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Short communication

New bizarre flies from mid-Cretaceous Burmese amber (Diptera, Rhagionemestriidae)

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ABSTRACT

Two new genera and species referred to the extinct family Rhagionemestriidae are illustrated and described as *Burminemestrinus qiyani* gen. et sp. nov. and *Viriosinemestrius mai* gen. et sp. nov. from "mid-Cretaceous" Burmese amber. Another new genus, *Cretinemestrimus* gen. nov., is proposed for the *Jurassinemestrinus euremus* (Grimaldi, 2016) (originally *Jurassinemestrinus eurema*, or *Jurassinemestrinus eurekus*) from the same locality. Based on the new records of Rhagionemestriidae, we emended the diagnosis of the family and summarized all the fossil records and their wing vernation variation through time.

1. Introduction

The family Rhagionemestriidae was first erected as a subfamily Rhagionemestriinae in Nemestrinidae by Ussatchov based on monotype from Karabastau Formation in Kazakhstan (Ussatchov, 1968), Nagatomi and Yang (1998) raised the subfamily to family level. Later, Mostovski and Martínez-Delclòs (2000) included two subfamilies Rhagionemestriinae and Heterostominae in the family Rhagionemestriidae, each of them including two tribes respectively, Rhagionemestriinae including Rhagionemestriini and Exeretomeurini (extant genus *Exeretoneura* Macquart, 1846 relict in Australia), Heterostominae including Heterostomini (extant genus *Heterostomus* Bigot, 1857 relict in Chile) and Sinomestriini (Early Cretaceous genus *Sinonemestrius* Hong and Wang, 1990 from Laiyang Formation). They also described two genera and three species (*Nagatommukha karabas* Mostovski and Martínez-Delclòs, 2000 from Middle-Upper Jurassic Karabastau Formation in Kazakhstan, *Iberomosca kakoeima* Mostovski and Martínez-Delclòs, 2000 from Lower Cretaceous of Spain and *Iberomosca ponomarenkoi* Mostovski and Martínez-Delclòs, 2000 from Lower Cretaceous Mongolia) in Rhagionemestriidae and argued Rhagionemestriidae as a connecting link between Xylophagidae and Nemestrinidae. Afterwards, based on larvae and molecular evidence, *Exeretoneura* appear to belong in the family Xylophagidae (Palmer and Yeates, 2000; Wiegmann et al., 2011), *Heterostomus* was in illustrated in Tabanomorpha based on adult and pupal morphology (Coscarón et al., 2013). After then, Zhang (2010) described a new genus and species *Jurassinemestrinus orientalis* Zhang (2010) from Middle-Upper Jurassic "Daohugou Formation" in Northeast of China, Nel (2010) described another genus and species *Sinomusca mostovkskii* Nel (2010) from Lower Cretaceous Yixian Formation in Northeast of China. Grimaldi (2016) described the first records of Rhagionemestriidae in Burmese amber and assigned it to *Jurassinemestrinus* formally known from Middle-Upper Jurassic Daohugou Formation, he stated the family Rhagionemestriidae distant from Xylophagidae, but quite closely related to Acroceridae. The component of Rhagionemestriidae becomes clear until 2017, Zhang described a new species in *Sinonemestrius* Hong and Wang, 1990 from the same locality, and transferred the genus to Heterostomidae, Sinonemestriinae (Zhang, 2017). Then,

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the fossil records of the extant family Rhagionemestriidae with only 3 species from Middle-Upper Jurassic, 3 species from Lower Cretaceous and 1 species in mid-Cretaceous Burmese amber.

Here we revised the diagnosis of the family based on all the fossil records and our new materials from mid-Cretaceous Burmese amber, have a detailed comparation between all records of Rhagionemestriidae, proposed *Jurassinemestrinus eurema* Grimaldi (2016) as a new genus and described two new genera and species from Burmese amber, to illustrate the high diversity on both species and vein venation of the enigmatic family.

2. Material and methods

The specimen QYAM-19001 is currently housed in the Nanjing Institute of Geology and Palaeontology (NIGP), Chinese Academy of Sciences, and will eventually be deposited in the Qiyan Amber Museum in Zibo City, Shandong Province (specimen available for study by contacting Bo WANG or Qingqing ZHANG). The other two specimens NIGP 171888 and NIGP 171889 are housed in the Nanjing Institute of Geology and Palaeontology (NIGP), Chinese Academy of Sciences. All of the specimens described and revised herein are from Hukawng Valley of Kachin Province, North Myanmar (Kania et al., 2015: fig. 1). The geological age of Burmese amber is considered as earliest Cenomanian, about 99 Ma based on the radiometric date obtained from amber bearing sedimentary rock (Shi et al., 2012), but recently an older age for the amber inclusions was widely accepted as the enclosing volcanoclastic matrix should be younger than amber, but recently Smith and Ross (2017) studied the amberground pholadid bivalve borings implicated the age of amber and amber-bearing bed were similar, suggest an early Cenomanian age for amber inclusions. As Cenomanian is earliest Late Cretaceous, so early Cenomanian locates at about the boundary of Late Cretaceous and Early Cretaceous, so here, we use "mid-Cretaceous" for wide geological age of Burmese amber.

The digital photomicrographs were taken using a stereomicroscope (Zeiss Stereo Discovery V 16 Microscope), all images are digitally stacked by Helicon software for better illustration of 3D structures. The figures were prepared with Adobe Photoshop CS6 for better contrast, line drawings were produced by Coreldrew X7, and measurements were taken by ImageJ software. All taxonomic acts established in the present work have been registered in ZooBank (see below), together with the electronic publication LSIC: urn:lsid:zoobank.org:pub:DB2D8647-2E33-463F-80E2-4206CE837F3D.

