

New representative of the family Panorpodidae (Insecta, Mecoptera) from Eocene Baltic Amber with a key to fossil species of genus *Panorpodes*

Agnieszka Soszyńska-Maj and Wiesław Krzemiński

ABSTRACT

Panorpodidae (short-faced scorpionflies) is a species-poor family of scorpionflies (Mecoptera). Fossils are extremely rare but indicate that this group was diverse in the past. Up to now, three species of the genus *Panorpodes* have been described from Eocene Baltic amber, as well as a possible panorpodid from the Lower Eocene of Patagonia. *Panorpodes gedanensis* sp. n. is the fourth species to be recognised in amber material. Wing markings are the most important character in the taxonomy of fossil short-faced scorpionflies. The new species described here shows a new pattern of markings – five dark spots and a terminal band. The Eocene representatives of the genus *Panorpodes* display different patterns of wing markings: highly transparent wings in *P. brevicauda* (Hagen, 1856), transparent wings with dark bands and spots in *P. weitschati* Soszyńska-Maj and Krzemiński, 2013, narrow transparent bands on a dark background in *P. hageni* Carpenter, 1954 and regular spots in *P. gedanensis* sp. n. This past diversity and distribution emphasises the relictual status of extant Panorpodidae. A key to fossil species of the genus *Panorpodes* based on characters of the forewing is provided.

Agnieszka Soszyńska-Maj. University of Łódź, Department of Invertebrate Zoology and Hydrobiology, Łódź, Poland, agasosz@biol.uni.lodz.pl

Wiesław Krzemiński. Institute of Systematic and Evolution of Animals, Polish Academy of Sciences, Kraków, Poland, krzeminski@muzeum.pan.krakow.pl

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INTRODUCTION

The order Mecoptera has a fossil record extending back to the early Permian. Up until the early Cretaceous scorpionflies were very diverse and subsequently underwent a decline (Novokshonov, 2002; Grimaldi and Engel, 2004).

The short-faced scorpionflies (Panorpodidae) is a species-poor family, with 13 extant species (Zhong et al., 2011) of relict distribution. Panorpodidae and Panorpidae are only two families which survived since the Eocene apex of Panorpoidea (sensu Willmann, 1989) diversity until present

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(Archibald et al., 2013). The fossil panorpids are represented by two putative genera. *Austropanorposes gennaken* Petrulevičius, 2009, from the Lower Eocene of Patagonia, is the sole representative of this genus (Petrulevičius, 2009). However, its affinity to Panorpodidae is not strongly supported, but if confirmed, it would be the only known member of the family from the Southern Hemisphere. The other genus known from fossils is *Panorposes*, and in addition to the new species described here, three species have been recorded from Eocene Baltic amber: *P. brevicauda* (Hagen, 1856), *P. hageni* Carpenter, 1954 and *P. weitschati* Soszyńska-Maj and Krzemiński, 2013.

Amber inclusions of Mecoptera which are sufficiently well-preserved to be studied are very rare, and all fossil data are important for understanding the history of this family. Consequently, the discovery of a new fossil species of Panorpodidae is of great interest. To date, only 12 species from three families of Mecoptera have been recorded from Baltic amber: Bittacidae (five species), Panorpidae (three species) and Panorpodidae (four species, including the one described here) (Pictet-Baraban and Hagen, 1856; Carpenter 1954, 1955, 1976; Krzemiński, 2007, Krzemiński and Soszyńska-Maj, 2012; Soszyńska-Maj and Krzemiński, 2013).

A description of new species of Eocene Panorpodidae from Baltic amber and a key to fossil species of the genus *Panorposes* based on the wings are presented here.

MATERIALS AND METHODS

The study was based on a single inclusion in Baltic amber, dated late Eocene, Priabonian (Perkovsky et al., 2007) from the collection of Christel and Hans Werner Hoffeins, Hamburg, Germany. The holotype will be deposited in Senckenberg Deutsches Entomologisches Institut (SDEI), Müncheberg, Germany.

