A new strange Archaeorthoptera from the Moscovian of Avion (France) (Insecta, Polyneoptera)

André Nel, Patrick Roques

Historical Biology

Manuscript DOI: 10.1080/08912963.2021.1978082

A new strange Archaeorthoptera from the Moscovian of Avion (France) (Insecta, Polyneoptera)

André Nel[a] and Patrick Roques[b]

[a]Institut de Systématique, Évolution, Biodiversité (ISYEB) Muséum national d'Histoire naturelle, CNRS, Sorbonne Université, EPHE, Université des Antilles, CP50, 57 rue Cuvier 75005 Paris, France

[b]2 Chemin des Processions, 93360 Neuilly Plaisance, France.

anel@mnhn.fr; https://orcid.org/0000-0002-4241-7651

patrick.roques93@wanadoo.fr; https://orcid.org/0000-0002-8721-9763

ABSTRACT

A new archaeorthopteran genus and species, *Avionugonioneura jouaulti*, is described from the Moscovian of the Avion in Northern France. It shows several strong similarities, with the two genera *Contracladus* (Pennsylvanian) and *Nugonioneura* (early Permian), viz. a simple vein M emerging anteriorly from M+CuA+CuPa and an anteriorly branched CuA+CuPa, which are putative synapomorphies, suggesting a possible attribution to the family Nugonioneuridae. This discovery confirms the very important diversity of the Archaeorthoptera in the outcrop of Avion.

KEYWORDS

Insecta; Polyneoptera; ?Nugonioneuridae; early late Carboniferous; diversity

Introduction

For a Moscovian outcrop, The Konservat-Lagerstätte of Avion (Northern France) is especially rich in polyneopteran insects of the superorder Archaeorthoptera (so-called 'orthopteroid' insects), with no less than eight genera and nine species: *Aviogramma gracilis* Prokop et al., 2014 (plus another Caloneurodea), *Aviocladus pectinatus* Prokop et al., 2014, *Aviohapaloptera bethouxi* Prokop et al., 2014, *Aviologus duquesnei* Coty et al., 2014, *Cacurgus avionensis* Schubnel et al., 2020, *Beloatta duquesnei* Nel et al., 2021, cf. *Tococladus* sp. (Coty et al. 2014; Prokop et al. 2014; Schubnel et al. 2020; Nel et al. 2020).

Here we describe a further new genus and species belonging to a family different of those previously recorded, confirming the impressive diversity of the clade in this outcrop.

Material and methods

The fossil was found by one of us (P.R.) in the slag heap of Avion. It was examined under a Nikon SMZ1500 and photographed with an AmScope camera MU900.

We follow the wing venation terminology of Béthoux and Nel (2002).

Wing vein terminology: CuA, cubitus anterior; CuP, cubitus posterior; CuPa, anterior branch of CuP; CuPb, posterior branch of CuP; M, median vein; PCu, postcubital vein; RA, radius anterior; RP, radius posterior; ScP, subcosta posterior.

Systematic palaeontology

Superorder Archaeorthoptera Béthoux and Nel, 2002

Family ?Nugonioneuridae Carpenter, 1976

Avionugonioneura gen. nov.

Zoobank xxxx

Type species

Avionugonioneura jouaulti sp. nov.

Diagnosis

Forewing characters only. CuPa ending into M+CuA and not in a free CuA; no CuPaβ, vein M+CuA+CuPa anteriorly pectinate; ScP ending into costa; short posterior branches of CuA+CuPa; five simple branches of RP; M simple and strictly parallel to branches of RP and to first anterior branch of CuA+CuPa; area between RA and RP broad with two rows of cells.

Etymology

Named after the outcrop of Avion and the genus name *Avionugonioneura*. Gender feminine.

Avionugonioneura jouaulti sp. nov.

(Fig. 1)

Zoobank xxxx

Etymology

Named after our friend and colleague Corentin Jouault, for his contribution to Palaeoentomology.

