Pathological dino-age cockroach with biramous cercus

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The cercus is one of the most conservative, often family-diagnostic structure of cockroach macromorphology. A male specimen of *Perlucipecta lacrima* sp.n. (Mesoblattinidae) of this common burmite species bears a uniquely asymmetrically bifurcated right cercus – evidencing a unique developmental error. The phenomenon contributes to the wide array of Mesozoic pathologies observed in extinct cockroaches.

Keywords: Fossil insect - Cretaceous amber - Mesozoic cockroach - new species - North Myanmar

Introduction

Taphonomical deformations of fossil containers can reach 60% of morphological measurements or more in amber (Koubová and Mlynský 2020). Thus it is rather difficult to observe and discriminate ancient pathological, teratological conditions, injuries from moulting errors and attacks due to distortion of amber and/or sedimentary rocks (see Poinar and Poinar 2008). These conditions are mainly accessible based on regular morphological structures such as geometrical patterns of wing venations – either as caused genetically or by a virus (Vršanský et al. 2017, 2021). Due to generally understudied variabilities in morphological structures of ancient animals and insects in particular, it is still possible to discriminate only major deformities such as modified 4-segmented tarsi contrasting with normal 5-segmented (see Vršanský 2002; Barna et al. 2019; Vršanský et al. 2022; Li and Huang 2022). In some marine fossil organisms such as trilobites malformations are well documented (Bicknell et al. 2022). The enormously deformed cercus of the present holotype specimen desiganted here along with normaly developed additional specimens allow to directly access to an unusual pathological condition of unknown cause.

MM

Samples (holotype SNM Z 40250; additional material 40252, 40253) were collected in Hukawng valley, North Myanmar amber (26.4° N, 96.7° E: paleocoordinates 12.4° N, 93.8° E) and deposited in Slovak National Museum. Optical microphotography (Fig. 2) was performed using the optical microscope Leica M205 C with lens Planapo 1.0 with embedded light sources and attached Flexacam C1 camera (4 K, HD and 12MP resolutions). Adobe Photoshop "Automatic Photomerge" algorithm was used to combine 2–15 lateral final photographs. All-surface adjustments (sharpness, contrast) were applied to fine-tune structures. Illustrations (holotype, Fig. 1) were performed using CorelDRAW - the proportions look different due to lens-like shape of the amber piece.

Results

Order Mantides Latreille, 1802 Suborder Blattaria Latreille, 1810 Family Mesoblattinidae Handlirsch, 1906 Genus *Perlucipecta* Wei et Ren, 2013



SNM Z 40250 Figure 1 Illustration of *Perlucipecta lacrima* sp. n. holotype SNM Z 40250. Dorsal and ventral view.

Type species. *Perlucipecta aurea* Wei et Ren, 2013; Yixian.

Diagnosis (after Wei and Ren 2013): The present genus can be assigned to the family Mesoblattinidae based on the following features: branched forewing Sc; hindwing simple Sc; Rs differentiated; simplified M; CuA with secondarily branched veins and blind rami. It differs from all the other representatives of the family by the following features: expanded venation with retained intercalaries and distinct cross-veins; large size; facultative simplification of hindwing M. **Composition:** *P. vrsanskyi* Wei et Ren, 2013 (Yixian); *P. santanensis* Lee, 2016 (Crato); *P. cosmopolitana* Vršanský, 2020 (Bakhar).

Geographic range: cosmopolitan (Wei and Ren 2013; Lee 2016; Vršanský 2020)

Stratigraphic range: Middle Jurassic – Santonian

Perlucipecta lacrima sp. n.

Holotype: SNM Z 40250. A complete winged adult male. Deposited in Slovak National Museum.

Type locality: Hukawng valley, North Myanmar **Type horizon:** Myanmar amber (Burmite), Upper Cretaceous, earliest Cenomanian, 98.8 ± 0.6 million years (Shi et al. 2012).

Additional material: SNM Z 40252, 40253.

Differential diagnosis Differs from other species in having dark maculation on the anterior part of the forewing. It differs furthermore from *P. aurea* (f= 12–17 mm), *P. vrsanskyi* (f= 9–11 mm), *P. santanensis* (b= 8.7–11.9 mm) and *P. cosmopolitana* (f= 13 mm) in size.

