

Mecoptera and Diptera from the early Toarcian (Early Jurassic) deposits of Wolfsburg – Große Kley (Lower Saxony, Germany)

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ABSTRACT: Twelve specimens of early Toarcian Mecoptera and Diptera from the vicinity of Wolfsburg were investigated for the present study. The material was found during house building activities in the 1980s at the locality Große Kley in Mörse, an urban district of the city of Wolfsburg, Lower Saxony, Germany. The specimens were found in calcareous nodules of the *Harpoceras falci-ferum* Zone that occur within the Liassic black shales (Posidonia shale). Six specimens of Mecoptera, five belonging to the family Orthophlebiidae and one belonging to the Bittacidae, and six representatives of the following Diptera families were identified: Ptychopteridae, Limoniidae, Anisopodidae and the superfamily Mycetophiloidea. The fossil fauna of Wolfsburg is similar to that of other early Toarcian sites in Germany, described by Handlirsch (1906, 1939), Bode (1905, 1953) and Ansorge (1996) from Braunschweig, Dobbertin and Grimmen. Two new species are described, *Mesorhyphus ulrichi* sp. nov. (Anisopodidae) and *Archipleciomima germanica* sp. nov. (Mycetophiloidea).



KEY WORDS: Anisopodidae, Bittacidae, Limoniidae, Mesozoic, Mycetophiloidea, nematoceras, Orthophlebiidae, Ptychopteridae, scorpionflies.

Data about Mecoptera and Diptera from the Early Jurassic of Germany were published by Geinitz (1883, 1884, 1887), Bode (1905, 1953), Handlirsch (1906–1908, 1920, 1939), Willmann (1978, 1984a, b, 1989), Krzemiński & Kovalev (1988), Krzemiński & Zessin (1990), Ansorge & Krzemiński (1994, 1995, 2002), Evenhuis (1994), Krzemiński & Ansorge (1995, 2000, 2005), Ansorge (1996, 2007) and Lukashovich *et al.* (1998). The best studied localities are Dobbertin and Grimmen (Mecklenburg–Vorpommern, Germany) (Handlirsch 1906–1908, 1920, 1939; Ansorge 1996, 1999, 2003). Comparably diverse and abundant specimens were found in the vicinity of Braunschweig (Bode 1905, 1953; Ansorge 2003).

Less well known are temporary outcrops that were exposed during the 1970s and 1980s at the locality of Große Kley in Wolfsburg (Lower Saxony, Germany, Fig. 1) from which insects have only been recorded by Kierst & Wiesner (1974). Most Early Jurassic insect localities of Germany are dated as early Toarcian and originate from the Posidonia shale or “Green series” clay. These localities are characterised by a high abundance of fossils in a varying state of preservation. More sclerotised wings with thick veins are generally much better preserved. Due to the fine-grained rock matrix of the carbonate nodules, the insects of the Grimmen site are the best preserved. Specimens are very often fragmented. Exceptionally rare are specimens with the whole body preserved. Therefore, it is extremely difficult to ascribe particular, separate parts to one species. Additionally, rudaceous sediment often

deforms preserved fragments, which are thus too poorly preserved for determination.

The present material comprises six specimens of the order Mecoptera belonging to two families: Orthophlebiidae (five specimens) and Bittacidae (one specimen). Six other fossils represent the order Diptera, belonging to the following families: Ptychopteridae (two specimens); Limoniidae (two specimens); Anisopodidae (one specimen); and Mycetophiloidea (one specimen). The available fauna of Mecoptera and Diptera is similar to that of other early Toarcian localities of Germany. Two of the fossil dipterans are described here as new species.

1. Material and methods

The locality Große Kley is located in Mörse, an urban district of the city of Wolfsburg, Lower Saxony, Germany. During house building activities in the 1970s and 1980s, temporary outcrops revealed rich invertebrate and vertebrate faunas in the Posidonia shale, as well as in calcareous nodules in certain horizons. The known insect remains were found within the nodules, originating from the early Toarcian *Harpoceras falci-ferum* Zone, formed during the Toarcian Oceanic Anoxic Event (*ca.* 181.5 Ma; Gradstein *et al.* 2012).

The material of fossil Mecoptera and Diptera described within the present study was collected by Ulrich Conrady between the years 1981 and 1984, and donated in October 1997