Type material

MNHN.F.A71353 (two nearly complete forewings overlapped at rest), stored at the Muséum National d'Histoire Naturelle, Paris, France.

Type locality

'Terril N°7', Avion, Pas-de-Calais, France.

Stratigraphic occurrence

Moscovian (Westphalian C/D equivalent to Bolsovian/Asturian).

Diagnosis

As for the genus by monotypy.

Description

Forewing elongate, 16.0 mm long, 5.0 mm wide; ScP reaching anterior wing margin at 8.7 mm from wing base; costal area rather narrow, 0.6 mm wide with no visible veinlet; a series of simple short crossveins in area between ScP and R; RP separating from RA 4.4 mm from wing base; area between RA and RP broad, 0.7 mm wide, with two rows of cells in its distal part, apically narrower; RA with a series of short, more or less curved anterior veinlets between it and anterior wing margin; apex of RA 2.4 mm of wing apex; RP with five posterior branches, three of them being forked again distally, parallel to M; RA and RP approximate in apical parts; a common stem R+M+CuA; M+CuA separating from R 2.5 mm from wing base, straight; M distally simple and straight, separating from CuA+CuPa 0.4 mm distal of point of fusion of CuPa with M+CuA; CuA+CuPa with at least an anterior simple branch parallel to M, and two weak posterior subapical branches; concave CuPa curved, elongate, 2.0 mm long, ending into M+CuA; concave CuPb straight and simple in its preserved part; convex PCu basally curved and simple in its preserved part; anal veins not preserved.

Discussion

This fossil is a pair of forewings in life position. It belongs to the Archaeorthoptera because of the following characters (Béthoux and Nel 2002): CuP differentiated into concave CuPa and CuPb; a common stem R+M+CuA, from which M+CuA separates distally; CuPa ending into M+CuA. *Avionugonioneura* gen. nov. does not fall into the Panorthoptera because CuPa is not differentiated into two branches CuPaα and CuPaβ; MA1 and MA2 cannot be differentiated. It has a very peculiar vein M+CuA+CuPa, with two strong and simple anterior branches, which is rarely found among the Archaeorthoptera but also present in the Paoliida for CuA only (Prokop et al. 2014a). Similar pectinations are found in the Cnemidolestodea sensu Béthoux (2005), but with the important difference in the first branch being itself forked several times. Another difference to the members of Cnemidolestodea is the vein CuPa ending into M+CuA in *Avionugonioneura* gen. nov., while it ends into CuA in the Cnemidolestodea. Tow Cnemidolestodea are already known from Avion, viz. *Aviocladus* Prokop et al., 2014 that differs from *Avionugonioneura* gen. nov. in ScP ending into R, and base of RP in a much distal position (Prokop et al. 2014b); and *Piesbergopterum avionensis* Nel and Roques, 2021 that differs from *Avionugonioneura* gen. nov. in the presence of a specialized area between an anterior branch of M and a posterior branch of the same vein (Nel and Roques, 2021). Few cases of Archaeorthoptera with CuPa ending into M+CuA and not in a free CuA are known. It is the case for *Bruaylogus magnificus* Coty et al., 2014, but this taxon has a CuPaβ as panorthopteran synapomorphy, and no anterior pectination of CuA+CuPa (Coty et al. 2014; Gu et al. 2017). *Nugonioneura* Tillyard, 1937 (*N. problematica* Tillyard, 1937 known from the Lower Permian of Elmo in Kansas, U.S.A.) (Tillyard 1937; Aristov 2020, p. 6, Figs 3, 4) and *Contracladus impar* Dvořák et al., 2021 (Pennsylvanian of Piesberg, Germany) also have no CuPaβ, a simple M anteriorly emerging from vein M+CuA+CuPa, and an anterior branch of CuA+CuPa parallel to M, as in *Avionugonioneura* gen. nov. Both differ from

126 *Avionugonioneura* gen. nov. in ScP ending into RA, the presence of an angle in M below base
127 of RP so that these two veins approximate, no posterior branch of CuA+CuPa, shorter anterior
128 branches of CuA+CuPa. *Nugonioneura* has only three simple branches of RP instead of five
129 with some being forked again more distally in *Avionugonioneura* gen. nov. and *Contracladus*.
130 M is distally forked in *Contracladus*, instead of being simple as in *Avionugonioneura* gen. nov.
131 and *Nugonioneura*.

