The impact of a new genus on the molecular phylogeny of Hemisphaeriini (Hemiptera, Fulgoromorpha, Issidae)

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Abstract
A new genus, Retaldar gen. nov. of the family Issidae (Hemisphaeriinae, Hemisphaeriini) is described from Guangxi Province of China. A revised molecular analysis for the Hemisphaeriini based on partial sequences of 18S, 28S, COXI and Cytb, provides evidence for a new lineage within the subtribe Mongolianina. With two subgroups of genera now identified, the monophyly of Mongolianinina is discussed from both a morphological and a molecular basis.

Keywords
Hemisphaeriinae, molecular, morphology, new species, Oriental, planthoppers

Introduction
Recently Wang et al. (2016) proposed important changes to the classification of the planthopper family Issidae based on the first molecular analysis of the family. Supported also by a new set of morphological characters, several new lineages were identified forming a major group including almost all Oriental genera in the subfamily Hemisphaeriinae Melichar, 1906 sec. Wang et al. (2016). This important monophyletic unit...
currently groups around 100 genera and 486 species distributed in the Oriental region (Bourgoin 2019) with a few taxa in the New World such as *Picumna* Stål, 1864 (Wang et al. 2016). The subfamily is divided into four tribes according to the following topology: (Kodiaanellini Wang, Zhang & Bourgoin, 2016 + (Sarimini Wang, Zhang & Bourgoin, 2016 + (Parahiraciini Cheng & Yang, 1991 + Hemisphaeriini Melichar, 1906))) (Wang et al. 2016). The last tribe currently contains 28 genera and is divided into two sister subtribes: Mongolianina Wang, Zhang & Bourgoin, 2016 (6 genera) and Hemisphaeriina Melichar, 1906 (11 genera). Two unnamed lineages in each subtribe were also identified in the Wang et al. (2016) analysis. They were not discussed being considered as artificial due to sampling bias: several taxa belonged to the same genus (viz. *Mongoliona* Distant, 1909 and *Hemisphaerius* Schaum, 1850). Beside these 17 Hemisphaeriini genera, 11 other genera still remain in an incertae sedis position within the Hemisphaeriini (Bourgoin 2019).

In this paper, we describe and sequence the genes (18S, 28S (D3–D5) and (D6–D7), COXI and Cytb) of a new species of Hemisphaeriini from Guangxi Province of China, and provide several sequences for other known genera. These new data allow the reassessment of the subtribal division of Hemisphaeriini proposed by Wang et al. (2016).

**Materials and methods**

The specimens were collected by net capture and stored in alcohol. The genitalia were separated from the insect body using micro-scissors, and then boiled in 10% NaOH solution for few minutes until muscles were completely dissolved leaving tegumentary structures. After rinsing in distilled water several times to clean the residual NaOH solution, the abdomen was subsequently transferred to glycerine for final dissection and observation. Genitalia were finally conserved under the specimen in genital vials. Photographs for external morphology and genitalia characters were taken using Leica DFC camera attached to Leica M205FA stereomicroscope and further refined with LAS X software. Morphological interpretations and subsequent terminologies follow Bourgoin (1987, 1993) for male and female genitalia respectively, Emeljanov (1971) for the term “hypocostal plate” on the forewing and Bourgoin et al. (2015) for wing venation. The type specimens are deposited in China West Normal University, Nanchong, Sichuan Province, China.

Total genomic DNA was extracted from the legs of type specimens using a Sangon Ezup column animal genomic DNA purification kit. The genes (18S, 28S, COXI, Cytb) were amplified using the same primers and amplification procedure as in Wang et al. (2016). DNA sequencing was conducted at Sangon Company (Shanghai, China). Taxon sampling includes all Hemisphaeriini taxa available from a previous analysis (Wang et al. 2016) for which several new sequences are added (Table 1). Both the newly described genus and an undescribed *Mongoliana* species from Thailand (*Mongoliana* sp. 1) were included in the new analysis. From Wang et al. (2016), 11 genera representing all major lineages were used as outgroups, plus a new species of the genus *Rhombissus*
Table 1. Taxa sampling used for the phylogeny tree and corresponding sequence numbers registered in GenBank. The symbol * denotes new added sequences in this study.

