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Short communication

Pelretes bicolor sp. nov., a new short-winged flower beetle (Coleoptera: Kateretidae) from mid-Cretaceous amber of northern Myanmar

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A B S T R A C T

Kateretid beetles are among the earliest known pollinators of angiosperms that can be traced back to the Cretaceous, but their palaeodiversity remains poorly explored due to the scarcity of fossil evidence. Here we report a new species, *Pelretes bicolor* sp. nov., from mid-Cretaceous Kachin amber mined in northern Myanmar. The new species is distinguished from the type species *Pelretes vivificus* most prominently by the elytral disc having a dull trapezoidal mark and 9 parallel punctate grooves on each elytron.

1. Introduction

Kateretidae, commonly known as short-winged flower beetles, are a small family of nitiduloid beetles with 10 fossil species and less than 100 described extant species in 14 genera globally (Jelinek and Cline, 2010). Kateretids are small-sized beetles ranging in length from 1.4 mm to 3.6 mm. They inhabit various biotopes, from forests to semideserts, mostly in temperate and subtropical zones of both the Northern and Southern Hemispheres, excluding New Zealand (Hisamatsu, 2011). Perhaps the most notable feature of their biology is that both larvae and adults are anthophagous, feeding on angiosperm pollen (Jelinek and Cline, 2010). On the basis of recent phylogenomic studies, Kateretidae are no longer classified in the old superfamily Cucujoidea, but are treated as a member of the newly defined Nitiduloidea (McKenna et al., 2019; Cai et al., 2022).

The rise of the angiosperms in the Cretaceous precipitated a series of changes known collectively as the Cretaceous Terrestrial Revolution (Lloyd et al., 2008; Benton et al., 2022). Since Kachin amber from northern Myanmar amber was formed during the earliest Cenomanian, perhaps even earlier (Cruickshank and Ko, 2003; Yu et al., 2019), coinciding with the rapid expansion of angiosperms, it offers a unique window for understanding how plant-insect interactions responded to this ecological transformation.

To date, six kateretid species have been described from Myanmar amber, namely *Furcalabratum burmanicum* (Poinar and Brown, 2018), *Cretaretes minimus* (Peris and Jelínek, 2020), *Eoceniretes antiquus* (Peris and Jelínek, 2020), *Polliniretes penalveri* (Peris and Jelínek, 2019), *Electrumeretes birmanicus* (Peris and Jelínek, 2019) and *Pelretes vivificus* (Tihelka et al., 2021). *Cretaretes minimus, E. antiquus* and *E. birmanicus* were suggested as potential pollinators of gymnosperms, whereas *P. penalveri* was suggested as pollinators for basal angiosperms (water lilies) (Peris et al., 2020). The present study describes a new species of Kateretidae preserved in Myanmar amber, enriching the palaeodiversity of the genus *Pelretes*. The new fossil also preserves some characteristics of the head and ventral abdomen that cannot be observed in the type species due to diagenetic artefacts.

2. Material and methods

The type specimen of Myanmar amber is housed in the Nanjing Institute of Geology and Palaeontology (NIGP), Chinese Academy of Sciences, Nanjing, China. Myanmar amber comes mainly from

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amber mines near the Noije Bum Hill summit site 20 km southwest of Tanai, in the Hukawng Valley, Kachin Province, northern Myanmar (Cruickshank and Ko, 2003; Yin et al., 2018). The age of Myanmar amber has been constrained to the middle Cretaceous, earliest Cenomanian (around 98.79 ± 0.62 Ma) with palaeontological and radiometric data (Shi et al., 2012). The studied specimen of Myanmar amber was legally acquired before June 2017 (see statement "Museum Catalogue Entry" in Supplementary material). The nomenclatural acts established herein are registered under ZooBank LSID urn:lsid:zoobank.org:pub:EDBF1D49-A09E-454B-9CF7-915A0C45FCCA.

The amber piece was ground with sandpapers of various sizes and polished with diatomite mud (Sidorchuk and Vorontsov, 2018). Photographs were taken using two devices: a Zeiss Stereo Discovery V16 microscope system with incident light and transmitted light, and a Zeiss Axio Imager 2 light microscope with a fluorescence imaging system. The images were rendered using the Helicon Focus software for extended depth of field. Figure plates were compiled and arranged in Adobe Photoshop 2021.