132 As a conclusion, *Contracladus*, *Nugonioneura*, and *Avionugonioneura* gen. nov. can
133 only be considered as Archaeorthoptera of uncertain affinities. A new phylogenetic analysis
134 will be necessary to clarify their positions, even if they possibly all belong to the same
135 archaeorthopteran family Nugonioneuridae that would be characterized by the putative
136 apomorphies: 'CuPa ending into M+CuA', a 'simple M anteriorly emerging from
137 M+CuA+CuPa', and 'presence of a simple anterior branch of CuA+CuPa'.

138

139 Remarks. Coty et al. (2014: 464, fig. 1) described and figured a wing fragment they attributed
140 to a 'cf. *Tococladus* sp.' (Cnemidolestodea Tococladidae). It strongly resemble the wing apex
141 of *Avionugonioneura* gen. nov. in the number of branches of RP, simple M and anterior
142 branches of CuA+CuPa, and RA and RP strongly approximating distally. The only difference
143 is the area between RA and RP narrower in the putative 'cf. *Tococladus* sp.' than in
144 *Avionugonioneura* gen. nov. Numerous Palaeozoic wings of Polyneoptera have very similar
145 patterns of venations in their distal parts. They can be discriminated and attributed to precise
146 clades only on the basis of the basal halves of the wings.

147 Rasnitsyn and Aristov (2021: 151) indicated that in *Tococladus garrici* Béthoux et al., 2003,
148 the vein 'CuPa' is convex, after the original photograph in Béthoux et al. (2003: fig. 4),
149 suggesting that the attribution of the Tococladidae to the Archaeorthoptera could be not well-
150 grounded. But the original photograph shows a CuPa of 'intermediate' convexity compared to

those of the convex M+CuA and the concave stem of CuP. Also Béthoux et al. (2003) did not indicate anything about the convexity of this vein. This uncertainness in the determination of the convexity of the vein CuPa is due to fossilization, but it is clear that this vein has a diameter and shape different of the more distal vein CuA+CuPa, supporting that it is a branch of CuP and not CuA. Thus the argument of Rasnitsyn and Aristov (2021) does not stand.

Acknowledgements

We sincerely thank Mr. Stéphane Carlier and Mr. Patrick Wypych, Eiffage Route Nord Est, for the kind authorization to collect fossil insects in the terril of Avion.

References

Aristov DS. 2020. Revision of the genera *Heteroptilon*, *Nugonioneura* and *Opistocladus* from the Lower Permian of USA (Insecta: Cnemidolestida: Tillyardembiidae, Nugonioneuridae and Parmapteridae). Far Eastern Entomologist 401:1–9.

Béthoux, O. 2005. Cnemidolestodea (Insecta): an ancient order reinstated. Journal of Systematic Palaeontology 3:403–408. https://doi.org/10.1017/S147720190500163X

Béthoux O, Nel A. 2002. Venation pattern and revision of Orthoptera sensu nov. and sister groups. Phylogeny of Palaeozoic and Mesozoic Orthoptera sensu nov. Zootaxa 96:1–88. https://doi.org/10.11646/zootaxa.96.1.1

Béthoux O, Nel A, Galtier J, Lapeyrie J, Gand G. 2003. A new species of Tococladidae Carpenter, 1966 from the Permian of France (Insecta: Archaeorthoptera). Geobios 36:275–283. https://doi.org/10.1016/S0016-6995(03)00030-5

