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Electrodysagrion neli sp. nov., the second Cretaceous dysagrionine damselfly (Odonata: Zygoptera: Dysagrionidae) from Kachin amber, northern Myanmar

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The dysagrionid damselflies, characterized by a broad quadrilateral discoidal cell, are widely recorded in the Lower Cretaceous–lower Oligocene, and frequently found in mid-Cretaceous Kachin amber (Zheng *et al*., 2016, 2017a, b, 2018a). Three genera and four species of Dysagrionidae have been described from Kachin amber, including *Burmadysagrion zhangi* Zheng, Wang & Nel, 2016, *Electrodysagrion lini* Zheng, Nel & Wang, 2017, *Palaeodysagrion cretacicus* Zheng *et al*., 2017 and *Palaeodysagrion youlini* Zheng, Chang & Wang, 2018 (Zheng *et al*., 2016, 2017a, b, 2018a). The dysagrionid damselflies have several types of discoidal cells seen in the Kachin amber species, contributing to evaluating the early evolution and diversification of the discoidal cell. For example, *Burmadysagrion* has the anterior and posterior sides of the discoidal cell not parallel, and the basal side longer than the distal side; *Electrodysagrion* has the anterior and posterior sides of the discoidal cell not parallel, and distal side longer than the basal side; and *Palaeodysagrion* has a long and narrow discoidal cell. In the present paper, a new dysagrionine damselfly is described representing the second dysagrionine in Kachin amber. The new damselfly allows for the revision of the generic characters of *Electrodysagrion* Zheng, Nel & Wang, 2017.

Material and methods

The specimen described herein was collected from the amber mines sited in the Hukawng Valley of Kachin Province, Myanmar (*i.e*., Kachin amber contra Tilin amber; locality in Zheng *et al*., 2018b). The rock containing the Burmese amber was radiometrically dated at 98.79 ± 0.62 Ma (Shi *et al*., 2012), which is widely accepted as a mid-Cretaceous age.

The amber piece (NIGP163292) 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). All taxonomic acts established in the present work have been registered in ZooBank (see below), together with the electronic publication LSID: urn:lsid:zoobank.org:pub:697FFF7B-C468-4888-B1AA-04BC2EF1CC87.

The nomenclature of the dragonfly wing venation used in this paper is based on the interpretations of Riek & 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). Vein abbreviations are as follows: AA, anal anterior; AP, anal posterior; Arc, arculus; Ax, primary antenodal crossvein; Cr, nodal crossvein; CuA, cubitus anterior; CuP, cubitus posterior; DC, discoidal cell; IR, intercalary radial vein; MA, median anterior; MP, median posterior; N, nodus; RA, radius anterior; RP, radius posterior; ScP, subcosta posterior; SdC, subdiscoidal cell; Sn, subnodal crossvein.

Systematic palaeontology

Order Odonata Fabricius, 1793
Suborder Zygoptera Selys-Longchamps, 1854
Family Dysagrionidae Cockerell, 1908
Subfamily Dysagrioninae Cockerell, 1908
Tribe Dysagrionini Cockerell, 1908

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Genus *Electrodysagrion* Zheng, Nel & Wang, 2017

Type species. *Electrodysagrion lini* Zheng, Nel & Wang, 2017; by original designation and monotypy.

Diagnosis (revised after Zheng et al., 2017a). No antenodal crossveins distal of Ax2; Arc aligned with Ax2; Cr and Sn obliquely aligned; ten postnodal crossveins present before Pt, well aligned with postsubnodal crossveins; Pt well-braced, covering one cell; RP1 with very slight angle below Pt-brace; longitudinal veins RA, RP1, IR1, RP2 and IR2 strongly converging on wing apex; IR1 zigzagged, originating nearer to Pt than N; RP2 originating three cells distal of Sn; IR2 base aligned with Sn; RP3/4 just below N; MA long, ending on posterior wing margin slightly distal of Pt; MP curved and long, ending on posterior wing margin two cells basal of Pt-brace; CuA zigzagged and long, ending on posterior wing margin basal of IR1 base; one row of cells present in cubito-anal area.

