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Earth Sciences

A first Triassic insect from Antarctica (Eisenhower Range, northern Victoria Land)

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Abstract

We report here an isolated insect forewing from Triassic deposits of the Eisenhower Range, northern Victoria Land, Antarctica. Based on the reduced venation (e.g. well-developed pterostigma, Rs dichotomously branched, Rs and M vein with five branches each), we tentatively identify the specimen as belonging to Permochoristidae (Mecoptera). However, due to incomplete preservation of the forewing, we prefer a determination under open nomenclature until more material of this taxon is available. The new specimen represents the first insect described from the Triassic of Antarctica and the first fossil record of Mecoptera in the continent, supporting the worldwide distribution and a greater diversity of the family during Triassic times.

Keywords: Antarctica; fossil insects; Mecoptera (Permochoristidae); Upper Triassic

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Introduction

Fossil insects have been reported from different outcrops in Antarctica: Permian Polarstar Formation, Sentinel Mountains (Hemiptera: Stenoviciidae; Tasch & Riek 1969), Permian Theron Mountains (Hemiptera; Plumstead 1962, Carpenter 1969), Permian Mount Glossopteris Formation, Ohio Range (Plecoptera; Carpenter 1969, Sinitshenkova 1987), Jurassic Mount Flora, Hope Bay, Grahamland (Coleoptera; Zeuner 1959, Carpenter 1969, Tasch 1970, 1973), Jurassic Victoria Land (Odonata, Blattodea, Coleoptera; Carpenter 1969, Bomfleur *et al.* 2011, Santos Filho *et al.* 2023) and Pliocene to mid-Miocene Meyer Desert Formation, Transantarctic Mountains (Coleoptera; Ashworth & Kuschel 2003). Similarly, Bomfleur *et al.* (2011) mentioned an isolated beetle elytra of the Triassic Section Peak Formation, southern north Victoria Land, but without providing further taxonomic identification.

The Transantarctic Mountains preserve a Late Palaeozoic to mid-Mesozoic sedimentary succession (Beacon Supergroup) that has been intensively studied since the beginning of major geological field campaigns in the area in the late 1950s (e.g. McKelvey & Webb 1961, Faure & Mensing 2010). The Triassic fluvio-lacustrine deposits of the Victoria Group (Permian-Triassic) in particular have become known for their rich and diverse assemblages of vertebrate remains (Barrett *et al.* 1968, Hammer 1990, Sidor *et al.* 2023) and well-preserved plant fossils (Schopf 1970, Taylor & Taylor 1990, Escapa *et al.* 2011).

In light of the numerous collections and large numbers of fossil specimens that have been accumulated since then, it is surprising that not a single invertebrate body fossil has been described from the Triassic of Antarctica so far. As a first step towards filling this gap, we here present an isolated insect forewing from Triassic deposits of the Eisenhower Range, northern Victoria Land, Antarctica. Therefore, in this paper, we report and describe the first insect record for the Triassic of Antarctica, representing the finding of a mecopteran that is novel for this continent.

Materials and methods

The specimen GXIII-SETI02-025 was collected during the course of the 13th German Antarctic North Victoria Land Expedition (GANOVEX XIII, 2018/2019) from a previously unvisited outcrop of the Section Peak Formation exposed along a prominent escarpment about halfway between Eskimo Point and Timber Peak, northern Eisenhower Range, East Antarctica (74°14'50"S, 162°28'47"E; Fig. 1. This lower part of the Section Peak Formation is made up of epiclastic sandstone and mudstone with intercalated coal seams (Schöner *et al.* 2011), and it is dated as Late Triassic based on palynostratigraphic data (Bomfleur *et al.* 2014). At the study site, one particular siltstone bed in the central part of the section has yielded a mass occurrence of narrow-leaved *Dicroidium* fronds and *Linguifolium* leaves. An otherwise-barren bedding

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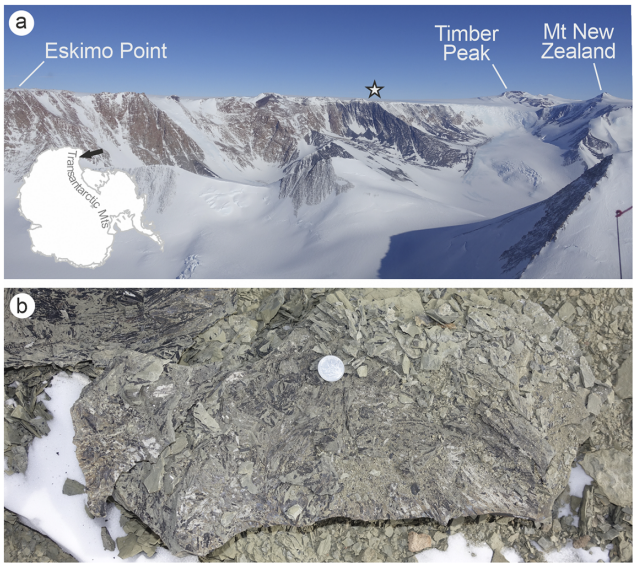

Figure 1. Field images of the new fossil locality. **a.** View west onto the escarpment of the Polar Plateau along the Eisenhower Range between Eskimo Point in the south and Mount New Zealand in the north, with an arrow indicating the fossil site on the Antarctic continent and an star marking the position of the outcrop where the specimen was collected. **b.** Mass accumulations of plant debris on a freshly exposed bedding surface at the new fossil site. Photographs by Jan Unverfärth.

surface on the flipside of one plant fossil-rich specimen contains the insect wing fragment.