Wing venation terminology follows Wootton and Ennos (1989).

3. Systematic palaeontology

Order Diptera Linnaeus, 1758.
Suborder Brachycera Zetterstedt, 1842.
Family Rhagionemestriidae Ussatchov, 1968.

Type genus and species. *Rhagionemestrius* Ussatchov, 1968. Holotype of the type species *Rhagionemestrius rapidus* Ussatchov, 1968. (Restudied by Mostovski and Martínez-Delclòs, 2000).
Taxonomic composition. *Rhagionemestrius rapidus* (Ussatchov, 1968); *Nagatomukha karabas* (Mostovski and Martínez-Delclòs, 2000); *Iberomosca kakoeima* (Mostovski and Martínez-Delclòs, 2000); *Iberomosca ponomarenkoi* (Mostovski and Martínez-Delclòs, 2000); *Sinomusca mostovskii* (Nel, 2010); *Jurassinemestrinus orientalis* (Zhang, 2010); *Burmimusca qiyani* gen. et sp. nov.; *Viriosinemestrius maii* gen. et sp. nov.; *Cretinemestrinus euremus* (Grimaldi, 2016) comb. nov.
Diagnosis (emended). Body robust, compact, without bristles; head large, hemispherical; antenna very small, only three segments, apical with long stylus; wing with r-m vestigial or totally absent, a diagonal vein composed of Rs, R4+5, M1+2 beyond r-m or fused vein of R4+5 + M1+2, rest of M1+2 and M2; R1 and R2+3 long.

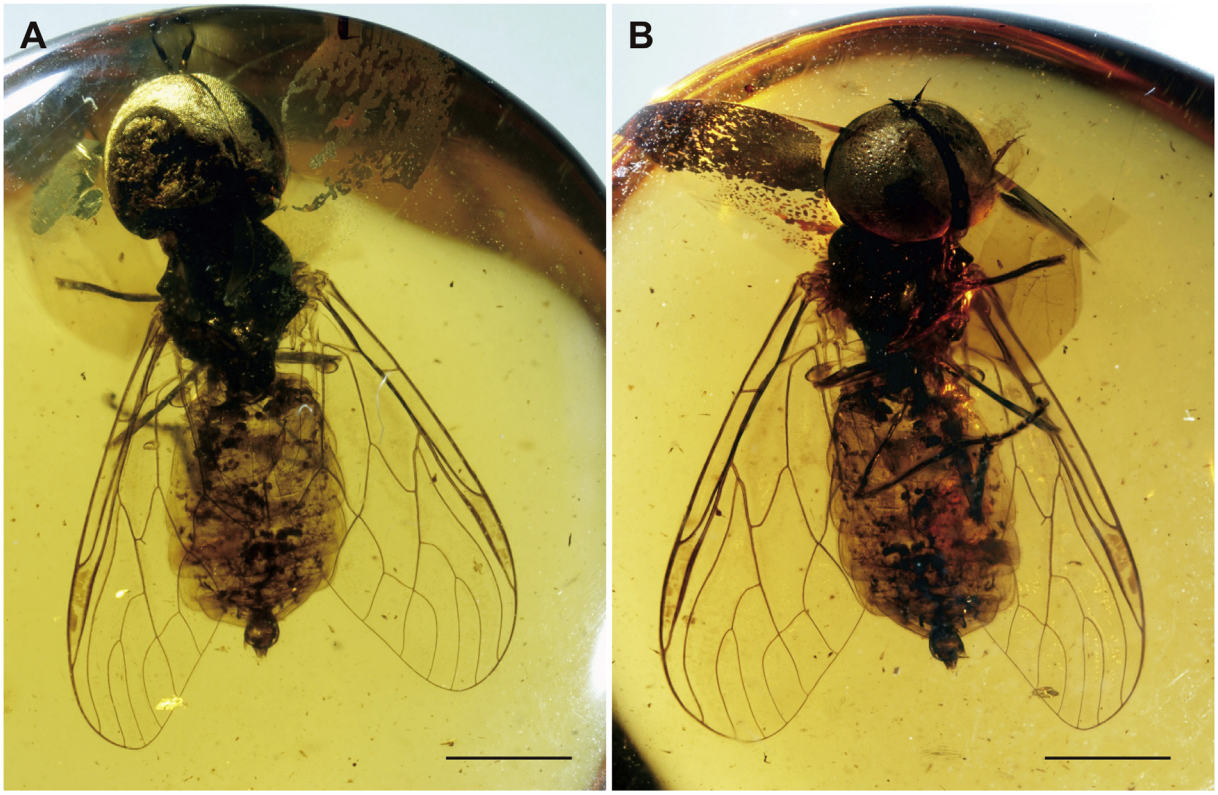

Fig. 1. *Burminemestrinus qiyani* gen. et sp. nov., holotype QYAM-19001. A, photograph of habitus in dorsal view; B, photograph of habitus in ventral view. Scale bars represent 2 mm.

Genus ***Burminemestrinus*** gen. nov.
(urn:lsid:zoobank.org:act:8268A757-7397-448F-BC5E-9CD7404DA84B)
Type species: *Burminemestrinus qiyani* sp. nov.

Etymology: The generic name is derived from the toponym Burma, the locality of the amber and the extant genus *Nemestrinus*. Masculine gender.
Diagnosis: Head large, hemispherical, distinctly wider than thorax; eyes holoptic, with extremely small facets; antennae small, flagellomere one-segmented, stylus well developed; mouthparts short, with expanded labellum exposed. Vernationally, apical part of R2+3, R4, R5 strongly downcurved; apex of R2+3 slightly lower than basad of R2+3; pterostigma present between Sc and R1; R4+5 arised from middle of cell d; distal part of M2 aligned with R4+5 + M1+2; cu closed before wing margin; epandrium small, simple, bulging from abdomen.