***Electrodysagrion neli* sp. nov.**
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Figs 1–3

Holotype. NIGP163292, complete forewing and hindwing; deposited in NIGPAS (Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences).

Etymology. The species name is in honour of Prof. André Nel, on his 60th birthday, for his contribution to palaeoentomology.

Diagnosis. Presence of a long cell in basal postdiscoidal area; maximum of two cells present between DC and N in postdiscoidal area.

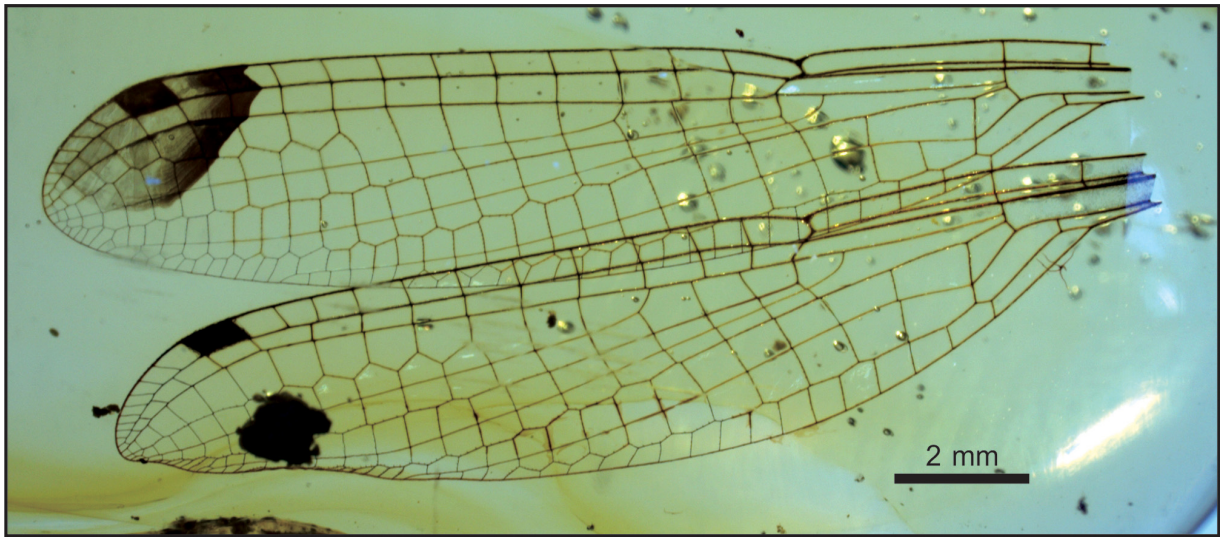

FIGURE 1. *Electrodysagrion neli* **sp. nov.**, holotype NIGP163292, photograph.

