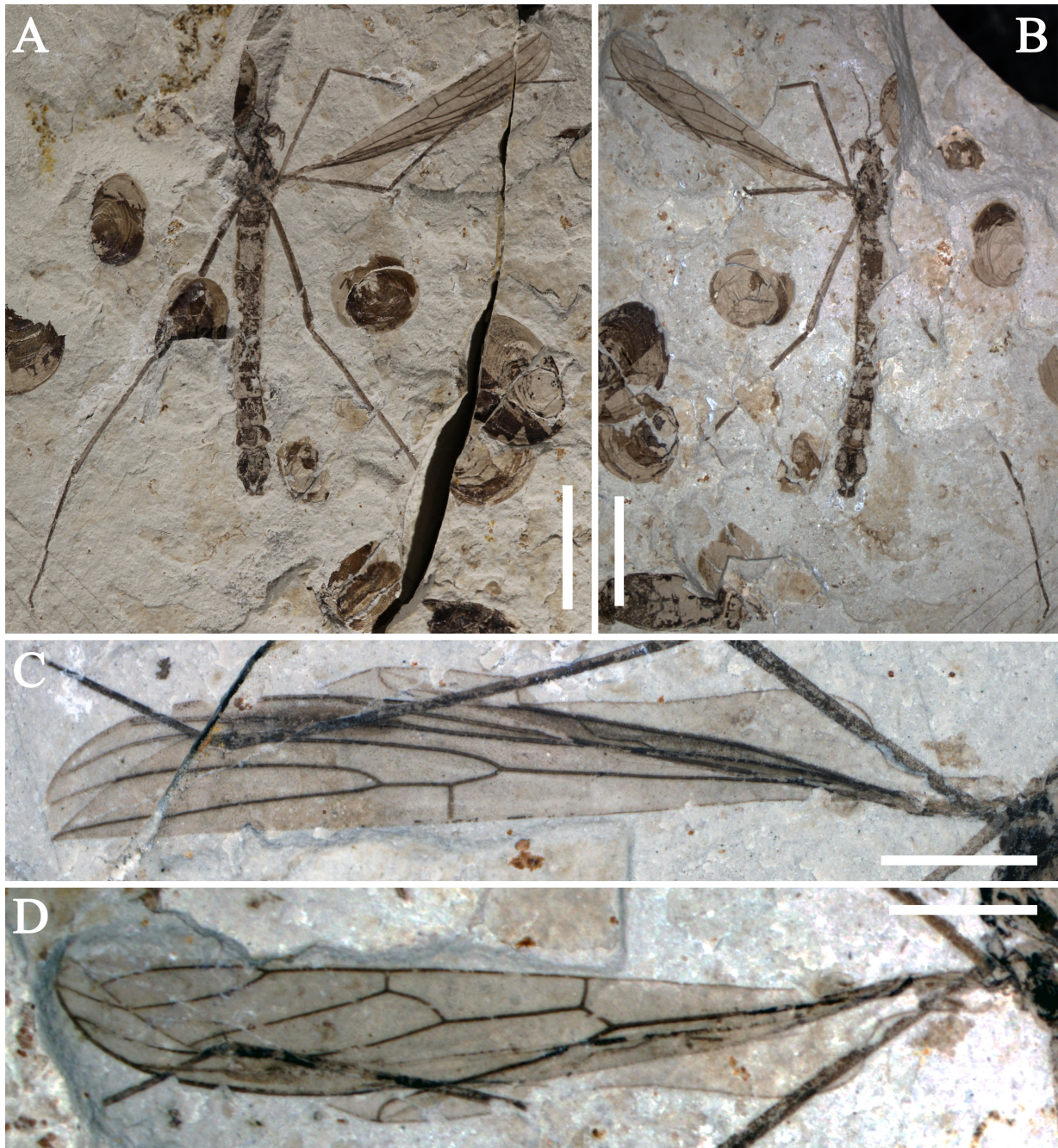
**Included species.** *P. handlirschi* Kalugina, 1985, *P. mongolica* Kalugina, 1988, *P. oleynikovii* Kalugina, 1989, *P. sharategica* Kalugina, 1992, *P. amota* Lukashevich, 1993, *P. evecta* Lukashevich, 1993, *P. gracilis* Lukashevich, 1993, *P. yeniseica* Lukashevich, 1993, *P. immense* Lukashevich, 2000, *P. Makarova* Lukashevich, 2000, *P. tenera* Lukashevich, 2000, *P. opinata* Lin & Lukashevich, 2006, and *P. jiyuanensis* **sp. nov.**

***Proptychoptera opinata* Lin & Lukashevich, 2006**  
(Figs 2–4)

**Material.** An almost complete male (NIGP133708).

**Locality and horizon.** Fossil locality near Beigou of the Daohugou Village, Wuhua Township, Ningcheng County, Inner Mongolia, north-eastern China; latest Middle Jurassic (Callovia).