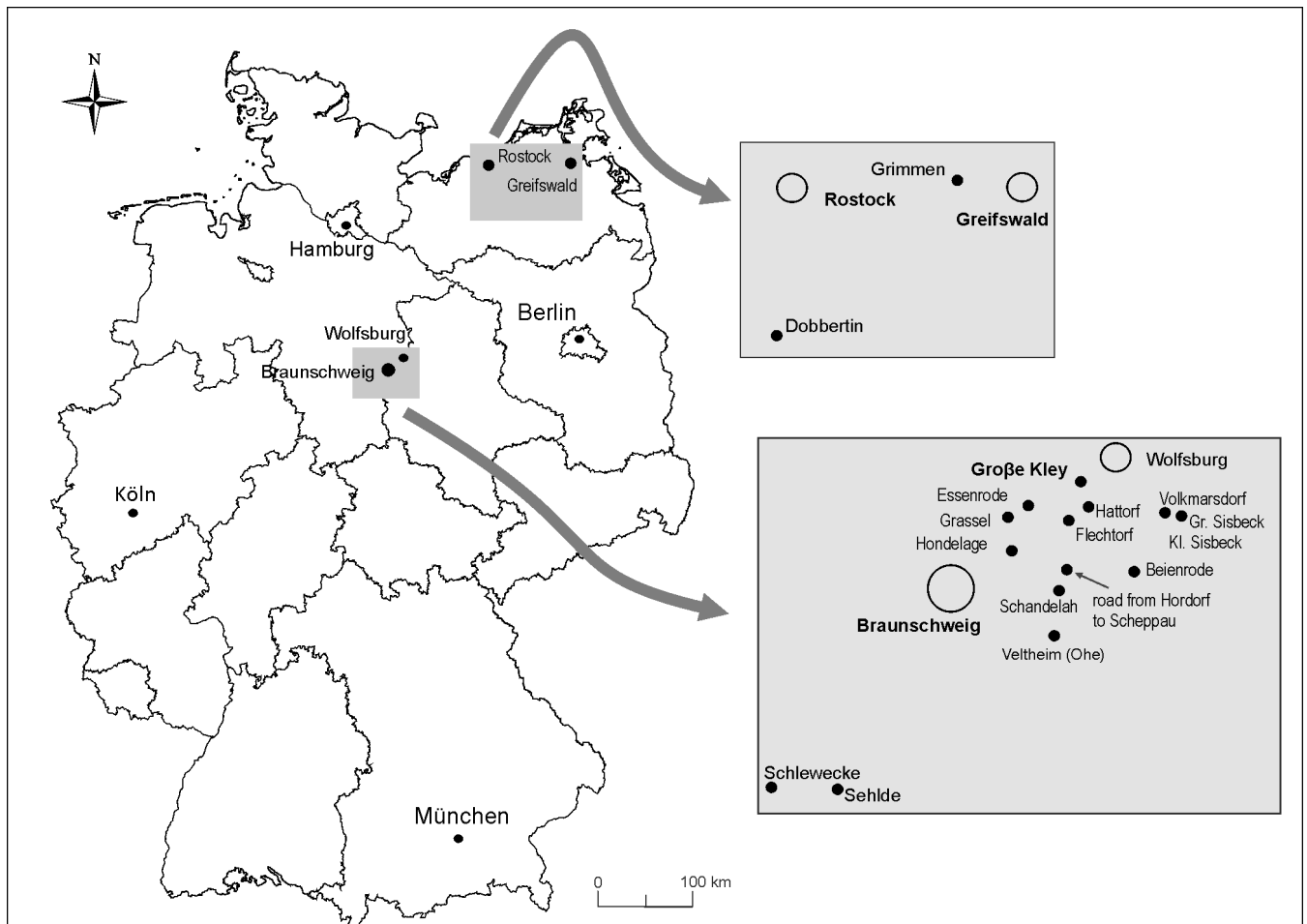


Figure 1 Map of early Toarcian insect localities in Northern Germany.

to one of the authors (AG) who, in 2015, deposited the material in the collections of the Geoscience Centre of the Georg-August University of Göttingen, Germany (GZG). From the collected material, six fossils have been identified as Mecoptera and six as Diptera. Most of them are sufficiently well preserved to be studied in detail. Additionally, three specimens from Grimmen, collected by Jörg Ansoerge, are used for the description of a new species *Archipleciomima germanica* sp. nov. The redescrptions of some species were made based on the re-examination of the holotypes.

The fossil specimens were examined and photographed under alcohol using a Keyence VHX 5000 with camera VHX 5020 (in Göttingen) and a Nikon Coolpix 4500 mounted on a Carl Zeiss Jena Lumipan with a Mikrotar macro lens and a Leitz Periplan eyepiece (in Greifswald).

The Diptera wing venation terminology used in this paper is based on the system proposed by Krzemiński & Krzemińska (2003) and Krzemińska *et al.* (2009), with four medial, one cubital and two anal veins. The terminology of the wing venation for Mecoptera follows Willmann (1989) with some modifications made by Soszyńska-Maj *et al.* 2017 (this volume).

2. Systematic palaeontology

Order Mecoptera Packard, 1886
 Infraorder Raptipedia Willmann, 1987
 Family Bittacidae Handlirsch, 1906
 (Fig. 2)

Material examined. GZG.INV.92007, Große Kley in Wolfsburg, Lower Saxony (Germany), housed in Göttingen.

Remarks. The single specimen is too poorly preserved for determination to the genus and species level. It belongs to the Bittacidae, according to following characters: elongated, narrow wing and four radial veins in radial sector.

Family Orthophlebiidae Handlirsch, 1906
 Genus *Orthophlebia* Westwood in Brodie, 1845

Type species. *Orthophlebia liassica* (Mantell, 1844).

Orthophlebia is the most speciose and most commonly encountered genus of Jurassic Mecoptera. About 35 species were described from the Lias (Early Jurassic) of Germany (Bode 1905, 1953; Handlirsch 1906–1908, 1939; Willmann 1978). Most specimens are poorly preserved and the reconstruction of the wing venation is sometimes difficult and not always explicit. According to Willmann (1989) and Ansoerge (1996), many species were described based on false interpretations of wing venation. Several of them were synonymised by those authors. However, the entire collections of Handlirsch and Bode have not been restudied and redescrbed; further investigations are essential and are being carried out by the present authors. Additional difficulty is caused by species described only from hind wings, as they could well belong to species described only from forewings.