The specimen was studied with the use of a Leica MZFLII stereomicroscope, under reflected and transmitted light. Photographs were made with a Leica DFC295 camera attached to the microscope. Drawings were made from the photographs on a digital tablet as proposed by Coleman (2003). The wing venation terminology follows Willmann (1989).

RESULTS

Systematic Palaeontology

Order MECOPTERA Packard, 1886
Family PANORPODIDAE Byers, 1965
Genus PANORPOSES MacLachlan, 1875

Type species. *Panorposes paradoxa* MacLachlan, 1875, by original designation.

Panorposes gedanensis sp. n.

Figure 1, 2

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Holotype. Sex unknown, No. 1193-2, amber embedded in polyester resin (Hoffeins, 2001). Inclusion with well-preserved head, thorax and complete wings, the ventral side not visible due to white milky coating; wings folded, therefore only forewing venation is clearly visible. The inclusion will be deposited as a part of the amber collection of the Senckenberg Deutsches Entomologisches Institut (SDEI), Müncheberg, Germany.

Etymology. The specific name refers to Gdańsk, Polish city famous for its amber tradition.

Diagnosis. Differs from all other fossil members of the genus in that the wings are transparent with five dark, oval spots and dark coloured apical parts, compared to narrow, unregular broken bands of *P. weitschati*, dark wings with narrow transparent bands of *P. hageni* and completely transparent wings of *P. brevicauda* from Baltic amber.

Description. Eyes large and round, rostrum short, only partly visible; antennae filiform, scapus and pedicel not visible, flagellum composed of 43 segments, mostly equal in length, gradually become narrower, last flagellomere thinner, half the length of previous one. Wings narrow; fore wing: 14.2 mm long, 4.1 mm wide; membrane transparent, with five clearly visible dark spots; one large spot in basal part of wing, four regularly distributed spots in central part, apical margin of wing with broad band extending from R_2 to M_3 ; Sc_1 joining costa at the level of Rs fork, Sc_2 reaches pterostigma at fork of R_{2+3} ; one crossvein c-sc in coastal area across fork of Rb ; R_1 characteristically sharply curved just above fork of R_{2+3} , one oblique cross vein between Sc and R_1 just across Rs fork; R_{2+3} about 0.2 longer than Rs and three times longer than R_2 , Rs twice as long as R_2 and twice length of R_{4+5} ; R_3 simple; R_4 almost six times longer than R_{4+5} ; M_1 slightly longer than M_{1+2} (about 0.125 longer); M_4 seven times longer than M_{3+4} ; m-cu joins M_4 with vein CuA ; A_1 joining posterior margin