Description. Length from head to end of hindwing 7.51 mm, width 2.92 mm. Head triangular (1.41/1.28 mm), almost entirely covered by pronotum. Antenna are slender, with at least 23 very small flagellomeres (0.11/0.05 mm), covered by moderately sized setae (0.08 mm long). Frons (0.82/1.29 mm), clypeus (0.18/0.76 mm), and labrum (0.41/0.35 mm) visible.

Pronotum rounded, broader than long, and somewhat discoidal centrally (2.77/1.4 mm).

Forewings well developed (6.06/2.45 mm), extending beyond abdomen, and with rich venation. Dark maculation anteriorly of the forewing. Costal area narrow. Sc short, with 1-2 branches. R richly branched, with at least 16 terminal veins, some apically forked. M stem parallel to R. M area wide, with at least 7 terminal branches. CuA area is somewhat reduced, with at least 5 terminal branches. CuP curved. Anal veins slightly curved, some forked, and joining CuP, with 8 branches. Intercalaries present.

Legs with standard carination. Procoxae elongated, triangular (1.11/0.53 mm). Femur (1.4/0.41 mm) preserved with 2 spines (0.32 mm long). Tibiae (?/0.18 mm) bearing large spines (0.29 mm long). Mesocoxae (1.11/0.71 mm) larger than procoxae. Metacoxae large, triangular (1.17/0.88 mm).

Body rounded, wide (4.21?/2.52 mm), last 5 sternites visible (0.47/2.75; 0.41/2.69; 0.41/2.57; 0.29/2.11; 0.36/1.52 mm). Sub-genital plate broad (0.47/1.05 mm). Supra-anal plate triangular (0.82/1.17 mm) with rounded edges, ventrolateral margin bearing small bristles (0.06 mm long). Cerci with 10 cercomeres (0.33/0.18; 0.10/0.13; 0.13/0.23; 0.20/0.15; 0.13/0.15; 0.18/0.10; 0.11/0.07;0.08/0.03; 0.07/0.03; 0.08/0.02) bearing dense long sensilla (0.59 mm long).

Derivation of name: after *lacrima* (Latin for a teardrop) – alluding to the shape of the amber piece.

Character of preservation. Sample (0.32 g) roundly polished and somewhat opaque due to bubbles and several cracks. Lower part of sample is linearly fractured, resulting in partially not preserved legs. Distal part of right cerci broken apart. Head not well-preserved; several flagellomeres, compound eyes, and mouthparts missing. Forewings are overlapping hindwings almost entirely.

Pathology: The right cercus is bifurcated at third cercomere. In the terminal cercomere both sides of the cercus were preserved excluding the simple split of dorsal and ventral side.

Discussion

The species can be classified within *Perlucipecta* due to the presence of slender antennae, rounded pronotum with characteristic pattern, narrow uncoloured costal area and colored rest of the wing, short Sc, M expanded, and narrow CuA.

Perlucipecta is a cosmopolitan genus known from the Middle Jurassic of Mongolia till the Santonian Taimyr amber (Vršanský 2019, 2020). It is apparently a generalist euryvalent taxon present in strict tropics of the Myanmar amber as well as in the forests beyond the polar circle. Nevertheless, it lived in times with warmer climate so it thermic tolerance might not be that significant. The first occurrence in Bakhar (FOD) of Mongolia relates with the thermic maximum.

Species belonging to this genus are coevally abundant, representing dominant species at least in Yixian and Taimyr, and possibly also in Crato. In the presently studied North Myanmar amber it is also a common genus with numerous adults and immature individuals collected. In the Bakhar it was rare (n= 4/1182 – Vršanský 2020).



Figure 2 Microphotography of *Perlucipecta lacrima* sp. n. **holotype** SNM Z 40250. **a** Dorsal; **b** Lateral; **c** Ventral; **d** Spine; **e** Antenna; **f** Ventral general; **g** Terminalia; **h** Wing apex; **I** Biramous cercus

This species apparently lived in the close vicinity of source amber trees as evidenced by its most common immature *Perlucipecta* individuals preserved. This is notable as usually, this taxon is rare in the sedimentary record with different source ecosystems. This inference supports the wide ecological tolerance of the genus.

