The oldest representative of the family Austropanorpidae (Mecoptera) from the Lower Jurassic of Siberia

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ABSTRACT: The family Austropanorpidae (Mecoptera) was described by Willmann in 1977 from the Eocene of Australia, based on one genus and species, *Austropanorpa australis* Riek, 1952. During a restudy of the collection of the Paleontological Institute, Russian Academy of Sciences in Moscow, a second and much older representative of this family was found. This specimen, described as *Orthophlebia martynovae* Sukatsheva, 1985 from Siberia (Russia), was considered until now to be a member of family Orthophlebiidae. We transfer this species to the Austropanorpidae, extending the age of this family back to the Early Jurassic. An updated diagnoses of the family Austropanorpidae and genus *Austropanorpa* are presented here.

KEY WORDS: Australia, *Austropanorpa australis, Austropanorpa martynovae*, distribution, Orthophlebiidae, revision, Russia.

Riek (1952) described a new genus with one species, *Austropanorpa australis* Riek, 1952, based on two incomplete forewings from the Tertiary of Queensland, Australia. This taxon was considered to be a new member of the family Panorpidae. Additional remarks on this taxon, based on a hind wing (part and counterpart) from the same locality and horizon, were provided by Riek (1967).

Willmann (1977) extensively discussed the morphological characters of *A. australis* and concluded that this taxon should be excluded from the family Panorpidae. He established (Willmann 1977) a new family, Austropanorpidae, which he considered to be a sister taxon to Panorpidae + Panorpodidae, based on the character of four medial veins in the forewing. Willmann (1987, 1989) additionally discussed the position of the family Austropanorpidae within the phylogenetic system of Mecoptera. Subsequently, Novokshonov (2002) recognised Austropanorpidae as a tentative synonym of the family Orthophlebiidae. However, Archibald *et al.* (2013) followed Willmann's (1977) conception and accepted Austropanorpidae as a separate family. According to Willmann (1987), Austropanorpidae, along with the families Orthophlebiidae, Muchoriidae, Panorpidae, Panorpodidae, Holcorpidae and Dinopanorpidae, formed the superfamily Panorpoidea. Archibald *et al.* (2013) added a new family to this group, Eorpidae.

During the taxonomic and phylogenetic investigation of the family Orthophlebiidae by the present authors, the species *Orthophlebia martynovae* Sukatsheva, 1985 was revised. It was found that the holotype of this species described from the Lower Jurassic of Siberia resembles *A. australis*. As a result, we have transferred *O. martynovae* to the family Austropanorpidae as *Austopanorpa martynovae* (Sukatsheva) comb. nov. An updated description of the family Austropanorpidae is provided.

1. Material and methods

The study was based on the restudied holotype of *Orthophlebia martynovae* Sukatsheva, 1985, N. 1588/67, housed in the Paleontological Institute, Russian Academy of Sciences in Moscow (PIN). The fossil was found at Iya, also known as Vladimirovka, one of numerous insect sites within the Cheremkhovo (= Cheremkovskaya) Formation of the Irkutsk Basin in Siberia (Russia). This locality is described in detail in Rasnitsyn & Quicke (2002, pp 440, 443), Rasnitsyn (1985, p. 7) and in sketch maps in Kolosnitsyna (1964, 1982). According to Akulov *et al.* (2015), it is dated as Early Jurassic, Toarcian, 174.1–182.7 MA (Cohen *et al.* 2013). The redescription of *Austopanorpa australis* Riek, 1952 is based on the original drawing and descriptions of the species by Riek (1952, 1967) and Willmann (1977) and on new photographs made by Geoff and Russell Thompson from the Queensland Museum. Both the holotype (UQF10634/10635) and paratype (UQF10636/10637) of *Austropanorpa australis* are in the collection of the Queensland Museum in Australia. All known specimens (two forewings and one hind wing) are housed in the Geology Department, University of Queensland, and were collected from the Tertiary Redbank Plains Series of Redbank Plains, near Goodna, Queensland, Australia.