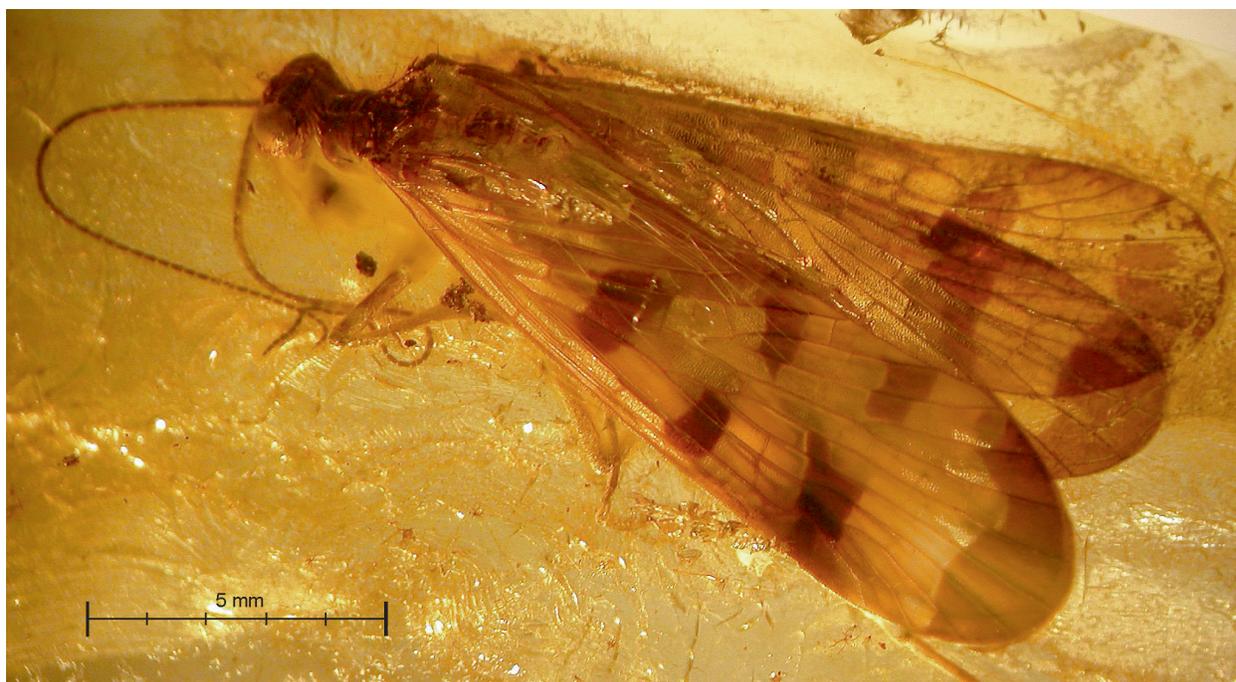


FIGURE 1. Photograph of *Panorpodes gedanensis* sp. n. – holotype no. 1193-2 (photo H.W. Hoffeins).

of wing across the Rs fork; A_2 reaching posterior edge in the middle of Rs; one crossvein between A_1 and A_2 ;

Remarks. The specimen was recognised as Panorpididae from the following characters: rostrum short, wide, twice height of eye, wings with Sc two branched, one cross vein between *humerus* and basal branch of Sc, vein R1 characteristically sharply curved, Rs 5-6 branched, Ms four branched, anal veins simple.

See Table 1 and Figure 3 for key to fossil species.

DISCUSSION

There are 757 species of scorpionflies in the extant fauna (Zhang, 2011), the majority belonging to two of the nine recognised families. More than 400 fossil species of Mecoptera have been described in 16-27 families, depending on the author (Willmann, 1978; Carpenter, 1992, Novokshonov, 2002) and including recently described families (Bashkuev, 2011, Archibald et al., 2013, Krzemiński et al., 2015). The huge morphological diversity combined with the modest number of extant taxa supports the view that extant Mecoptera are only the remnants of a once very diverse group (Penny, 1975). Family Panorpidae is cur-

Table 1. Key to fossil species of *Panorpodes* based on fore wing characters.

1	wing transparent	(Figure 3.1)	<i>P. brevicauda</i> (Hagen, 1856)
	wing coloured		2
2	dark wing with narrow transparent bands	(Figure 3.2)	<i>P. hageni</i> Carpenter, 1954
	transparent membrane with dark spots and bands		3
3	five dark regular spots and dark coloured apical part of the wing	(Figure 3.3)	<i>P. gedanensis</i> sp. n.
	four irregular spots and two narrow, irregular broken bands in distal part of the wing	(Figure 3.4)	<i>P. weitschati</i> Soszyńska-Maj and Krzemiński, 2013

