The first orthophlebiid scorpionfly (Insecta: Mecoptera) from the Wealden (Lower Cretaceous) of southern England

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ABSTRACT: The Family Orthophlebiidae ranges from the Middle Triassic to the Early Cretaceous. The Wealden Mecoptera have added to our knowledge of the Mecoptera from the Early Cretaceous of southern England, but have been comparatively little studied. Here we present the description of the first orthophlebiid from the Wealden of England. *Mesopanorpa brooksorum* sp. nov. from England is the earliest Cretaceous representative of this genus.

KEY WORDS: *Mesopanorpa*, new species, Orthophlebiidae, UK, Weald Clay.

The Mecoptera are currently a small, relict order of insects consisting of little more than 600 species (Cai *et al.* 2008; Bicha 2010). Living Mecoptera are divided into nine families among which only two, Panorpidae and Bittacidae, are comparatively abundant and widely distributed. Since the Cretaceous biotic changes which affected the insect fauna (Szwedo & Nel 2015), mecopteran abundance has significantly decreased (e.g. Kopeć *et al.* 2016), and the order has gradually evolved into its modern composition. The family Orthophlebiidae is considered to be the ancestral stock of Eocene panorpoid scorpionflies (Krzemiński *et al.* 2017 (this volume)) which reached their peak of diversity during the Palaeogene (Archibald *et al.* 2013). The oldest Orthophlebiidae are known from the Middle Triassic (e.g., Hong *et al.* 2002) and the last known are from the Early Cretaceous of China (Ren *et al.* 1995; Ren 1997).

To date, Mecoptera from the Early Cretaceous Wealden Supergroup of southern England have been little studied (Table 1). They are uncommon as fossils in the Wealden and only a few taxa have been documented. The family Orthophlebiidae, without species descriptions, was reported as present by Crowson (1946), Jarzembowski (1984, 2011) and Ross & Cook (1995). Petrulevičius & Jarzembowski (2004) described a new species and genus of the family Bittacidae from the Wealden in the county of Surrey, later restudied by Kopeć *et al.* (2016). A new family, Englathaumatidae, comprising two new species, has also recently been recognised in Surrey, as well as Sussex (Novokshonov *et al.* 2016).

A new species description of the first English Wealden representative of the family Orthophlebiidae is given below.

1. Geological context

The Weald Clay Formation (Hopson *et al.* 2008), outcropping in the counties of Kent, Surrey and Sussex, represents an ancient non-marine, muddy wetland with some open water; river run-off from the London area deposited terrestrial insect remains in the outcrop basin (Jarzembowski 1995). Some 35 metres of the lower Weald Clay Formation were formerly exposed at the Clockhouse brickworks, near Capel, Surrey (Fig. 1; National grid reference [TQ 175385]; latitude 51° 8′ N., longitude 0° 19.5′ W.). The section differed from that of other Wealden localities where Mecoptera have been described (Table 1) in that the insect remains occurred in discarded siltstone lenticles and domes which originated as well-cemented scour fills in the mudstone sequence (Jarzembowski 1991; Ruffell *et al.* 1996). The insects are disarticulated but numerous; the new species described below being associated, amongst others, with cockroaches (Blattodea), termites (Isoptera), plant bugs (Homoptera), true flies (Diptera) and beetles (Coleoptera). The insect-bearing sequence is dated as upper Hauterivian, below British Geological Survey beds '3'/3a (Rasnitsyn *et al.* 1998; Batten & Austen 2011) ~130 Ma (Cohen *et al.* 2013).

2. Material and methods

The five fossil wings studied herein are preserved as three-dimensional impressions with brown-coloured pigmentation and veins, although the latter may be faint in unpigmented areas (Fig. 2). They occur in yellow, grey or even green calcareous siltstone. Any degagement was done with a finely-tuned Burgess vibrotool. Drawings were prepared with the help of a camera lucida mounted on an M4A Wild binocular microscope, then digitally processed using Corel X5 software. B/W photography was done on a Wild photomicroscope. Solid lines represent definite veins or margins and dashed lines represent damaged, faint or even extrapolated ones.