| Taxa name | Collecting location | Gene 18S (1F–5R) | Gene 18S (3F–Bi) | Gene 18S (A2–9R) | Gene 28S (D3–D5) | Gene 28S (D6–D7) | COXI | Cytb |
|-----------|---------------------|-------------------|------------------|------------------|-----------------|-----------------|------|-----|
| Hemisphaeriini |                     |                   |                  |                  |                 |                 |      |     |
| Ceratogergithus pseudotessellatus (Che, Zhang & Wang, 2007) | China | KX761574 | – | KX761576 | KX761444 | KX702806 | KX702919 | KX702906 |
| Ceratogergithus spinatus (Che, Zhang & Wang, 2007) | China | KX761491 | KX761491 | KX761491 | KX761532 | KX761521 | KX761502 | KX761513 |
| Choutagus longicophilus Zhang, Wang & Che, 2006 | China | KX650620 | KX650620 | KX650620 | KX761450 | KX702810 | KX761460 | – |
| Chyrenomius centrodonus Gnedilov & Souliet-Perkins, 2017 | Vietnam | – | – | – | – | – | – | – |
| Eusudasia nanonumensis Yang, 1994 | China | JX196136 | – | – | – | – | HM052838 | HM452266 |
| Euroalderus brevipes Gnedilov, Bourgois & Wang, 2017 | Vietnam | KX761573 | – | KX761565 | KX761412 | – | – | – |
| Gergithoides carinatifrons Schumacher, 1915 | China | – | KX761538 | KX761538 | KX702805 | KX761555 | KX702905 | |
| Gergithoides rugulosus (Melichar, 1906) | Vietnam | KX761575 | – | – | – | – | – | – |
| Gergithus yunnanensis Che, Zhang & Wang, 2007 | China | KJ702831 | KJ702831 | KJ702831 | KJ702861 | KJ702861 | KJ702861 | KJ702861 |
| Hemisphaerius palaemon Fennah, 1978 | China | KX702825 | KX702825 | KX702825 | KX761454 | KX702812 | KX702933 | KX702883 |
| Hemisphaerius rufovarius Walker, 1858 | China | KX702828 | KX702828 | KX702828 | KX761399 | KX702861 | KX702934 | KX702884 |
| H. lysanias Fennah, 1978 | China | KX702833 | KX702833 | KX702833 | KX761404 | KX702861 | KX702935 | KX702904 |
| H. coccinelloides (Burmeister, 1834) | Philippines | KX702834 | KX702834 | KX702834 | KX761405 | KX702861 | KX702936 | KX702885 |
| H. sp. | Laos | KX702835 | KX702835 | KX702835 | KX761406 | KX702862 | KX702937 | KX702886 |
| H. testaceus Distant, 1906 | China | JX196135 | – | – | – | – | HM052831 | HM452258 |
| Macroderuma pertinax Fennah, 1978 | Vietnam | KX702832 | KX702832 | KX702832 | KX761402 | KX702859 | KX702931 | KX702882 |
| Macrederuma sp. | China | KX702828 | KX702828 | KX702828 | KX761399 | KX702857 | KX702927 | KX702881 |
| Maculergithus multipunctatus (Che, Zhang & Wang, 2007) | China | KX702816 | KX702816 | KX702816 | KX761443 | KX702804 | KX702918 | KX702904 |
| Maculergithus nonomaculatus (Meng & Wang, 2012) | China | KX761492 | KX761492 | KX761492 | KX761533 | KX761522 | KX761503 | KX761514 |
| Mongoliana triangularis Che, Wang & Chou, 2003 | China | – | – | KX761561 | KX761528 | – | – | KX761510 |
| Mongoliana sinuata Che, Wang & Chou, 2003 | China | KX702820 | KX702820 | KX702820 | KX761448 | – | – | KX761508 |
| Mongoliana sp.1 | Thailand | – | – | MN422135* | MN381854* | – | – | MN332233* |
| Mongoliana sp. 2 | China | JX196130 | – | – | – | – | HM052830 | HM452272 |
| Mongoliana serrata Che, Wang & Chou, 2003 | China | KX761572 | MN422136* | KX761566 | KX761534 | MN381849* | – | – |
| Neopogezilides tuberculatus Sun, Meng & Wang, 2012 | China | KX702822 | KX702822 | KX702822 | KX761451 | MN381845* | KX761558 | KX702910 |
| Ophthalmosphaerius erithibulus (Che, Zhang & Wang, 2006) | China | KX702826 | KX702826 | KX702826 | KX761455 | KX702813 | KX761462 | KX702914 |
| Retaldar yantchinus sp. nov. | China | MN381856* | MN381856* | MN381856* | MN381856* | MN381856* | MN381856* | MN381856* |
| Thioniini | Panama | KX761559 | KX761559 | KX761407 | KX702935 | KX702886 | | |

