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Palaeodisparoneura cretacica sp. nov., a new damselfly (Odonata: Zygoptera: Platycnemididae) from mid-Cretaceous Burmese amber

Palaeodisparoneura cretacica *sp. nov., une nouvelle demoiselle (Odonata : Zygoptera : Platycnemididae) de l'ambre birman du Cretacé moyen*

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ABSTRACT

Abundant odonatans have been discovered from mid-Cretaceous Burmese amber, and Burma has played an important role in early damselfly diversification during the mid-Cretaceous. In this paper, a new damselfly, *Palaeodisparoneura cretacica* sp. nov., is described from Burmese amber. It is the second species of the extinct genus *Palaeodisparoneura* Poinar, Bechly et Buckley, 2010. *P. cretacica* sp. nov. differs from *P. burmanica* Poinar, Bechly et Buckley, 2010 in having more postnodal and postsubnodal crossveins, the base of IR1 being more cells distal of the base of RP2, a hyaline pterostigma and a longer RP3/4. Our find increases the diversity of damselflies during the mid-Cretaceous.

Mots clés :
Platycnemididae
Zygoptera
Odonates
Cénomanien
Crétacé
Ambre birman

RÉSUMÉ

D'abondants Odonates ont été découverts dans l'ambre birman du Crétacé moyen, et la Birmanie a joué un rôle important dans la diversification précoce des demoiselles pendant le Crétacé moyen. Dans cet article, une nouvelle demoiselle, *Palaeodisparoneura cretacia* sp. nov., est décrite dans l'ambre birman. C'est la seconde espèce du genre éteint *Palaeodisparoneura* Poinar, Bechly et Buckley, 2010. *P. cretacia* sp. nov. diffère de *P. burmanica* Poinar,

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Bechly et Buckley, 2010 par l'existence d'un plus grand nombre de veines croisées postnodales et postsubnodales, la base d'IR1 ayant plus de cellules éloignées de la base de RP2, un perostigma hyalin et un plus long RP3/4. Notre découverte augmente la diversité des demoiselles au cours du Crétacé moyen.

1. Introduction

Platycnemididae Yakobson and Bianki, 1905, currently consists of over 400 species and is widely distributed in the Old World (Dijkstra et al., 2014; Orr and Kalkman, 2010; Schorr and Paulson, 2015; Theischinger et al., 2015). Adults of this family are characterized by a laterally expanded head and the tibiae bearing dense long spines (Carle et al., 2008; Dijkstra et al., 2014; Rehn, 2003). Platycnemididae is divided into six extant subfamilies after a recent molecular phylogeny of Dijkstra et al., 2014: Allocnemidinae Dijkstra et al., 2014, Calicnemiinae Fraser, 1957, Disparoneurinae Fraser, 1957, Idiocnemidinae Dijkstra et al., 2014, Onychargiinae Dijkstra et al., 2014, and Platycnemidinae Yakobson and Bianki, 1905. A fossil subfamily Palaeodisparoneurinae Poinar, Bechly et Buckley, 2010 (type species: *Palaeodisparoneura burmanica* Poinar, Bechly et Buckley, 2010) was attributed to Platycnemididae based on a well-preserved damselfly from mid-Cretaceous Burmese amber; however, this subfamily was out of consideration of the molecular results provided by Dijkstra et al. (2014). *P. burmanica* cannot be attributed to any recent taxa since it possesses the following unique autapomorphies: the midfork (the base of RP3/4) originates midway between the arculus and nodus, the pterostigma is of rectangular shape, RP1 is strongly kinked at the pterostigmal brace, and IR1 originates below the pterostigma. It is attributed to Platycnemididae by the presence of a special shape of the short male terminalia (superior appendages shaped like the hammer of a revolver), which is shared by Disparoneurinae and Caconeurinae (Poinar et al., 2010).

Here we describe a new species of *Palaeodisparoneura*, *P. cretacica* sp. nov., from Burmese amber.

2. Material and methods

The specimen described herein was collected from the Hukawng Valley of Kachin Province, Myanmar (locality in Kania et al., 2015: fig. 1). The age of Burmese amber is radiometrically dated at 98.79 ± 0.62 Ma (Earliest Cenomanian; Cohen et al., 2013) based on U–Pb zircon dating of the volcanoclastic matrix (Shi et al., 2012).