**Description (revised).** Male. Eyes large. Antenna as long as the head and thorax combined, ca. 24 segments, each flagellum armed with a pair of long setae, last flagellum small and relatively pointed. Labella large, pubescent, labial palp elongate, 5-segmented, fourth segment the longest, fifth segment ca. two-thirds as long as the fourth segment. Wing not pubescent, relatively narrow and elongate, 12.5 mm long, ca. three times as long as broad. Apex of Sc situated distad of  $R_{4+5}$  fork.  $R_{4+5}$  bifurcation 2.8 times as long as its stem. Prostigma elongate, occupying  $R_{1+2}$  from distal Sc level to basal  $R_1$  area. Crossvein r-m present at the level of  $M_{3+4}$  bifurcation.  $DisM_{1+2}$  ca. twice as long as  $medM_{1+2}$ ,  $medM_{1+2}$  three times as long as im.  $M_{3+4}$  fork longer than discal cell.  $basM_{3+4}$  section shorter than m-cu and shorter than half of  $basM_3$ . CuP curved, reaching ca. one-third of the wing length. Legs long and slender, mid-legs slightly larger than forelegs, hind legs much larger. Hind tarsi long, first tarsomere very elongate, more than 3.5 times as long as tarsomeres 2–5 combined, second tarsomere slightly longer than tarsomeres 3–5 combined, third tarsomere ca. half as long as the second tarsomere, fourth tarsomere small, fifth tarsomere ca. twice as long as the fourth; paired pretarsal claws long and strongly curved apically, armed with lateral setal rows in the basal section. Abdomen elongate, close to the length of the forewing, densely pubescent. Hypopygium



**FIGURE 2.** *Proptychopterina opinata* Lin & Lukashevich, 2006 from Daohugou, holotype, NIGP133708. **A**, General habitus, part. **B**, General habitus, counterpart. **C**, Forewing, counterpart. **D**, Forewing, part. Scale bars: **A**, **B** = 5 mm, **C**, **D** = 2 mm.

narrower than the last abdominal segment, pubescent; two pairs of processes directed towards the median line; one pair long, finger-like, pubescent and situated dorsally, the other pair much shorter, chitinized, with numerous teeth, and situated ventrally. Gonostyles pubescent, without apical hook, armed with an elaborate process and inner teeth.