3. Systematic palaeontology

Order Coleoptera Linnaeus, 1758
Superfamily Nitiduloidea Latreille, 1802
Family Kateretidae Erichson in Agassiz, 1846
Genus *Pelretes* Tihelka, Li, Fu, Su, Huang and Cai 2021

Species ***Pelretes bicolor*** sp. nov.
(ZooBank LSID urn:lsid:zoobank.org:act:428C6483-964A-40AC-A6EB-535F88ADC273)
Figs 1–3

Etymology. The specific epithet is derived from the colouration of the elytra, a distinctive feature of this species.
Diagnosis. Body elongate, almost parallel-sided and dorso-ventrally flattened; mandibles not enlarged; head not distinctly constricted behind the eyes; antennal insertions concealed by protruding expansions of the frons; antennal club not parallel-sided; pronotum distinctly wider than long, with rounded anterior and posterior angles, smooth lateral margins and no carinae; scutellum large and triangular with a rounded apex; four abdominal segments exposed; apical elytral margin straight in medial half; elytron bicoloured, with a trapezoidal white spot; elytra decorated with indistinct nine longitudinal stripes each; meso- and metatibia with two rows of spines.
Holotype. NIGP179899, sex unknown.
Type locality and horizon. Amber mine in the Hukawng Valley, Myitkyina District, Kachin State, Myanmar; Cenomanian.
Description. Body almost parallel-sided and dorsoventrally flattened, pale brown to dark brown (Fig. 1). Setae on antennae, legs, and abdomen (Fig. 1B). Body length 1.2 mm (measured from mandibular apex to abdominal apex), body width 0.6 mm across the elytra at the broadest point.

Head prognathous, not covered by pronotum, subtrapezoidal, 0.2 mm long exclusive of the mandibles and 2.2 times wider than long (Fig. 2A). Mandibles extended slightly, and reaching as far as pedicel, base width slightly greater than pedicel length, and apex strongly curved such that outer apical margin runs parallel to the anterior margin of the frons; two symmetrical semicircular sclerites observed in the middle of mandible, about half of mandible