The amber containing the damselfly is yellow and transparent. Photographs were taken using a Zeiss Stereo Discovery V16 microscope system and Zen software. In most instances, incident and transmitted light were used simultaneously. All images are digitally stacked photomicrographic composites of approximately 40 individual focal planes obtained using the free software Combine ZP for a better illustration of the 3D structures. The line drawings were prepared from photographs using image-editing software (CorelDraw X7 and Adobe Photoshop CS6). The specimen is housed in the Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences (NIGPAS).

The nomenclature of the dragonfly wing venation used in this paper is based on the interpretations of Riek (1976) and Riek and Kukalová-Peck (1984), as modified by Nel et al. (1993) and Bechly (1996). The higher classification of fossil and extant Odonatoptera, as well as family and generic characters followed in the present work, are based on the phylogenetic system proposed by Bechly (1996) and Dijkstra et al. (2014) for the phylogeny of extant Zygoptera. Wing abbreviations are as follows: Cr, nodal crossvein; CuA, cubitus anterior; DC, discoidal cell; IR, intercalary radial veins; MA, median anterior; MP, median posterior; N, nodus; Pt, pterostigma; RA, radius anterior; RP, radius posterior; Sn, subnodal crossvein. All measurements are given in mm.

3. Systematic palaeontology

Order Odonata Fabricius, 1793

Suborder Zygoptera Selys-Longchamps, 1854

Family Platycnemididae Yakobson and Bianki, 1905

Subfamily Palaeodisparoneurinae Poinar, Bechly et Buckley, 2010

Genus: ***Palaeodisparoneura*** Poinar, Bechly et Buckley, 2010

Type species. *Palaeodisparoneura burmanica* Poinar, Bechly et Buckley, 2010

Palaeodisparoneura cretacica sp. nov. (Figs. 1–6)

Etymology. After the age of the species.

Material. Holotype. NIGP164075, four wings associated with a fragmentary abdomen and fragmentary legs, gender feminine; deposited in the Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, China.

Type stratum and locality. Hukawng Valley, Kachin Province, Myanmar; Lowermost Cenomanian, lowermost Upper Cretaceous.

Diagnosis. Eight postnodal crossveins and eight postsubnodal crossveins present before Pt, well aligned; IR1 seven or eight cells distal of base of RP2; RP3/4 long, ending on posterior wing margin two or three cells distal of base of IR1; Pt hyaline; tarsi armed with dense spines.

Description. All wings with basal part somewhat absent. Abdomen with basal five segments preserved, 13.39 mm long; gender feminine in absence of male accessory genitalia on ventral side of segment 2. Right forewing most completed preserved (Figs. 2B, 3). Wing length 7.88 mm, maximum width 2.25 mm; length from base of RP3/4 to Pt base 5.61 mm, from Pt base to wing

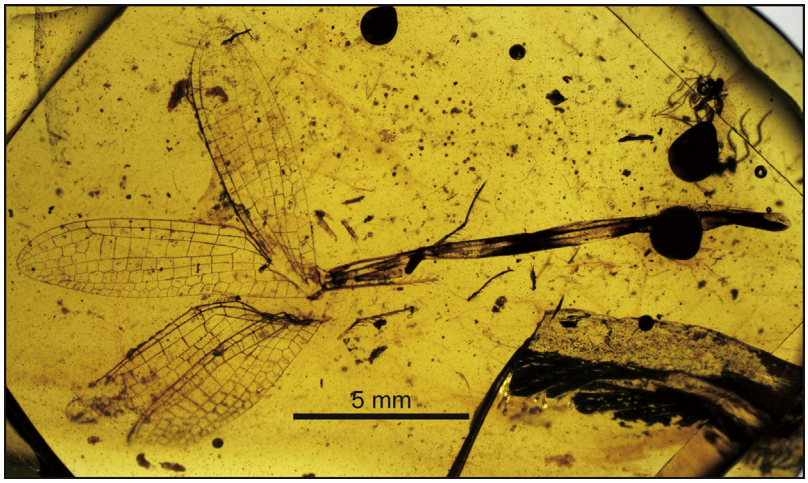

Fig. 1. *Palaeodisparoneura cretacica* sp. nov., holotype, NIGP164075, photomicrograph of specimen.
Fig. 1. *Palaeodisparoneura cretacia* sp. nov., holotype, NIGP164075, microphotographie de l'échantillon.