Burminemestrinus qiyani sp. nov.
(urn:lsid:zoobank.org:act:B14D972D-BC1B-417D-B8E0-9B355C4E2502)
Figs. 1-3.

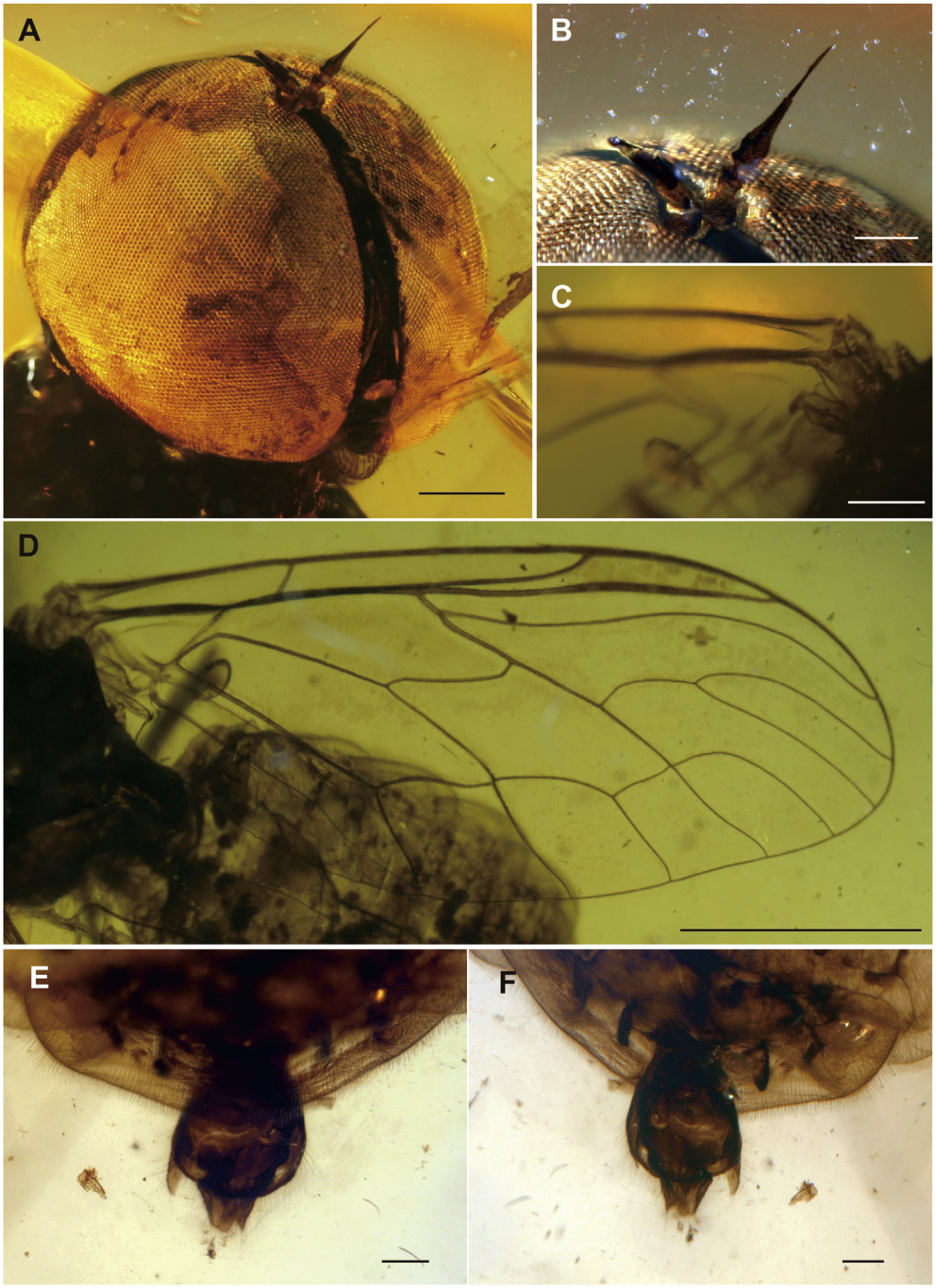

Fig. 2. *Burminemestrinus qiyani* gen. et sp. nov., holotype QYAM-19001. A, photograph of head in lateral-ventral view; B, photograph of antenna; C, photograph of wing base; D, photograph of wing; E, photograph of genitalia in dorsal view; F, photograph of genitalia in ventral view. Scale bars represent 0.5 mm in A, C; scale bars represent 2 mm in D; scale bars represent 0.2 mm in B, E, F.