The specimen of *O. martynovae* was studied with the use of a stereomicroscope, under reflected light. Drawings were based on the photographs and digitally processed in Corel X5. The terminology of wing venation follows Willmann (1989), with some modifications (Soszyńska-Maj *et al.* 2017 (this volume)).

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2. Systematic palaeontology

Order Mecoptera Packard, 1886
Superfamily Panorpoidea Latreille, 1805
Family Austropanorpidae Willmann, 1977

Type genus. *Austropanorpa* Riek, 1952, p. 11, fig. 2 – Tertiary, Redbank Plains Series, Redbank Plains, Queensland, Australia.

Composition. One genus, *Austropanorpa* Riek, 1952, with two species included.

Emended diagnosis. Distinguished from all other families by a combination of the following characters: Rs_1 pectinate in both wings, radial sector (Rs) with nine veins reaching the outer margin, Rs_2, Rs_3 and Rs_4 single, four medial veins in fore- and hind wings.

Redescription. Wings length 18–25 mm, with colour markings; vein Sc long in forewing, reaching pterostigmal area, shorter in hind wing, reaching outer margin opposite the end of M_4; Rs_{1+2} 2–2.5 times longer than Rs in forewing and about 1.5 times longer in hind wing; Rs_1 pectinate, forks on six single veins reaching outer margin in both wings; Rs_2 single; Rs_{3+4} significantly shorter than Rs_{1+2}, forks to two single veins reaching wing margin; four medial veins only in both wings; M_{1+2} a few times longer than M_{3+4}.

Remarks. Description based on four known specimens (wings): of which three (two forewing and one hind wing) belong to one species, *A. australis*, and one hind wing to *A. martynovae* comb. nov. The paratype forewing of *Austropanorpa australis* (F. 10336, part and F. 10337, counterpart) described by Riek (1952, p. 11, fig. 3) is not fully preserved and only eight veins are apparent in the radial sector. Nine radial veins reaching the wing margin are characteristic for the genus *Austropanorpa* and it is likely the damaged paratype wing also originally had nine radial veins, like the holotype. All specimens have only four longitudinal medial veins reaching the outer margin in both wings. This supports Willmann's (1977) conclusion that this is a stable character for the family Austropanorpidae.