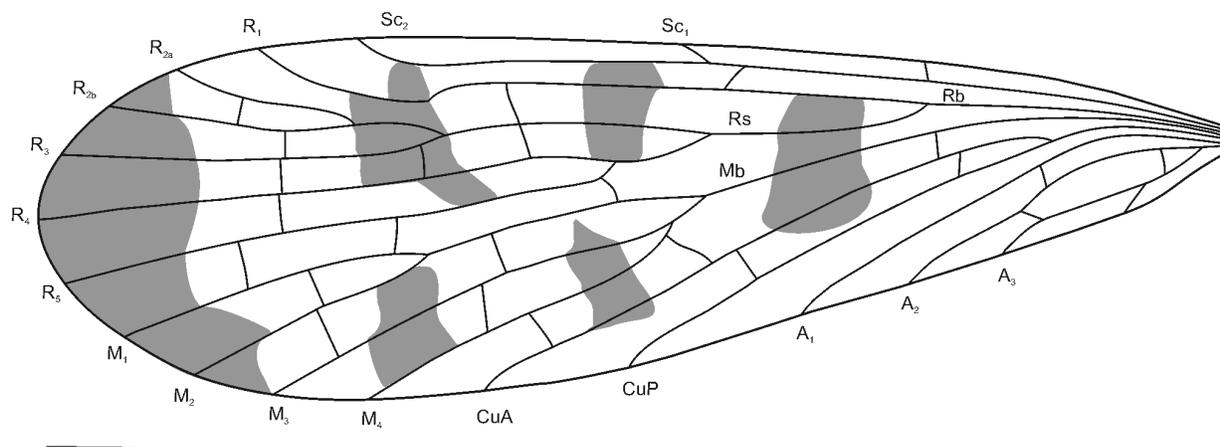


FIGURE 2. Drawing of *Panorpodes gedanensis* sp. n. fore wing of holotype no. 1193-2.

rently the most diverse and abundant, containing about 400 species belonging to six genera (Chau and Byers, 1978; Cai et al., 2008; Cai and Hua, 2009; Ma and Hua, 2011; Zhong and Hua, 2013). This family has a disjunctive holarctic distribution with some representatives in the oriental region (Archibald et al., 2013) and to date there is no fossil evidence for a wider past distribution (Ding et al., 2014). The second most abundant family of scorpionflies is Bittacidae, with ca. 170 species in 16-20 genera distributed worldwide (Penny, 1997; Petrulevičius, 2003; Tan and Hua, 2009; Yang et al., 2012).

In comparison, the short-faced scorpionflies (Panorpididae) is a small family containing 13 extant species within the genera *Brachypanorpa* Carpenter, 1931 and *Panorpodes* MacLachlan, 1875 (Byers, 2005; Zhong et al., 2011). All five representatives of the genus *Brachypanorpa* and one *Panorpodes* species live only in North America (Byers, 2005), whilst the remaining *Panorpodes* species occur in Japan, Korea and China (Tan and Hua, 2008; Zhong et al., 2011). However, in the Eocene Panorpididae were probably more diverse; the four described species from Baltic amber being numerically equivalent to 50% of extant species in this genus. In comparison, the two species of the genus *Panorpa* and five bittacids of the genus *Bittacus* described from Baltic amber equate to merely 0.8% of extant species of *Panorpa* and 4% of the genus *Bittacus*, respectively. Nevertheless, representatives of Panorpididae and Panorpidae are less abundant than Bittacidae in amber (Krzemiński and Soszyńska-Maj, unpubl. data). Wing markings are the most important character in the taxonomy of fossil short-faced scorpionflies. The newly described taxon

shows a new pattern of markings – five regular dark spots and a terminal band. The fossil representatives of the genus *Panorpodes*, all Eocene, display different patterns of wing markings: highly transparent wings in *P. brevicauda*, transparent wings with dark bands and spots in *P. weitschati*, regular spots in *P. gedanensis* sp. n. and narrow transparent bands on a dark background in *P. hageni*. However, only one species, *P. brevicauda* with transparent wings, is common in Baltic amber, whereas the remainder are known only from single specimens (Soszyńska-Maj and Krzemiński, 2013). Fully transparent wings predominate in extant Panorpididae, being characteristic of five species. Only three living species have coloured wings (Zhong et al., 2011).

The distribution of extant panorpidids is limited to a small area of the Northern Hemisphere. The fossil evidence indicates that Panorpididae were present in Europe during the late Eocene and possibly also in South America. They subsequently became extinct in these regions and declined in overall diversity. The past distribution and diversity emphasises the relictual status of extant Panorpididae.

