



# New Ephialtitidae (Insecta: Hymenoptera) from the Jurassic Daohugou Beds of Inner Mongolia, China

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## Abstract

Five new species are described from the Middle–Upper Jurassic Daohugou Beds of Inner Mongolia, China, and assigned to the genus *Karataus* Rasnitsyn, 1977 in the subfamily Symphytopterinae of Ephialtitidae. They are illustrated as *Karataus daohugouensis* n. sp., *K. strenuus* n. sp., *K. vigoratus* n. sp., *K. exilis* n. sp., and *K. orientalis* n. sp., and a key to species of *Karataus* is presented.

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**Keywords:** Hymenoptera; Ephialtitidae; *Karataus*; New species; Middle–Upper Jurassic; China

## 1. Introduction

The Ephialtitidae is an extinct family of Hymenoptera known from the deposits ranging in age from the Early Jurassic to the Early Cretaceous, and 27 genera have been listed in this family (Meunier, 1903; Rasnitsyn, 1975, 1977, 1990, 1999; Zessin, 1981, 1985; Zhang, 1986; Darling and Sharkey, 1990; Rasnitsyn and Ansoerge, 2000; Rasnitsyn and Martínez-Delclòs, 2000; Zhang et al., 2002; Rasnitsyn et al., 2003; Rasnitsyn and Zhang, 2004, 2010; Ding et al., 2013; Li et al., 2013). This family only flourished in the Middle–Late Jurassic and was only moderately successful at other times (Zhang et al., 2002, 2010; Ding et al., 2013). It is considered to be the most primitive Apocrita, the most advanced one of the two suborders of Hymenoptera, and all other apocritans are considered to have originated from this group (Rasnitsyn and Zhang, 2010).

The family is divided into two subfamilies: Ephialtinae Handlirsch, 1906 and Symphytopterinae Rasnitsyn, 1980 (Handlirsch, 1906–1908; Zhang et al., 2002; Rasnitsyn et al., 2003; Rasnitsyn, 1980, 2008a, 2008b; Rasnitsyn and Zhang, 2010). The Symphytopterinae differs from the Ephialtinae in having a very short ovipositor and a more distal position of cu-a in the forewing, and consists of seven genera: *Symphyopterus* Rasnitsyn, 1975, *Micrephialtites* Rasnitsyn, 1975, *Symphyogaster* Rasnitsyn, 1975, *Karataviola* Rasnitsyn, 1975, *Trigonalopterus* Rasnitsyn, 1975, *Karataus* Rasnitsyn, 1977, and *Brigittepterus* Rasnitsyn et al., 2003 (Rasnitsyn, 1975, 1977, 1980; Rasnitsyn and Martínez-Delclòs, 2000; Rasnitsyn et al., 2003) (Table 1). The genus *Stephanogaster* is clearly assigned to Ephialtinae for having a long ovipositor and an interstitial cu-a crossvein in the forewing (Rasnitsyn, 1975; Rasnitsyn and Zhang, 2010) but was mistakenly placed in Symphytopterinae by Ding et al. (2013).

The genus *Karataus* includes only two species, *K. pedalis* Rasnitsyn, 1977, the type species, from the Upper Jurassic of Kazakhstan, and *K. hispanicus* Rasnitsyn and Martínez-Delclòs, 2000 from the Lower Cretaceous of Spain. Here we report five new species from the Middle–Upper Jurassic Daohugou Beds of

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Table 1  
Distribution of genera of the Symphytopterinae.

| Genus                  | Age                                                                  | Distribution                                                  | References                                                            |
|------------------------|----------------------------------------------------------------------|---------------------------------------------------------------|-----------------------------------------------------------------------|
| <i>Symphytopterus</i>  | Late Jurassic<br>Late Middle–early Late Jurassic                     | Karatau, S. Kazakhstan<br>Daohugou, NE China                  | Rasnitsyn, 1975<br>Rasnitsyn and Zhang, 2004                          |
| <i>Microphialtites</i> | Late Early Jurassic                                                  | Schandelah, Germany                                           | Rasnitsyn et al., 2003                                                |
| <i>Symphyogaster</i>   | Late Jurassic                                                        | Karatau, S. Kazakhstan                                        | Rasnitsyn, 1975                                                       |
| <i>Karataviola</i>     | Late Jurassic<br>Late Middle–early Late Jurassic                     | Karatau, S. Kazakhstan<br>Daohugou, NE China                  | Rasnitsyn, 1975<br>Rasnitsyn and Zhang, 2004                          |
| <i>Trigonalopterus</i> | Late Jurassic                                                        | Karatau, S. Kazakhstan                                        | Rasnitsyn, 1975                                                       |
| <i>Karataus</i>        | Late Jurassic<br>Early Cretaceous<br>Late Middle–early Late Jurassic | Karatau, S. Kazakhstan<br>Lleida, Spain<br>Daohugou, NE China | Rasnitsyn, 1977<br>Rasnitsyn and Martínez-Delclòs, 2000<br>This study |
| <i>Brigittepterus</i>  | Late Early Jurassic                                                  | Dobbertin, Germany                                            | Rasnitsyn et al., 2003                                                |

China and attribute them to *Karataus*. The diagnosis of *Karataus* is refined based on this new material.

## 2. Material and methods

The new species established herein are based on the specimens found in the Daohugou Beds at Daohugou, Ningcheng County, Chifeng City, Inner Mongolia, China. The Daohugou Beds were previously considered to be Bathonian to Callovian (Middle Jurassic) in age and to belong to the Jiulongshan Formation (e.g., Li et al., 2013). However, recent radiometric dating results suggest that they are of Callovian–Oxfordian age (latest Middle–earliest Late Jurassic) (Liu Y.X. et al., 2006; Liu Y.Q. et al., 2012; Cohen et al., 2013; Wang et al., 2013) and should be correlated with the Lanqi Formation in western Liaoning Province (or Tiaojishan Formation in northern Hebei Province) (Liu Y.X. et al., 2006; Chang et al., 2009; Liu Y.Q. et al., 2012; Wang et al., 2013).