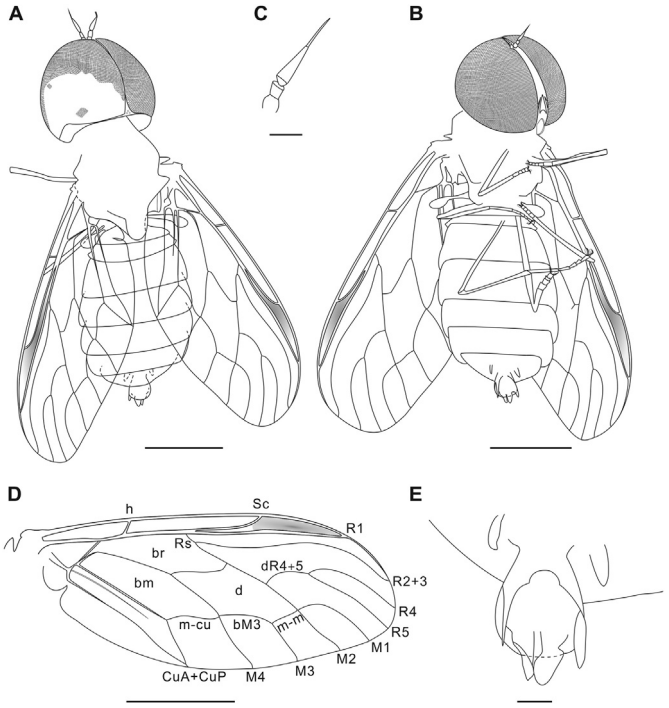

Fig. 3. *Burminemestrinus qiyani* gen. et sp. nov., holotype QYAM-19001. A, line drawing of habitus in dorsal view; B, line drawing of habitus in ventral view; C, line drawing of antennae; D, line drawing of wing; E, ling drawing of genitalia in dorsal view. S, D; scale bars represents 0.2 mm in C, E.

Etymology: Named after Mr. Qiyan (戚岩), amber collector from Zibo, Shandong Province, who provided the unique type specimen for us to study. Masculine gender.

Material: Holotype QYAM-19001 (male), shored at the Qiyan Amber Museum in Zibo City, Shandong Province.

Diagnosis: Eyes occupying nearly entire head; antennae with first flagellomere conical, apical with thin, tapered stylus; posterior margin of eye with simple indentation at the level of the antennae, but without dividing line; fork of R4+5 at the same level with fork M1+2; base of dR4+5 arising from cell d with a right angle; fork of R4 and R5 long; R4 ending near wing apex, R5 terminating apparently posterior to wing apex; pterostigma located between apices of Sc and R1; cell br as long as, but wider than bm; M2 aligned with the diagonal vein M1+2, R4+5 + M1+2 and Rs; m-cu linking to fork of M3+4; vein A present; thorax slightly thinner than head; two protuberances present beside the genitalia on apex of abdomen; epandrium bluging, convex.

Description: (male, based on the well preserved holotype QYAM-19001). Body large, 9.1 mm in length; thorax length 2.94 mm; abdomen length 4.66 mm (including genitalia); wing length 6.93 mm, width 2.69 mm.

Head very large, 2.07 mm length; hemispherical, wider than thorax in dorsal view. Eyes occupying nearly all the area of head, eyes bare, ommatidium small, diameter 0.025 mm, without any differentiation in dorsal, ventral and lateral view; face thin, with widest part only 0.24 mm, parafacial not present; eyes in vertex concave beside antennal sockets; frons nearly fully occupied by eyes, holoptic for 2/3 length of frons; posterior margin of eye with simple U-shaped indentation at the level of the antennae, but without dividing line visible; ocelli small, located on triangle ocellar tubercle, middle of ocellar tubercle with several soft hairs on. Occiput dark, without pilosity. Antennae small, 0.66 mm long, covered by microchaetae; antennal bases close together, antennal sockets meet; scape and pedicel cylindrical, equally in length, scape slightly wider than pedicel; flagellum 2 segments, equally in length; basal flagellomere coniform, apical with long stylus. Mouthparts small, with only labellum exposed beyond margins of eyes; labellum fleshy, expansive, laterally compressed, with pseudotracheal channels visible; palps attached beside clypeus, only one segment; clypeus well below antennae, small, just slightly longer than palps; clypeus just bulging beyond the level of eyes in lateral view.

Thorax thinner than head and abdomen, devoid of bristles; cuticle on thorax folding, dark in color, suture indiscernible; scutellum narrow triangle in dorsal view, covered by microchaeta. Wing broad and long, hyaline expect for the discrete light pterostigma between apex of Rs and R1; basicosta developed, slightly elongated; wing membrane glassy, devoid of microtrichia; h long, located basal to cell br; R1 long, apex reaching to 0.85× length of wing; Rs short, 0.3× bR4+5 length; R2+3 strongly sinuous, apex downcurved; dR4+5 arised from cell d vertically; vein R4 and R5 long, R4 ending near wing apex, R5 terminates apparently posterior to wing apex; cell br wider than bm, equally in length; cell d large, pentagonal, upper part of cell d evenly divided by vein dR4+5, lower part of cell d evenly divided by M4 and m-cu joint; M1 and M2 diverged from the same point of cell d; cell d with a spur on left wing; base of M1 upcurved; M2 strictly aligned with the diagonal; m-cu contact with cell d and M4 connection at the same point; cell cu closed just before wing margin, CuA thick, CuP much weaker; vein A present, near CuA. Legs slender, without macrosetae, only dense vestiture of microsetae present; tibial spurs absent on all legs; length of 1–4 tarsomeres diminishing; apical tarsomere as long as the second segment; pretarsus large, claws hook shaped; empodium pulvilliform, wider than pulvilli; empodium and pulvilli slightly shorter than claws.

Abdomen wide, fusiform, dorsoventrally flattened, 7 tergites visible; tergites overlapped sternites, all tergites setose; the widest tergite as wide as head; tergite 1 and 2 small; tergite 3, 4, 5 large, width increasing; tergite 6 slightly shorter and thinner than tergite 5; tergite 7 much thinner apically; sternites indistinguishable; two thorn shaped protuberances present beside the genitalia in dorsal view, the protuberances darker than tergite.

Male genitalia with epandrium bulged, well exposed, much thiner than tergitr 7; anterior half of epandrium covered by tergite 7, posterior margin of epandrium convex; cerci 1-segmented, expanded, laterally compressed; gonocoxite present, lobe shaped; gonostylus absent; all lobes on genitalia covered by fine setae.