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Gnezdilov & Hayashi, 2016 (*Rhombissus* sp.) from the issid tribe Parahiraciini. All sequences are registered in GenBank with their accession numbers provided in Table 1. Contigs assembly was made using the software SEQMAN from package DNASTAR v5.01 (www.dnastar.com). MEGA v7.0 (Kumar et al. 2016) was used for performing alignments. IQTREE v1.4.1 (Nguyen et al. 2015) was used for maximum likelihood phylogenetic analysis using 10,000 ultrafast bootstraps (Minh et al. 2013) with substitution model automatically selected for partitions unlinked; other parameters were used as per default. FIGTREE v1.1.2 (Rambaut 2016) was used to visualize the tree.

### Taxonomy

#### Hemisphaeriini Melichar, 1906

**Mongolianina Wang, Zhang & Bourgoin, 2016**

Retaldar gen. nov.

http://zoobank.org/9A9AD297-9A97-44C2-B710-B1B34A0D1817

**Type species.** *Retaldar yanitubus* sp. nov., here designated.

**Etymology.** Genus name masculine from the free combination of the Latin word ‘rete’ meaning network as for the reticulated forewings and the suffix ‘-aldar’ from the genus *Euxaldar* Fennah, 1978.

**Diagnosis.** This new genus is similar to the genus *Clypeosmilus* Gnezdilov & Soulier-Perkins, 2017 in general appearance, but differs by: 1) a more complex and
obscure reticular venation of the forewing (Fig. 1) while a simpler pattern is found in *Clypeosmilus* (Gnezdilov and Soulier-Perkins 2017, fig. 1A); 2) an asymmetrical male genitalia with the periandrium more developed on right side and the aedeagus processes emerging at different levels, more posteriorly on right side (Figs 9, 10) while it is symmetrical in *Clypeosmilus* (Gnezdilov and Soulier-Perkins 2017, fig. 3A); 3) gonostyli with ventral margin deeply convex (Fig. 8), while it is much more elongated in *Clypeosmilus* (Gnezdilov and Soulier 2017, fig. 3C). The new genus is also similar to the genus *Eusudasina* Yang, 1994, from which it differs also by its more complex reticulate venation and by its longer frons, around 1.2 times longer (in middle) than broad at widest part (Figs 3, 21), only around 0.9 times longer in *Eusudasina* (Chan and Yang 1994, fig. 34C). With *Euxaldar* Fennah, 1978, *Retaldar* gen. nov. shares the general form of the gonostyli, which is strongly developed ventrally (Fennah 1978, fig. 251; Gnezdilov et al. 2017, fig. 8) but definitively differs by its distal postero-ventral protuberance (Fig. 8) and by its near-symmetric subapical processes on the periandrium (Figs 9, 10) while they are asymmetrical in the former (Gnezdilov et al. 2017, figs 1, 2).

**Description.** Head with compound eyes slightly wider than pronotum, almost same width as mesonotum (Fig. 1). Vertex rectangular, obviously broader than long at midline, anterior margin almost straight, lateral margins nearly parallel, posterior margin slightly roundly concave at middle; median carina absent on disc (Fig. 1). Frons obviously longer than wide, gradually broadening from dorsal margin to below the level of antennae, then curved to frontoclypeal suture (Figs 3, 21); dorsal margin slightly concave, lateral margins slightly broaden below level of compound eyes, median carina nearly invisible. Frons with numerous tiny tubercles on the whole disc. The tubercles larger on the lateral areas, arranged into a vertical line on each side of frons (Figs 3, 21). Frontoclypeal suture straight (Figs 3, 21). Gena in lateral view flattened and oblique (Fig. 2). Clypeus in lateral view with a protuberance below frontoclypeal suture slightly surpassing the gena (Fig. 2); in ventral view, clypeus without median carina (Figs 3, 21). Rostrum reaching midcoxae; apical segment slightly shorter than subapical one. Antennae with scape extremely short, pedicel rounded (Figs 3, 21). Pronotum triangular, apical margin roundly convex, posterior margin nearly straight, with some faint small nodules on each side or nodules invisible, median carina absent (Figs 1, 19, 20). Mesonotum triangular, a little longer than pronotum in midline, without carina on the disc; with (Fig. 1) or without (Figs 19, 20) some faint small nodules in lateral part apically. Forewings obviously longer than broad, without hypocostal plate, with elevated irregular reticular venations and venation poorly recognizable, costal margin and posterior margin subparallel, costal margin roundly convex, apical margin straight and oblique inward to posterior margin (Fig. 4), CuP obvious, Pcu and A1 fused exceeding middle of clavus (Figs 1, 4). Hindwing one-lobed. Metatibia with two lateral spines on apical half and seven spines apically.