These specimens were prepared with PaleoTools Micro-Jack 3, observed dry and under ethanol using a light microscope (NIKON SMZ1000) and photographed with a digital camera (DXM1200) connected to the microscope at the State Key Laboratory of Palaeobiology and Stratigraphy, Nanjing. Line drawings were made using CorelDRAW X5 software. Wing-venation terminology of Rasnitsyn (1969) and Rasnitsyn and Zhang (2010) is adopted herein.

All specimens described herein are housed at the Nanjing Institute of Geology and Palaeontology (NIGP), Chinese Academy of Sciences.

## 3. Systematic palaeontology

Order Hymenoptera Linnaeus, 1758  
Suborder Apocrita Gerstaecker, 1867  
Superfamily Stephanoidea Leach, 1815  
Family Ephialtitidae Handlirsch, 1906  
Subfamily Symphytopterinae Rasnitsyn, 1980

Genus *Karataus* Rasnitsyn, 1977

Type species: *K. pedalis* Rasnitsyn, 1977, Upper Jurassic of Kazakhstan.

Species included: *K. pedalis* Rasnitsyn, 1977, *K. hispanicus* Rasnitsyn and Martínez-Delclòs, 2000, and five new species described below.

**Revised diagnosis:** Antenna at least 20-segmented. Hind femur greatly swollen in males but just incrassate in females. Forewing with basal section of Rs strongly oblique towards wing base; 1r-rs absent to complete; 2r-m closer to 2m-cu than to 2r-rs; 2rm longer than 3rm; 1m-cu joining M slightly beyond bifurcation of Rs + M; Rs + M fork about at the level of pterostigmal base; cu-a much distad of M + Cu fork; 2A present basad of a1-a2; a1-a2 complete and cell 2a closed. Hindwing with basal section of Rs much longer than r-m; r closed at wing front edge; r-m meeting r at its hind margin before its mid-length. Metasoma fusiform and widest beyond its mid-length. Ovipositor slightly extending beyond metasomal apex.

**Remarks:** *K. hispanicus* was established based on a female wasp with forewings damaged (Rasnitsyn and Martínez-Delclòs, 2000) and its systematic position was questioned (Rasnitsyn and Ansoorge, 2000). The preserved characteristics of the type specimen, especially the short ovipositor, assign this species to Symphytopterinae.

*Karataus daohugouensis* n. sp.  
(Figs. 1A, E, F, 2A–C)

**Etymology:** From the insect Lagerstätte Daohugou.

**Types:** Holotype NIGP161232, a male wasp in dorsal view, with left wings missing distally and right hindwing completely, and right forewing slightly deformed and damaged.

**Description:** NIGP161232. Body brown in colour. Head medium-sized. Antennae composed of 25 segments. Scape thin basally and gradually increasing in thickness apically, 3 times as long as wide; pedicel small and slightly thickened apically, slightly wider than long; flagellum thin basally and apically, and gradually increasing in thickness towards its middle, first flagellomere cylindrical, slightly thinner than apex of pedicel, and 2.3 times as long as wide; second to fifth gradually increasing in thickness apically, and slightly longer than wide; sixth as long as wide; seventh to sixteenth cylindrical and slightly wider than long; following flagellomeres about as long as wide; terminal one rounded apically. Mesosoma distinctly broader than head; pronotum very short; mesonotum broad with notauli connected