Viriosinemestrius gen. nov.
(urn:lsid:zoobank.org:act:8AFB2F1B-46D6-4E5B-8E29-BAD515F601DB)

Type species: *Viriosinemestrius mai* sp. nov.

Etymology: The generic name is derived from "*Viriosus*" Latin, for various wing vein venation.

Diagnosis: Closely similar to *Burminemestrius* gen. nov. but, venationally, pterostigma shorter; cell br longer and wider than cell bm; R4, R5, M1 and M2 petiolate, arising distad to end of cell d; R4 strongly arched; R5 and M1 petiolate; cell cu closed at wing margin.

Viriosinemestrius mai sp. nov.
(urn:lsid:zoobank.org:act:B2B3B927-614C-4908-A3EA-76424D7F6C80)
Figs. 4-5.

Etymology: The specific name is from family name of Mr. Ma Wei (马威), the amber Collector Beijing, in honor of his contribution to donate species for scientific study.

Material: Holotype NIGP 171888 (male?) and paratype NIGP 171889 (male), stored at Nanjing Institute of Geology and Palaeontology (NIGP), Chinese Academy of Sciences, Nanjing, China.

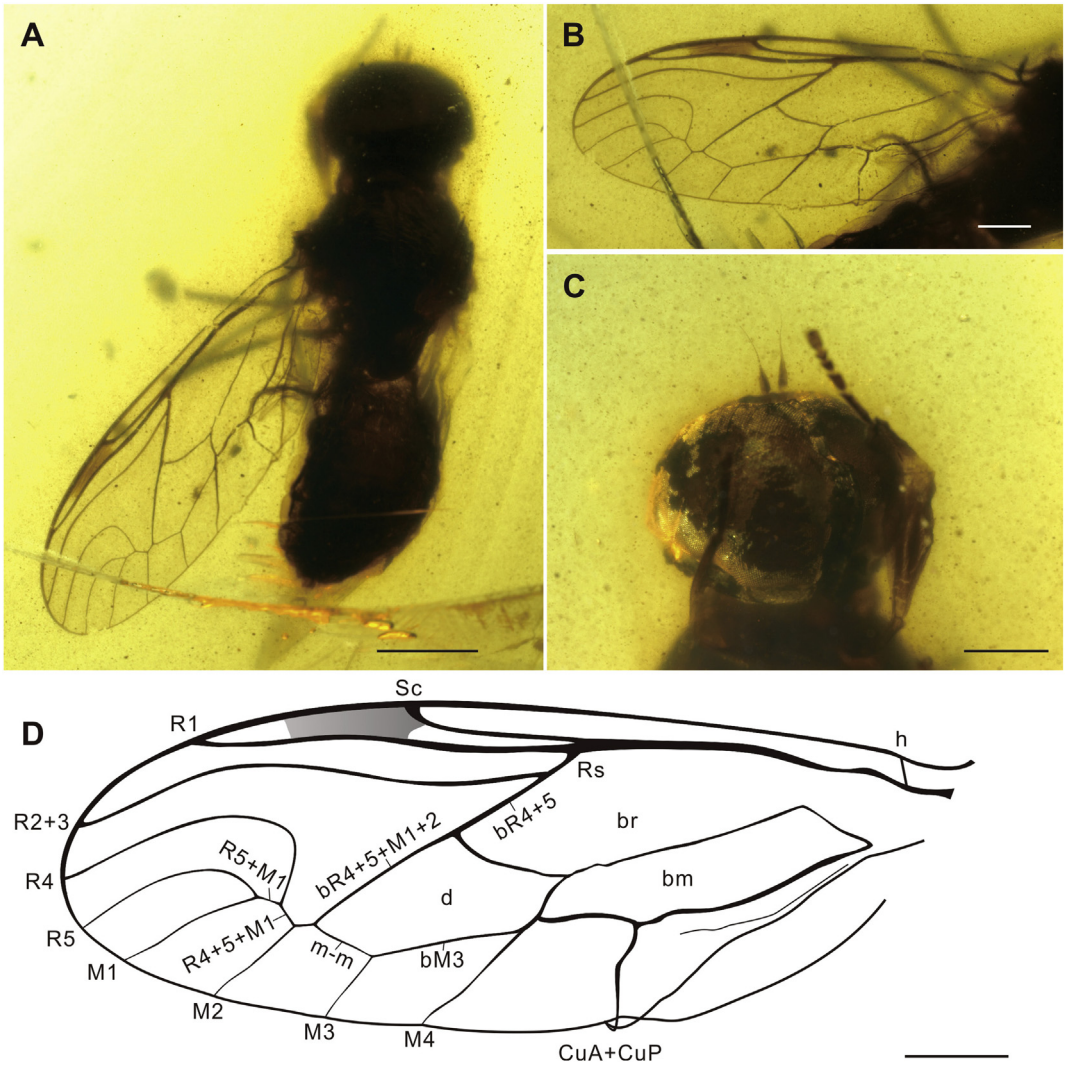

Fig. 4. *Viriosinemestrius mai* gen. et sp. nov., holotype NIGP 171888. A, photograph of head in dorsal view; B, photograph of head wing; C, photograph of head in lateral-ventral view; D, line drawing of wing. Scale bar represents 2 mm in A; scale bars represent 1 mm in B, C, D.

Diagnosis: redundant crossvein missing; connection of M2 and cell d short; br distinctly wider and longer than bm; cu closed at about wing margin; genitalia with epandrium deeply concave, gonocoxite and gonostylus horizontal articulated.