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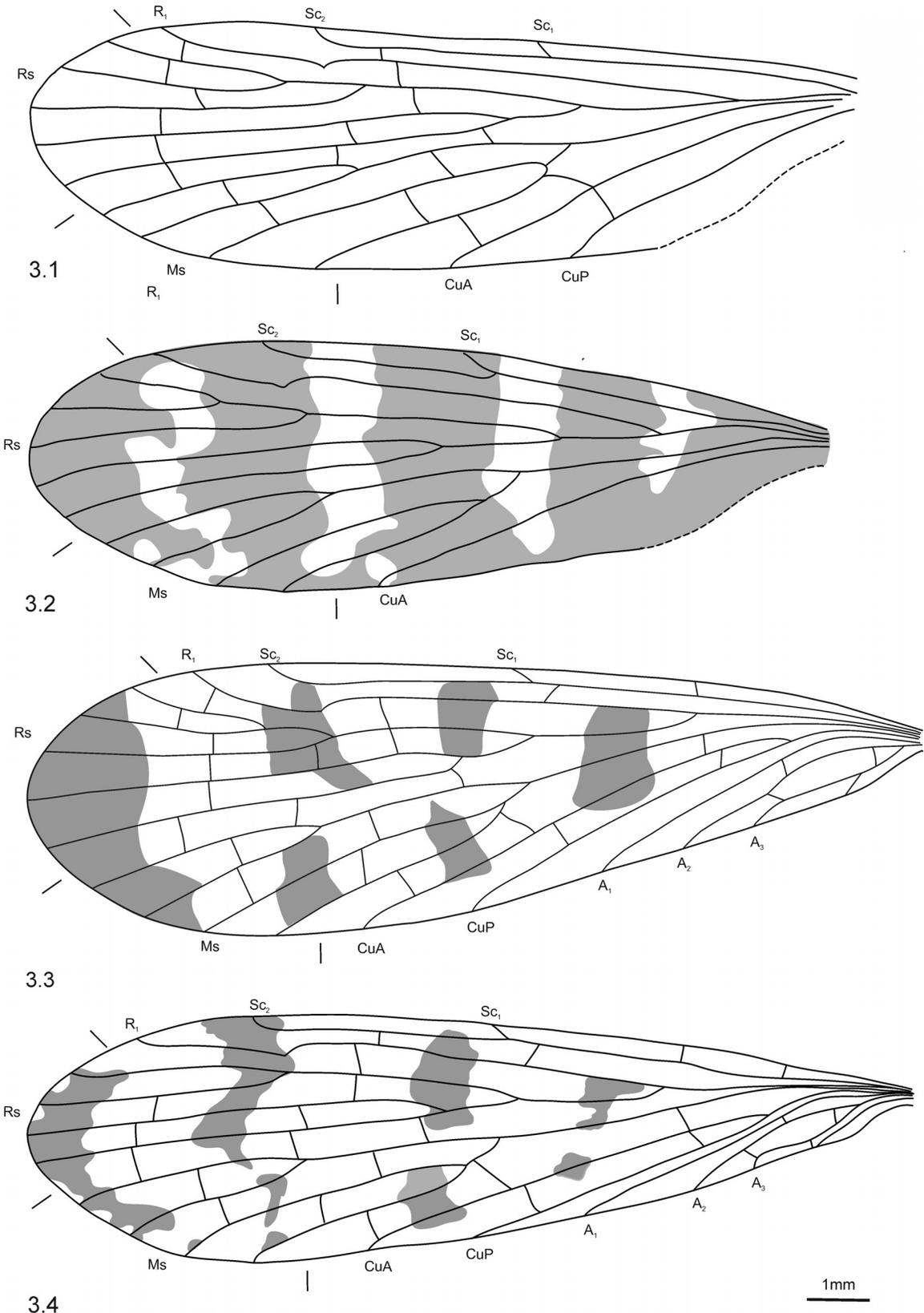


FIGURE 3.1-4. Forewings of fossil representatives of genus *Panorpodes*: 3.1) *Panorpodes brevicauda*, 3.2) *P. hageni*, 3.3) *P. gedanensis*, 3.4) *P. weitschati*, modified after Soszyńska-Maj and Krzemiński (2013).