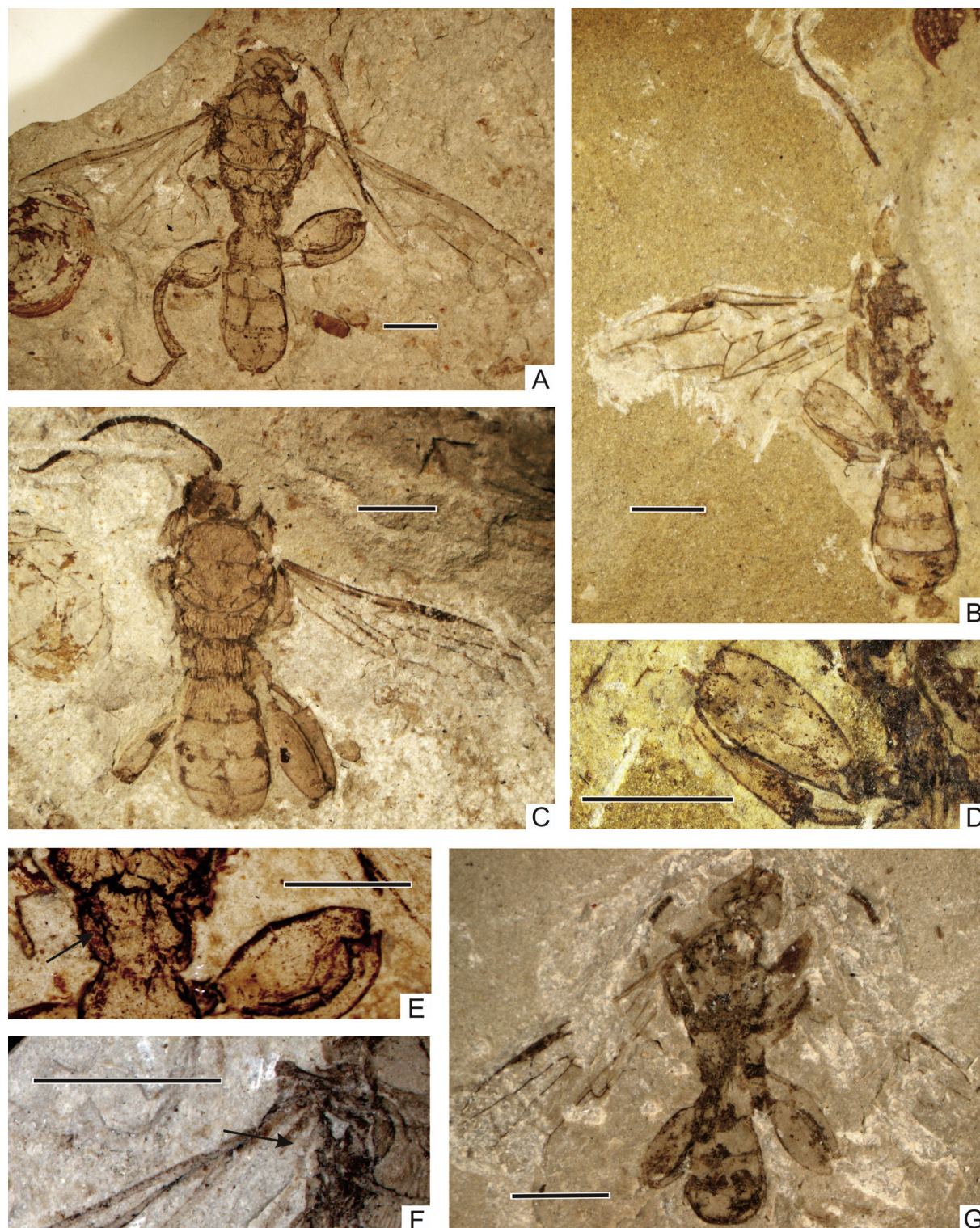


Fig. 1. (A, E, F) *Karataus daohugouensis* n. sp., holotype NIGP161232, male, dorsal view; (A) general view; (E) first metasomal segment and hind femur (in alcohol), with an arrow indicating the position of first metasomal spiracles; (F) basal left forewing, with an arrow indicating the position of the loop of 2A. (B, D) *Karataus strenuus* n. sp., holotype NIGP161233, male, ventral view; (B) habitus; (D) right hind leg. (C) *Karataus vigoratus* n. sp., holotype NIGP161235, male, dorsal view. (G) *K. strenuus* n. sp., NIGP161234, male, ventral view. Scale bars represent 2 mm.

with prescutal suture; metanotum short; propodeum transversely broad, some 3 times as wide as long; scutum, metanotum and propodeum corrugated. Fore- and midleg small. Hindleg with coxa stout; trochanter and trochantellus small; femur 1.8 times as

long as wide, and about twice as long as first metasomal segment, with four short teeth in basal half of inner edge; tibia as long as femur, strongly curved (particularly at about 0.3 its length) to fit femur; tarsus as long as tibia with two claws apically, and length