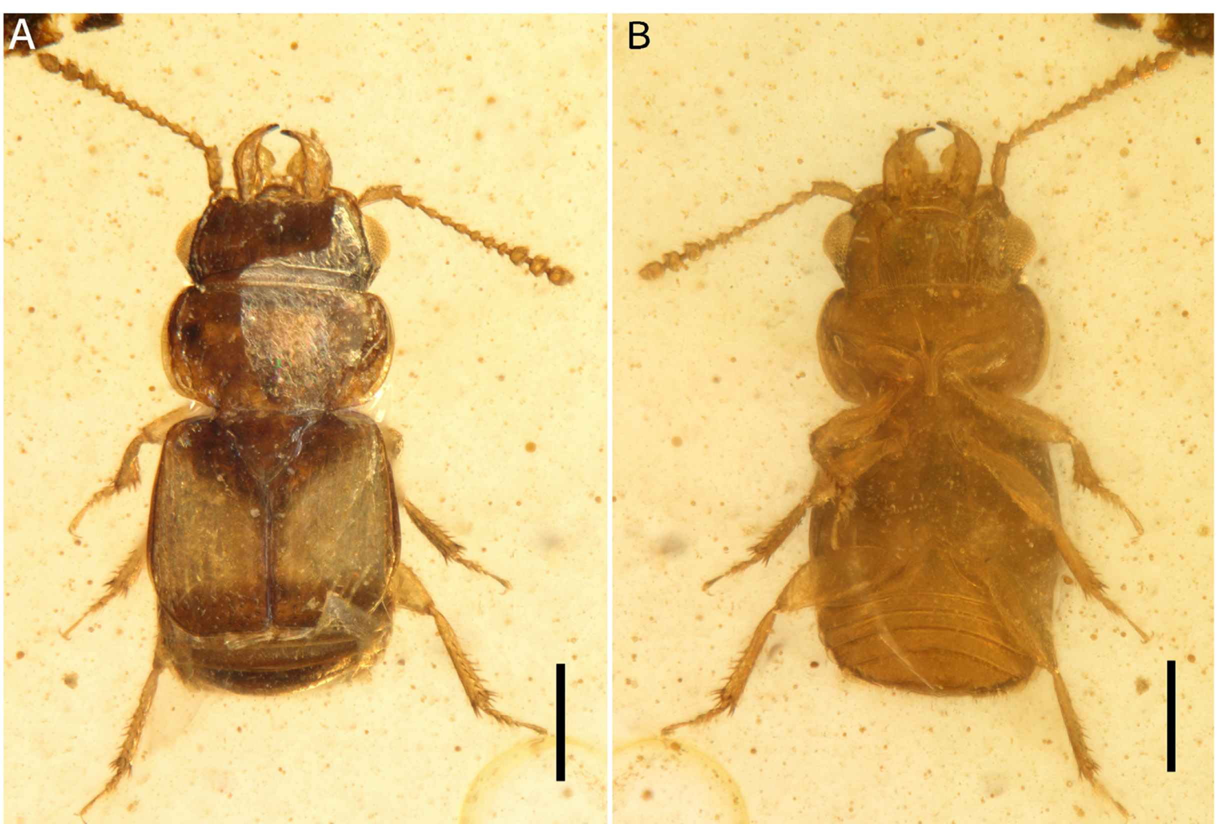

Fig. 1. Photomicrographs of *Pelretes bicolor* sp. nov. from mid-Cretaceous Burmese amber; under normal reflected light (holotype, NIGP179899). A, dorsal view. B, ventral view. Scale bars, 250 μm.