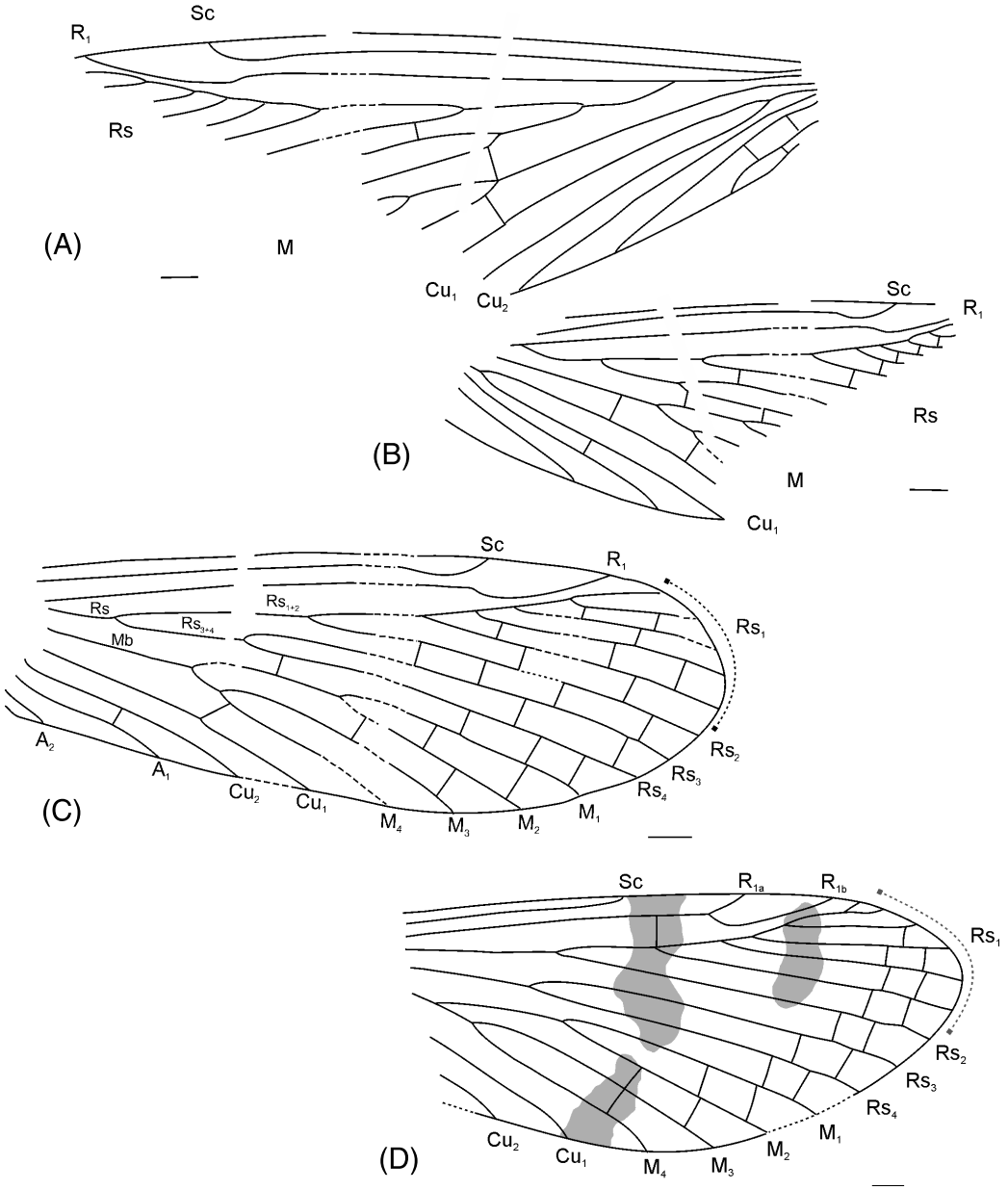

Figure 1 Wings of *Austropanorpa australis* Riek, 1952: (A) forewing, holotype F. 10634A; (B) forewing, holotype F. 10634B; (C) forewing, paratype F. 10336 (from new photographs); (D) hind wing F. 15572A (redrawn from Riek 1967). Scale bars = 1 mm.