REFERENCES

- Archibald, S.B., Mathewes, R.W., and Greenwood, D.R. 2013. The Eocene apex of panorpoid scorpionfly family diversity. *Journal of Paleontology*, 87:677-695.
- Bashkuev, A. 2011. Nedubroviidae, a new family of Mecoptera: the first Paleozoic long-proboscid scorpionflies. *Zootaxa*, 2895:47-57
- Byers, G.W. 1965. *Families and genera of Mecoptera*. Proceedings of the XIIth International Congress of Entomology, London, 1964, p.123.
- Byers, G.W. 2005. *Panorpodes* discovered in North America (Mecoptera: Panorpididae). *Journal of the Kansas Entomological Society*, 78:71-74.
- Cai, L.J. and Hua, B.Z. 2009. A new *Neopanorpa* (Mecoptera, Panorpididae) from China with notes on its biology. *Deutsche Entomologische Zeitschrift*, 56:93-99.
- Cai, L.J., Huang, P.Y., and Hua, B.Z. 2008. *Sinopanorpa*, a new genus of Panorpididae (Mecoptera) from the oriental China with descriptions of two new species. *Zootaxa*, 1941: 43-54.
- Carpenter, F.M. 1931. Revision of the Nearctic Mecoptera. *Bulletin of the Museum of Comparative Zoology*, 72:205-277.
- Carpenter, F.M. 1954. The Baltic amber Mecoptera. *Psyche*, 61:31-40.
- Carpenter, F.M. 1955. An Eocene *Bittacus* (Mecoptera). *Psyche*, 62:39-41.
- Carpenter, F.M. 1976. Note on *Bittacus validus* in Baltic amber. *Psyche*, 82:303.
- Carpenter, F.M. 1992. *Treatise on Invertebrate Paleontology. Part R. Arthropoda 4. Vols. 3 and 4: Superclass Hexapoda*. The Geological Society of America and The University of Kansas, Boulder, Colorado and Lawrence, Kansas.
- Chau, H.C. and Byers, G.W. 1978. The Mecoptera of Indonesia: genus *Neopanorpa*. *University of Kansas Science Bulletin*, 51:341-405.
- Coleman, C.O. 2003. "Digital inking": How to make perfect line drawings on computers. *Organisms Diversity & Evolution*, Electronic Supplement, 14:1-14.
- Ding, H., Shih, C., Bashkuev, A., Zhao, Y., and Ren, D. 2014. The earliest fossil record of Panorpididae (Mecoptera) from the Middle Jurassic of China. *ZooKeys*, 431:79-92.
- Grimaldi, D. and Engel, M.S. 2005. *Evolution of the Insects*. Cambridge University Press, New York.
- Hagen, H. 1856. Die im Bernstein befindlichen Neuropteren der Vorwelt bearbeitet von F.J. Pictet-Baraban und Dr. H. Hagen, p. 41-125. In Berendt, G.C. (ed.), *Die im Bernstein Befindlichen Organischen Reste der Vorwelt Gesammelt in Verbindung mit Mehreren Bearbeitet und Herausgegeben*, Bd. 2. Berlin.
- Hoffeins, H.W. 2001. On the preparation and conservation of amber inclusions in artificial resin. *Polish Journal of Entomology*, 70:215-219.
- Krzemiński, W. 2007. A revision of Eocene Bittacidae (Mecoptera) from Baltic amber with the description of a new species. *African Invertebrates*, 48:153-162.
- Krzemiński, W. and Soszyńska-Maj, A. 2012. A new genus and species of scorpionfly (Mecoptera) from Baltic amber, with an unusually developed postnotal organ. *Systematic Entomology*, 37:223-228.
- Krzemiński, W., Soszyńska-Maj, A., Bashkuev, A., and Kopeć, K. 2015. Revision of the unique Early Cretaceous Mecoptera from Koonwarra (Australia) with description of a new genus and family. *Cretaceous Research*, 52:501-506.
- Ma, N. and Hua, B.Z. 2011. *Furcatopanorpa*, a new genus of Panorpididae (Mecoptera) from China. *Journal of Natural History*, 45:2251-2261.
- MacLachlan, R. 1875. Neuroptera s. str, Planipennia, p. 1-24. In Fedtschenko, A.P. (ed.), *Reise in Turkestan von Alexis Fedtschenko, auf veranlassung des General-Gouverneurs von Turkestan, General von Kaufmann*, Vol.2. pt.5. Der Gesellschaft der Freunde der Naturwissenschaften in Moskau, Moskau.
- Novokshonov, V.G. 2002. Order Panorpidia Latreille, 1802, p. 194-199. In Rasnitsyn, A.P. and Quicke, D.L.J. (eds.), *History of Insects*. Kluwer Academic, Boston/London.
- Packard, Jr. A. S. 1886. A new arrangement of the orders of insects. *The American Naturalist*, 20, 1-808.
- Penny, N.D. 1975. Evolution of the extant Mecoptera. *Journal of the Kansas Entomological Society*, 48:331-350.
- Penny, N.D. 1997. World Checklist of Extant Mecoptera Species. downloaded 20.01.2014. www.calacademy.org/research/entomology/Entomology_Resources/mecoptera/index.htm
- Perkovsky, E.E., Rasnitsyn, A.P., Vlaskin, A.P., and Taraschuk, M.V. 2007. A comparative analysis of the Baltic and Rovno amber arthropod faunas: representative samples. *African Invertebrates*, 48:229-245
- Petrulevičius, J.F. 2003. Phylogenetic and biogeographical remarks on *Thyridates* (Mecoptera: Bittacidae), with the first fossil record of the taxon. *Acta Zoologica Cracoviensia*, 46 (suppl.–Fossil insects):257-265.
- Petrulevičius, J.F. 2009. A panorpoid (Insecta: Mecoptera) from the Lower Eocene of Patagonia, Argentina. *Journal of Paleontology*, 83:994-997.
- Pictet-Baraban, F.J. and Hagen, H. 1856. Die im Bernstein befindlichen Neuropteren der Vorwelt, p. 41-126. In Berendt, G.C. (ed.), *Die im Bernstein befindlichen organischen Reste der Vorwelt*, vol. 2. Nicolaischen Buchhandlung, Berlin.
- Soszyńska-Maj, A. and Krzemiński, W. 2013. Family Panorpididae (Insecta, Mecoptera) from Baltic amber (upper Eocene): new species, redescription and palaeogeographic remarks of relict scorpionflies. *Zootaxa*, 3636:489-499.
- Tan, J.L. and Hua, B.Z. 2008. The second species of the Chinese Panorpididae (Mecoptera), *Panorpodes brachypodus* sp. nov. *Zootaxa*, 1751:59-64.
- Tan, J.L. and Hua, B.Z. 2009. *Bicaubittacus*, a new genus of the Oriental Bittacidae (Mecoptera) with