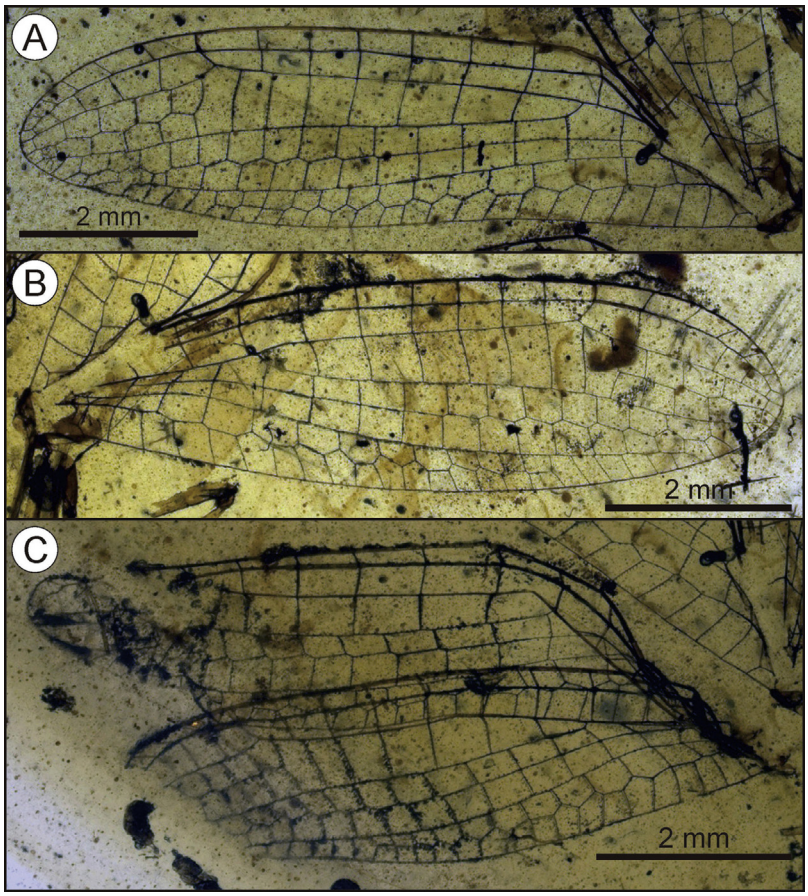

Fig. 2. *Palaeodisparoneura cretacica* sp. nov., holotype, NIGP164075. A: photomicrograph of right forewing; B: photomicrograph of right hindwing; C: photomicrograph of left forewing (upper) and hindwing (lower).
Fig. 2. *Palaeodisparoneura cretacia* sp. nov., holotype, NIGP164075. A : microphotographie de l'aile antérieure droite ; B : microphotographie de l'aile postérieure droite ; C : microphotographie de l'aile antérieure gauche (en haut) et de l'aile postérieure gauche (en bas).

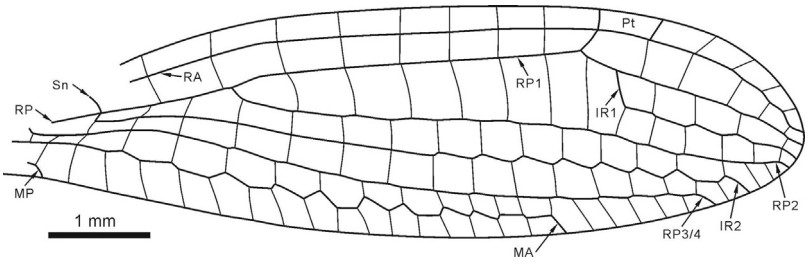

Fig. 3. *Palaeodisparoneura cretacica* sp. nov., holotype, NIGP164075, line drawing showing right hindwing venation.
Fig. 3. *Palaeodisparoneura cretacia* sp. nov. holotype, NIGP164075, dessin au trait de la venation de l'aile postérieure droite.