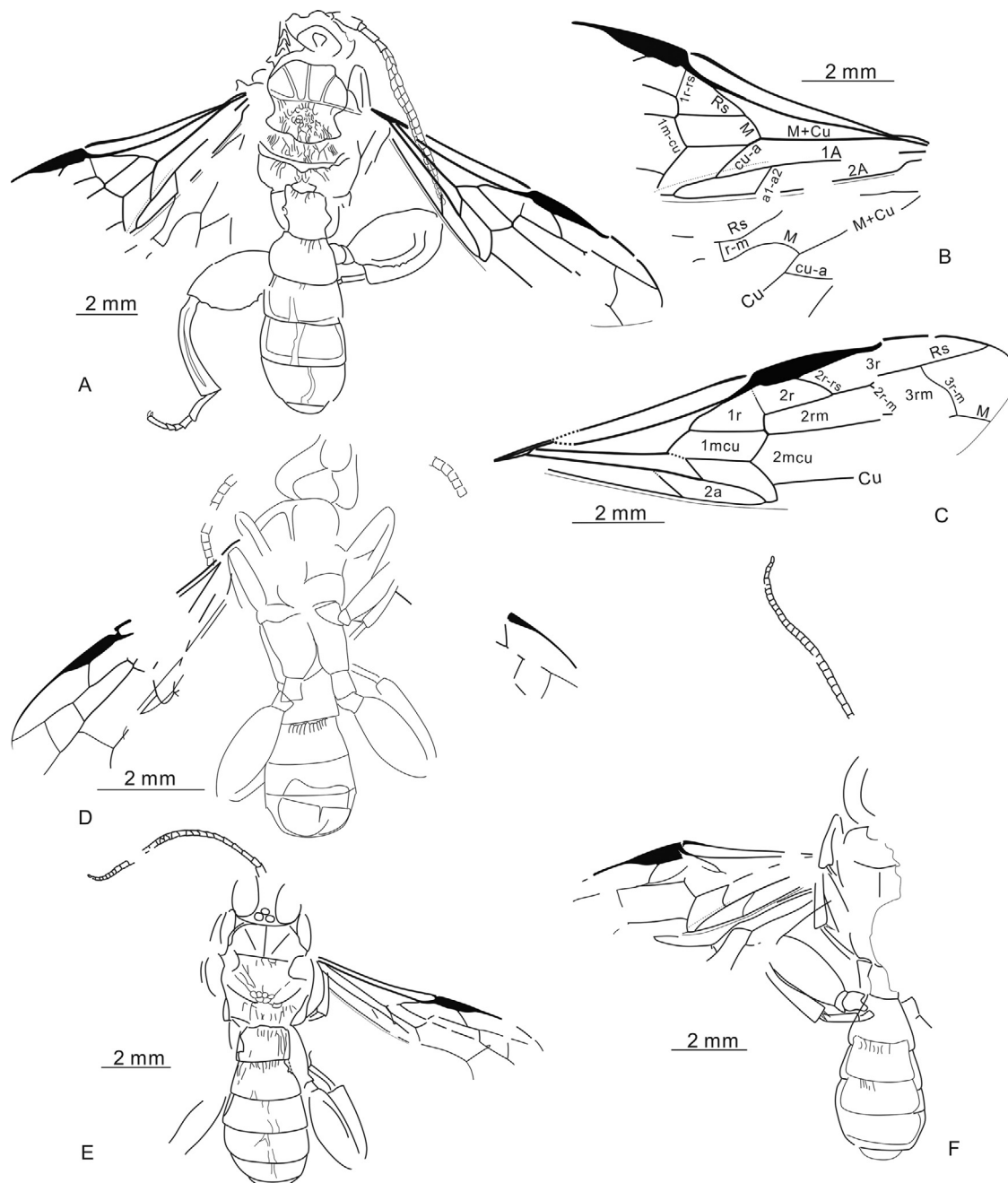


Fig. 2. (A–C) *Karataus daohugouensis* n. sp., holotype NIGP161232, male, dorsal view; (A) habitus; (B) left forewing and hindwing; (C) right forewing. (D, F) *Karataus strenuus* n. sp.; (D) NIGP161234, male, ventral view; (F) holotype NIGP161233, male, ventral view. (E) *Karataus vigoratus* n. sp., holotype NIGP161235, male, dorsal view.

ratio of tarsomeres 4.6:1.6:1.1:2.7. Forewing with pterostigma elongate, nearly parallel-sided before issuing 2r-rs slightly basad of its midlength; 1r-rs weak but complete, nearly vertical to C, and meeting Rs where Rs is nearly right-angled; 2r-rs twice as long as pterostigmal width, meeting cell 2rm at its basal 0.6 length; cell 3r elongate-triangular, slightly longer than 1r and 2r combined; 3r-m greatly sinuate (probably resulting partly from wing deformation), meeting Rs slightly closer to 2r-m than to apex of 3r; cell 2rm about twice as long as cell 3rm; 1m-cu joining M slightly beyond bifurcation of Rs + M; Rs + M fork slightly basad of pterostigmal base; basal section of Rs about as

long as its distance from pterostigmal base, and about 1.5 times as long as basal section of Rs; basal sections of Rs and M aligned to form smooth basal vein; cu-a about 2.5 times as long as section Cu between M + Cu fork and cu-a; 2A complete and slightly sinuate subbasally indicating 2A loop remnant (Fig. 1F, Fig. 2B); a1-a2 much basad of and slightly shorter than cu-a. Hindwing with basal section of Rs at least four times as long as r-m; basal section of M greatly bent; cu-a distinctly distad of divergence of M + Cu and Cu section between M + Cu fork and cu-a slightly longer than r-m. Metasoma with 7 segments distinguished and widest at basal 0.7 metasoma length (fourth segment); first

segment cylindrical, slightly longer than wide, and swollen medially where spiracles are located (Figs. 1E, 2A); second to fourth about as long as first; fifth and sixth about half as long as fourth; terminal very small. Measurements in mm: body length 12.9; head (excluding mandibles) length 1.2, width 2.3; antennal length 7.5; mesosomal length 4.6, width 3.3; hind femur length 3.1, maximum width 1.7; right forewing length 11.7, width 3.4 (as preserved); left forewing (as preserved) length 8.1, width 3.1; hindwing (as preserved) length 5.4, width 2.2; metasomal length 7.3, maximum width 2.8.

**Remarks and comparison:** This new species is characterized by the great swollen and ventrally toothed hind femur, the complete forewing 2A with the loop vestigial, and the first metasomal segment medially swollen at spiracle location. Besides, it differs from *K. pedalis* and *K. hispanicus* in 1r-rs being complete (although weak), and further from *K. hispanicus* in having a hindwing with cu-a postfurcal.

*Karataus strenuus* n. sp.

(Figs. 1B, D, G, 2D, F)

**Etymology:** From Latin *strenuus*, active, vigorous.

**Types:** Holotype NIGP161233, a male wasp in ventral aspect, with head and mesosoma incomplete, left antenna and wings missing, and right wings incomplete and partly deformed. NIGP161234, a male wasp in ventral view, with antennae and wings incomplete.

**Description:** NIGP161233 (Figs. 1B, D, 2F). Head large, partly preserved. Right antenna with apical 27 segments preserved; flagellum thickened medially, and gradually decreasing in thickness apically and basally, with several basal flagellomeres slightly longer than wide, others as long as wide or slightly shorter than wide, and terminal one distinctly longer than wide and rounded apically. Fore- and midleg small, mid tibia with one apical spur. Hindleg (Fig. 1D) with coxa stout; trochanter small but much longer than trochantellus; femur slightly wider than first metasomal segment distally (indicated by base of second segment); tibia thin and slightly shorter than femur, nearly straight except basally, with two apical spurs; tarsus with basal two tarsomeres preserved, short. Forewing with first section of Rs longer than its distance to pterostigmal base; 2r-rs issuing from pterostigma at about its mid-length, and 1.3 times as long as pterostigmal width; 2mcu large, about 1.5 times as long as cua; a1-a2 quite basad of cu-a, and 1A section between cu-a and a1-a2 slightly longer than a1-a2; 2A long and probably complete, 2a slightly longer than cua. Hindwing with cell r elongate; r-m much shorter than basal section of Rs; basal section of M strongly bent; cu-a distinctly distad of M + Cu fork. Metasoma narrow basally, widest far beyond mid-length; first segment ill-preserved, probably cylindrical, as long as hind coxa; second tergum about 1.5 times as long as first segment, and twice as wide distally as basally; third about 0.7 as long as second; fourth half length of third, and widest of the metasoma; fifth as long as third, much narrowed distally; sixth short, rounded apically. Measurements in mm: antennal length (as preserved) 5.0; body length (as preserved) 10.6; forewing (as preserved) length 6.4, width 2.4; hindwing (as preserved) length 4.6, width 1.5;

metasomal length 5.0; femur length (as preserved) 2.5, maximum width 1.1.