Carpenter FM. 1976. The Lower Permian insects of Kansas. Part 12. Protorthoptera (continued), Neuroptera, additional Palaeodictyoptera, and families of uncertain position. Psyche 83:336–376. https://doi.org/10.1155/1976/932123

Coty D, Háva J, Prokop J, Roques P, Nel A. 2014. New archaeorthopteran insects from the Late Carboniferous of the Nord and Pas-de-Calais basins in northern France (Insecta: Cnemidolestodea, Panorthoptera). Zootaxa 3878:462–470. https://doi.org/10.11646/zootaxa.3878.5.4

Dvořák T, Pecharová M, Leipner A, Nel A, Prokop J. 2021. New archaeorthopteran insects from the Pennsylvanian of Piesberg reveal unexpected mosaic of morphological traits and colouration pattern of the tegmina. Historical Biology https://doi.org/10.1080/08912963.2020.1867127

Gu J-J, Béthoux O, Ren D. 2017. A new, rare and distinctive species of Panorthoptera (Insecta, Archaeorthoptera) from the Upper Carboniferous of Xiaheyan (Ningxia, China). Fossil Record 20:253–257. https://doi.org/10.5194/fr-20-253-2017

Nel A, Garrouste R, Roques P. 2020. The first representative of the archaeorthopteran family Eoblattidae in the Konservat-Lagerstätte of Avion (France) (Insecta: Polyneoptera). Palaeoentomology 3:552–555. https://doi.org/10.11646/palaeoentomology.3.6.3

Nel A, Roques P. 2021. The second species of the cnemidolestid genus *Piesbergopterum* from the Upper Carboniferous of Avion, Northern France (Archaeorthoptera: Cnemidolestidae). Palaeoentomology 4:323–325. https://doi.org/10.11646/palaeoentomology.4.4.6

Prokop J, Krzeminski W, Krzeminska E, Hörnschemeyer T, Ilger J-M, Brauckmann C, Grandcolas P, Nel A. 2014a. Late Palaeozoic Paoliida is the sister group of Dictyoptera (Insecta: Neoptera). Journal of Systematic Palaeontology 12:601–622. https://doi.org/10.1080/14772019.2013.823468