The specimen was examined and photographed using a Canon EOS 5D Mark IV camera with a Canon MP-E 65 mm f/2.8 1–5× Macro Photo lens under polarized light with a circular analyser at sub-maximum extinction. Line drawings were prepared from the photographs using *CorelDraw 7* image editing software.

The venational nomenclature is based on Willmann (1989), Minet *et al.* (2010) and Bashkuev & Sukatsheva (2021). The specimen GXIII-SETI02-025 is housed at the palaeobotanical collections of the University of Münster, Münster, Germany. Forewing venation abbreviations: Sc = subcosta; ScP = posterior subcosta; R = radius; Rs = radius sector; pt = pterostigma; M = median vein; CuA = anterior cubitus.

Systematic palaeontology

Order MECOPTERA Packard, 1886
Family PERMOCHORISTIDAE Tillyard, 1917
Subfamily PERMOCHORISTINAE Tillyard, 1917
(Fig. 2)

Referred material

GXIII-SETI02-025 imprint of fragmentary forewing, with basal part missing.

Locality

Lower part of the Section Peak Formation (Upper Triassic), northern Eisenhower Range, northern Victoria Land, East Antarctica (74°14'50"S, 162°28'47"E; Fig. 1).

Description

The forewing is very small (with a preserved length of only 8.2 mm), sub-oval in shape and completely flattened; the membrane appears rather soft and without distinct corrugation or sculpture (Fig. 2). The basal and apical regions are not preserved, and the basal connections of the main veins are not preserved. The anterior margin is slightly convex, with a long concave course at the distal end of R_1. The venation is strongly reduced, with only few, vaguely visible cross-veins. The Sc is short, very slightly sigmoidal and ending in the anterior margin far proximally from the midwing. The pterostigma (pt) is partially visible, in coloured pigment, and is nearly lanceolate and elongate. R_1 is long and straight, ending in the proximal third of the concave course of the anterior margin. Rs and M bifurcate at the same level. Rs is basally bifurcate at the level of the distal end of ScP, with five terminal branches (Rs_1 (bifurcated), Rs_2, Rs_3 and Rs_4) running parallel to each other and reaching the apical margin, with an additional short fork on Rs_1. Rs_{1+2} is forked apical of the Rs_{3+4} fork. Stem M is long, straight and divided into two main branches (MP_{1+2} and MP_{3+4}) at the same level as the forking of Rs. M is five-branched (with additional forks on M_4). M_{1+2} is forked distal of the bifurcation of Rs_{1+2}. CuA remains visible. There is a distinctive stained colour pattern in the forewing.

Discussion

The general wing shape and venation are consistent with the ground pattern of Permian and Triassic Mecoptera. Based on the reduced venation, we tentatively identify specimen GXIII-SETI02-025 as belonging to the Mecoptera Packard, 1886, with a probable affiliation within Permochoristidae Tillyard, 1917 based on the well-developed pterostigma, the dichotomously branched Rs and with Rs and M having five branches each (10 branches in total). The preserved venation appears to be of the typical scheme of Permochoristinae Tillyard 1917 *sensu* Novokshonov (1997b; e.g. Rs is not pectinate with four to five branches - an additional fork on Rs_1 may be an individual variation; M with five veins with forks on M_4), but due to the rather incompletely preserved wing base, and thus without clear knowledge of the basal connection of the main veins, we prefer a determination under open nomenclature until more material of this taxon is available.

Specimen GXIII-SETI02-025 differs from Triassic genera of Permochoristidae Tillyard, 1917 (e.g. *Duraznochorista* Lara & Bashkuev, 2020, Upper Triassic of Argentina; *Mesochorista* Tillyard, 1916, Middle Triassic of China, Middle-Upper Triassic of Kyrgyzstan, Upper Triassic of Australia and Kazakhstan; *Agetopanorpa* Carpenter, 1930, Middle Triassic of China, Middle-Upper Triassic of Kyrgyzstan; *Hongchoristites* Rivaz Hernández, 2018, Middle-Upper Triassic of China; *Kalochorista* Lin, 1992, Upper Triassic of China; *Mesageta* Novokshonov, 1997a, Middle-Upper Triassic of Kyrgyzstan; *Xenochoristella* Riek, 1955, Upper Triassic of Australia; *Qingochorista* Guo & Hong, 2003, Middle Triassic of China) in: Sc is probably simple, Rs_{1+2} and Rs_{3+4} stem and M_{1+2} and M_{3+4} stem long, Rs_1 is twice branched and M_2 is unbranched.