**Male genitalia.** Anal tube in lateral view long and curved (Fig. 6). Pygofer long triangular in lateral view, posterior margin roundly convex (Fig. 6). Gonostyli irregularly quadrangular in profile, almost as high as long, dorsal margin nearly straight, ventral margin strongly convex with a strong posteroapical protuberance, caudo-ventral angle rounded (Figs 6, 8). Capitulum of gonostyli finger-shaped, with a small peaked...
spine (Fig. 8). Periandrium tubular, subapical nearly symmetric, medially constricted and slightly asymmetric in ventral view. Aedeagus processes asymmetric, right one emerging more posteriorly than left one (Figs 9, 10). Aedeagus a little longer than dorsolateral lobe and ventral lobe of periandrium (Figs 9, 10).

**Female genitalia.** Anal tube in dorsal view a little longer than wide (Fig. 12). Gonoplaes nearly rectangular in lateral view, apical margin rounded (Fig. 13), in dorsal view fused at middle near base, broadest near base, outer lateral margins straight and roundly convex at base (Fig. 14). Gonapophysis IX in lateral view long and narrow, boat-shaped (Fig. 16); in dorsal view nearly triangular, basal half broader than apical half, with a spine on each side (Fig. 15); gonospiculum bridge developed (Fig. 16). Gonocoxa VIII long rectangular (Fig. 18). Three teeth at apex and three keeled teeth on outer lateral margin of anterior connective lamina of gonapophysis VIII (Fig. 18). Endogonocoaxal process membranous (Fig. 18).

**Distribution.** China (Guangxi).
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Figures 6–11. Retaldar yanitubus sp. nov., holotype. 6 male genitalia, lateral view 7 male anal tube, dorsal view 8 gonostylius, lateral view 9 phallic complex, left lateral view 10 phallic complex, right lateral view 11 apical half of phallic complex, ventral view. The arrows on Fig. 8 indicates the distal postero-ventral protuberance of gonostylius.

Retaldar yanitubus sp. nov.
http://zoobank.org/7098817F-FAE5-4A30-AE8A-3D4E7DAE2EA1

Etymology. Specific epithet built by the arbitrary combination of the alphabet letter “Y” and “anal tube” latinised into “anitubus”, referring to the Y-shaped male anal tube in dorsal view.

Diagnosis. The species is close to Clypeosmilus centrodasus Gnezdilov & Soulier-Perkins, 2017, from which it differs by its generic characters (complex reticular veination (Fig. 1), more or less quadrangular gonostyli bearing a postero-apical protuberance) and the form of the male anal tube, which is deeply concave on the apical margin, Y-shaped in dorsal view (Fig. 7), while very shallowly concave and cylindrical in the latter species (Gnezdilov and Soulier-Perkins 2017, fig. 3E). From Euxaldar guangxiensis Zhang, Chang & Chen, 2018, another Guangxi species, it differs by: 1) its tegmina pattern black (Fig. 19) to dark tawny with a yellow slender or broader transverse marking (Figs 1, 4, 20), while it is dark brown with more than four yellow irregular markings in E. guangxiensis (Zhang et al. 2018, figs 1, 3); 2) the form of the male anal tube which is obviously protruded in the later (Zhang et al. 2018, fig. 10), and 3) the base of periandrium with a finger-shaped dorsal process (Figs 9, 10), while it is with three dorsal processes in E. guangxiensis (Zhang et al. 2018, figs 15a, b, 16a, b).
Figures 12–18. Retaldar yanitubus sp. nov., paratype. 12 female anal tube, dorsal view 13 gonoplacs, lateral view 14 gonoplacs, dorsal view 15 gonapophysis IX and gonaspiculum bridge, dorsal view 16 gonapophysis IX and gonaspiculum bridge, lateral view 17 sternite VII 18 gonocoxa VIII and gonapophysis VIII, ventral view.