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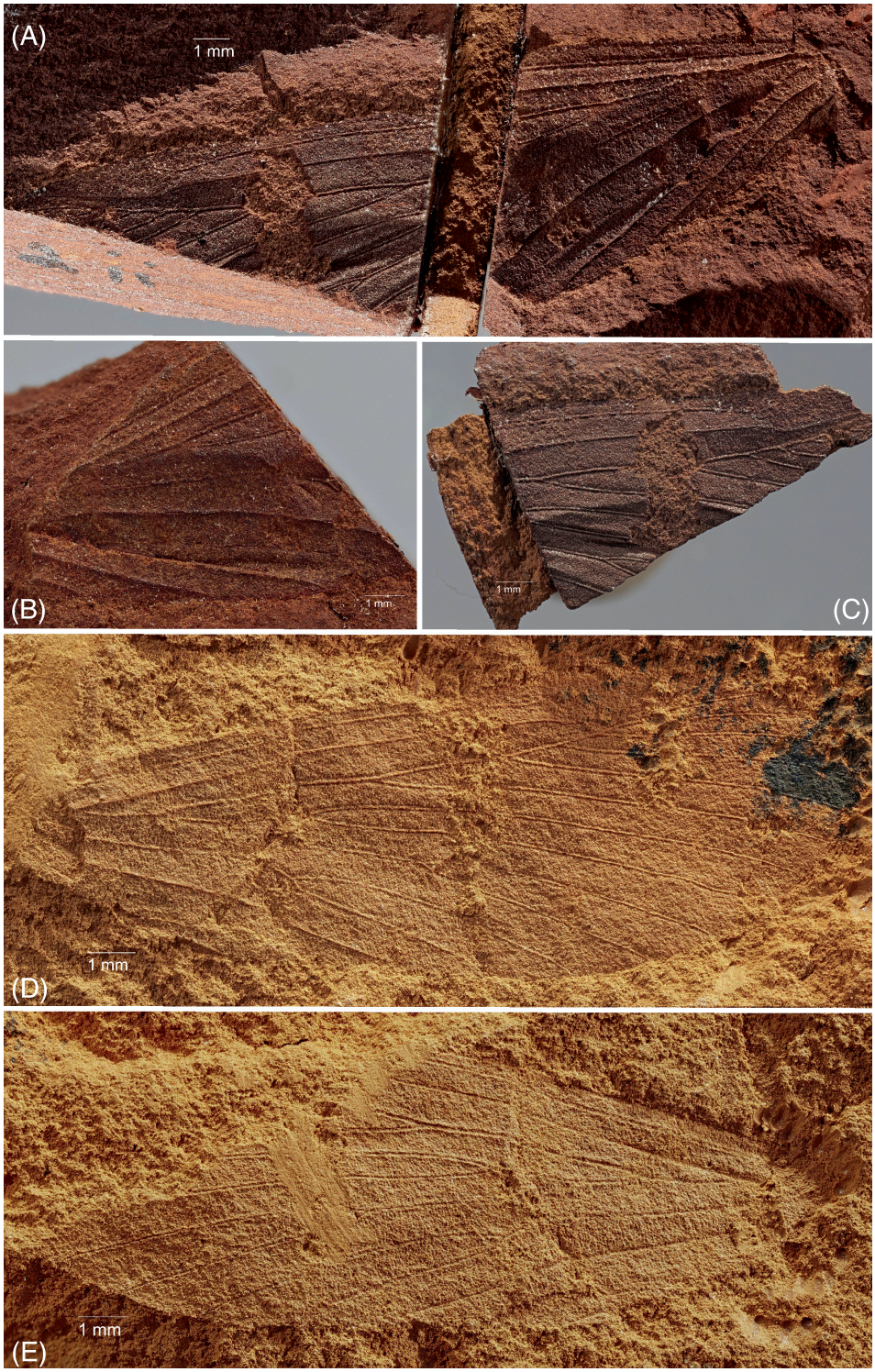

Figure 2 Photographs of *Austropanorpa australis* Riek, 1952, forewing: (A) holotype F. 10634A; (B, C) holotype F. 10634B, counterpart (in two pieces); (D, E) paratype F. 10336, part and counterpart. (photos Geoff & Russell Thompson).

Genus *Austropanorpa* Riek, 1952

Type species. *Austropanorpa australis* Riek, 1952, p. 11, Eocene, Redbank Plains Series, Redbank Plains, Queensland, Australia.

Composition. Currently two species belong to this genus: the type species and *Austropanorpa martynovae* (Sukatsheva, 1985) comb. nov., from the Lower Jurassic of Siberia.

Diagnosis. As for family by monotypye.

Redescription. As for family by monotypye.

Austropanorpa australis Riek, 1952 (Figs 1, 2)

Material. Holotype no. F. 10634, part and F. 10635, counterpart, forewing with distal part missing; paratype no. F. 10336, part and F. 10337, counterpart, with basal part not preserved; housed in the University of Queensland, Department of Geology Collection. Hind wing no. F. 15572A, part and F. 15572B, counterpart, with small basal part missing.