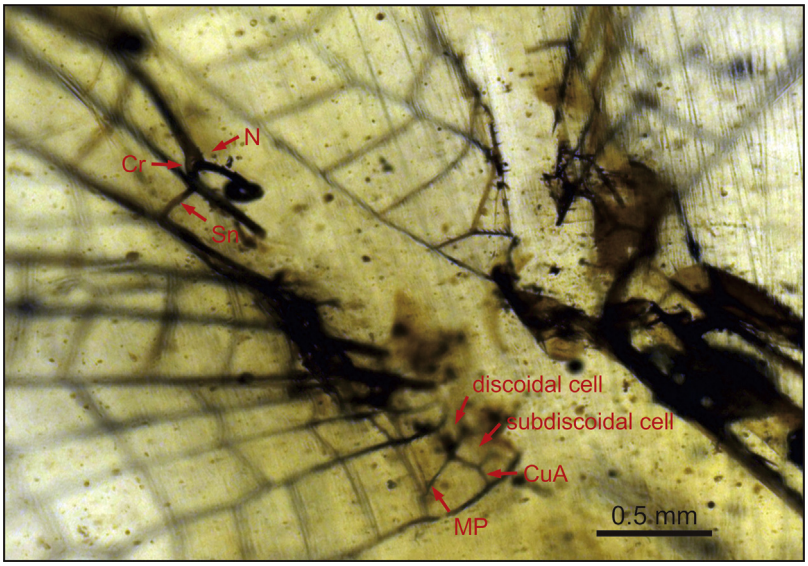

Fig. 4. *Palaeodisparoneura cretacica* sp. nov., holotype, NIGP164075, photomicrograph showing detail of basal wings.
Fig. 4. *Palaeodisparoneura cretacia* sp. nov., holotype, NIGP 164075, microphotographie montrant le détail des ailes basales.

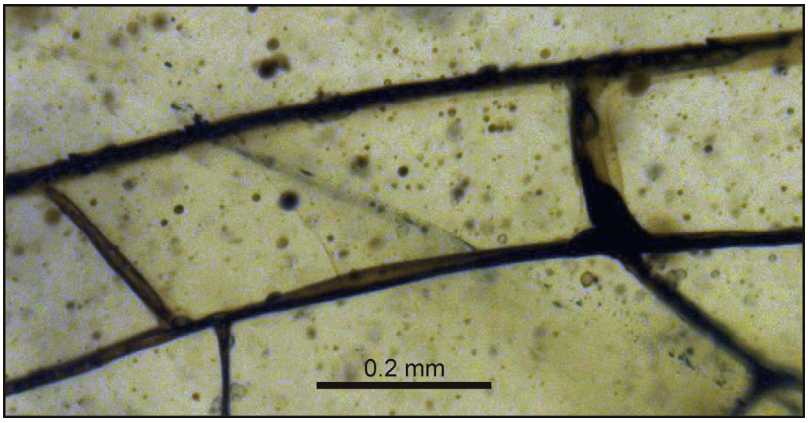

Fig. 5. *Palaeodisparoneura cretacica* sp. nov., holotype, NIGP164075, photomicrograph of right forewing pterostigma.
Fig. 5. *Palaeodisparoneura cretacia* sp. nov., holotype, NIGP164075, microphotographie du pterostigma de l'aile antérieure droite.

apex 2.03 mm. Eight postnodal crossveins and eight postsubnodal crossveins present before Pt, well aligned. Four postnodal crossveins and four postsubnodal crossveins present distal of Pt, non-aligned. Nodal structures not well preserved; Sn present and aligned with base of IR2. Midfork one long cell and 0.66 mm basal of Sn, ending on posterior margin three cells distal of base of IR1. IR2 basally straight but distally zigzagged. Base of RP2 three cells distal of Sn, lying 1.28 mm distally, nearer to N than to Pt. Base of IR1 eight cells distal of base of RP2, lying 3.81 mm distally and

Fig. 6. *Palaeodisparoneura cretacica* sp. nov., holotype, NIGP164075, photomicrograph of legs.
Fig. 6. *Palaeodisparoneura cretacia* sp. nov., holotype, NIGP164075, microphotographie des pattes.