Type materials. Holotype: ♂, CHINA: Guangxi Province, Jinxiu, Dayaoshan natural reserve, Hekou, 24°14′11″N, 110°14′11″E, 689.9 m, 23 vii 2018, Feilong Yang & Kun Zhao leg.

Paratypes: 2♀, same data as for holotype.

Description. Length: male (including forewings) ($N = 1$): 3.1 mm; female (including forewings) ($N = 2$): 3.3–3.4 mm.

Coloration. Vertex tawny, disc with two dark brown circular markings; anterior, lateral and posterior margins tawny (Figs 1, 19, 20). Center of the compound eyes mostly black, surrounded by brown (Figs 1, 3, 20) or compound eyes grayish (Figs 19, 21). Frons mostly tawny, scattered with many yellow nodules on the whole disc (Figs 3, 21); the central area slightly black (Figs 3, 21); lateral areas black, with the yellow nodules arranged into a distinct line on each side (Figs 3, 21); lateral margins tawny (Figs 3, 21). Clypeus in frontal view tawny, with two vertical dark brown markings at middle (Fig. 3) or tawny but the vertical dark brown markings invisible; the basal part black (Fig. 21). Rostrum tawny (Fig. 21). In lateral view gena tawny (Fig. 2), clypeus...
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with a broad black oblique patch covering the base of the gena and most part of the clypeus (Fig. 2). Antennae dark brown (Figs 3, 21). Pronotum tawny, with three small yellow nodules present on each side (Fig. 1) or without them (Figs 19, 20), anterior and posterior margins brown (Figs 1, 19, 20). Mesonotum mainly tawny mixed with some black, disc with two small yellow nodules on each side (Fig. 1) or disc black with nodules almost invisible (Figs 19, 20); anterior margin tawny. Forewings dark tawny, with a discontinuous yellow transverse band from the end of clavus to the middle of forewing (Figs 1, 2) or the transverse marking lighter and broader (Figs 4, 20), or the whole forewing black without any markings (Fig. 19); venations tawny or black, reticulate and inconspicuous (Figs 1, 2, 4, 19, 20). Hindwing grayish-brown, with grayish reticulate venations (Fig. 5).

Head and thorax. Vertex 2.5 times wider than long in midline, without median carina; anterior margin straight; posterior margin roundly concaved (Fig. 1). Frons 1.2 times longer in middle than broad at widest part, 1.4 times wider at the widest part than apical margin (Fig. 3). Pronotum with posterior margin 3.6 times wider than long in midline, anterior margin roundly protruded (Fig. 1). Mesonotum with anterior margin 2.0 times wider than long in midline, anterior margin straight (Fig. 1). Forewings 1.6 times longer in longest part than widest part (Fig. 4), clavus obvious, the tip reaching to the middle of forewing in dorsal view (Fig. 1). Metatibiotarsal formula: 2–7/7/2.

Male genitalia. Anal tube in lateral view arc-shaped, gradually narrowing from the base to the end, apical part conical (Fig. 6); in dorsal view anal tube Y-shaped with two long straight posterolateral arms, middle part in between deeply concave; in dorsal view arms as long as median part of anal tube (Fig. 7); anal opening located at the basal 1/4 of anal tube, epiproct protruded (Fig. 7). The highest length of pygofer around 3.4 times of the widest length, no basal notch (Fig. 6). Periandrium with a finger-shaped process originated from dorsal margin of base extending to the middle, directed to caudal (Figs 9, 10); dorsolateral lobe of periandrium a little longer than ventral lobe.

Figures 19–21. Retaldar yanitubus sp. nov., paratype. 19 adult (female), dorsal view 20 adult (female), dorsal view 21 adult (female), frontal view.
(Figs 9, 10), the ventral lobe in ventral view rounded in apex (Fig. 11). Aedeagus asymmetric, left hooked process emerging at its mid length, S-shaped, curved and directed dorso-cephalad in lateral view, the tip not exceeding the base of right process (Figs 9, 10); right hooked process almost same length as the left but emerging from its apical 1/4, curved and directed dorsad (Figs 9, 10); apex of aedeagus rounded in lateral view, slightly exceeding dorsolateral and ventral lobe of periandrium (Figs 9, 10). The connective with strongly developed tectiductus (Figs 9, 10).

