Hidden jewels of Malaysia: two new genera and species of remarkable clearwing moths (Lepidoptera: Sesiidae: Osminiini)

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Abstract
A stunning scarlet-coloured clearwing moth was found mud-puddling on a rainforest river bank in Malaysia and is described herein as a new genus and species, *Scarlata nirvana* gen. et sp. Nov. This sesiid seems to be a rare case of a mimic of an assassin bug (Hemiptera: Reduviidae) in a family otherwise known for hymenopteran mimicry. A high-quality video of the moth’s behaviour in its habitat is provided. Studies of the collections of the Natural History Museum in London revealed another member of the new genus, *S. guichardii* sp. nov. A third species, *S. ignisquamulata* Kallies, 2018 comb. nov. is transferred to *Scarlata* gen. nov. from the genus *Aschistophleps* Hampson, 1892. The second new lineage from Malaysia described here, *Malayomelitta gen. nov.*, includes two species, *Malayomelitta pahangensis* Skowron, 2015 comb. nov. and *M. ruficrista* Rothschild, 1912 comb. nov. Additionally, *Heterospechia bantanakai* Arita & Gorbunov, 2000 is placed as a junior synonym of *H. hyaloptera* Hampson, 1919 syn. nov. Morphological descriptions, remarks on behaviour, conditions of occurrence and a discussion about potential mimicry models are included. All new taxa are figured, including images of male genitalia.

https://urn:lsid:zoobank.org:pub:32AF6419-F859-4931-BCA7-848B636CC2EE
New genus Scarlata: https://urn:lsid:zoobank.org:act:B8DC2871-DF12-49A9-A7A7-D67E60776E91
New genus Malayomelitta: https://urn:lsid:zoobank.org:act:07B2830B-7E00-4B9D-9D5A-82A7538427F9

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Introduction
Oriental clearwing moths (Lepidoptera: Sesiidae) are rarely encountered in nature, yet it has been observed in recent years that they come to river banks, streams, puddles and wet soil remaining after drying out of flowing water, seeking moisture and minerals (Gorbunov 2015; Skowron et al. 2015). The observation of this behaviour (known as puddling, or mud-puddling) has recently allowed for both taxonomic (Gorbunov 2015; Kallies & Štolc 2018; Skowron Volponi 2020) and novel behavioural studies (Skowron Volponi et al. 2018) of these elusive insects. Interestingly, this behaviour has been noted only for representatives of the tribe Osminiini in Asia and in one case for the tribe Similipepsini in Africa (Sáfár & Pühringer 2016). Exactly why sesiids come to the vicinity of flowing water and are not observed near lakes or at salt licks away from water sources remains to be elucidated. Clearwing moths are predominantly diurnal lepidopterans known for their often striking resemblance to hymenopterans. Mimicking features include narrow, at least partially transparent wings, bright colouration and sometimes narrowed or misleadingly coloured abdominal segments, resembling a wasp-waist. Several genera have characteristic tufts of elongated hair-like scales on the hind legs which further add to their hymenopteran-like appearance.

The Osminiini are probably the most diverse Sesiidae tribe in the Oriental region. This paper contributes to the process of taxonomic clarification within the group.
In their study from 2018, Kallies & Štolc proposed the genus *Pyrophleps* Arita & Gorbunov, 2000 to be a junior subjective synonym of *Aschistophleps* Hampson, 1892, arguing that the latter genus is more diverse than previously thought. Recently, Gorbunov (2021) restored the genus *Pyrophleps* and described a new, closely related genus *Nepyropleps*. Taking into account major morphological differences in genitalia, hind leg tufts, labial palps and eye shape in these Osminiini genera, I consider *Pyrophleps* and *Nepyropleps* to be valid taxa. Based on new findings in Southeast Asia, as well as specimens from the Natural History Museum in London, I derive two further genera of the Osminiini tribe, *Malayomelittia* gen. nov. and *Scarlata* gen. nov., describe two new species, *Scarlata nirvana* sp. nov. (see suppl. video; Figures 1, 2, 3(a), 4(b) and 5) and *S. guichardii* sp. nov. (Figures 3(b) and 6), and transfer three species from the genera *Aschistophleps* Hampson, 1892 and *Heterosphecia* Le Cerf, 1916 (i.e. *ruficrista*, *ignisquamulata*, *pahangensis*, *bantanakai*).

The type species of the new genera described herein, *Malayomelittia pahangensis* comb. nov. (figured and filmed in Skowron et al. 2015; Skowron Volponi et al. 2018, 2021) and *Scarlata nirvana* sp. nov., were both found puddling on banks of crystal clear rivers flowing through Malaysian rainforests. It is highly probable that their existence depends on the conservation of these pristine ecosystems.