originating just below Pt. RP1 with a strong angle below pterostigmal brace. MA distally zigzagged and long, reaching posterior wing margin just below Pt-brace. MP curved and short. Pt one cell long, rectangular and hyaline (Fig. 5), 0.64 mm long and 0.21 mm wide, strongly braced; Pt-brace more oblique than base of Pt. All intercalary veins (except for IR1 and IR2) suppressed. Longitudinal veins RA, IR1, RP1, IR2 and RP2 strongly converging to wing apex. Other wings resemble this wing except for following differences: IR1 seven cells distal of base of RP2 in left hindwing (Fig. 2C); N well preserved (Fig. 4) in left forewing, and Sn aligned with base of IR2; MP one cell length distal of CuA, ending on posterior wing margin just below N in left hindwing (Fig. 4); CuA short and oblique in left hindwing (Fig. 4); distal part of DC and subdiscoidal cell rectangular in left hindwing (Fig. 4). Four fragmentary legs preserved (Fig. 6), paired long spines present on tibia and tarsi; tarsi armed with about 14 pairs of spines.

4. Discussion

P. cretacica can be attributed to the subfamily Palaeodisparoneurinae Poinar, Bechly et Buckley, 2010 by sharing the characters provided by Poinar et al. (2010): small damselfly species characterized by greatly shortened veins MP (only one cell long) and CuA (only an oblique crossvein); aligned postnodal and postsubnodal crossveins; rectangular and distinctly braced Pt; RP1 strongly kinked at pterostigmal brace; very short IR1 originating beneath Pt. *Palaeodisparoneura* Poinar, Bechly et Buckley, 2010 is also characterized by a rectangular discoidal cell, a well-developed sub-rectangular subdiscoidal cell being not fused to the wing margin, the midfork being situated halfway between the arculus and subnodus, and the male terminalia being short. These characters are poorly discernible in *P. cretacica*. However, the rectangular distal parts of the discoidal cell and subdiscoidal cell further support the attribution.

Although *P. cretacica* shares the diagnosis of *P. burmanica*, some obvious differences can be observed between these two species. Specifically, *P. cretacica* has more postnodal crossveins and postsubnodal crossveins (eight instead of five in *P. burmanica*) before the pterostigma, the base of IR1 is seven or eight cells distal of the base of RP2 instead of five rows in *P. burmanica*, the pterostigma is hyaline instead of dark colour, a long RP3/4 ends on the posterior wing margin three cells distal of the base of IR1 instead of one cell in *P. burmanica*. In view of the above differences, we suggest a new species for the new specimen.

The recently described odonatans in Burmese amber help us understand the role of Burma in odonatan diversification during the mid-Cretaceous. The damselfly group is represented by some extant families, viz., Platycnemididae, Platystictidae, Hemiphlebiidae and Perilestidae (Huang et al., 2015; Poinar et al., 2010; Zheng et al., 2016a, b, c). Besides *P. burmanica*, *Cretadisparoneura hongi* Huang, Azar, Cai et Nel, 2015 is the third representative of Platycnemididae (Huang et al., 2015). *Burmalindenia imperfecta* Schädel and Bechly, 2016 is the first true dragonfly from Burmese amber (Schädel and Bechly, 2016). *Burmaphlebia reifi* Bechly and Poinar, 2013 is the first damsel-dragonfly from amber (Bechly and Poinar, 2013). *Burmahemiphlebia zhangi* Zheng et al., 2016a is the first member of the Hemiphlebiidae in Burmese amber and may be the most common damselfly in these deposits, since about 40 specimens have been observed by the present authors (Zheng et al., 2016a). *Palaeodysagrion cretacica* Zheng et al., 2016a represents the second Cretaceous dysagrionid damselfly (Zheng et al., 2016a). *Mesosticta burmatica* Huang, Azar, Cai et Nel, 2015 and *Mesosticta electronica* Zheng et al., 2016b are

the earliest fossil platystictid damselflies, which puts the origin of Platystictidae to at least mid-Cretaceous (Huang et al., 2015; Zheng et al., 2016b). *Palaeoperilestes electronicus* Zheng et al., 2016c is the first fossil representative of perilestid damselfly (Zheng et al., 2016c).

5. Conclusions

Abundant extant damselfly families have been discovered from mid-Cretaceous Burmese amber, indicating the important geological position of these tropical forests for early damselfly diversification. In the present paper, a new platycnemid damselfly, *P. cretacica* sp. nov., representing the second species of the extinct subfamily Palaeodisparoneurinae Poinar, Bechly et Buckley, 2010, is described from Burmese amber.

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