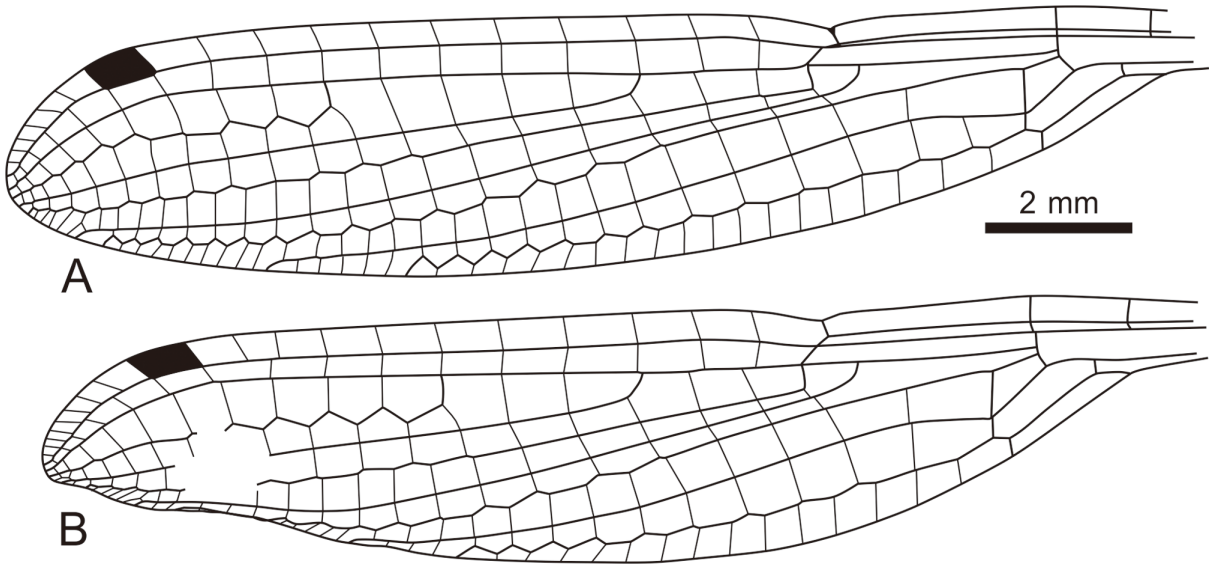

FIGURE 2. *Electrodysagrion neli* **sp. nov.**, holotype NIGP163292, line drawings. **A**, Forewing. **B**, Hindwing.