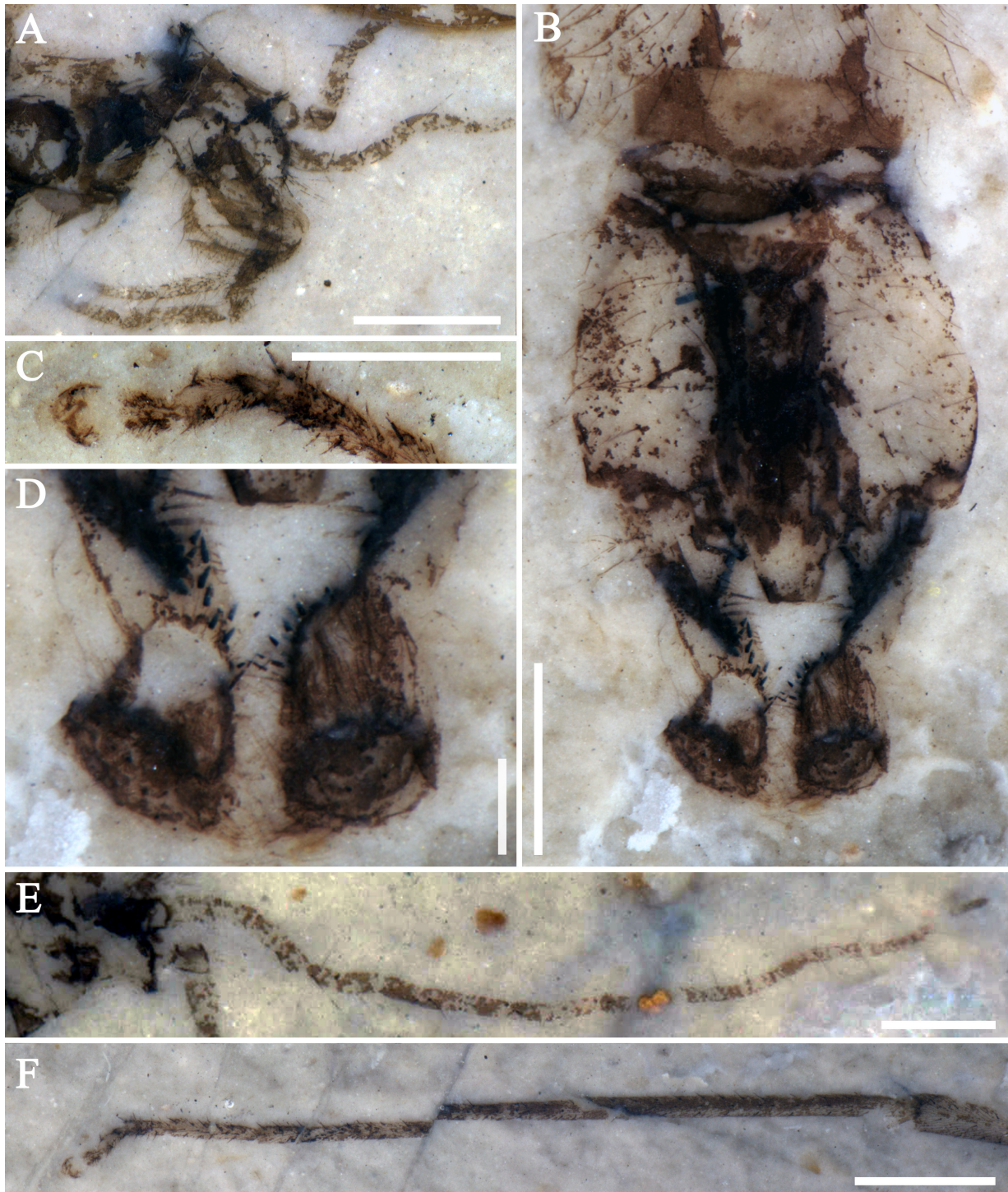
***Proptychopterina jiyuanensis* sp. nov.**

**Material.** Holotype, NIGP210148, an incomplete forewing missing its basal and apical portions.

**Etymology.** The specific epithet is derived from Jiyuan, the type locality where the holotype was discovered.

**Diagnosis.** Sc terminating at the level of distal  $R_{4+5}$  fork;  $R_{4+5}$  fork much longer than stem  $R_{4+5}$ ;  $basR_{4+5}$  distinctly longer than  $disR_{4+5}$ ; im situated at the same level as distal  $R_{4+5}$  fork;  $disM_{1+2}$  ca. 1.5 times as long as  $medM_{1+2}$  and ca. three times as long as im.

**Locality and horizon.** Locality near Anyao Village, Jiyuan City, Henan Province, central China; Middle Jurassic (Callovian).



**FIGURE 3.** Details of *Proptychopterina opinata* Lin & Lukashevich, 2006 from Daohugou, holotype, NIGP133708, moistened with 70% ethanol. **A**, Head. **B**, Genitalia. **C**, Enlargement of apical section of metatarsus, showing details of claws and last three tarsomeres. **D**, Apex of genitalia. **E**, Antenna. **F**, Metatarsus. Scale bars: **A**, **B** = 1 mm, **C**, **D** = 0.5 mm, **E**, **F** = 0.2 mm.

**Description.** Wing 6.2 mm long (as preserved). Wing relatively narrow, without colour spots. Sc-r not visible, apex of Sc situated distad of the  $R_{4+5}$  fork. Prostigma elongate, occupying  $R_{1+2}$  from distal Sc level to basal  $R_1$  area. Rs stem almost straight,  $R_{2+3}$  nearly equidistant from  $R_1$  and  $R_4$ .  $R_2$  distinctly shorter than dis  $R_1$ .  $R_{4+5}$  fork much longer than stem  $R_{4+5}$ ; dis $R_{4+5}$  distinctly shorter than

bas $R_{4+5}$ . Crossvein r-m connecting mid-length of  $R_{4+5}$  and  $M_{1+2}$  before im. Crossvein r-m located at the middle level of im and the  $M_{3+4}$  fork. M with four branches, im connecting  $M_{1+2}$  well before its bifurcation and  $M_3$ .  $M_{3+4}$  not longer than  $M_4$ . Section dis $M_{1+2}$  1.5 times as long as med $M_{1+2}$ , which is ca. three times as long as im. Discal cell somewhat shorter than  $M_{3+4}$  fork. Bas $M_{3+4}$  shorter