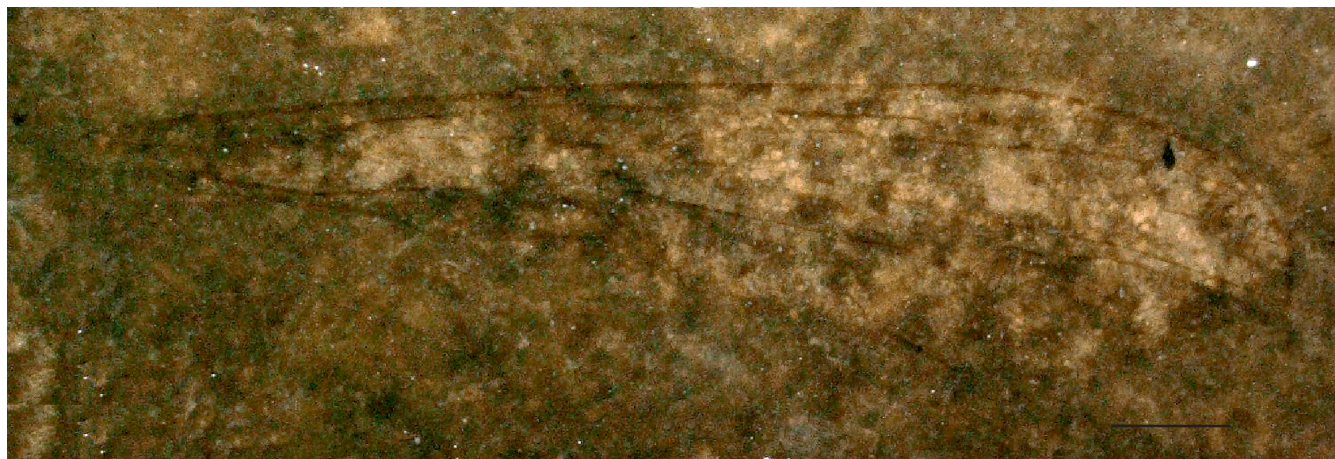


Figure 2 Bittacidae det., new specimen from Große Kley, GZG.INV.92007 (photograph by Alexander Gehler). Scale bar = 1 mm.

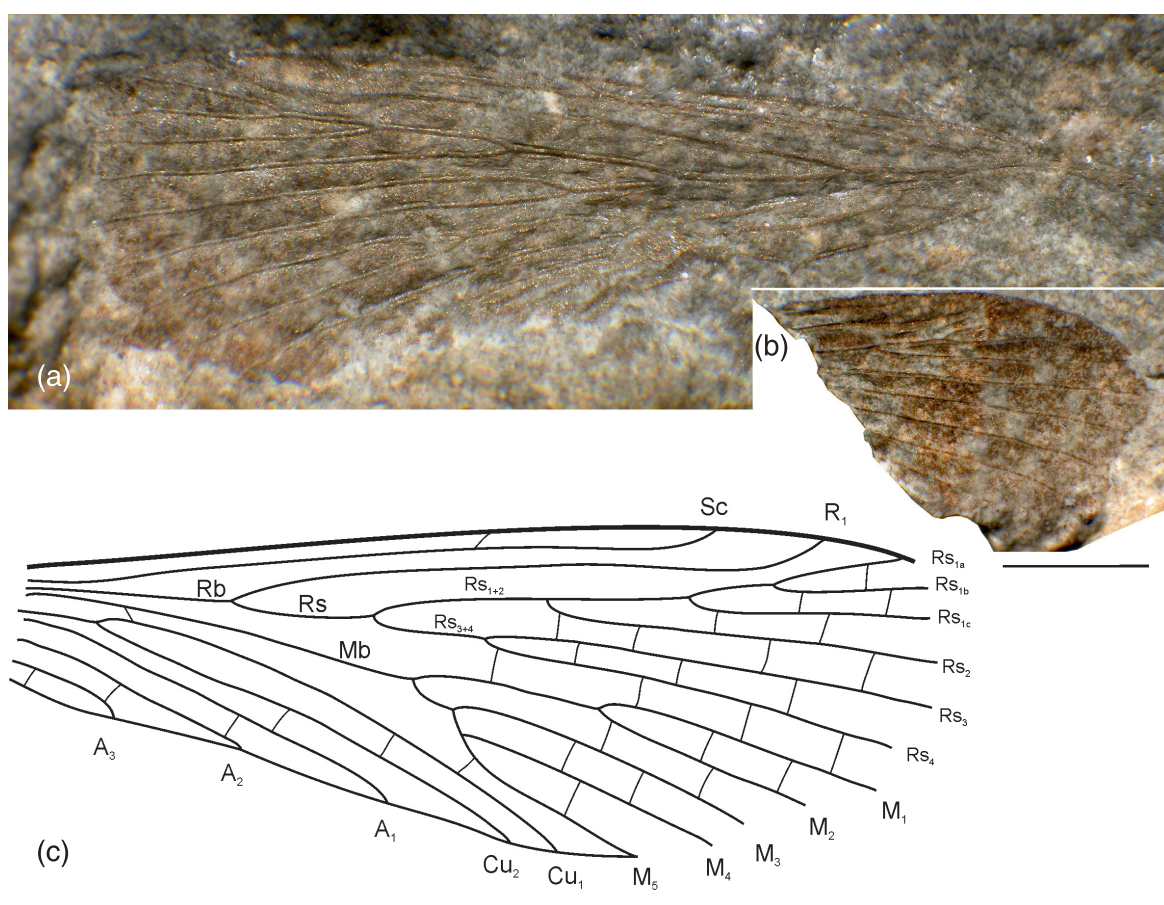


Figure 3 *Orthophlebia elongata* Handlirsch, 1939: (a) holotype 123/55, part; (b) holotype 123/55, counterpart. (Photographs by Jörg Ansoerge); (c) drawing of new specimen from Große Kley, GZG.INV.92006. Scale bars = 2 mm.

Orthophlebia elongata Handlirsch, 1939
(Fig. 3)

Material examined. Holotype No 123/55 from Dobbertin (Mecklenburg, Germany), early Toarcian, housed in the Institute of Geography and Geology, Ernst-Moritz-Arndt University Greifswald, Germany; and five specimens from Große Kley in Wolfsburg, Lower Saxony (Germany), housed in Göttingen: No. GZG.INV.92006 – forewing, with veins well visible, distal part of the wing is missing; No. GZG.INV.92008 – distal part of the wing, wing venation well preserved; No.