The genus widens the taxonomical spectrum of the family Mesoblattinidae in the burmite which includes *Spinaeblattina* Hinkelman, 2019; *Mesoblatta* Hinkelman in Hinkelman and Vršanská (2020); *Sivis* Vršanský 2009; *Cuniculoblatta* Hinkelman, 2021 and *Mongolblatta* Vršanský, 2004 (Hinkelman 2019, 2021ab; Kováčová 2023).

The abundance of this family possibly played a role in the diversification of modern crown cockroaches (Blattidae, Blaberidae, Ectobiidae) (see Šmídová 2019, 2020; Šmídová and Lei 2017; Šmídová et al. 2021; Sendi 2021).

The herein studied pathological condition was rarely preserved in fossil insects and mostly are evidenced by cockroaches – in particular those with genetically-based wing venation deformities, virus-caused wing membrane deformity and presumably mechanically damaged 4-segmented tarsi (Vršanský 2005; Vršanský et al. 2017, 2021, 2022; Li and Huang 2022). The present deformity is apparently not caused genetically, as it is asymmetrical. Mechanical damage and any kind of infection in addition to a developmental (possibly shedding) failure cannot be excluded.

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References

Barna P, Šmídová L, Coutino Jose MA (2019) Living cockroach genus Anaplecta discovered in Chiapas amber (Blattaria: Ectobiidae: Anaplecta vega sp.n.). PeerJ 7:AR e7922. 10.7717/peerj.7922 Bicknell RD, Holmes JD, García-Bellido DC, Paterson JR (2023) Malformed individuals of the trilobite Estaingia bilobata from the Cambrian Emu Bay Shale and their palaeobiological implications. Geol Mag, 1-10. Handlirsch A (1906) Revision of American Paleozoic insects. Proc US Natl Mus 29(1441):661-820. https://doi.org/10.5479/si.00963801.29-1441.661 Hinkelman J (2019) Spinaeblattina myanmarensis gen. et sp. nov. and Blattoothecichnus argenteus ichnogen. et ichnosp. nov. (both Mesoblattinidae) from mid-Cretaceous Myanmar amber. Cretac Res 99:229-239. https://doi.org/10.1016/j.cretres.2019.02.026 Hinkelman J (2021a) Cuniculoblatta brevialata gen. et sp. n., the second case of brachyptery from Cretaceous North Myanmar amber. Palaeontogr Abt A 321(1-6):97-107. https://doi.org/10.1127/pala/2021/0104 Hinkelman J (2021b) Mongolblatta sendii sp. n. (Mesoblattinidae) from North Myanmar amber links record to Laurasian sediments. Palaeontogr Abt A 321(1-6):81-96.

https://doi.org/10.1127/pala/2021/0105 Hinkelman J, Vršanská L (2020) A Myanmar amber cockroach with protruding feces contains pollen and a rich microcenosis. Sci Nat 107(13). https://doi.org/10.1007/s00114-020-1669-y

Koubová I, Mlynský T (2020) Two new mid-cretaceous dictyopterans (Umenocoleidae: Vitisminae) from northern Myanmar exemplify taphonomic bias. AMBA Projekty 10(1):1–16

Kováčová Z (2023) New cockroach (Insecta: Blattaria) from North Myanmar amber. Biologia.

https://doi.org/10.1007/s11756-022-01295-1 Latreille PA (1802) Histoire naturelle, générale et particuliére des crustacés et des insectes. De L'imprimerie de F. Dufart, Paris.

Latreille PA (1810) Considérations Générales sur l'Ordre Naturel des Animaux Composant les Classes des Crustacés, des Arachnides, et des Insectes; Avec un Tableau Méthodique de leurs Genres, Disposés en Familles 1–444. F. Schoel, Paris.

https://doi.org/10.5962/bhl.title.39620 Lee SW (2016) Taxonomic diversity of cockroach assemblages (Blattaria, Insecta) of the Aptian Crato





Figure 3 (previous page) Microphotograph of *Perlucipecta lacrima* sp. n. paratypes SNM Z 40252 and 40253. **a** Ventral; **b** Dorsal (both 40252); **c** Head detail (40253).