- descriptions of two new species. *Zootaxa*, 2221:27-40.
- Willmann, R. 1978. Mecoptera (Insecta, Holometabola). *Fossilium Catalogus, Animalia*, 124:1-139.
- Willmann, R. 1989. Evolution und phylogenetisches System der Mecoptera. *Abhandlungen der Senckenbergischen Naturforschenden Gesellschaft*, 544:1-153.
- Yang, X., Ren, D., and Shih, S. 2012. New fossil hangingflies (Mecoptera, Raptipeda, Bittacidae) from the Middle Jurassic to Early Cretaceous of Northeastern China. *Geodiversitas*, 34:785-799.
- Zhang, Z.Q. 2011. Phylum Arthropoda von Siebold, 1848, p. 99-103. In Zhang, Z.-Q. (ed.), *Animal biodiversity: An outline of higher-level classification and survey of taxonomic richness*. *Zootaxa*, 31481:99-103.
- Zhong, W. and Hua, B.Z. 2013. *Dicerapanorpa*, a new genus of East Asian Panorpidae (Insecta: Mecoptera: Panorpidae) with descriptions of two new species. *Journal of Natural History*, 47:1019-1046.
- Zhong, W., Zhang, J.X., and Hua, B.Z. 2011. *Panorpedes kuandianensis*, a new species of short-faced scorpionflies (Mecoptera, Panorpididae) from Liaoning, China. *Zootaxa*, 2921:47-55.