Female genitalia. Anal tube in dorsal view ovate, widest near middle, 1.2 times longer in midline than widest part, apical margin and lateral margins rounded (Fig. 12); anal opening situated at basal 1/4 (Fig. 12). Gonoplacs in dorsal view fused at middle near base, broadest near base, outer lateral margins straight and roundly convex at base (Fig. 14). Posterior connective lamina of gonapophysis IX in dorsal view nearly triangular, the basal half relatively sclerotized, slightly broader than apical half, apical half membranous, the inner bifurcation at apical 1/3 (Fig. 15); the posterior fibula sclerotized, with a spine on each side on apical 1/4 (Fig. 15). In lateral view, gonapophysis IX long and narrow, dorsal and ventral margins nearly parallel each to another, tip pointed (Fig. 16); gonospiculum bridge in lateral view triangular, needle-like ventrally (Fig. 16). Anterior connective lamina of gonapophysis VIII subrectangular, with three closely situated teeth at apex and three keeled teeth on the outer lateral margin, inner lateral margin without teeth (Fig. 18). Endogonocoxal process membranous, reaching the level of the apical teeth (Fig. 18). Gonocoxa VIII long rectangular, vertical with the gonapophysis VIII (Fig. 18). Hind margin of sternite VII with middle part slightly prominent and truncates in ventral view (Fig. 17).

Molecular data. Genes sequences were registered in GenBank with accession numbers as following: MN381856 (whole 18S), MN381853 (28S D3–D5), MN381851 (28S D6–D7), MN381857 (COXI), MN332232 (Cytb). The COXI sequence of this species differs respectively by 87 bp (over 601 bp: 14.5%) and 103 bp (over 681 bp: 15.1%) from Eusudasina nantouensis Yang, 1994 (Genbank accession number: HM052838) and Clypeosmilus centrodasus (Genbank accession number: KX761470).

Note. As in the genus Euxaldar (Gnezdilov et al. 2017), color and color-pattern variation on forewing is reported in R. yanitubus sp. nov. Forewings might be nearly black (Fig. 19) or dark tawny (Figs 1, 2, 20), while color-patterns on the forewing varies from a light yellowish broad traverse band apically curved upward (Fig. 4) to a much thinner band only visible on the middle of forewing (Figs 1, 2) or even absent (Fig. 19).

Phylogenetical analysis

In-group sampling comprised 14 Hemisphaeriini genera and 27 species while 12 other issid genera were used as outgroups (Fig. 22). In all configurations tested, Hemisphaeriini reached a full 100% bootstrap (BS). Monophyly of Hemisphaeriini appears less supported (BS=69) than in Wang et al. (2016: BS=98) although the group was recovered in all analyses. Monophyly of Mongolianina is not recovered but appeared
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Figure 22. Maximum likelihood tree of Hemisphaeriini based on combined sequences (18S, 28S, COXI, Cyrb) with genera of Thioniini, Hysteropterini, Issini, Kodiaianellini, Sarimini and Parahiraciini as outgroups. At each node, values denote ML ultrafast bootstrap support

paraphyletic, disclosing a new well-supported lineage (BS=94). It includes Retaldar gen. nov. at its base in the following relationship (Retaldar + (Clypeosmilus + Eusudasina)). The other Mongolianina taxa form another weakly supported lineage (BS=49) comprising three taxa in the following relationship: (Mongoliana + (Euxaldar + Macrodaruma)). In several analyses, these two lineages appear in a sister group relationship.