GZG.INV.92009a, GZG.INV.92009b, GZG.INV.92010 – wing venation less preserved, but visible characters indicate that it belongs to this species.

Emended Diagnosis. Wing dark, with spots; Rs forks into six longitudinal single veins, forkings of Rs_{2+3} , Rs_{4+5} and Mb almost perfectly aligned.

Redescription. Holotype No 123/55 – forewing 12 mm long; Sc reaches the costa opposite fork of Rs_{1c} ; in costal area, one cross-vein c-sc lies opposite mid R_{1+2} ; R_1 reaches costa almost opposite mid Rs_{1a} ; Rs almost equal in length to Rs_{2+3} and Rs_{2a} and 1.3 times as long as R_{4+5} ; forks of Rs_{2+3} , Rs_{4+5} and

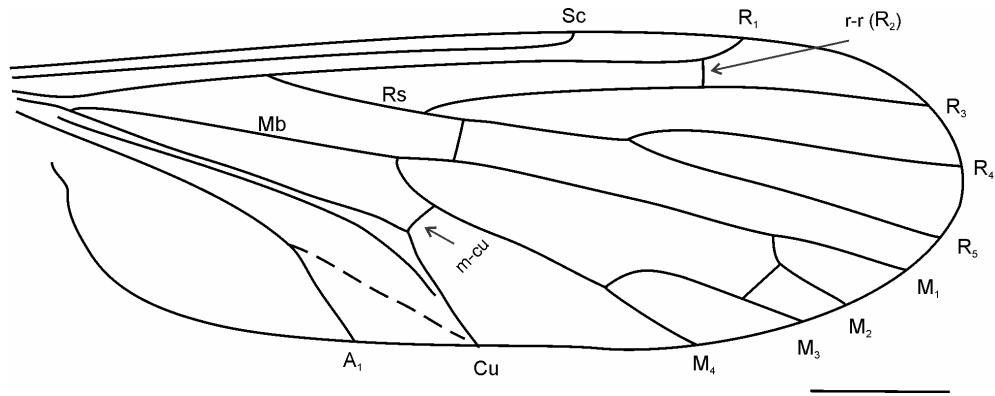


Figure 4 *Eoptychoptera simplex* (Geinitz, 1887), GZG.INV.92000, drawing of new specimen from Große Kley. Scale bar = 1 mm.

Mb lie almost on one line (Fig. 2); five medial veins present, Mb is free to the base of the wing, M_1 more than twice as long as M_{1+2} ; three anal veins present.

Remarks. The specimens from Wolfsburg (wing length 10.9–11.8 mm; width 3.4–3.5 mm) are concordant with the holotype of *Orthophlebia elongata* described by Dobbertin by Handlirsch (1939) and differ slightly in the ratio of some veins: R_1 reaches outer margin slightly before mid Rs_{1a} ; Rs is 1.25 times as long as Rs_{1a} ; vein M_1 only 1.75 times as long as M_{1+2} . In our opinion, these differences are within the range of wing venation variability in this species.

Order Diptera Linnaeus, 1758
 Family Ptychopteridae Osten Sacken, 1862
 Subfamily Eoptychopterinae Handlirsch, 1906
 Genus *Eoptychoptera* Handlirsch, 1906

Type species. *Eoptychoptera simplex* (Geinitz, 1887) – Dobbertin (Mecklenburg, Germany), Lower Toarcian.

Eoptychoptera simplex (Geinitz, 1887)
 (Fig. 4)

Material examined. No GZG.INV.92000 and GZG.INV.91999, Große Kley in Wolfsburg, Lower Saxony (Germany), housed in Göttingen.

Remarks. Two isolated wings (length 5.2–5.3 mm; width 1.6–1.7 mm) belong to this, the most common species of the family Ptychopteridae from the early Toarcian of Germany. The species was originally described by Geinitz (1887) as *Phryganidium (Polycentropus) simplex* in the order Trichoptera. Handlirsch (1906) transferred it to Diptera: Eoptychopteridae. All species described by Handlirsch (1906, 1939) and Bode (1953) were revised by Lukashovich *et al.* (1998) and transferred to *Eoptychoptera simplex*. Specimens are well preserved, with clearly visible and preserved veins (Fig. 4); dark wing spots hardly visible.

Family Limoniidae Speiser, 1909
 Subfamily Architipulinae Handlirsch, 1906
 Genus *Architipula* Handlirsch, 1906

Type species. *Architipula seebachi* (Geinitz, 1884) – Dobbertin (Mecklenburg, Germany), Early Jurassic (Toarcian).

Architipula bodei Handlirsch, 1939
 (Fig. 5)

Phryganidium arcuiferum Bode, 1905, p. 244, plate 6, fig. 21;
Architipula bodei n. sp. Handlirsch, 1939, p. 112.

Material examined. Holotype Inst. Geol. S, Gr A.42 Nr 45, housed in Berlin in the collections of the Bundesanstalt für Geowissenschaften und Rohstoffe (BGR), partially preserved, basal part is missing; No. GZG.INV.92001(+, –) from Große Kley in Wolfsburg, Lower Saxony (Germany), housed in Göttingen.

Emended diagnosis. Vein Sc reaching the outer margin opposite 2/3 length of vein R_{2+3+4} ; R_3 almost half longer than R_{2+3+4} ; R_4 slightly more than three times longer than R_{2+3+4} .

Redescription. The preserved wing fragment 7.1 mm long, width at mid-length 2.7 mm; new specimen 7.3 mm length, 3.0 mm width; Sc reaching the costa at two thirds of length of vein R_{2+3+4} ; sc-r ending at twice its length before end of Sc; R_1 ending opposite one third point of R_3 ; cross-vein r-r (R_2) at 1/5 R_{2+3} and R_3 combined; Rs long, only partly preserved in holotype; d-cell strongly cut-off in lower part; cross-vein m-m oblique; upper margin of d-cell twice as long as its base; M_1 almost 1.5 times as long as length of upper margin d-cell; cross-vein m-cu situated in fork of M_{3+4} . Well-developed pterostigma.