**Methods**

The type specimen of *S. nirvana*, as well as all of the studied specimens of *M. pahangensis*, were collected without the use of synthetic sex attractants. Temperature and air humidity were measured with an electronic thermo-hygrometer placed in the shade.

Dissections were performed by abdomen lysis in proteinase K (55°C, overnight), and genitalia dehydrated by passing through ethanol solutions of increasing concentration. The genitalia were then mounted in Euparal. Specimens were studied and genitalia photographed with a Leica M80 stereomicroscope coupled with a Sony α6500 camera (*S. guichardii* and *M. ruficrista*) and Leica M205A stereomicroscope (*S. nirvana*).

**Taxonomic accounts**

**Abbreviations.** ATA = anterior transparent area, ETA = external transparent area, PTA = posterior transparent area.

*Malayomelittia* Skowron Volponi gen. nov.

Type species: *Heterosphecia pahangensis* Skowron, 2015.
Figure 3. (a) *Scarlata nirvana* gen. et sp. nov. holotype male; (b) *S. guichardii* gen. et sp. nov. holotype male; (c) *Malayomelittia ruficrista* comb. nov. holotype female; (d) *M. ruficrista* male NHMUK10605228.

Figure 4. Details of the head and outline of the eye of: (a) *Malayomelittia pahangensis* comb. nov.; (b) *Scarlata nirvana* gen. et sp. nov. Note differences in the shape of the eye and in scaling of labial palp apically.
**Heterosphecia pahangensis**: Skowron et al. 2015; Skowron Volponi et al. 2018, 2021

Small (alar expanse 10–17 mm) and slender clearwing moths with highly conspicuous tufts of elongated scales on the hind legs (resembling pollen baskets of bees in the type species). Representatives of *Malayomelittia* do not use their hind legs for locomotion but rather to expose the tufts of hair-like scales by making delicate flicking movements. Frons smoothly scaled; labial palps long and upturned, with wide, elongated, erect scales ventrally and elongated hair-like scales apically; proboscis long and well-developed; vertex with elongated scales. Thorax covered with smooth scales. Legs: fore, mid and hind femur smooth scaled; fore and mid tibia and tarsus with elongated scales gradually shortening towards the 5th tarsomere; characteristic tufts of erect hair-like scales on hind tibia and 1st tarsomere. Hind tarsi extend further caudally than abdomen. Both fore- and hindwings rather slender; forewing with well-developed transparent areas covered with semi-hyaline scales, vein R₃ absent (possibly fused with R₂), R₁ and R₄ separated basally, M₁ terminating at apex, CuA₁ and CuA₂ arising from a common point, cross vein rugged, remnant of veins 1A+2A very short; hindwing transparent, partially covered with semi-hyaline scales, vein M₂ arising from about middle of cross-vein, distance between origin of vein CuA₁ and M₁ more than seven times that between M₁ and cross-vein, 1A well-developed, arising from 2A, remnant of veins 2A+3A fused distally. Abdomen smooth scaled, with narrow whitish bands, anal tuft very small. Male genitalia: valva broad with an upturned extension, mostly covered by long setae; gnathos developed, pointed distally; uncus covered with setae; tegumen somewhat narrowed distally; saccus quite long and thin, with a flat or slightly bifurcate base; aedeagus about twice as long as valva.

**Figure 5.** Male genitalia *Scarlata nirvana* gen. et sp. nov. holotype.

**Figure 6.** Male genitalia *Scarlata guichardii* gen. et sp. nov. holotype.

**Differential diagnosis**

The new genus appears to be closest to *Aschistophleps* Hampson, 1893, *Scarlata* gen. nov. and *Heterosphecia* Le Cerf, 1916 demonstrating a combination of their features (Arita & Gorbunov 1995, 2000). Hind tarsi extend further caudally than abdomen, they are not as long as in *Aschistophleps*, but longer than in *Heterosphecia*. Hind tibia and 1st tarsomere entirely, strongly tufted with hair-like scales (only apical half of hind tibia tufted in *Aschistophleps*). The shape of fore- and hindwings and venation differ from *Heterosphecia* (distance between base of vein CuA₁ and M₁ about seven times longer than that between M₁ and cross-vein in *Malayomelittia*, these distances are of equal length in *Heterosphecia*) and more closely resemble the wings of *Aschistophleps* (except that veins R₃ and R₄ do not arise from a common point). The male genitalia differ from all other genera in the shape of the valvae and are most similar to *Heterosphecia*. However, they are not as robust as and can be
further differentiated by the pointed gnathos and the rather long thin saccus. Furthermore, Malayomelittia differs from all species of *Heterosphecia* by the much less robust body and this is quite obvious when specimens, either pinned or alive, are seen next to each other. For differences between *Malayomelittia* and *Scarlata*, see differential diagnosis for *Scarlata* gen. nov. Representatives of *Malayomelittia* do not use their hindlegs at all for locomotion (see Suppl. video in Skowron et al. 2015), whereas species of *Heterosphecia* (see Suppl. Video of Skowron Volponi & Volponi 2017a), *Melanosphecia* (see Suppl. video in Skowron Volponi 2019) and *Aschistophleps* (see Suppl. video in Skowron Volponi & Volponi 2018) use them actively to move around and *Pyrophleps* (see Suppl. video in Skowron Volponi & Volponi 2017), as well as *Scarlata* keep their hindleg tarsi curled up, using them occasionally to tap the ground (Suppl. Video TC 02:41–02:47; Figure 2).