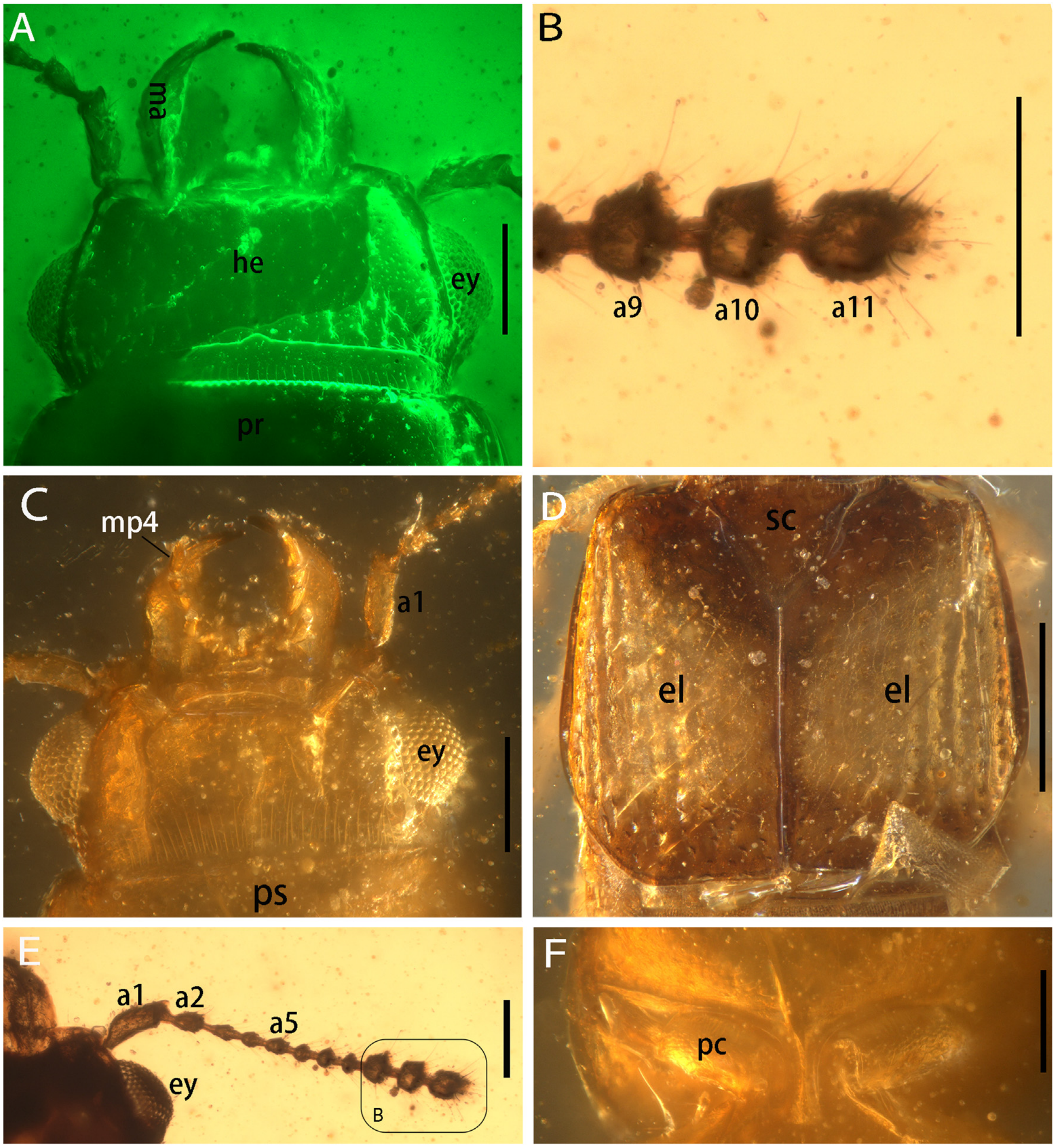

Fig. 2. Morphological details of *Pelretes bicolor* sp. nov. from mid-Cretaceous Burmese amber (holotype, NIGP179899) A under green epifluorescence, B and E under transmitted light, C, D and F under normal reflected light. A, dorsal view of head. B, antenna club. C, ventral view of head. D, elytra. E, antenna. F, prosternum. Abbreviations: a1, antennomere 1; a2, antennomere 2; a5, antennomere 5; a9–a11, antennomeres 9–11; el, elytron; ey, eye; he, head; ma, mandible; mp4, maxillary palpomere 4; pc, procoxa; pr, pronotum; ps, prosternum; sc, scutellum. Scale bars: 200 μm in D, 100 μm in others.

length and 1/5 of width (Fig. 2A). Maxillary palpi four-segmented, with a cylindrical apical palpus, 1.8 times longer than the preceding segment (Fig. 2C). Anterior margin of frons straight, with angular expansions concealing the antennal insertions dorsally (Fig. 2E). Eyes oval, protruding, finely faceted, with interfacetal setae absent (Fig. 2E). Antennae 11-segmented and setose with relatively loose antenna club. Scape (antennomere 1) enlarged (Fig. 2E). Pedicel (antennomere 2) 1.1 times longer and 1.2 times wider than the following segment (Fig. 2E). Antennomeres 3–8 gradually shorten and widen such that 1.8 times the length and 0.8 times the width differences between antennomere 3 and 8 (Fig. 2E). Antennomeres 9–11 form a loose, non-parallel-sided antennal club, with antennomeres lengthening and narrowing apically such that antennomere 9 is 1.1 times longer and 0.7 times wider than antennomere 11 (Fig. 2B). Ultimate antennomere rounded smoothly at apex (Fig. 2B). Distinct sutures between vertex and frons present (Fig. 2A). Temples length hold approximately one-third of eye length (Fig. 2E). Gular sutures invisible (Fig. 2C).

Pronotum transverse, 0.3 mm long, 1.8 times wider than long, 1.5 times longer, and 1.2 times wider than head (Fig. 1A). Anterior margin of pronotum and prosternum straight with a row of setae (Fig. 2A, 2C). Lateral margins smooth, arc-shaped, with thin, light yellow translucent extension (Fig. 1A). Posterior margin slightly convex, anterior and posterior pronotal angles rounded, with posterior angles smoother (Fig. 1A). Disc of pronotum glabrate (Fig. 1A). Prosternum slightly raises and the meso- and metaventrite flattened (Fig. 1B, 2F, 3A). Scutellum large and triangular, 0.3 times elytral length and ~1 times width of a single elytron (Fig. 2D).

