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

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15
16 ABSTRACT

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

24
25 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), *Aviocladius 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.

51 Zoobank xxxx

52

53 *Type species*

54 *Avionugonioneura jouaulti* sp. nov.

55

56 *Diagnosis*

57 Forewing characters only. CuPa ending into M+CuA and not in a free CuA; no CuPa β , vein

58 M+CuA+CuPa anteriorly pectinate; ScP ending into costa; short posterior branches of

59 CuA+CuPa; five simple branches of RP; M simple and strictly parallel to branches of RP and

60 to first anterior branch of CuA+CuPa; area between RA and RP broad with two rows of cells.

61

62 *Etymology*

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

64

65 *Avionugonioneura jouaulti* sp. nov.

66 (Fig. 1)

67 Zoobank xxxx

68

69 *Etymology*

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

71 Palaeoentomology.

72

73 *Type material*

74 MNHN.F.A71353 (two nearly complete forewings overlapped at rest), stored at the Muséum

75 National d'Histoire Naturelle, Paris, France.

76

77 *Type locality*

78 ‘Terril N°7’, Avion, Pas-de-Calais, France.

79

80 *Stratigraphic occurrence*

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

82

83 *Diagnosis*

84 As for the genus by monotypy.

85

86 *Description*

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

100

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 CuPa α and CuPa β ; 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. Two Cnemidolestodea are already known from Avion, viz. *Aviocladius* 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 *Piesbergopterus 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 CuPa β 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 CuPa β , 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

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

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

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

Rasnitsyn and Aristov (2021: 151) indicated that in *Tococladius garrici* Béthoux et al., 2003, the vein ‘CuPa’ is convex, after the original photograph in Béthoux et al. (2003: fig. 4), suggesting that the attribution of the Tococladidae to the Archaeorthoptera could be not well-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 uncertainty 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.

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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.