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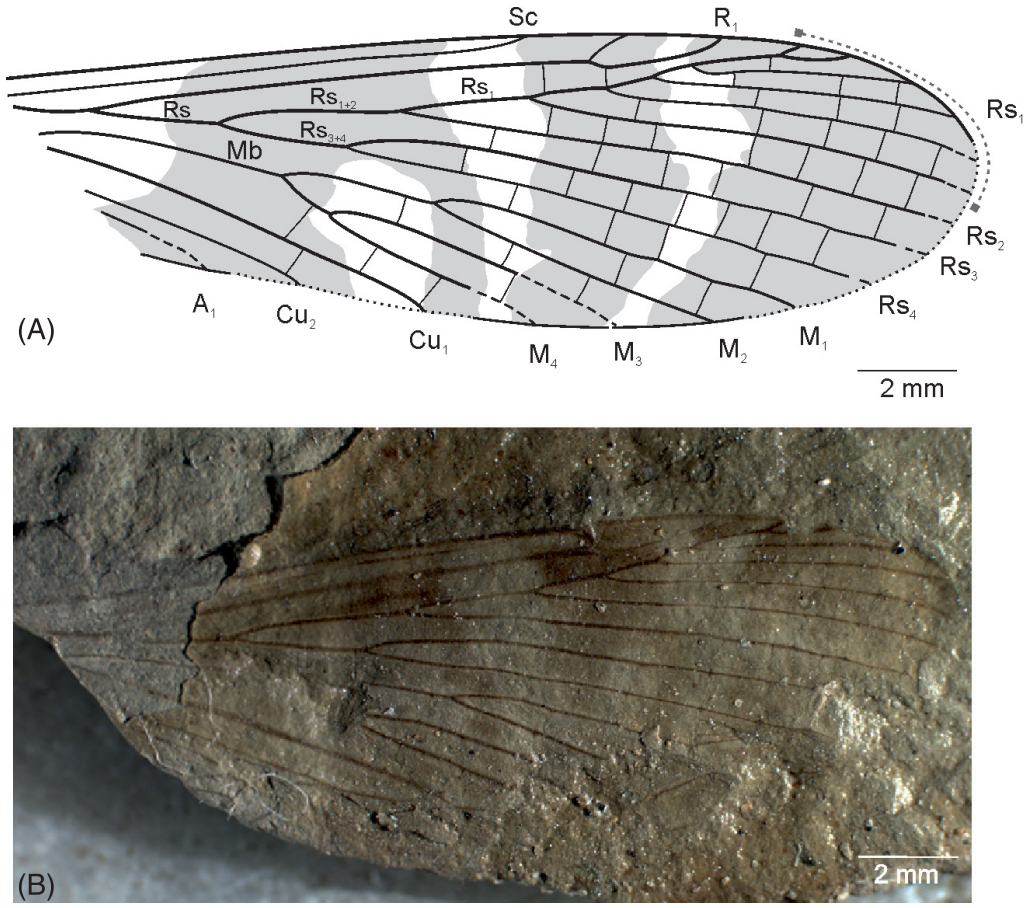

Figure 3 *Austropanorpa martynovae* (Sukatsheva, 1985) comb. nov., hind wing, holotype N. 1588/67: (A) drawing; (B) photograph.

Diagnosis. Membrane of the wing transparent with narrow, elongated dark spots; forkings of Rs_{1+2}, Rs_{3+4} and Mb do not lie along the same line in hind wing.

Redescription. Wing *c*.25 mm length, with elongated, narrow dark markings; Sc long in the forewing, reaching the outer margin at pterostigmal area; Sc in the hind wing short and reaching the outer margin slightly before M_4 ends; R_1 long in forewing, ending significantly beyond the last forking of Rs_1, R_1 in hind wing shorter, with two branches, reaching the outer margin before last forking of Rs_1; in forewing Rs short, vein Rs_{1+2} twice as long as Rs and almost half the length of vein Rs_1 before first forking; in hind wing vein Rs is not preserved; Rs_1 pectinate with six single longitudinal veins in both wings; forkings Rs_{1+2}, Rs_{3+4} and Mb lie along the same diagonal line in the forewing, but do not lie along the same line in the hind wing; in forewing Rs_{3+4} forks in one third of M_{1+2}, in hind wing in two thirds of M_{1+2}; M_{1+2} almost four times longer than M_{3+4}; M_1 ca. twice as long as M_{1+2}, M_3 six times longer than M_{3+4}.

Austropanorpa martynovae (Sukatsheva, 1985)
(Fig. 3)

Orthophlebia martynovae Sukatsheva, 1985, p. 102, fig. 8.

Material. Holotype N. 1588/67 housed in PIN, from Iya, Cheremkhovo (= Cheremkovskaya) Formation of the Irkutsk Basin, Siberia, Russia, dated as Early Jurassic, Toarcian, 174.1–182.7 MA (Akulov *et al*. 2015).