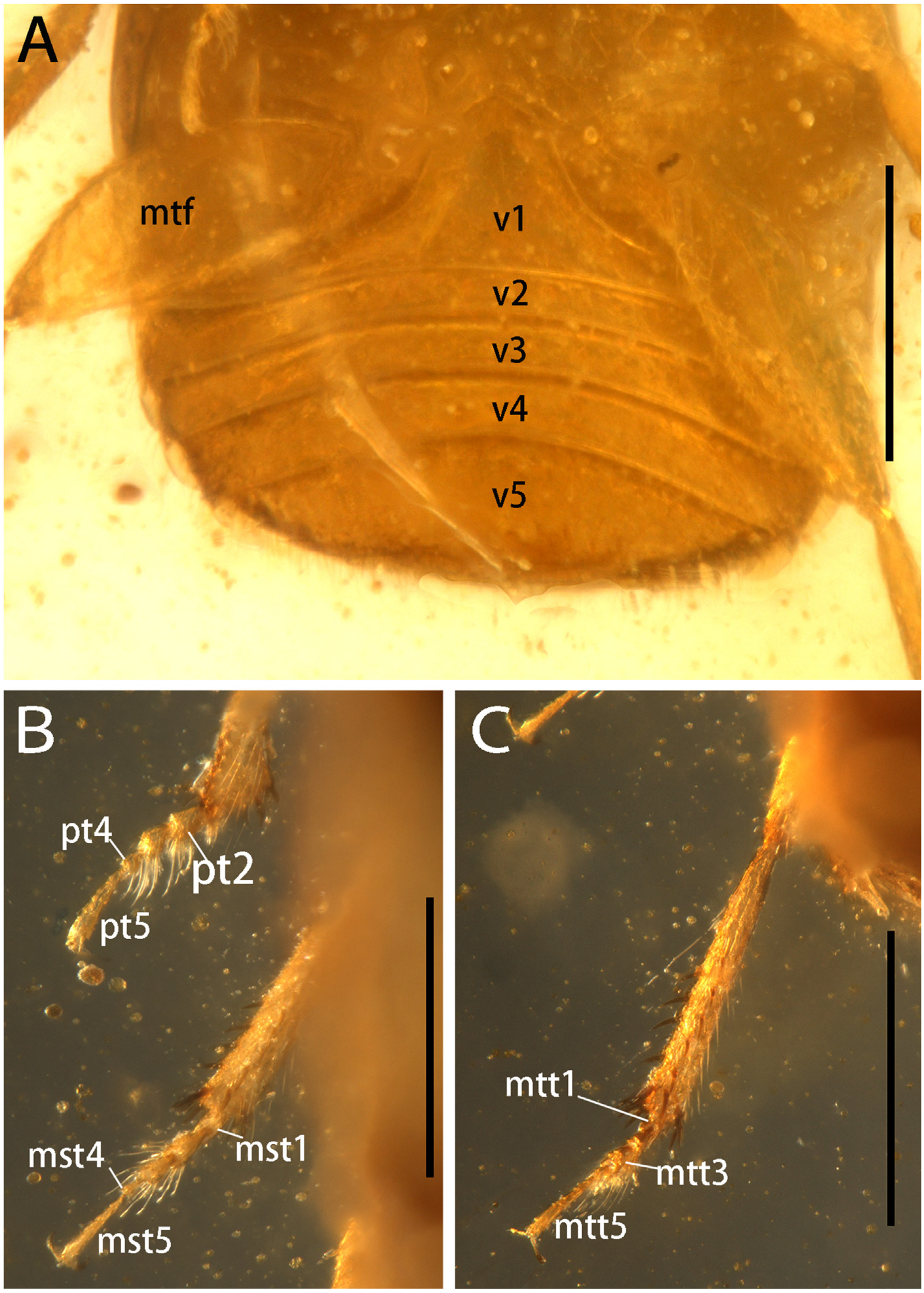

Fig. 3. Details of *Pelretes bicolor* sp. nov. from mid-Cretaceous Burmese amber; under normal reflected light (holotype, NIGP179899). A, ventral view of abdomen. B, pro- and mesotibia. C, metatibia. Abbreviations: mst1 mesotarsomere 1; mst4, mesotarsomere 4; mst5, mesotarsomere 5; mtf, metafemur; mtt1, metatarsomere 1; mtt3, metatarsomere 3; mtt5, metatarsomere 5; pt2 protarsomere 2; pt4 protarsomere 4; pt5, protarsomere 5; v1–5, ventrites 1–5. Scale bars: 200 μm.