Remarks. The specimen from the Wolfsburg locality is almost identical to the holotype of *A. bodei* Handlirsch, 1939 figured by Bode (1905). Slight differences in venation are within intra-specific variability.

Architipula clara Handlirsch, 1939
 (Fig. 6)

Material examined. Holotype No 123/114 – Dobbertin (Mecklenburg, Germany), early Toarcian, housed in Institute of Geography and Geology, Ernst-Moritz-Arndt University Greifswald, Germany; No. GZG.INV.91997(+, –) Große Kley in Wolfsburg, Lower Saxony (Germany), housed in Göttingen.

Emended diagnosis. Vein Sc reaching outer margin opposite Rs forking; R_3 almost 2.5 times longer than R_{2+3+4} ; R_4 four times longer than R_{2+3+4} .

Redescription. Wing length 7–7.1 mm, width 2.1–2.2 mm; Sc ending opposite forking of Rs ; sc-r ending at twice its length before end of Sc; R_1 long, reaching the outer margin almost opposite around one-seventh of length of vein R_3 ; R_{2+3+4} very short; Rs 10 times as long as R_{2+3+4} and equal to veins R_{2+3} and R_3 combined; base of d-cell deeply notched, upper margin of d-cell twice as long as its base; d-cell twice as long as stem; M_1 1.25 times as long as d cell and almost twice as long as stem; cross-vein m-cu situated almost in fork of M_{3+4} , in mid d-cell base.

Remarks. Specimen No. GZG.INV.91997 from Große Kley is most similar to *A. clara*, described by Handlirsch (1939). Differences in proportions of veins are very small and considered to fall within intraspecific variability. Also similar to

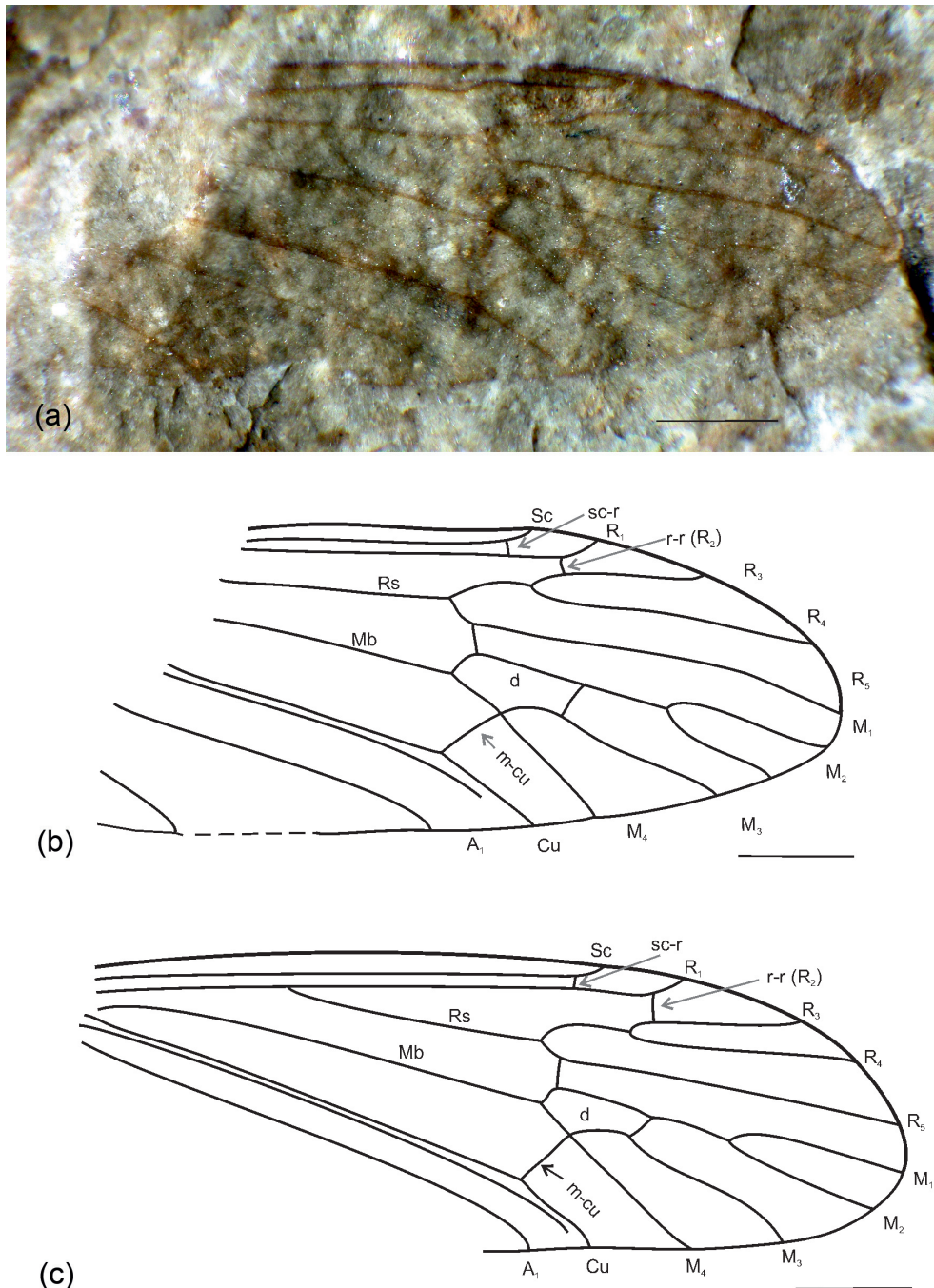


Figure 5 *Architipula bodei* Handlirsch, 1939: (a) photograph of holotype (by Jörg Ansoerge); (b) drawing of holotype; (c) drawing of GZG.INV.92001. Scale bars = 1 mm.