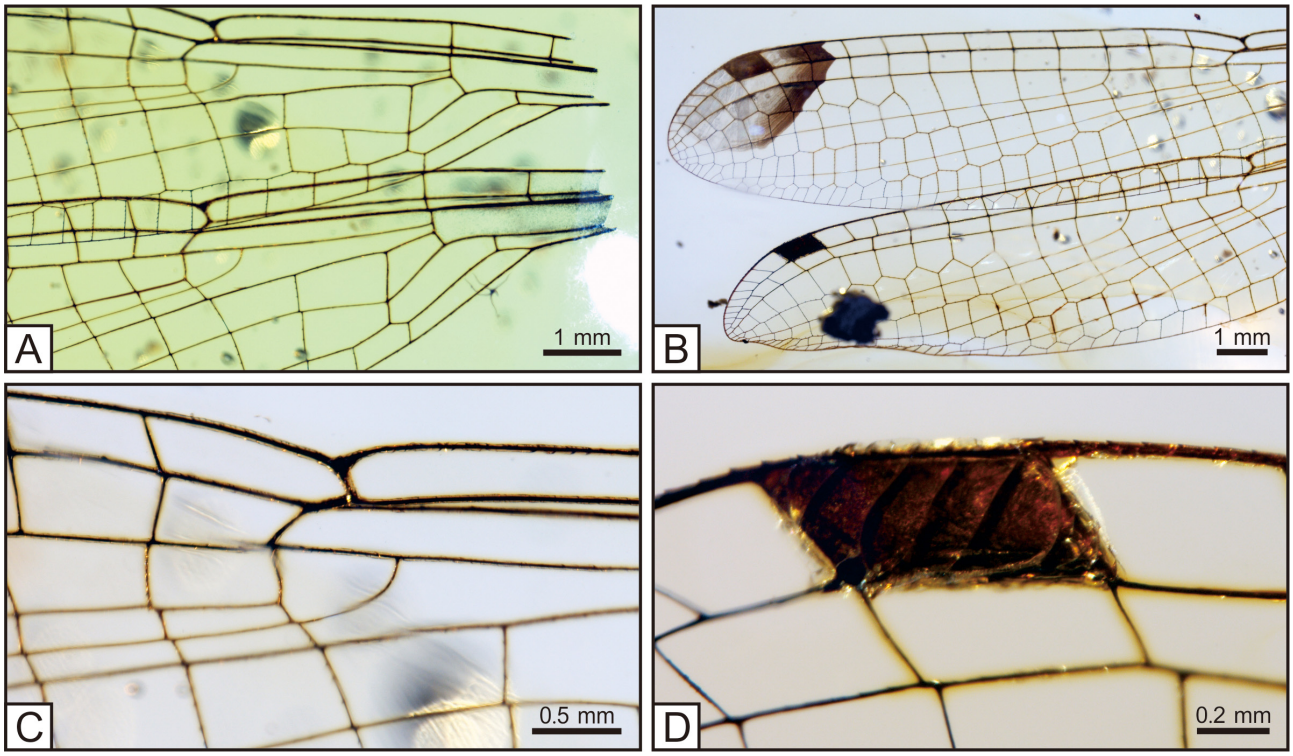

FIGURE 3. *Electrodysagrion neli* **sp. nov.**, holotype NIGP163292, photographs showing details. **A**, Wing bases. **B**, Wing apexes. **C**, Forewing nodus. **D**, Hindwing pterostigma.

Locality and horizon. Hukawng Valley, Kachin Province, Myanmar; lowermost Cenomanian, Upper Cretaceous.

Description. Specimen NIGP163292 (Fig. 1). Forewing length 16.37 mm, width at level of N 2.65 mm; length from wing base to Arc 2.02 mm, from Arc to N 3.02 mm, from N to Pt 9.24 mm, from Pt to wing apex 2.07 mm. Primary antenodal crossveins Ax1 and Ax2 preserved (Fig. 3A), Ax2 1.26 mm distal of Ax1; no secondary antenodal crossveins present. Ten postnodal crossveins present, well aligned with ten postsubnodal crossveins before Pt; six postnodal crossveins and five postsubnodal crossveins present distal of Pt, non-aligned (Fig. 3B). Arc angular and aligned with Ax2. DC basally closed, free and broad, somewhat quadrangular with distal side longer than basal side, with length of basal side 0.28 mm long, of anterior side 0.52 mm, of distal side 0.6 mm, of posterior side 0.88 mm. Subdiscoidal cell free and long, 1.58 mm long and maximum 0.41 mm wide. AA separated from AP 0.18 mm basal of Ax1. CuP nearer to Ax1 than to Ax2, 0.38 mm distal of Ax1. Nodal structures well preserved (Fig. 3C), Sn aligned with Cr. Midfork (base of RP3/4) basal of N, nearer to N than to Arc. IR2 aligned with Sn, one cell and 0.68 mm distal of midfork; base of IR2 lying towards wing base, almost perpendicular to RA and RP. IR1 long, originating five cells distal of base of RP2 and three cells basal of Pt base. RP1 with very slight angle below Pt brace. Longitudinal veins RA, RP1, IR1, RP2 and IR2 strongly converging on wing apex. MA distally zigzagged and long, reaching posterior wing margin slightly distal of Pt. MP curved and long, ending on posterior wing margin under mid-point between IR1 base and Pt-brace. CuA zigzagged and long, ending on posterior wing margin slightly basal of IR1. Pt well braced, covering one cell, 0.72 mm long and 0.48 mm wide (Fig. 3D).

Discussion

The new specimen has all the characters of the genus *Electrodysagrion* Zheng, Nel & Wang, 2017: no antenodal crossveins distal of Ax2, Arc aligned with Ax2; Cr and Sn obliquely aligned; postnodal crossveins well aligned with postsubnodal crossveins; base of IR2 aligned with Sn; RP2 originating three cells distal of Sn; IR1 zigzagged, originating nearer to Pt than to base of RP2; Pt hyaline and well braced; cubital area slightly broadened distally, with one row of cells just below N. *E. lini* was based on two very fragmentary wings with basal part preserved. The complete wing in this species provides additional characters for the wing apex. The difference between *Electrodysagrion neli* and *E. lini* is that the former has a long cell just distal of the discoidal cell and no more than two cells present between the discoidal cell and nodus in the postdiscoidal area compared with three in the latter.

Conclusion

The genus *Electrodysagrion lini* Zheng, Nel & Wang, 2017 is the first Cretaceous and the oldest record of the tribe Dysagrionini with the unique 'sieblosiid-dysagrionine' type of discoidal cell. The new species, *Electrodysagrion neli* **sp. nov.** adds to the diversity of dysagrionine damselflies, and helps to evaluate the early evolution of Dysagrionidae and the discoidal cell.

Acknowledgements

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