Elytra truncate, with four abdominal tergites exposed dorsally (Fig. 1). Carinae on lateral margin of elytra absent (Fig. 2D). Epipleuron widest in basal half, and distinctly narrower in apical half. Symmetrical white trapezoidal colour markings on disc of elytra with 9 rows of parallel longitudinal grooves on each single elytron, and dense rows of punctures (striae indistinct from the overall observation, but numerable according to dot modification and arrangement of setae under microscope). Posterior margin of elytra straight in medial half and smoothly rounded laterally (Fig 2D).

Abdomen setose dorsally and ventrally (Fig. 3A). Ventrites 2.1 times wider than combined length with longest in the last ventrite, gradually taper apically, with basal ventrite the broadest (Fig. 3A).

Legs relatively elongate (Fig. 1). Procoxal cavities open (Fig. 2F). Meso- and metacoxae clearly separated by distance almost equal to coxal diameter (Fig. 1B). Femora setose, widest medially and shallowly caniculate for the reception of tibiae (Fig. 3A). Tibiae dilated apically (Fig. 1B). Protibiae setose in rows, with strong terminates setae (Fig. 3B). Meso- and metatibiae externally armed with two rows of spines; meso- and metatibial apex with about five spines

(Fig. 3B, 3C). Tarsal formula 5-5-5 (Fig. 3B, 3C). Tarsomeres 2–3 dilated and densely setose ventrally (Fig. 3B, 3C). Length of tarsomere 1 twice that of tarsomere 4 (Fig. 3B). Tarsomere 4 around half of tarsomere 3 length and approximately globular (Fig. 3B). Tarsomere 5 about 0.7 times as long as the preceding three segments combined (Fig. 3B, 3C). Claws simple (Fig. 3C).

4. Discussion

4.1. Morphological comparison

The new species is attributed to the extinct genus *Pelretes* based on the following characters: body approximately 1 mm long; prognathous head with a loose three-segmented antennal club; antennal insertions concealed by protruding expansions of the frons; subantennal grooves absent; scutellum relatively smooth, large and triangular; elytra short, with indistinctly impressed striae; procoxal cavities open; tarsal formula 5-5-5; transverse and rounded pronotum without carinae; and meso- and metatibia armed with rows of setae and spurs apically (Tihelka et al., 2021). *Pelretes bicolor* sp. nov. represents the second described species of *Pelretes* from the mid-Cretaceous Kachin amber.

The most distinctive difference between *P. bicolor* and *P. vivificus* is that the former has bilaterally symmetrical trapezoidal white markings on the elytra and 9 rows of punctures on each elytron, while *P. vivificus* has unfirmly coloured elytra with only faintly impressed grooves. In fact, longitudinal grooves in *P. bicolor* are not obvious along the entire length of the elytra The white markings on the elytra of *P. bicolor* are an obvious feature that separates the two species. Small sclerites were found in the middle of the mandible of *P. bicolor*, but these cannot be confirmed in *P. vivificus* where they are obstructed by diagenetically-formed foam. The protibia of *P. bicolor* are dilated apically making the terminals subtrapezoidal, while the protibia are elongate cylindrical and the apex slightly narrowed in *P. vivificus*. In *P. biocolor*, meso- and metacoxae are clearly separated by about the coxal diameter, while in *P. vivificus*, the distances are clearly more than the coxal diameter (Tihelka et al., 2021).

4.2. Palaeoecology

Kachin amber from northern Myanmar has yielded numerous insect pollinators, including the extinct family Panguidae, which may have been one of the earliest insect clades to pollinate angiosperms (Li et al., 2020), members of the extinct order Permopsocida preserving angiosperm pollen among their gut content (Huang et al., 2016), pollinating lacewings that occupied a broad spectrum of ecological niches as evidenced by their diverse mouthparts (Liu et al., 2018), and cockroaches (Hinkelman and Vršanská, 2020). Among beetles, members of the family Boganiidae Kachin amber have been found preserved alongside gymnosperm pollen (Cai et al., 2018), while an oedemerid beetle from Cretaceous Spanish amber has been found associated with gymnosperm pollen (Peris, 2020). Given that extant kateretids are pollinators, and associations with gymnosperm and angiosperm pollen have been reported in Kachin amber fossils (Peris et al., 2020; Tihelka et al., 2021, 2022), it is reasonable to expect that *P. biocolor* may have likewise belonged among Cretaceous pollinators, although direct evidence in the form of gut content or co-preserved pollen is lacking in the present fossil.