Discussion

According to their results, Wang et al. (2016) subdivided Issidae into three subfamilies. At their base, Thioniinae Melichar, 1906 with at least two genera, Thonia Stål, 1859 and Cheiloceps Uhler, 1895 form a monophyletic group sister to the rest of the Issidae. For practical reasons of classification, all New World genera were placed in Thioniinae by Wang et al. (2016), but it is important to note that the subfamily does not necessarily include all of these taxa: Picumna Stål, 1864 for instance, never grouped within Thioniinae in their analysis, but in Hemisphaeriinae sec. Wang et al. (2016), although its place is not stabilized. This indicates a mixed origin of New World Issidae, which includes at least an older lineage (Thonia, Cheiloceps) of Lower Cretaceous origin and another slightly younger one (Picumna) originating from the Oriental lineages (Bourgoin et al. 2018). Several other genera are also waiting for a better placement in the issid phylogeny and it might be that other, still younger, taxa have also expanded more
recently from Asia into the Nearctic as proposed by Gnezdilov (2019). Only future phylogenetic analyses including New World genera will help to better understand the heterogeneous composition of the Issidae fauna in the Nearctic.

In the phylogeny of Wang et al. (2016), the second subfamily Issinae Spinola, 1839 was less supported (BS = 72). In all subsequent analyses including more taxa (Bourgoin et al. 2018), this node was no more supported, suggesting a paraphyletic Issinae with Issini sec. Wang et al. (2016), no longer sister to Hysteropterini but moving to sister of Hemisphaeriinae as in this study (Fig. 22). Because in some cases Thioniinae also grouped with Hysteropterini, we suggest that these tribes recover separate subfamily ranks in a basal polytomic node with the following topology [Thioniinae, Hysteropterinae, (Issinae + Hemisphaeriinae)].

Within Hemisphaeriinae, Hemisphaeriini sec. Wang et al. (2016) form a natural group of at least 28 genera (Bourgoin 2019) for which monophyly has always been strongly supported in all our analyses since 2016 with a BS=100. Two lineages were recognized as subtribes: Mongolianina and Hemisphaeriina, both well supported (BS = 95 and 98 respectively) in Wang et al. (2016). Addition of new taxa with an almost full set of sequences for the genes under this study has however slightly modified previous results allowing recognition of three main lineages within Hemisphaeriini while eleven other genera still remain in an incertae sedis position.

Hemisphaeriina remains the most diverse subtribe with, at least, 11 described genera, eight having being sequenced and providing the following topology: ((Ophthalmosphaerius + Gergithus) + (Hemisphaerius + (Ceratogergithus + (Maculergithus + (Neogergithoides + (Choutagus + Gergithoides)))))), Three genera remain unsequenced: Ephyhemisphaerius Chan & Yang, 1994, Neohemisphaerius Chen, Zhang & Chang, 2014 and Rotundiforma Meng, Wang & Qin, 2013. Moreover, Gergithus yunnanensis Che, Zhang & Wang, 2007 probably belongs to another new genus and Gergithus s.s. should remain in an incertae sedis position within Hemisphaeriini. According to Gnezdilov (2017), the Maculergithus clade might include two different genera.

According to our analysis, Mongolianina should be now restricted to the following genera: (Mongoliana + (Euxaldar + Macrodaruma)), separated from a third new lineage (Retaldar + (Clypeosmilus + Eusudasina)). The support of this last lineage is high (BS= 94) and higher than the Mongolianina lineage itself. Because the monophyly of the Mongolianina lineage itself remains weak and unstable, we prefer to keep provisionally a paraphyletic Mongolianina, including in it this new lineage. When more genera will be sequenced, a better and stronger topology will probably appear. Genera such as Bruneastrum Gnezdilov, 2015, Tapirissus Gnezdilov, 2014 and Neotapirissus Meng & Wang, 2016 should also join this group, but, as for Hemisphaeriini, new morphological analyses are still needed to better identify these lineages without molecular sequencing.

The new species Retaldar yanitubus gen. & sp. nov. has a protruded clypeus in lateral view. In the tribe Hemisphaeriini, several other genera also display such a protruded clypeus: Euxaldar, Clypeosmilus and Eusudasina. They also share a plesiomorphic clearly visible CuP on the forewing while this vein is not visible in Hemisphaeriina
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(Gnezdilov et al. 2017; Gnezdilov and Soulier-Perkins 2017). Although appearing in two separate lineages, Retaldar gen. nov. and Euxaldar share also an obscure reticulate forewing venation with the main veins poorly recognizable, while these are clearer in Clypeosmilus and Eiusadasina.

Including more sequenced taxa in the molecular analysis, revisiting morphological characteristics of Hemisphaeriini and investigating the etho-ecology of these fascinating ladybug-like planthoppers is now urgently needed.

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