Superficially similar members of the extinct family Permochoristidae Tillyard, 1917 are distributed widely from the Permian to the Jurassic in South Africa, Australia, Asia, Europe, South America and North America (e.g. Carpenter 1930, Riek 1953, 1955, 1976, Pinto 1972, Papier *et al.* 1996, Novokshonov 1997a,b,c, 2001, Van Dijk & Geertsema 1999, Guo & Hong 2003, Bashkuev 2010,

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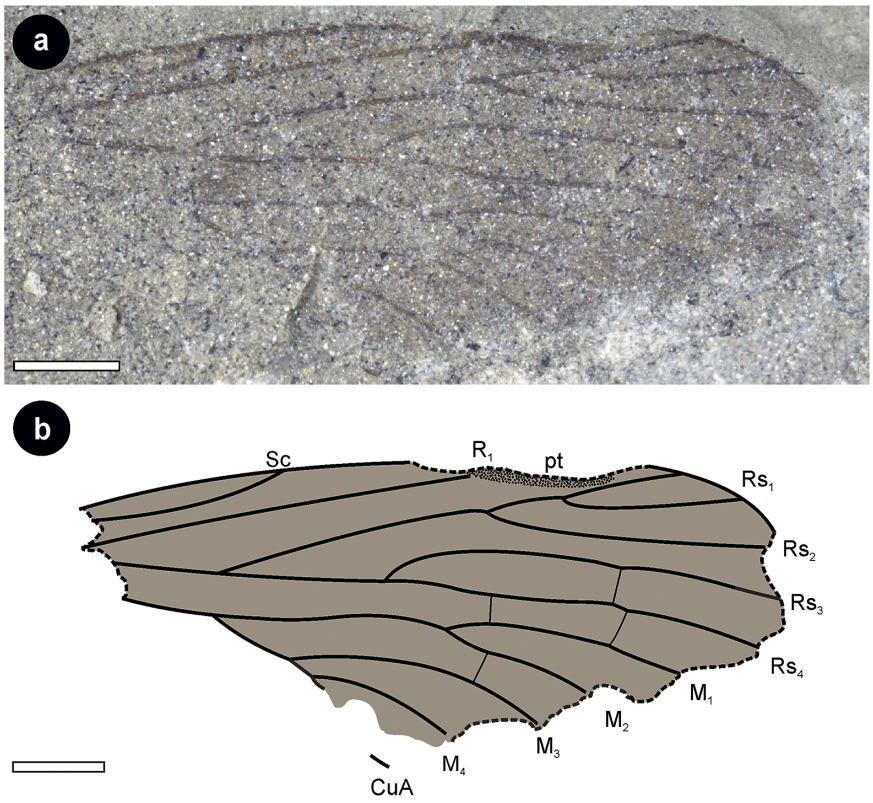

Figure 2. Specimen GXIII-SETI02-025 (Mecoptera: Permochoristidae) from the lower part of the Section Peak Formation (Upper Triassic), northern Eisenhower Range, northern Victoria Land, East Antarctica. **a.** Photograph of the forewing. **b.** Line drawing of the forewing. Scale bar = 1 mm. See text for abbreviations.

Lin *et al.* 2010, Lara *et al.* 2015, Lara & Bashkuev 2020, Lian *et al.* 2022, 2023; PaleoBioDB). However, they were dominant among mecopteran faunas throughout the Permian, but they decreased greatly in diversity and abundance from the Triassic (probably impacted by the end-Permian mass extinction event) until becoming quite rare in the Jurassic, being replaced by more derived groups (Lara *et al.* 2015, Lian *et al.* 2023). Triassic permochoristids are known mainly from Central Asia and Australia (Riek 1955, Novokshonov 1997c, 2001) and from rare specimens recorded from Europe, South Africa, South America (Argentina) and China (Riek 1974, Papier *et al.* 1996, Guo & Hong 2003, Lara *et al.* 2015, Lara & Bashkuev 2020). Therefore, the new fossil described herein, besides representing the first record of Mecoptera from the continent, supports the worldwide distribution and a greater diversity of the Permochoristidae during Triassic times.

Conclusions

The paucity of insect fossils and – as a consequence - of reported insect-mediated herbivore damage in plant-fossil assemblages from the Antarctic Triassic compared to coeval assemblages from, for example, South Africa (Scott *et al.* 2004) has previously been speculated to reflect a latitudinal gradient, with decreased insect diversity at the very high palaeolatitudinal setting of the Antarctic sites (Bomfleur *et al.* 2011).

In this respect, our report of the first insect forewing fossil from the Antarctic Triassic may support an alternative interpretation: that such small and inconspicuous fossils might have been overlooked previously. We anticipate that future dedicated searches through the extensive available collections could reveal the Antarctic Triassic invertebrate fossil record to be richer than previously thought.

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Competing interests. The authors declare none.

Author contributions. JU and TM performed the fieldwork. MM surveyed the fossil assemblage and photographed the material. MBL, BB and CB analysed the material. All authors discussed the results, wrote the manuscript and provided illustrations.

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