Description: (*Body structure based on holotype NIGP 171888 and male genitalia based on the paratype NIGP 171889).* Robust flies, darkly preserved, devoid macrosetae, only procumbent minute setae; large flies with body length 10.5 mm; wing length 8.7 mm, width 3.0 mm; head large, length 2.3 mm; **Head** hemisphere, slightly wider than thorax; compound eye bare, holoptic, occupying nearly all of head; facets of eyes small, without any differentiation; ocelli small, located slightly posterior to occiput; head capsule around antenna socket deeply sunken, with only apical of pedicel, basal flagellomere and stylus visible; antenna with basal flagellomere coniform, tapered to marrow width, apical with thin and long stylus; apex of pedicel with short hairs; length of basal flagellomere 0.40 mm, stylus 0.58 mm long; frons bare, very thin with width only 0.12 mm; clypeus with only upper part visible, slightly projected compound eyes, lower part of clypeus and mouthparts invisible.

Thorax dark, width 2.6 mm, without macrosetae; scutum slightly convex, scutellum large, wide triangular, with basal 1.29 mm wide, 1.38 mm long; wing long and narrow, hyaline except for heavily sclerotized pterostigma between apices of Sc and R1; pterostigma brown, not reached apices of sc; C circumambient, most strong between Sc and R1, thinned posterior to R4 apex; crossvein h faint, located in basal 1/4 of wing; Sc and R1 long, apex of Sc reaching 0.6× length of wing, apex of R1 reaching 0.85× length of wing; R1 slightly sinuous, with middle upcurved and apex slightly downcurved, basad of R1 parallel to apex of R1; R2+3 strongly sinuous, basad upper than apical of R2+3; vein Rs, basal R4+5, R4+5 + M1+2 composed the oblique line, they strictly assigned in this line; R5, M1, R4 and M2 connected with cell d by a short stem; M2 bifurcated directly from the stem, vein M2 straight, parallel to the diagonal vein; R4+5 + M1 nearly perpendicular with main stem R4+5 + M1+2; R4 bifurcated from the stem R4+5 + M1, strongly upcurved, apical parallel to R2+3; basal of R5 upcurved, apical parallel to R4; M1 straight, slightly shorter than R5; stem R4+5 + M1+2, R4+5 + M1 and R5+M1 about same length; width of cell r2+3 similar to r4; cell d large, hexagonal, width 1.02 mm, length 2.47 mm; cell br distinctly longer and wider than bm; bm with 3 apical corners; M3 short, straight; M4 much longer than M3, parallel with M3; cu closed just before wing margin; anal lobe undeveloped. Legs simple, without tibial spurs; all segments with dense short hairs; metatarsus with basal tarsus longest, about the same

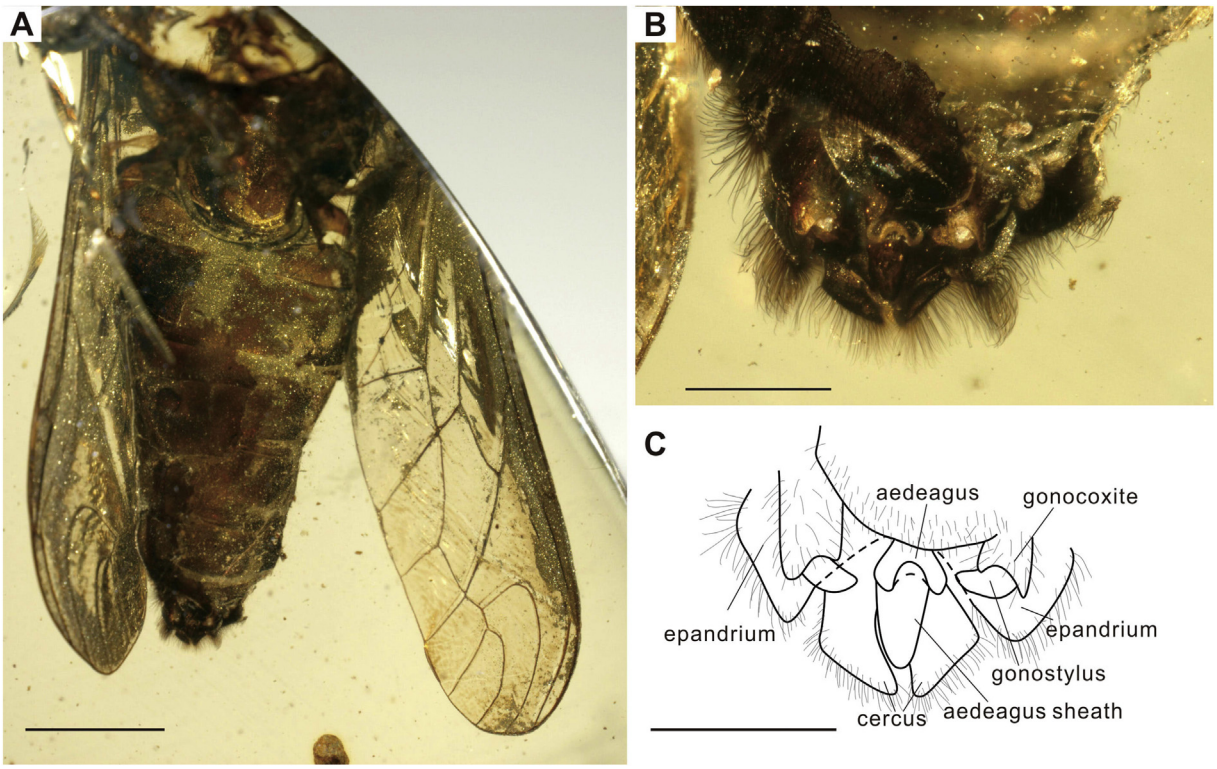

Fig. 5. *Viriosinemestrius mai* gen. et sp. nov., paratype NIGP 171889. A, photograph of habitus in dorsal view; B, photograph of genitalia in ventral view; C, line drawing of genitalia in ventral view. Scale bar represents 2 mm in A; scale bars represent 0.5 mm in B, C.

length with other tarsus combined; fourth tarsomere shortest, 0.1 mm long; pretarsus with claws developed, simple; empodium pulvilliform, shorter than claws; pulvilli as long as claws.
Abdomen broad, dorsoventrally flattened; basal tergites slightly wider than thorax; lateral tergites overlapped sternites, flatten.
Holotype with terminal structure indistinguishable.