A. clara are *A. intermedia* and *A. obliqua*, described by Handlirsch (1939). All these specimens and species may belong to one taxon, but this requires further research, which is ongoing (Kopeć *et al.* 2017).

Family Anisopodidae Knab, 1912
Genus *Mesorhyphus* Handlirsch, 1920

Type species. *Mesorhyphus nanus* Handlirsch, 1920; Dobbertin (Mecklenburg, Germany), early Toarcian.

The genus *Mesorhyphus* is a Jurassic representative of the family Anisopodidae and comprises seven species described from Asia and Europe (Rohdendorf 1962; Kovalev 1990; Ansoerge & Krzemiński 1995; Ansoerge 1996; Lukashevich 2012).

Mesorhyphus ulrichi Kopeć & Gehler sp. nov.
(Fig. 7)

Diagnosis. Vein Sc and R_{2+3} extraordinary long, distinguishing the new species from all other known recent and fossil Anisopodidae; cross-vein m-cu situated just before the half of d-cell base. This is by far the biggest Toarcian species of *Mesorhyphus*, twice as large than *Mesorhyphus nanus* Handlirsch, 1920 and more than three times larger than *M. nanus* Ansoerge, 1996.

Etymology. Named to honour the collector Ulrich Conrady, who donated the specimen.

Material examined. Holotype No GZG.INV.92002(+, -) from Große Kley in Wolfsburg, Lower Saxony (Germany).

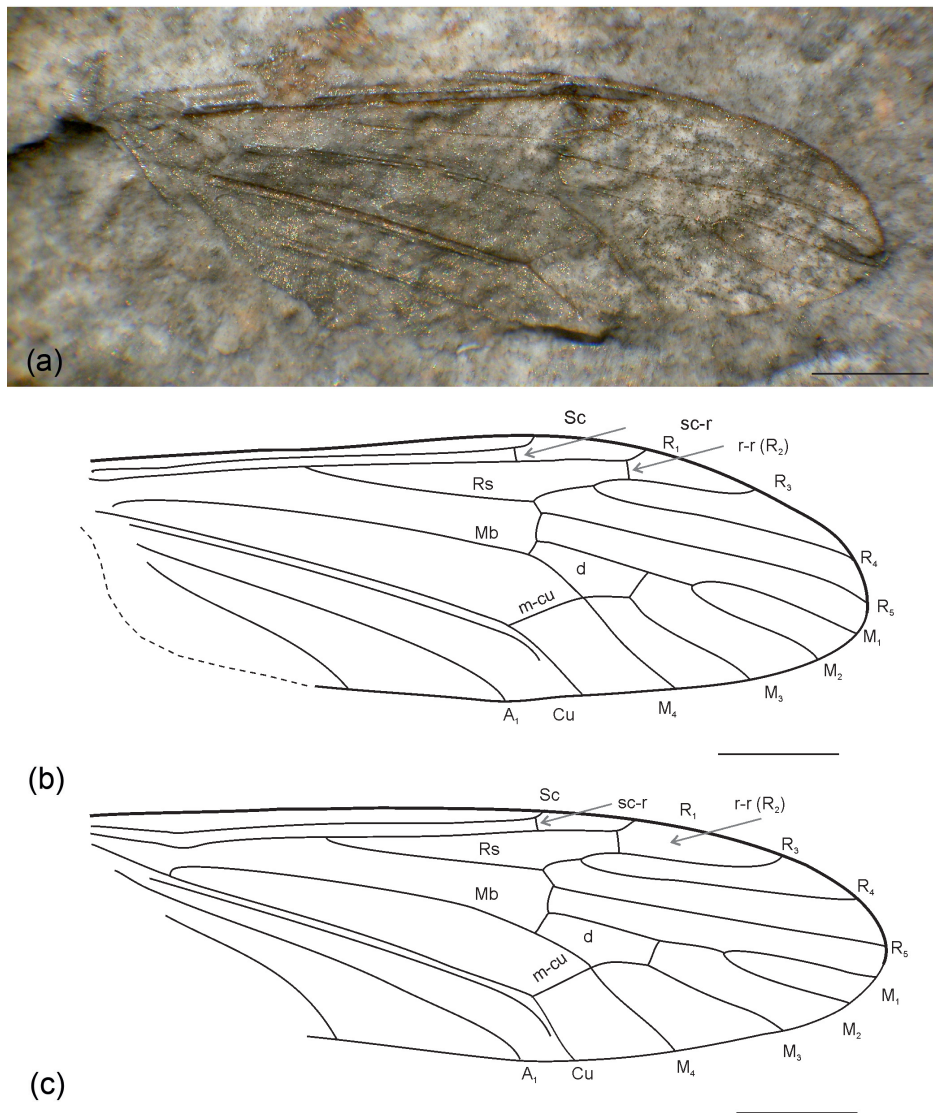


Figure 6 *Architipula clara* Handlirsch, 1939, No 123/114: (a) photograph of holotype (by Jörg Ansorge); (b) drawing of holotype; (c) drawing of GZG.INV.91997. Scale bar = 1 mm.

Only one fore wing preserved with veins very well visible, basal part of wing is missing.

Description. Wing length 6.6 mm, width 3.5 mm; vein Sc very long, reaching costa opposite end of d-cell; R_1 ends opposite one third of vein M_1 ; R_{2+3} very long, 0.75 times length of R_{4+5} ; cell m2 long and narrow; cross-vein r-m situated at one-third of distance along upper edge of d-cell; M_1 about 1.3 times as long as M_{1+2} ; d-cell about one quarter of length of wing; cross-vein m-cu just before mid d-cell base; Cu strongly wavy in distal part.