Figure 4 Microphotograph of *Perlucipecta lacrima* sp. n. paratype SNM Z 40253.

Formation (Cretaceous, NE Brazil). Geol Carpath 67, 5: 433-450. 10.1515/geoca-2016-0027 Li XR, Huang DY (2022) Predators or herbivores: cockroaches of Manipulatoridae revisited with a new genus from cretaceous Myanmar amber (Dictyoptera: Blattaria: Corydioidea). Insects 13:732. https://doi.org/10.3390/insects13080732 Poinar G, Poinar R (2008) What bugged the dinosaurs?: insects, disease, and death in the Cretaceous. Princeton University Press ISBN: 9780691124315 Shi G, Grimaldi DA, Harlow GE, Wang J, Wang J, Yang M, Lei W, Li Q, Li X (2012) Age constraint on Kachin amber based on U-Pb dating of zircons. Cretac Res 37:155-163. https://doi.org/10.1016/j.cretres.2012.03.014 Šmídová L (2019) Unusual cockroaches (Blattidae) from Cenomanian Myanmar amber. Charles University, Prague Šmídová L (2020) Cryptic bark cockroach

(Blattinae: *Bubosa poinari* gen. et sp. nov.) from mid-Cretaceous amber of northern Myanmar. Cretac Res 109:104383. https://doi.org/10.1016/j.cretres.2020.104 383

Šmídová L, Lei X (2017) The earliest amber-recorded type cockroach family was aposematic (Blattaria: Blattidae). Cretac Res 72:189–199.

https://doi.org/10.1016/j.cretres.2017.01.008 Šmídová L, Vidlička Ľ, Wedmann S (2021) Appearance of the family Blaberidae (Insecta: Blattaria) during the cretaceous and a review of fossils of this family. Palaeontogr Abt A 321(1–6):71–79. https://doi.org/10.1127/pala/2021/0109 Sendi H (2021b) Highly specialised basal ectobiid cockroaches (Blattaria: Blattoidea) were rare in burmese amber. Palaeontogr Abt A 321(1–6):109– 125. https://doi.org/10.1127/pala/2021/0106 Vršanský P (2002) Origin and the early evolution of mantises. AMBA Projekty 6(1):1–16 Vršanský P (2005) Mass mutations of insects at the Jurassic/Cretaceous boundary? Geol Carpath 56(6):473– 781

Vršanský P (2019) Santonian cockroaches from Yantardakh amber (Russia: Taimyr) differ in dominance. Palaeoentomology 2(3):297–307. https://doi.org/10.11646/palaeoentomology.2.3.15 Vršanský P (2020) Cockroaches from Jurassic sediments

of the Bakhar formation in Mongolia. Springer Nature, Cham, pp 1–98. https://doi.org/10.1007/978-3-030-59407-7

Vršanský P, Oružinský R, Aristov D, Wei DD, Vidlička L, Ren D (2017) Temporary deleterious mass mutations relate to originations of cockroach families. Biologia 72:886–912. https://doi.org/10.1515/biolog-2017-0096 Vršanský P, Vršanská L, Beňo M, Bao T, Lei XJ, Ren XJ, Wu H, Šmídová L, Bechly G, Jun L, Yeo M, Jarzembowski E (2019a) Pathogenic DWV infection symptoms in a cretaceous cockroach. Palaeontogr Abt A 314:1–10. https://doi.org/10.1127/pala/2019/0084 Vršanský P, Palková H, Vršanská L, Koubová I, Hinkelman J (2022b) Mesozoic origin-delayed explosive radiation of the cockroach family Corydiidae Saussure, 1864. Biologia. https://doi.org/10.1007/s11756-022-01279-1 Wei DD, Ren D (2013) Completely preserved cockroaches of the family Mesoblattinidae from the Upper Jurassic-Lower Cretaceous Yixian Formation (Liaoning Province, NE China). Geol Carpath 64, 4: 291-304. 10.2478/geoca-2013-0021

Vršanský P, Sendi H (2022) Pathological dino-aged cockroach with biramous cercus. *Amba projekty* 12(1):1–8

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