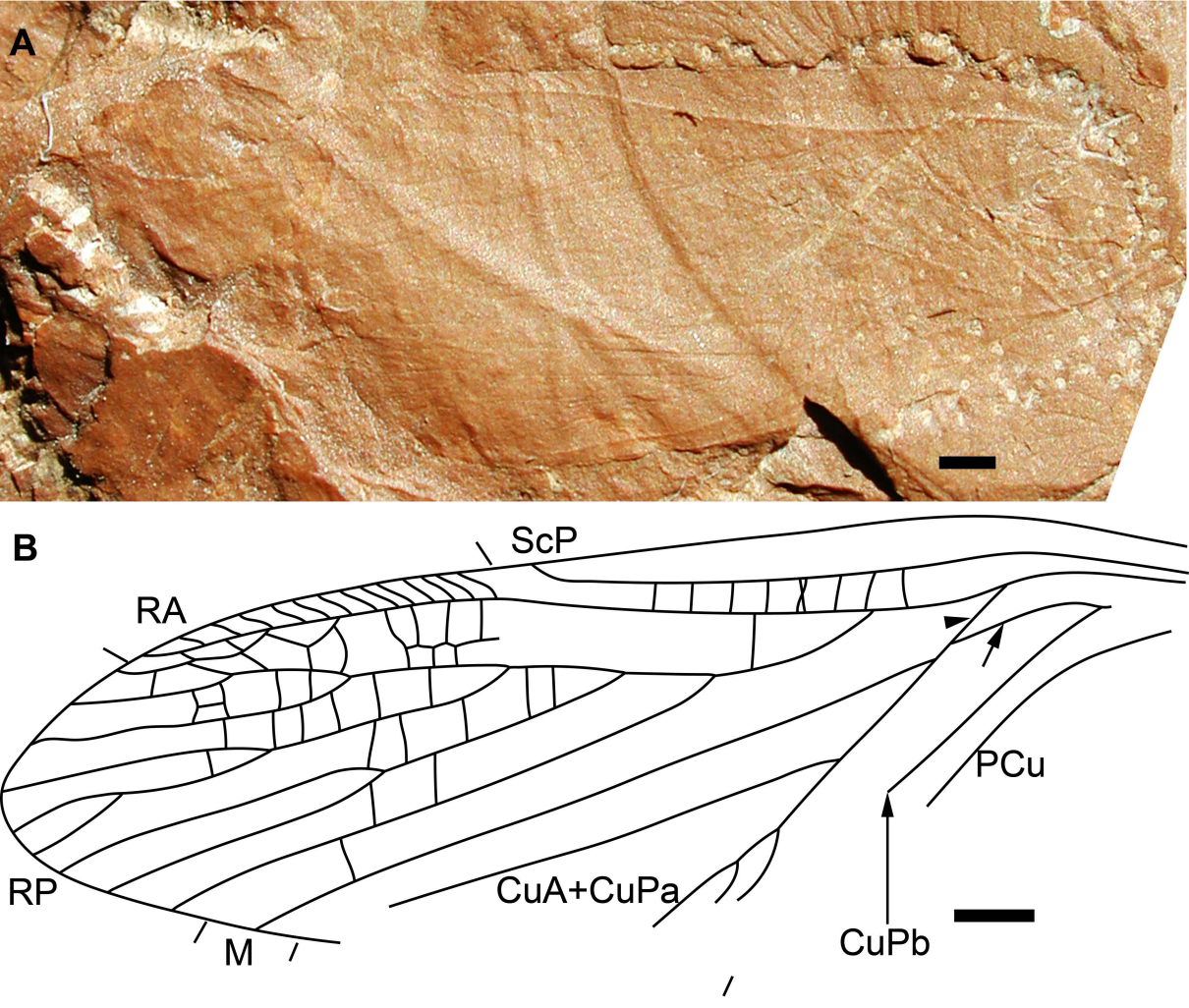
Prokop J, Roques P, Nel A. 2014b. New non-holometabolous insects from Pennsylvanian of Avion locality in Pas-de-Calais, France (Insecta: 'Exopterygota'). Alcheringa 38:155–169. https://doi.org/10.1080/03115518.2014.848620

Rasnitsyn AP, Aristov DS. 2021. Review of the Family Tococladidae Carpenter (Insecta: Eoblattida) from the Permian of North America and Europe. Paleontological Journal 55:151–156. https://doi.org/10.1134/S003103012102012X

Schubnel T, Roberts D, Roques P, Garrouste R, Desutter-Grandcolas L, Nel A. 2020. Moscovian fossils shed light on the enigmatic polyneopteran families Cacurgidae and Eoblattidae (Insecta: 'Eoblattida', Archaeorthoptera). Journal of Systematic Palaeontology 18:499–511. https://doi.org/10.1080/14772019.2019.1627595

Tillyard RJ. 1937. Kansas Permian insects. 17. The order Megasecoptera and additions to the Palaeodictyoptera, Odonata, Protoperlaria, Copeognatha and Neuroptera. American Journal of Science (5) 33:81–110. https://doi.org/10.2475/ajs.s5-33.194.81

Figure 1. *Avionugonioneura jouaulti* gen. et sp. nov., holotype MNHN.F.A71353. (A) photograph of habitus; (B) forewing reconstruction, arrowhead: M+CuA, arrow: CuPa. Scale bars = 1 mm.


A
B
ScP
RA
PCu
RP
CuA+CuPa
M
CuPb