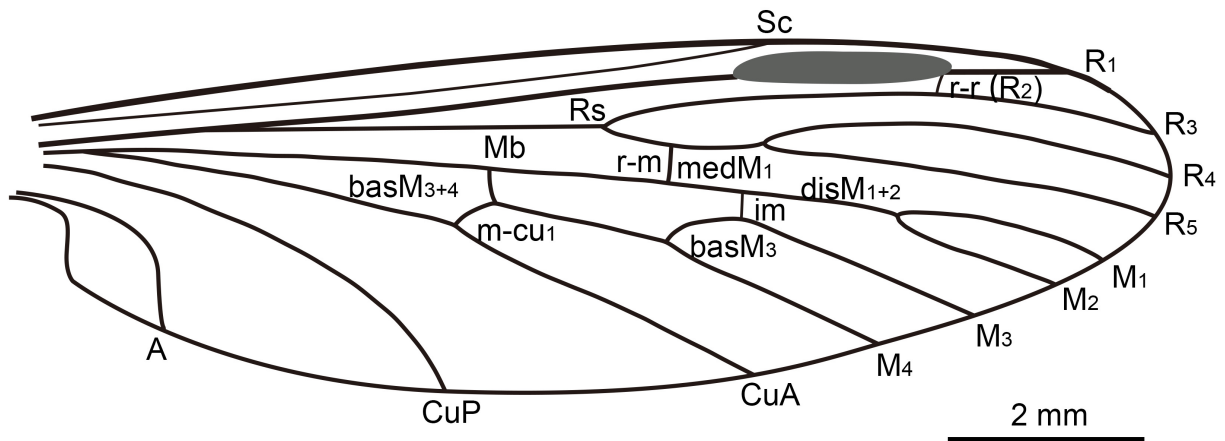


FIGURE 4. Forewing reconstruction of *Proptychopterina opinata* (modified from Lin & Lukashevich, 2006).

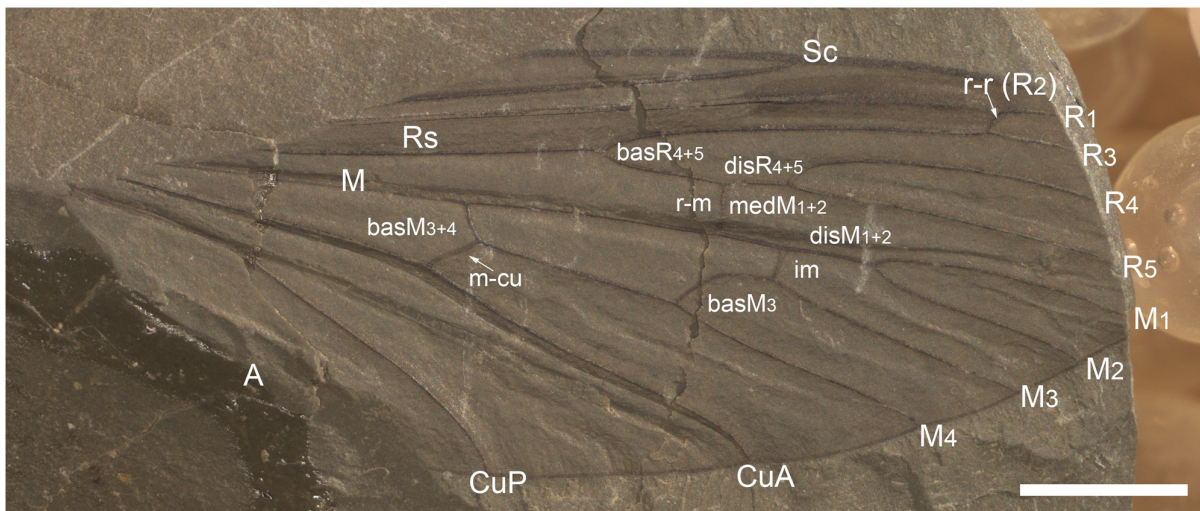


FIGURE 5. Forewing of *Proptychopterina jiyuanensis* sp. nov. from the Yangshuzhuang Formation. Scale bar = 1 mm.

than m-cu and shorter than half of basM<sub>3</sub>. CuA almost straight. CuP slightly curved apically.