Diagnosis. Membrane of the wing transparent, with dark, wide bands; forking of Rs_{1+2}, Rs_{3+4} and Mb lie almost along the same line in hind wing.

Redescription. Only a single hind wing known, *c*.18 mm length, with elongated, wide, dark clearly visible bands; Sc ends opposite one quarter of length of $Rs_{1a+b;}$ R_1 reaching outer margin opposite the point where M_2 reaches the outer margin; Rs one third shorter than Rs_{1+2} and equal in length to Rs_{3+4}; forkings of Rs_{1+2}, Rs_{3+4} and Mb lie almost along the same line; Rs_1 pectinate, with six single, longitudinal veins; M_{1+2} about 2.5 times longer than M_{3+4}; M_1 about 2.5 times longer than M_{1+2}, M_3, five times longer than M_{3+4}.

Remarks. Diagnosis based on the hind wing only, as forewing is not known for this species.

3. Discussion

The wing venation of the family Austropanorpidae displays a specific pattern not seen in any other mecopteran family. In both wings, the radial sectors are nine-branched and the medial sectors have four veins. The initial inclusion of this taxon in the family Panorpidae (Riek 1952) was rejected by Willman (1977), who erected a new family, Austropanorpidae, since all representatives of Panorpidae + Panorpodidae, both fossil and extant, have radial sectors which are five- or, exceptionally, six-branched, including the oldest Panorpidae, *Jurassipanorpa inpunctata* (Ding *et al.* 2014). Willmann (1977) considered the similarity of the medial sector, including the reduction of one medial vein in the forewing, to be either a symplesiomorphy (with Panorpidae + Panorpodidae as sister taxon to Austropanorpidae), or a homology which evolved independently. A pectinate Rs_1 is characteristic for Orthophlebiidae, leading to *Austropanorpodes martynovae* comb. nov. originally being described as an orthophlebiid (Sukatsheva 1985). However, Orthophlebiidae is now considered to be a

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paraphyletic stem group of the Panorpoidea (Willmann 1989). Thus, the loss of M_{4b} in the forewing could have happened more than once in orthophlebiids and this wing might, also, be only convergently similar to the Austropanorpidae. However, this requires further study and new fossil material.

In addition to issues of wing venation, Willmann (1977) also stressed the differences in the geographic distribution of Panorpidae, Panorpodidae and Austropanorpidae. Panorpidae 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 (Krzemiński & Soszyńska-Maj 2012; Ding *et al.* 2014). The distribution of extant Panorpodidae is limited to a small area of the Northern Hemisphere (Byers 2005; Zhang 2011). Until now, the only fossil evidence of panorpodids has been from Eocene Baltic amber (Carpenter 1954; Soszyńska-Maj & Krzemiński 2013, 2015). The affinity of one species from the Eocene of South America, *Austropanorpodes gennaken* Petrulevičius, 2009, to Panorpodidae is not strongly supported (Soszyńska-Maj & Krzemiński 2015). Previously, Austropanorpidae were known only from Australia, and a revision of the species *Austropanorpa martynova* comb. nov. extends their known distribution into the Northern Hemisphere. Willmann (1977) argued that the geographical isolation of these families supported the conclusion that the four-branched medial vein in the forewing is a homology in Austropanorpidae and Panorpidae + Panorpodidae. Willmann (1977) suggested that the stem group of these three families most likely comprised Orthophlebiidae, which were widely distributed in Eurasia and Australia, from which a lineage, including Austropanorpidae, separated in the Late Triassic.

Our paper improves knowledge about Austropanorpidae distribution. Currently, we have evidence of this family in the Jurassic of Siberia and in the Eocene of Australia. This is, therefore, not an endemic but a relictual family in Australia, which probably evolved before the break-up of Pangaea. It leads to the conclusion that of the closely related families grouped together into Panorpoidea (Willmann 1987; Archibald *et al.* 2013), not only Orthophlebidae but also Austropanorpidae were distributed more widely. However, of all Panorpoidea families, only Panorpodidae and Panorpidae have survived from the Eocene apex of Panorpoidea diversity (*sensu* Willmann 1987) until the present (Archibald *et al.* 2013).

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