NIGP161234 (Figs. 1G, 2D). Head large. Antennae with at most 9 segments preserved; each flagellomere slightly longer than or as long as wide. Mesosoma stout and slightly longer than wide. Fore and mid legs small, mid-tibia with one apical spur. Hind leg with coxa stout, as long as first metasomal segment; trochanter distinctly larger than mid trochanter, and slightly narrowed basally; trochantellus shorter than trochanter; femur remarkably swollen, 2.2 times longer than wide; tibia thin, nearly straight except basally, and as long as femur; tarsus with only basitarsomere preserved basally. Forewing with pterostigma nearly parallel-sided before issuing 2r-rs distad of its mid-length; 1r-rs vestigial as a short stub on Rs where Rs is nearly right-angled; 2r-rs twice as long as pterostigmal width, meeting cell 2rm at its basal 2/3 of fore side and as long as its distance to 2r-m; 2rm about twice as long as 3rm; 2r-m and 3r-m slightly oblique; 2m-cu at basal third of hind side of 3rm; 2A ill-preserved and only distinguishable basally. Hindwing with r long; r-m far distad of Rs origin. Metasoma with 5 segments distinguished and maximum width at fourth segment; first segment partly covered by hind femora, very probably cylindrical, and slightly longer than wide; second and third slightly shorter than first; fourth transversely rectangular, and slightly shorter than third; fifth about as long as third. Measurements in mm: head length 1.4, width 1.6; mesosomal length 2.1; forewing (as preserved) length 5.7, width 1.9; hindwing (as preserved) length 3.6; metasomal length 4.0; hind femur length 1.8, maximum width 0.8.

**Remarks and comparison:** Although poorly preserved, the holotype is undoubtedly assigned to *Karataus* in that vein 2A is long and crossvein a1-a2 is complete in the forewing, the hind femur is clearly swollen and the metasoma is broadest beyond its mid-length. Specimen NIGP161234, also poorly preserved, has observable characters very similar to the holotype and therefore the two male wasps are placed in the same species, *K. strenuus* n. sp. This new species differs from *K. pedalis* in having a much longer and more segmented antenna, and a vestigial forewing 1r-rs crossvein like a short stub on Rs where Rs is nearly right-angled; from *K. hispanicus* in having a forewing with 1r-r remnant and 2m-cu received by 3rm, and a hindwing with cu-a meeting Cu beyond M + Cu fork; and from *K. daohugouensis* in the hind femur much narrower without teeth ventrally and 1r-rs vestigial as a short stub.

*Karataus vigoratus* n. sp.

(Figs. 1C, 2E)

**Etymology:** From Latin *vigoratus* for stout.

**Types:** Holotype NIGP161235, a male wasp in dorsal aspect. Left antenna slightly damaged and right one missing; left wings and right hindwing missing, and right forewing slightly damaged and deformed; legs incomplete.

**Description:** Head large, roundish, with eyes ovoid and occupying head sides, posterior ocelli touching anterior one and almost touching each other and eyes. Antenna with 29 segments preserved (probably 30 in total); scape thick and damaged basally;

pedicel narrower than scape apically, subcylindrical and twice as long as wide; basal four flagellomeres about 3 times longer than wide, following more or less shorter. Mesosoma stout and about as long as wide. Pronotum very short. Mesonotum with notauli greatly oblique and nearly reaching transscutal suture; scutum as long as scutellum. Metanotum short and propodeum long. Fore and mid legs small. Hind leg with coxa stout, and about twice as long as first metasomal segment; trochanter unclear, trochantellus short; femur swollen midway, about 2.5 times as long as wide; tibia slightly shorter than femur, nearly straight except basally; tarsus with only basitarsomere preserved, thin. Forewing clearly deformed owing to anteroposterior compression; first section of Rs slightly longer than that of M and its distance to pterostigma; pterostigma elongate; 2r-rs issuing from pterostigma slightly beyond its mid-length, about twice as long as pterostigmal width, and meeting 2rm at its basal 3/4 of fore side; 2rm nearly twice as long as 3rm; 2r-m about as long as its distance to 2r-rs; 2r-m and 3r-m slightly oblique; 2m-cu meeting 3rm at about basal 1/4 of hind side; cu-a distinctly postfurcal; a1-a2 present but ill-preserved; 2A complete. Metasoma with 6 segment distinguished and broadest at about its distal 1/3 length; first segment subcylindrical and about 2/3 as long as wide; second nearly trapezoid and slightly longer than first; third similar to second in shape but slightly shorter than the latter, and its end broadest for the whole metasoma; fourth as long as third, but gradually becoming narrow apically; rest much narrower and shorter. Scutellum, propodeum and basal two metasomal segments coarsely rugose, metanotum coarsely areolate. Measurements in mm: head length (as preserved) 1.1, width 2.0; antennal length 6.7; mesosomal length 2.9; forewing (as preserved) length 7.0, width 1.8; metasomal length 4.7; hind femur length 2.5, maximum width 0.9.

**Remarks and comparison:** The new species has a stout metasoma widest beyond its mid-length, swollen hind femora and a forewing venationally similar to *K. pedalis*, and therefore should be assigned to *Karataus*. It differs from the other congeners in the first metasomal segment being much broader and distinctly shorter than hind coxae. It further differs from *K. pedalis* in having a much longer and more-segmented antenna; from *K. hispanicus* in having a forewing with 2m-cu received by 3rm; and from *K. daohugouensis* in the hind femur being much narrower with teeth absent ventrally.