Vein nomenclature is according to Willmann (1989) with some modifications (Soszyńska-Maj *et al.* 2017 (this volume)).

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Table 1 Fossil Mecoptera from the Weald Clay Formation of southern England.

Genus/species	Formation/locality	References
BITTACIDAE		
Antiquanabittacus nanus Petrulevičius & Jarzembowski, 2004	Lower Weald Clay (Hauterivian), Clockhouse Brickworks, Surrey	Petrulevičius & Jarzembowski 2004; Kopeć *et al.* 2016
ORTHOPHLEBIIDAE		
Mesopanorpa sp. ?*Protorthophlebia* sp.	As above	Jarzembowski 1984, 2011
ENGLATHAUMATIDAE		
Englathauma crabbi Novokshonov, Ross, Krzemiński & Soszyńska-Maj, 2016	Upper Weald Clay (Barremian), Rudgwick Brickworks, West Sussex	Novokshonov *et al.* 2016
Englathauma mellishae Novokshonov, Ross, Krzemiński & Soszyńska-Maj, 2016	Upper Weald Clay (Barremian), Smokejacks Brickworks, Surrey	Novokshonov *et al.* 2016

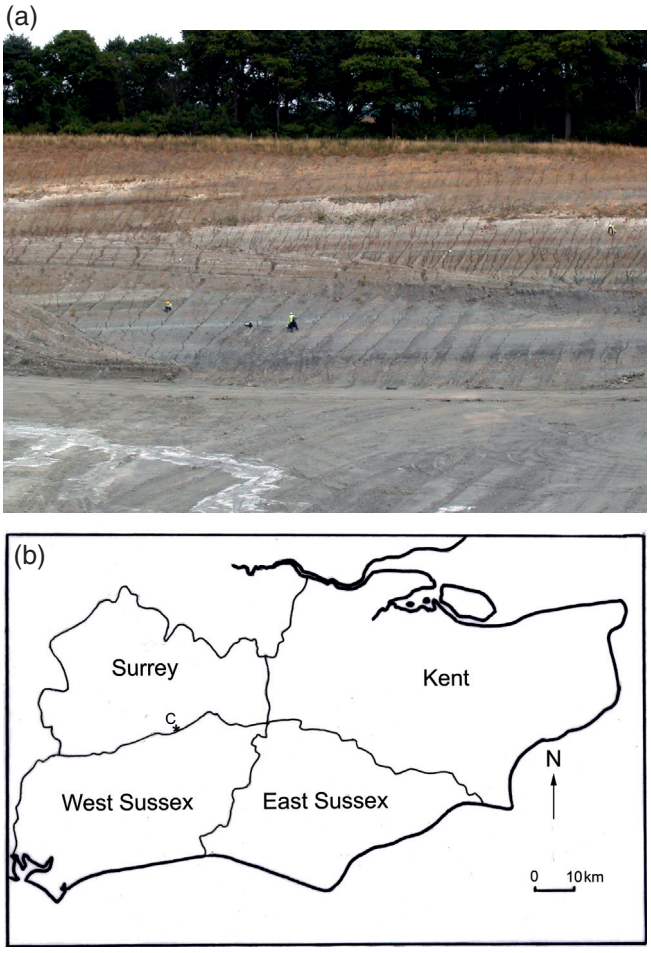

Figure 1 Clockhouse brickworks, near Capel, Surrey: (a) the 'new' pit (2005), looking East. Photo: EJ; (b) location map – brickworks marked as 'C'.

Collection abbreviations. NHMUK, Natural History Museum, London; BMB, Booth Museum of Natural History, Brighton. Field numbers given in parenthesis for continuity (prefixed CH, Clockhouse).