Paratype well preserved, but with only scutellum, wings, tergites of abdomen and genitalia present, head and most of thorax missing; **male genitalia** well exposed, densely fringed with long, soft hairs; posterior margin of epandrium deeply concave; cercus large, 1 segmented, flat in lateral; gonocoxite stout and long, cylindrical, apical with horizontal articulated gonostylus; gonostylus relatively small, clavate, apical slightly pointed; aedeagus large, fusiform, apical of aedeagus backcurved; aedeagus sheath just above aedeagus, slightly shorter than cerci; hypandrium large, triangular, 0.5 mm width, 0.18 mm length.

Cretinemestrinus gen. nov.
(urn:lsid:zoobank.org:act:CAF4E74F-7902-4EEB-A652-52157054B36E)

Etymology: The generic name is derived from Cret- (Latin) and the extant genus *Nemestrinus*. Masculine gender.

Type species: *Cretinemestrius euremus* (Grimaldi, 2016) com. nov.

Diagnosis: pterostigma long; Sc long; R2+3 forked; R2 short crossvein-like, meeting R1; R3 running oblique downwards; crossveins present between R3 and R4, R4+5 and M1, respectively, and forming two subapical cells; cell br shorter but much wider than cell bm; R4+5 stem without short, incomplete vein projecting into cell rr; cell cu closed before wing apex; epandrium small, posterior margin flat; antenna three segmentations, flagellomere thin basally, fusiform, stylus long.

Remarks Grimaldi (2016) described a new species based on a male fly (AMNH Bu-SE3/3) from the Burmese amber, and named *Jurassicinemestrinus euremus* Grimaldi (2016). Originally, the specific name is mistaken as *J. eurema* and *J. eurekus* (Grimaldi, 2016, p. 55). Meanwhile, in the description, the vein R2 is absent, and R4+5 stem is with short, incomplete vein projecting into cell rr. However, on the basis of original microphotographs published (p. 111, figs 51A, E), the vein R2 should be present, and the short, incomplete vein projecting into cell rr missing.

This new genus is proposed for this species for the following reasons: R2+3 strongly sinuous and downcurved apically in which much similar with most of Cretaceous species but only slightly sinuous in *Jurassicinemestrinus orientalis*; R4 and R5, M1 and M2 distinctly downcurved in *C. euremus* but symmetrical branched in *J. orientalis*; apical part of R2+3, R4, R5, M1, M2, M3, M4 all subparallel in species in the known species in Burmese, but quite different in *J. orientalis*; pterostigma absent in *J. orientalis* but well developed in *C. euremus*. Griamaldi (2016) argued crossveins are considered minor modifications, but here *C. euremus* so different with *J. orientalis* that far beyond species level, so here we propose *Cretinemestrinus* gen. nov for the species.

4. Discussion

The representative of Rhagionemestrinidae in Jurassic show wing venation as fellows: r-m absent; R4+5 arised from cell d; R2+3 simple, not strongly sinuous (Fig 6, A-C). In Early Cretaceous, rhagionemestrinids have two different types: with very short r-m crossvein and R2+3 straight (Fig. 6 D); with sinuous R2+3, cell d quite large (Fig. 6E). In the mid-Cretaceous Burmese amber, Rhagionemestriidae has high diversity in the wing venation: with