*Karataus exilis* n. sp.  
(Figs. 3A–C, 4A,B)

**Etymology:** From Latin *exilis* for slender.

**Types:** Holotype NIGP161236, a male wasp in dorsal view and slightly deformed, with head partly missing, legs incomplete and wings slightly damaged.

**Description:** NIGP161236. Body brown. Antenna with apical 9 flagellomeres preserved. Pronotum very short. Mesonotum with notauli nearly reaching transscutal suture; scutum about as long as scutellum. Metanotum very short, approximately 1/4 scutellal length. Propodeum about twice as long as metanotum. Hind leg with coxa stout, and about as long as first metasomal segment; trochanter distinctly larger than trochantellus; femur

with inner edge toothed and about 2.5 times as long as wide (Fig. 3C); tibia as long as femur, nearly straight except basally. Forewing with pterostigma elongate; 1r-rs rudimentary; 2r-rs connected to pterostigma slightly beyond its middle, and about twice as wide as pterostigma; first section of Rs strongly oblique to wing base, slightly longer than that of M; Rs + M fork slightly distad of pterostigma base; cell 2rm slightly longer than 3rm; 2r-m vertical, and 3r-m slightly sinuate; 1m-cu meeting 2rm slightly beyond Rs + M fork, slightly longer than basal section of M; 2m-cu meeting 3rm at its basal 1/4 of posterior margin; cu-a greatly postfurcal and slightly longer than its distance to M + Cu fork; 2A complete; a1-a2 far basad of cu-a, and 2a closed. Hindwing with Rs ending in anterior margin; r elongate-triangular; r-m oblique and about 1/3 as long as basal section of Rs; M + Cu fork basad of Rs origin, basal section of M bent strongly, and distinctly longer than that of Rs; cu-a sinuate, and meeting Cu just beyond M + Cu fork. Spindle-like metasoma with 7 segments and broadest medially; first segment thin basally, gradually thickened apically, and reaching its maximum width slightly before its end, and 1.6 times as long as width (Fig. 3B); second segment nearly trapezoid and as long as first with base slightly narrower than first segment distally; remaining ones slightly shorter with fourth widest. Mesonotum and metanotum coarsely decorated; propodeum areolate and hind coxae coarsely granular. Measurements in mm: mesosomal length 4.4; hind femur length 3.1, maximal width 1.2; right forewing length 9.6, width 2.9 and hindwing (as preserved) length 5.7, width 1.7; left forewing length 8.3, width 3.7 and hindwing (as preserved) length 4.3, width 2.6; metasomal length 8.7.

**Remarks and comparison:** It is apparent that the left forewing is shorter but wider than the right one, and the mesosomal and metasomal scuta are obliquely deformed in the specimen. Similar situations also occur in some other insects from the same horizon and locality, such as *Karatauvites junfengi* (Rasnitsyn and Zhang, 2010, pl. II-1, fig. 3b) and *Martynovocossus bellus* (Wang et al., 2008, fig. 1). The distortion is generally considered to result from the deformation of sedimentary rocks (Wang et al., 2007, 2008). The new species can be distinguished in having a much more slender metasoma with first segment frustum-shaped, a slightly longer forewing 2rm cell than 3rm, and a swollen and ventrally toothed femur. It differs from *K. pedalis*, *K. strenuus* and *K. vigoratus* in having a characteristic femur; from *K. hispanicus* in having a forewing 2m-cu crossvein received by cell 3rm and a hindwing cu-a crossvein just postfurcal; and from *K. daohugouensis* in having a much narrower hind femur.

*Karataus orientalis* n. sp.  
(Figs. 3D–F, 4C,D)

**Etymology:** Species name is from Latin *orientalis*, eastern.

**Types:** Holotype NIGP161237, in lateral view, nearly complete female wasp with head, antennae, legs and first metasomal segment damaged.

**Description:** Head incomplete with eyes ovoid. Antennae about 20-segmented with flagellum gradually becoming thin and short towards its apex. Mesosoma short and approximately as long as