3. Systematic palaeontology

Order Mecoptera Packard, 1886
Family Orthophlebiidae Handlirsch, 1906

Type genus. *Orthophlebia* Westwood *in* Brodie, 1845.
Type species. *Orthophlebia liassica* (Mantell, 1844) = '*Panorpa*' *liassica* Mantell, 1844.
Type locality. Wainlode Cliff, Gloucestershire (United Kingdom); Rhaetian (Upper Triassic).

Genus *Mesopanorpa* Handlirsch, 1906

Type species. *Panorpa hartungi* Brauer, Redtenbacher & Ganglbauer, 1889.
Type locality. Ust-Baley, Russia; Toarcian (Lower Jurassic).

Mesopanorpa brooksorum sp. nov.
(Figs 2, 3)

Material. Five incomplete wings; holotype II 3094 [CH200b, b'], right forewing; paratypes II 3095 [CH815a, b], II 3096 [CH817c, c']; other material P1 II 3097 [CH62c, d], housed in NHMUK, London; Paratype 014914.1 [CH320], housed in BMB, Brighton.

Horizon and locality. Weald Clay Formation, Clock House Brickworks, Surrey.

Etymology. After Ken and the late Diana Brooks of Hastings, Sussex, local geologists.

Diagnosis. Wing dark coloured, with narrow transparent spots merging into bands, Rs_{1+2} about twice as long as Rs_{3+4}, Sc long in forewing, reaching pterostigmal area, M_{4a+b} very short in forewing.

Description. Forewing, narrow and elongated, more than three times longer than wide; 10.3–10.6 mm long, 3.2–3.4 mm wide; membrane with distinctive brown colour markings, comprising three connected but discrete transverse bands, and several coalesced bands in the apical one-third of the wing; basal part of wing not preserved, veins in the areas without colouring (pigmentation) weakly preserved; cross-veins very few or weakly preserved; vein Sc ending opposite first fork of Rs_1, slightly beyond fork of R_1; R_1 with one branch surrounding the pterostigmal area; in radial sector (Rs), six veins reaching the outer margin; Rs_1 with three veins reaching the outer margin; Rs_{1a-c} slightly shorter than length of Rs stem and a little longer than Rs_{3+4}; Rs_2 simple, straight; Rs_{3+4} ca. half length of Rs_{1+2}, forking with two simple veins reaching the margin; five veins in median area; M_{1+2} twice longer than M_{3+4}; M_4 forking with two simple veins, M_{4a} and M_{4b}, reaching the outer margin, M_{4a+b} very short; two cubital veins, three anal veins present. Hindwing, vein Sc shorter than in forewing, reaching the outer margin slightly beyond end of Rs_{1+2} stem; four simple median veins reaching outer margin, M_{1+2} ca. three times longer than M_{3+4}.

4. Discussion

Although few in number, the Wealden Mecoptera have added to our knowledge of the order in the Mesozoic. The Orthophlebiidae are described here for the first time from the Hauterivian of England. This species was already given by Jarzembowski (1984) as a representative of the genus *Mesopanorpa* Handlirsch, 1906, but without a species description. This new species

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Figure 2 Forewing of *Mesopanorpa brooksorum* sp. nov., holotype no. II 3094 [CH200b], Weald Clay, Clockhouse. Photo: EJ.