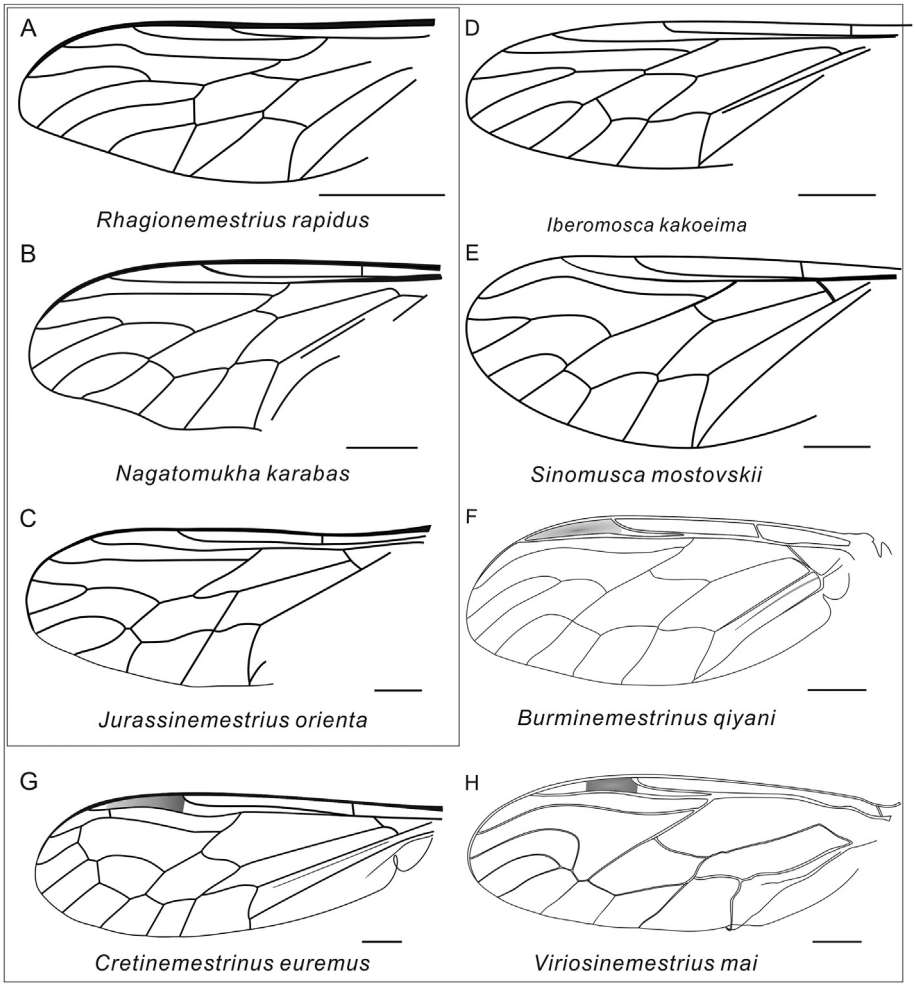

Fig. 6. Line drawing of wing vernation of Rhagionemestriidae fossil record. A-C from middle-late Jurassic; D-E from Early Cretaceous; F–H from mid-Cretaceous Burmese amber. A, *Rhagionemestrius rapidus*; B, *Nagatomukha karabas*; C, *Jurassinemestrius orienta*; D, *Iberomosca kakoeima*; E, *Sinomusca mostovskii*; F, *Burminemestrinus qiyani* gen. et sp. nov.; G, *Cretaceousinemestrinus euremus* gen. et sp. nov.; H, *Viriosinemestrius mai* gen et sp. nov. Scale bars all represent 1 mm.

the same similarities of strongly sinuous R2+3, pterostigma present, cu closed before wing margin. But, R4+5 and M1 are greatly various: *Burminemestrinus qiyani* with R4+5 directly from cell d, *Viriosinemestrius mai* with R4+R5+M1 from a common stem distad to the end of cell d; wing vernation of *Cretinemestrinus euremus* becomes much unique: R2+3 is forked; R2, as a short crossveins, meets R1; crossveins are well developed between R3 and R4 as well as R4+5 and M1 respectively.

Burminemestrinus qiyani gen. et sp. nov. shares similarities in the wing venation with those rhagionemestriids from the Early Cretaceous, especially for *Sinomusca mostovskii* Nel (2010) from the Yixian Formation of Northeast of China. They are similar in long Sc, R1, long and sinuous R2+3; R4+5 arised from middle of cell d with a right angle; M1 and M2 from the same corner of cell d; basal of M1 strongly upcurved. *Burminemestrinus qiyani* differs from *Sinomusca mostovskii* by apical of R2+3 lower than basad; R4 and R5 strongly downcurved; cell br much larger, nearly as long as bm; cell cu closed before wing apex and presence of pterostigma. *B. qiyani* shows characters with Jurassic and Early Cretaceous records, reveals characters of primitive and much advanced through time.

Cretinemestrinus euremus is quite unique in particular crossvein of r-r, short R2 and a vein connects between cell d with dR4+5 formed an additional cell rm; formed additional cells rr and rm in *Cretaceousinemestrinus euremus* than in other rhagionemestriids. Originally, *Cretinemestrinus euremus* was regarded as a member of *Jurassicinemestrinus* which occurs in Middle-Upper Jurassic "Daohugou Formation" of China, as the similar characteristics of R1, R2+3, R4+5 and M veins; the redundant crossveins and fork of R2+3 and argued crossveins are minor modifications in Orthorrhapha as a bracing mechanism for the wing tip during flight (Grimaldi, 2016), but besides the crossveins, *Cretinemestrinus euremus* shares the similarities with Cretaceous rhagionemestriids in strongly sinuous R2+3 and presence of pterostigma, but different in smaller cell d, stem M1+2 beyond cell d and much wider cell br.

The wing vernation in Burmese amber shows more advanced flight ability with present of pterostigma and various wing venation; eyes well developed with facets quite small and without any differentiation, similar to the Pipunculidae. Grimaldi (2016) illustrated that Rhagionemestriidae undisputable closely related with Acroceridae as hemispherical head comprised mostly of eyes; antenna small, with simple, stylate terminal article, reduced mumber of antennal segmentation. Fossil records of Acroceridae only include 13 species in 12 genera been described, 1 in Jurassic and 2 in Cretaceous Burmese amber. Acroceridae might have evolved during the late Triassic and diversified greatly in the Cretaceous based on molecular evidence (Winterton et al., 2007). The new record will build a connection to the evolution of Rhagionemestriidae and Acroceridae.

5. Conclusion

As the discovery of *Burminemestrinus qiyani* and *Viriosinemestrius mai* together with the record of *Cretinemestrinus euremus* in mid-Cretaceous Burmese amber, not only greatly increases the fossil record of the mysterious family, but also improving the diversity and abundance of this family in mid-Cretaceous Burmese amber. Vernation of brachyceran flies is quite stable, the new discoveries also illustrated the high diversity in wing venation of the family Rhagionemestriidae in mid-Cretaceous.

Declaration of competing interest

We declare that we have no financial and personal relationships with other people or organizations that can inappropriately influence our work, there is no professional or other personal interest of any nature or kind in any product, service and/or company that could be construed as influencing the position presented in, or the review of, the manuscript entitled “New bizarre flies from mid-Cretaceous Burmese amber (Diptera, Rhagionemestriidae)”.

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