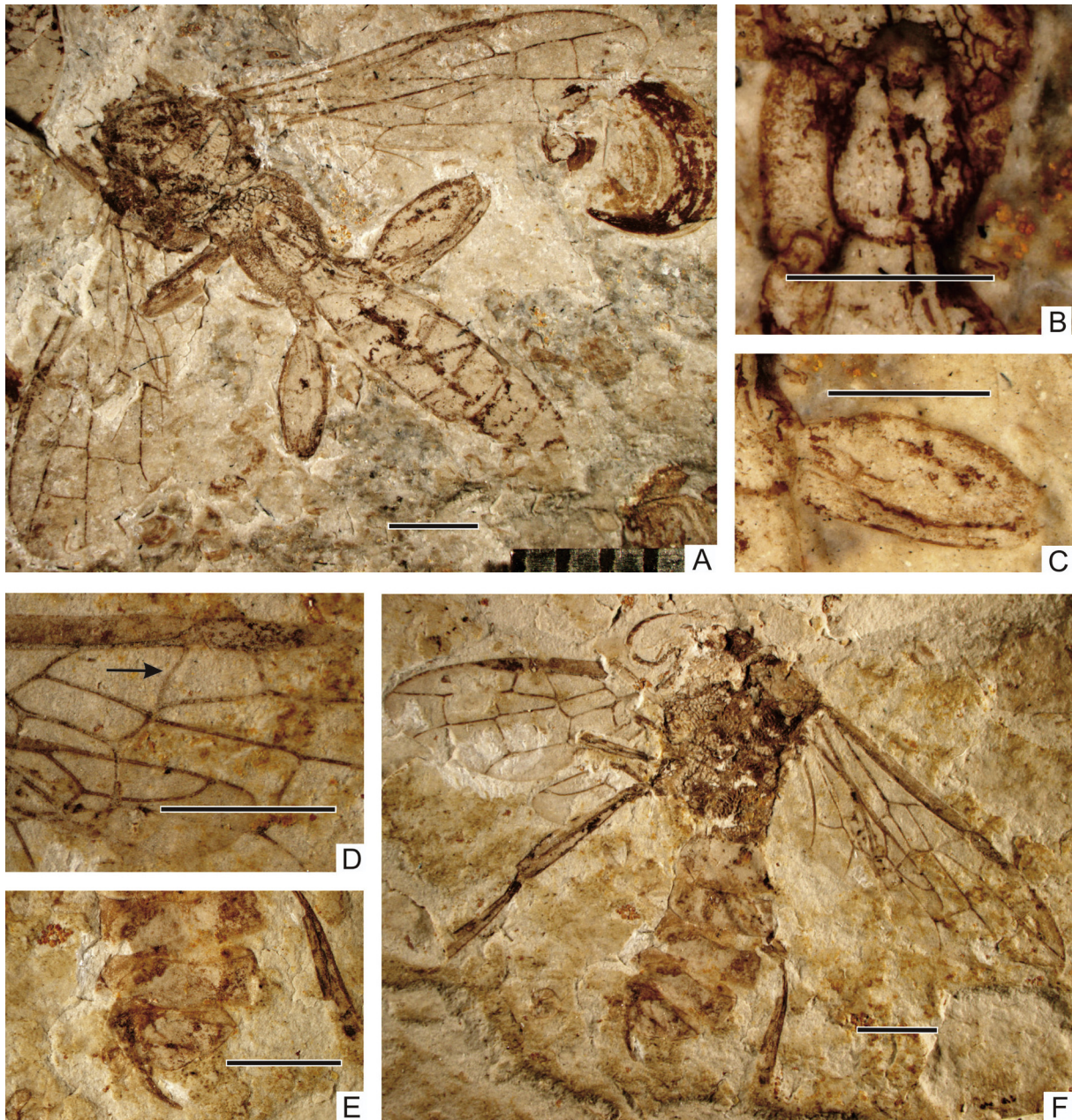


Fig. 3. (A–C) *Karataus exilis* n. sp., holotype NIGP161236, male, dorsal view; (A) general view; (B) first metasomal segment and hind coxae (in alcohol); (C) right hind leg (in alcohol). (D–F) *Karataus orientalis* n. sp., holotype NIGP161237, female, lateral view; (D) right wings, with an arrow indicating the 1r-rs crossvein; (E) distal metasomal segments and ovipositor; (F) general view. Scale bars represent 2 mm.

high. Pronotum short. Mesonotum with notauli reaching transscutal suture and scutum as long as scutellum. Metanotum shorter than propodeum. Fore and mid legs thin and short; hind leg with coxa short and very wide, trochanter small, femur thin and slightly becoming thick at its basal 2/3 length, tibia thin and slightly longer than femur, straight except basally. Forewing with first abscissa of Rs about as long as that of M, and approximately half its distance to pterostigma; pterostigma long, subparallel basad of 2r-rs and gradually narrowed apically; 2r-rs issuing from pterostigmal mid-length, slightly longer than its maximal width and meeting fore side of cell 2rm at its distal 1/3 length; 1r-rs weak but complete, slightly curved, distinctly longer than 2r-rs (Fig. 3D); 3r distinctly longer than 1 + 2r and ending in

anterior margin near wing apex; 3r-m longer than 2r-m and both subvertical; 2rm slightly longer than 3rm; 1m-cu meeting M just distad of fork of Rs + M; cu-a meeting Cu at about its basal 1/5 length; 2A present but nebulous subbasally; a1-a2 as long as its distance to cu-a and shorter than cu-a. Hindwing with Rs origination slightly distad of M + Cu fork; first section of RS 1.6 times as long as r-m and longer than that of M; cu-a joining M + Cu quite basad of its fork. Metasoma spindle-like with fourth segment broadest; first segment damaged ventrally, probably cylindrical and as long as hind coxa; second one trapezoid and about as long as first; third to fifth equal in length and shorter than second. Ovipositor curved and slightly longer than first metasomal segment (Fig. 3E). Mesosoma (except