5. Concluding remarks

The present paper describes a new short-winged beetle, *Pelretes bicolor*, belonging to the extant Kateretidae, which are anthophagous, feeding on angiosperm pollen. *Pelretes bicolor* is distinguished from *P. vivificus*, the other species of *Pelretes*, by distinctive bilaterally symmetrical trapezoidal markings on the elytra and small sclerites on the middle of mandible. The discovery of *Pelretes bicolor* enriches the fossil record of Kateretidae in the Cretaceous Burmese amber.

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Data availability

The type specimen of Myanmar amber is housed in the Nanjing Institute of Geology and Palaeontology (NIGP), Chinese Academy of Sciences, Nanjing, China.

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References

Benton, M.J., Wilf, P., Sauquet, H., 2022. The Angiosperm Terrestrial Revolution and the origins of modern biodiversity. New Phytologist 233, 2017–2035. https://doi.org/10.1111/nph.17822.

Cai, C.Y., Escalona, H.E., Li, L.Q., Yin, Z.W., Huang, D.Y., Engel, M.S., 2018. Beetle pollination of cycads in the Mesozoic. Current Biology 28, 2806–2812. https://doi.org/10.1016/j.cub.2018.06.036.

Cai, C.Y., Tihelka, E., Giacomelli, M., Lawrence, J.F., Slipinski, A., Kundrata, R., Yamamoto, S.H., Thayer, M.K., Newton, A.F., Leschen, R.A., Gimmel, M.L., Lü, L., Engel, M.S., Bouchard, P., Huang, D.Y., Pisani, D., Donoghue, P.C., 2022. Integrated phylogenomics and fossil data illuminate the evolution of beetles. Royal Society Open Science 9, 211771. https://doi.org/10.1101/2021.09.22.461358.

Cruickshank, R., Ko, K., 2003. Geology of an amber locality in the Hukawng Valley, northern Myanmar. Journal of Asian Earth Sciences 21, 441–455. https://doi.org/10.1016/S1367-9120(02)00044-5.

Hinkelman, J., Vršanská, L., 2020. A Myanmar amber cockroach with protruding feces contains pollen and a rich microcenosis. The Science of Nature 107, 13. https://doi.org/10.1007/s00114-020-1669-y.

Hisamatsu, S., 2011. A review of the Japanese Kateretidae fauna (Coleoptera: Cucujoidea). Acta Entomologica Musei Nationalis Pragae 51, 551e585. https://doi.org/10.1016/j.pestbp.2010.11.008.

Huang, D.Y., Bechly, G., Nel, P., Engel, M.S., Prokop, J., Azar, D., Cai, C.Y., Kamp, T.v.d, Staniczek, A.H., Garrouste, R., Krogmann, L., Rolo, T.d.S., Baumbach, T., Ohlhoff, R., Shmakov, A.S., Bourgoin, T., Nel, A., 2016. New fossil insect order Permopsocida elucidates major radiation and evolution of suction feeding in hemimetabolous insects (Hexapoda: Acercaria). Scientifc Reports 6, 23004. https://doi.org/10.1038/srep23004.

Jelinek, J., Cline, A.R., 2010. Chapter 10.25 Kateretidae Erichson in Agassiz, 1846. In: Leschen, R.A.B., Beutel, R.G., Lawrence, J.F. (Eds.), Handbook of Zoology, Arthropoda: Insecta, Coleoptera, Beetles Morphology and Systematics. De Gruyter, Berlin, pp. 386–390. https://doi.org/10.1515/9783110911213.386.

Li, L.F., Rasnitsyn, A.P., Shih, C.K., Li, D.Q., Ren, D., 2020. A new species and diagnostic characters for Panguidae (Hymenoptera, Panguoidea). Cretaceous Research 115, 104563. https://doi.org/10.1016/j.cretres.2020.104563.

Liu, Q., Lu, X.M., Zhang, Q.Q., Chen, J., Zheng, X.T., Zhang, W.W., Liu, X.Y., Wang, B., 2018. High niche diversity in Mesozoic pollinating lacewings. Nature Communications 9, 3793. https://doi.org/10.1038/s41467-018-06120-5.