Superfamily Mycetophiloidea

Stemgroup of Pleciofungivoridae and Pleciomimidae *sensu* Ansorge, 1996.

Remarks: These have a reduced (faint and desclerotised) M stem (Mb) and a set of plesiomorphic characters of the superfamily. In contrast to their closest relatives Pleciofungivoridae and Pleciomimidae, they retain from a protopleciid-like ancestor with well-developed Mb, a rather long Rs and a long sigmoidally waved R_{2+3+4} . A considerably short Sc is an apomorphic character in comparison with Protopleciidae.

Genus *Archipleciomima* Rohdendorf, 1962

Type species. *Archipleciomima obtusipennis*, Rohdendorf, 1962, pp 321, 1017, erroneously labeled in captions fig. 1019 – Issyk-kul (Kyrgyzstan), Early Jurassic (Sinemurian).

The genus contains to date six species described from Jurassic localities of Asia (Kalugina & Kovalev 1985; Blagoderov 1996). Ansorge (1996) reported one new representative of the genus *Archipleciomima* from the early Toarcian locality of Grimmen, Germany.

Archipleciomima germanica Krzemiński & Ansorge, sp. nov.
(Figs 8, 9)

Diagnosis. New species differs from the other species in the following combination of characters: Sc short, reaching the costa beyond the half of Rs; Rs only slightly shorter than $R_{2+3+4+5}$; R_5 is almost 2.3 times longer than R_{2+3+4} ; cross-vein r-m in half of M_{1+2} .

Etymology. The species is named after Germany, the country of its locality.

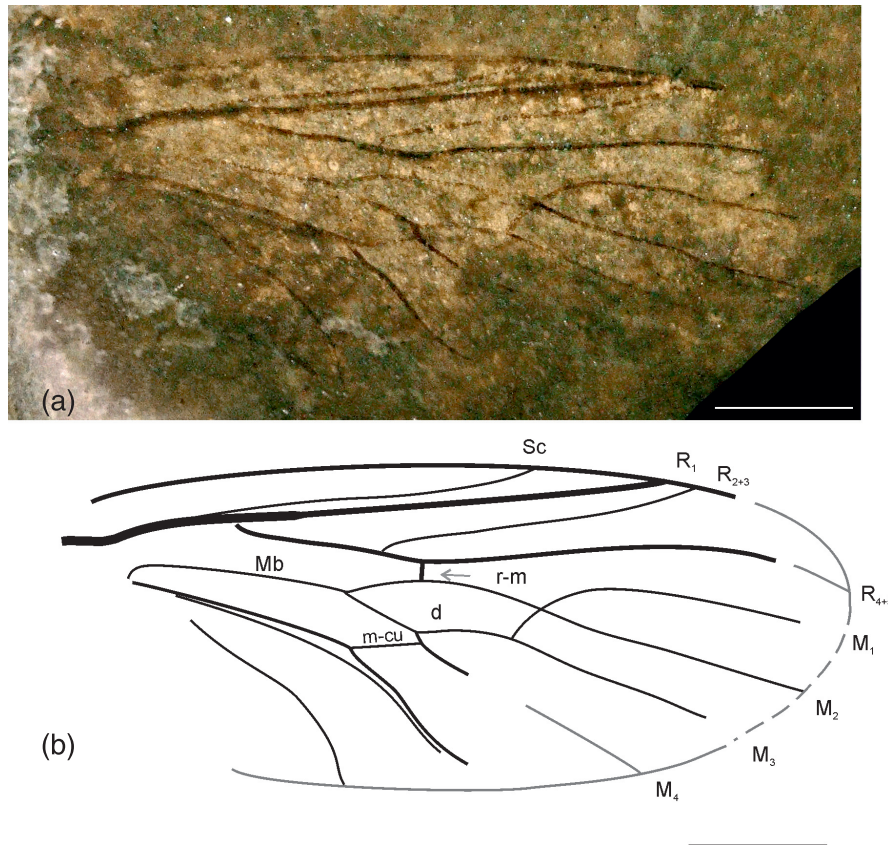


Figure 7 *Mesorhyphus ulrichi* Kopeč & Gehler sp. nov., holotype GZG.INV.92002: (a) photograph (by Alexander Gehler); (b) drawing. Scale bars = 1 mm

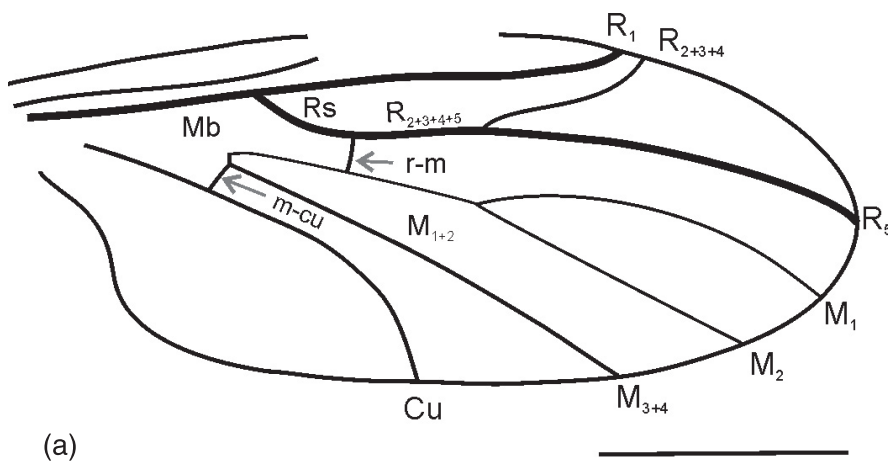


Figure 8 *Archipleciomima germanica* Krzemiński & Ansoerge sp. nov., holotype LGA 1550: (a) drawing; (b) photograph (by Jörg Ansoerge). Scale bar = 1 mm.