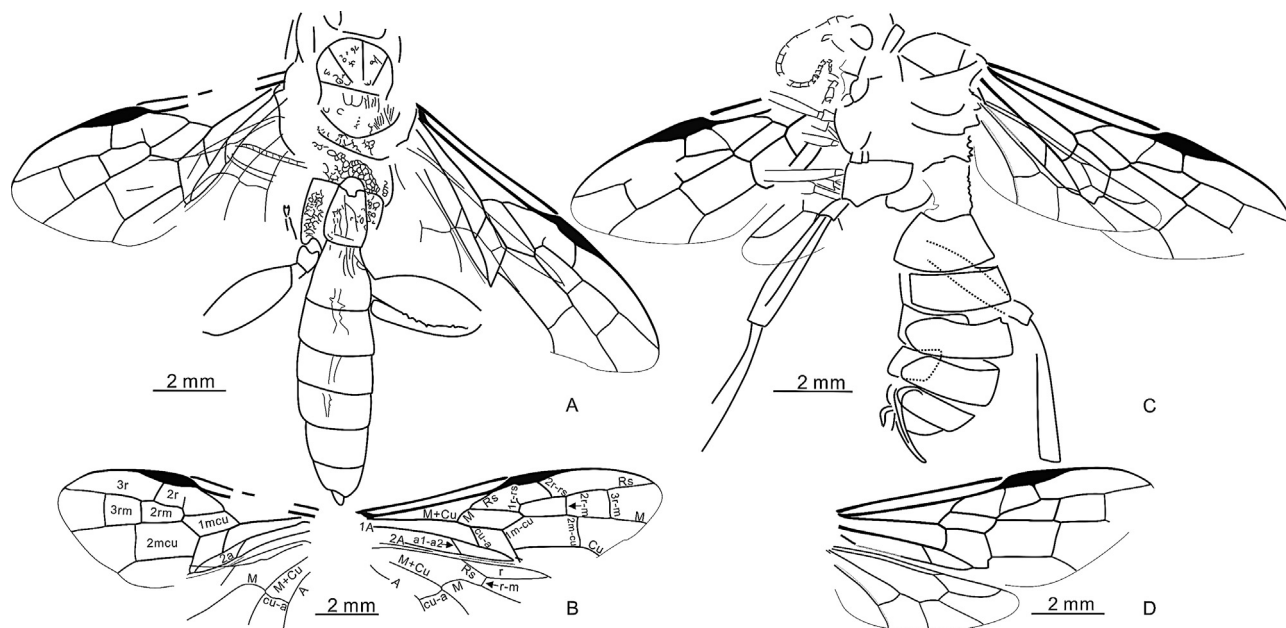


Fig. 4. (A, B) *Karataus exilis* n. sp., holotype NIGP161236, male, dorsal view; (A) habitus; (B) forewing and hindwing. (C, D) *Karataus orientalis* n. sp., holotype NIGP161237, female, lateral view; (C) habitus; (D) right forewing and hindwing.

pronotum), coxae and first metasomal segment coarsely granulated. Measurements in mm: antennal length 4.7; mesosomal length 3.6; forewing length 8.8, width 3.1 and hindwing length 5.4, width 1.9; metasomal length 6.9; ovipositor length 2.1.

**Remarks and comparison:** The new species is similar to *K. hispanicus* which is also known from only a female and in which the hind femur is just incrassate. However, it differs from the latter in having a much longer first metasomal segment, a forewing with 1r-rs complete, both 2r-m and 3r-m straight, and 2m-cu received by cell 3rm, and having a hindwing with first section of M much shorter. It also differs from the remaining congeners which are based on only males in having a much narrower hind femur and a hindwing with cu-a greatly antefurcal and first section of M much shorter, and having a forewing with 1r-rs complete (except for *K. daohugouensis*). Furthermore, it differs from *K. daohugouensis* in having fewer segments in the antenna.

## 4. Discussion

Very few symphyopterine taxa have been reported from areas other than Karatau (the Upper Jurassic Karabastau Formation) in southern Kazakhstan (Rasnitsyn, 1975, 1977, 1980; Rasnitsyn and Martínez-Delclòs, 2000; Rasnitsyn et al., 2003; Rasnitsyn and Zhang, 2010) (Table 1). Although plenty of ephialtitids have been reported from the Daohugou Beds, they mostly belong to the subfamily Ephialtitinae (Rasnitsyn and Zhang, 2004, 2010; Ding et al., 2013; Li et al., 2013) except *Symphyopter* spp., *Karataviola* spp. and some indeterminate symphyopterines (Rasnitsyn and Zhang, 2004). The fossil insect collections at the NIGP show that the Symphyopterinae is as diversified in the Daohugou Beds at least as in the Karabastau Formation.

Thick hind femora are widely present in wasps, but are rarely as swollen as in the species described above in Hymenoptera. The family Stephanidae [Leach, 1815](#) is derived from

Ephialtidae and the two families form the superfamily Stephanioidea (Rasnitsyn and Zhang, 2010). In Stephanidae, the hind femur is more or less swollen and dentate, usually with 2 or 3 large teeth and several small ones ventrally in both males and females (Hong et al., 2011). But in Ephialtidae, swollen hind femora are only known in male *Trigonalopterus brachycerus* and *Karataus pedalis* (Rasnitsyn, 1975, 1977). However, the female of the first species has normal hind femora in shape without teeth on its inner margin. The second species is represented by only one male specimen and its females are unknown (Rasnitsyn, 1977). Likewise, the other species of *Karataus*, *K. hispanicus*, is known from a female specimen and also has moderately incrassate hind femora (Rasnitsyn and Martínez-Delclòs, 2000). The new material described above further suggests that the genus *Karataus* is probably sexually dimorphic with hind femora much swollen in males but just incrassate in females, those of the former being involved in copulation (either in display or to assist fixation on the female). This kind of sexual dimorphism is apparently uncommon in Hymenoptera.

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## Appendix A.

### Key to species of *Karataus*.

1. Female. Hind femur just incrassate; hindwing with cu-a antefurcal 2  
Male. Hind femur swollen; hindwing with cu-a postfurcal 3
2. Forewing with 1r-rs absent, 2r-m and 3r-m arched, and 2m-cu received by cell 2rm; hindwing with first section of M long and greatly arched  
*K. hispanicus* Rasnitsyn and Martínez-Delclòs, 2000
- Forewing with 1r-rs complete, 2r-m and 3r-m straight, and 2m-cu received by cell 3rm; hindwing with first section of M short and nearly straight *K. orientalis* n. sp.
3. Hind femur ventrally toothed 4  
Hind femur without teeth ventrally 5
4. Metasoma stout with first segment protruding laterally at enlarged spiracles; hind femur greatly swollen; hind tibia strikingly curved; forewing with 1r-rs complete *K. daohugouensis* n. sp.  
Metasoma slender with first segment frustum-shaped and spiracles not visible (small); hind femur moderately swollen; forewing with 1r-rs incomplete *K. exilis* n. sp.
5. First metasomal segment shorter than wide and greatly shorter than hind coxae *K. vigoratus* n. sp.  
First metasomal segment about as long as wide, and as hind coxae 6
6. Forewing with 1r-rs remnant as a short stub on Rs (where Rs is nearly right-angled); antenna consisting of over 27 segments *K. strenuus* n. sp.  
Forewing with 1r-rs absent and second section of Rs rounded basally; antenna consisting of about 21–23 segments *K. pedalis* Rasnitsyn, 1977

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