Lloyd, G.T., Davis, K.E., Pisani, D., Tarver, J.E., Ruta, M., Sakamoto, M., Hone, D.W., Jennings, R., Benton, M., 2008. Dinosaurs and the Cretaceous Terrestrial Revolution. Proceedings of the Royal Society of London. Series B 275, 2483–2490. https://doi.org/10.1098/rspb.2008.0715.

McKenna, D.D., Shin, S., Ahrens, D., Balke, M., Beza-Beza, C., Clarke, D.J., Donath, A., Escalona, H.E., Friedrich, F., Letsch, H., Liu, S., Maddison, D., Mayer, C., Misof, B., Murin, P.J., Niehuis, O., Peters, R.S., Podsiadlowski, L., Pohl, H., Scully, E.D., Yan, E.V., Zhou, X., Ślipiński, A., Beutel, R.G., 2019. The evolution and genomic basis of beetle diversity. Proceedings of the National Academy of Sciences 116, 24729–24737. https://doi.org/10.1073/pnas.1909655116.

Peris, D., 2020. Coleoptera in amber from Cretaceous resiniferous forests. Cretaceous Research 113, 104484. https://doi.org/10.1016/j.cretres.2020.104484.

Peris, D., Jelínek, J., 2019. Atypical short elytra in Cretaceous short-winged flower beetles (Coleoptera: Kateretidae). Palaeoentomology 2, 505–514. https://doi.org/10.11646/palaeoentomology.2.5.14.

Peris, D., Jelínek, J., 2020. Syninclusions of two new species of short-winged flower beetle (Coleoptera: Kateretidae) in mid Cretaceous Kachin amber (Myanmar). Cretaceous Research 106, 104264. https://doi.org/10.1016/j.cretres.2019.104264.

Peris, D., Labandeira, C.C., Barron, E., Delclos, X., Rust, J., Wang, B., 2020. Generalist pollen-feeding beetles during the mid-Cretaceous. iScience 23 (3), 100913. https://doi.org/10.1016/j.isci.2020.100913.

Poinar Jr., G., Brown, A.E., 2018. Furcalabratum burmanicum gen. et sp. nov., a short-winged flower beetle (Coleoptera: Kateretidae) in mid-Cretaceous Myanmar amber. Cretaceous Research 84, 1–5. https://doi.org/10.1016/j.cretres.2017.11.010.

Shi, G., Grimaldi, D.A., Harlow, G.E., Wang, J., Wang, J.Y.M., Lei, W., Li, Q., Li, X., 2012. Age constraint on Burmese amber based on U-Pb dating of zircons. Cretaceous Research 37, 155e163. https://doi.org/10.1016/j.cretres.2012.03.014.

Sidorchuk, E.A., Vorontsov, D.D., 2018. Preparation of small-sized 3D amber samples: state of the technique. Palaeoentomology 1, 80–90. https://doi.org/10.11646/palaeoentomology.1.1.10.

Tihelka, E., Li, L.Q., Fu, Y.Z., Su, Y.T., Huang, D.Y., Cai, C.Y., 2021. Angiosperm pollinivory in a Cretaceous beetle. Nature Plants 7 (4), 445–451. https://doi.org/10.1038/s41477-021-00893-2.

Tihelka, E., Li, L., Fu, Y., Su, Y., Huang, D., Cai, C., Li, L., Fu, Y., Su, Y., Huang, D., Cai, C., 2022. Reply to: Pelretes vivificus was a pollinator of Cretaceous angiosperms. Nature Plants 8, 41–44. https://doi.org/10.1038/s41477-021-01045-2.

Yin, Z., Cai, C., Huang, D., 2018. Last major gap in scydmaenine evolution filled (Coleoptera: Staphylinidae). Cretaceous Research 84, 62–68. https://doi.org/10.1016/j.cretres.2017.10.026.

Yu, T.T., Kelly, R., Mu, L., Ross, A., Kennedy, J., Broly, P., Xia, F.Y., Zhang, H.C., Wang, B., Dilcher, D., 2019. An ammonite trapped in Burmese amber. Proceedings of the National Academy of Sciences 116, 11345–11350. https://doi.org/10.1073/pnas.1821292116.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.cretres.2022.105330.