**Remarks.** The new species shares several characters with *Proptychopterina gracilis* Lukashevich, 1993: Sc terminates at the level of distal R<sub>4+5</sub> fork, disM<sub>1+2</sub> is c. 1.5 times as long as medM<sub>1+2</sub>, and r-m is positioned at the same level as the distal R<sub>4+5</sub> fork. It differs in disR<sub>4+5</sub> being shorter than basR<sub>4+5</sub> (subequal in *P. gracilis*), and a medM<sub>1+2</sub>/im ratio of 1.8 (vs. 3 in *P. gracilis*). The new species also shares several characters with *Proptychopterina opinata* Lin & Lukashevich, 2006: Sc terminating at the level of the distal R<sub>4+5</sub> fork, and R<sub>4+5</sub> fork longer than stem R<sub>4+5</sub>. It differs from *Proptychopterina opinata* in that disR<sub>4+5</sub> is shorter than basR<sub>4+5</sub> (vs. disR<sub>4+5</sub> longer than basR<sub>4+5</sub> in *P. opinata*), and in the ratios of disM<sub>1+2</sub>/medM<sub>1+2</sub> (1.5 vs. 2) and disM<sub>1+2</sub>/im (3 vs. 7.5).

## Discussion

The superfamily Ptychopteroidea Osten-Sacken, 1862,

currently placed within the infraorder Ptychopteromorpha (Pape *et al.*, 2011; Zhang & Zhang, 2003), includes the families Ptychopteridae Osten-Sacken, 1862, Henningmatigae Shcherbakov, 1995 and Nadipteridae Lukashevich, 1995, the latter tentatively retained within the superfamily (Lukashevich, 2008, 2012). The traditional concept of Ptychopteroidea is followed here. Ptychopteridae is currently divided into five subfamilies—three extinct (Proptychopterininae, Eoptychopterininae, and Eoptychopterininae) and two extant (Ptychopterinae and Bittacomorphinae) (Lukashevich, 2012). *Proptychopterina* (Proptychopterininae) comprises 12 species (Kalugina & Kovalev, 1985; Kalugina, 1988, 1989, 1992; Lukashevich, 1993, 2000; Lin & Lukashevich, 2006). Most specimens have been recovered from the Middle Jurassic deposits of Kubekovo (Itat Formation, Siberia), where Ptychopteridae are relatively abundant, accounting for ca. 20% of dipteran fossils, including ca. 11% assigned to *Proptychopterina*. In contrast, at Daohugou, Ptychopteridae account for ca. 10% of dipterans, whereas *Proptychopterina* represents only ca. 0.5% (Lin & Lukashevich, 2006). Similarly,

among the 50 specimens recently collected from the Yangshuzhuang Formation in the Jiyuan Basin, only one specimen may be assigned to *Proptychopterina*.

Biostratigraphic data indicate that insect assemblages from the Haifanggou Formation (north-eastern China) and the Yangshuzhuang Formation (central China) share several species, including *Jurocercopis grandis* Wang & Zhang, 2009 (Fu & Huang, 2020) and several undescribed taxa. The present specimen represents the second recorded species of *Proptychopterina* from China and adds further evidence for biostratigraphic correlation, demonstrating that the Yangshuzhuang Formation is contemporaneous with the Haifanggou Formation. Similar stratigraphic sequences in the two units also reinforce this correlation. The insect faunas of the Yangshuzhuang and Haifanggou formations, which belong to the early assemblage of the Yanliao Biota, also share species with the fauna from the Yan'an Formation of the Ordos Basin (Early–Middle Jurassic), such as *Jurocercopis grandis* (Fu & Huang, 2020). This faunal pattern implies that the insect assemblages of the former two formations probably evolved from those of the Yan'an Formation. Accordingly, the entomofauna of the Yan'an Formation may represent an early developmental stage of the Yanliao Biota. In addition, *Kisa fasciata* (Hemiptera, Cicadomorpha, Archijassidae) has been documented from the Yangshuzhuang Formation of the Jiyuan Basin, the Yan'an Formation of the Ordos Basin and the Itat Formation of Siberia. This distribution supports biostratigraphic linkage between the Yangshuzhuang and Itat Formations (Fu *et al.*, 2023). Collectively, this evidence suggests that the Haifanggou Formation, the key stratum of the Yanliao Biota, is stratigraphically correlated with the Itat Formation in Central Asia.

In light of these broader regional correlations, the discovery of a new species of *Proptychopterina* provides taxonomic data that bridge the palaeogeographic gaps between these distinct Jurassic basins. These new findings further indicate that the early assemblage of the Yanliao Biota was not restricted to the Yanliao region of northern China, but extended at least to central China and Siberia.

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