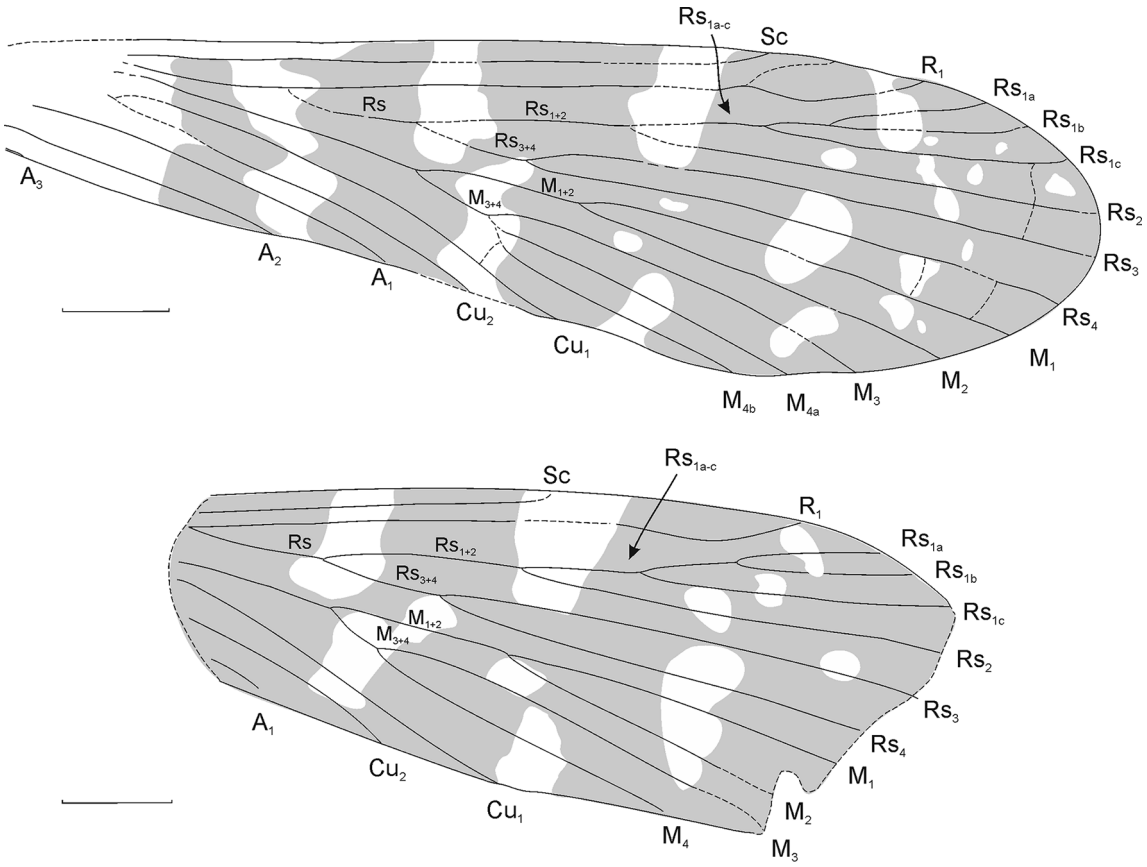

Figure 3 Wing venation of *Mesopanorpa brooksorum* sp. nov.: (A) forewing, holotype no. II 3094 [CH200b]; (B) hindwing, paratype no. 014914.1 [CH320 + 774]. Abbreviations: A = anal vein; Cu = cubitus; M = media; R = radius; Rs = radial sector; Sc = subcosta. Scale bars = 1mm.

is the first, but not necessarily the only representative of the genus in the Wealden; continuing insect finds including Mecoptera at the Smokejack's brickworks may well extend the range. According to the existing taxonomic system of the family Orthophlebiidae the character of Rs_{1+2} almost twice as long as Rs_{3+4} is considered as a feature of the genus *Mesopanorpa* with Rs_1 two- or three-branched (Handlirsch 1906). This is in contrast to the genus *Orthophlebia*, which includes species with the radial sector forking with seven or eight simple veins to the wing margin and Rs_{1+2} not significantly longer than Rs_{3+4}. However, there are some species which do not have either character Rs_{1+2} twice as long as Rs_{3+4} (*Mesopanorpa*) or Rs_{1+2} forking at the same level as Rs_{3+4} (*Protorthophlebia*). This supports the need to establish a new, updated taxonomic system of the family Orthophlebiidae. The preliminary results of this work are being submitted separately (Krzemiński *et al.* 2017 (this volume); Soszyńska-Maj *et al.* 2017 (this volume)). However, the final diagnoses of the genera are still under consideration.

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