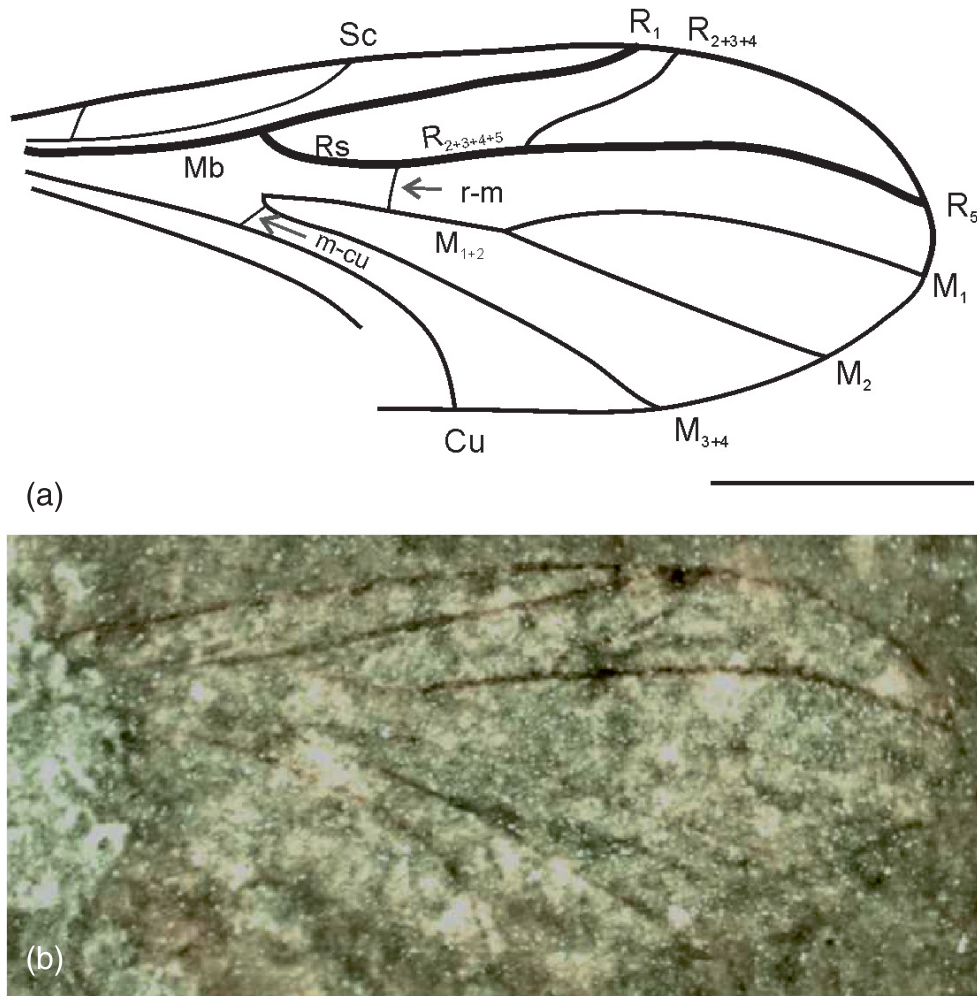


Figure 9 *Archipleciomima germanica* Krzemiński & Ansoerge sp. nov., paratype GZG.INV.91998: (a) drawing; (b) photograph (by Alexander Gehler). Scale bar = 1 mm.

Material examined. Holotype No. LGA 1550 – Toarcian, Lower Jurassic, from J. Ansoerge collection, Grimmen, Germany, housed in the Museum für Naturkunde, Berlin. Paratypes: LGA 1803, LGA 2282 from J. Ansoerge collection, Grimmen, housed in the Museum für Naturkunde, Berlin; and GZG.INV.91998(+, –) from Große Kley in Wolfsburg, Lower Saxony (Germany); wing well preserved, with veins clearly visible.

Description. Wing length 3.4–3.5 mm, width 1.2–1.3 mm, with well-preserved veins; only anal part of wing is obscure. Vein Sc short, reaching costa beyond half of Rs; R_1 almost straight on its entire length; Rs only slightly shorter than $R_{2+3+4+5}$; R_5 almost three times longer than Rs and 2.25 longer than R_{2+3+4} ; cross-vein r-m situated almost before mid M_{1+2} ; M_1 2.75 times longer than M_{1+2} ; cross-vein m-cu situated just behind fork of Mb into M_{1+2} and M_{3+4} ; CuA very strongly curved in two thirds of its length. Faint pterostigma at R_1 termination, bordered by the wing margin and R_{2+3+4} .

Remarks. The new species *A. germanica* sp. nov. is considerably larger than a specimen of *Archipleciomima* sp. described by Ansoerge (1996) from Grimmen, and differs from other representatives of this genus in the details of the proportions of the wing venation. The taxonomical status of the genus *Archipleciomima* at the family level is debatable. Kovalev (1985, in Kalugina & Kovalev 1985) transferred this genus from the family Pleciofungivoridae into the family Protopleciidae. However, Ansoerge (1996) queried whether this decision was correct.

He (Ansoerge 1996) suggested that faint vein Mb in the genus *Archipleciomima* excluded this genus from the family Protopleciidae.

3. Summary

The fauna of the locality of Große Kley is generally quite similar to the fauna of the early Toarcian known from other localities in Germany, especially from the vicinity of Braunschweig, Dobbertin and Grimmen. The description of two new species, *Mesorhynchus ulrichi* sp. nov. (Anisopodidae) and *Archipleciomima germanica* sp. nov. (Mycetophiloidea), enriches our knowledge of this fauna.

4. Acknowledgements

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