Composition: Only two known species belong to this newly described genus: *Malayomelittia pahanensis* (Skowron, 2015), comb. nov. and *Malayomelittia ruficrista* (Rothschild, 1912), comb. nov.

Etymology. The name derives from Malaysia, the country of origin of representatives of this genus, and the Greek “melita” (bee), due to the type species’ splendid mimicry of *Trigona* bees. The gender is feminine.

*Malayomelittia ruficrista* (Rothschild, 1912), comb. nov.

Figs 3C, 3D, 7.

*Aegeria ruficrista* Rothschild, 1912: 122. Holotype ♀ (not ♂!), ORIGINAL LABELS: “Type; 4th Mile Rock Road 21-4-09; Aegeria ruficrista Roths. Type; Tring Mus. 190; 2.; Rothschild Bequest B.M.1939-1.; BMNH(E) #846007; NHMUK010605231”.

*Aschistophleps ruficrista*: Arita & Gorbunov 1995: 83; Kallies & Štolc 2018: 597.

*Pyrophleps ruficrista*: Arita & Gorbunov 2000: 65; Skowron Volponi & Volponi 2017: 134.

MATERIAL. 2♂, 2♀, all in NHMUK. Holotype ♀, Borneo, Sarawak, Kuching, 4th Mile Rock Road, 21.V.1909, W. Rothschild, NHMUK010605231; 1♂, same location, 06.V.1909, W. Rothschild, NHMUK010605223; 1♂, same location, 08. IV.1909, W. Rothschild, NHMUK010605228, genitalia slide no. NHMUK010316680; 1♀, Borneo, Sarawak, Kuching, T. Hewitt [?], NHMUK010605226.

The original species description written by Rothschild (1912) was based on the female holotype. However, Rothschild additionally collected two male individuals of this species (both of which are in the NHMUK collection, in a slightly worse condition than the female holotype) in the same location and period. This allowed me to perform genitalia dissection, whose morphology proved highly similar to that of *M. pahanensis* Skowron, 2015 comb. nov. Sexual dimorphism is not highly pronounced in *M. ruficrista*. However, the male has a more developed external transparent area of the forewing and less scaling on the hindwing margins than the female. The two studied males also have more black scales in the external part of the hindleg tuft in comparison to the female. However, this might only be intraspecific colour variation (*M. pahanensis* males differ greatly in hindleg tuft colouration), rather than sexual dimorphism.

Male genitalia. Tegumen-vinculum form a perfectly round ring, tegumen gradually narrowing towards uncus; gnathos small and distally pointed; uncus covered with quite long delicate setae; valva broad, rectangular in proximal 2/3, distal 1/3 upturned and rounded; long setae covering nearly entire valva; saccus rather long and slender, gradually narrowing towards bluntly-ended apex; aedeagus almost twice as long as valva.

Figure 7. Male genitalia *Malayomelittia ruficrista* comb. nov.
**Scarlata** Skowron Volponi *gen. nov.*

Type species: *Scarlata nirvana* Skowron Volponi *sp. nov.*

Small (wingspan 14–17 mm) and slender clearwing moths with scarlet coloured, conspicuous hindleg tufts of elongated scales. Antennae simple and clavate, frons covered with smooth scales, labial palpi mostly smooth-scaled with narrow elongated scales at tip and wide, slightly erected scales at base. Thorax and abdomen covered with smooth scales, either scarlet or black. Wings mostly transparent with broad black fore- and hindwing discal spots and margins. Male genitalia morphology distinct from other Osminini: uncus with very short sclerotized setae on margins, similar setae forming a small patch or row at tip of valva, valva folded inwards subapically on coastal margin.

**Differential diagnosis**

Superficially similar to *Malayomelittia* and *Aschistophleps* but can be differentiated by the morphology of the male genitalia, the shape of the eye, scaling of labial palps (more hair-like scales apically in *Malayomelittia*), broader hindwing discal spot and the structure of the hindleg tuft: in *Scarlata*, the hair-like scales are strongly elongated on the inner margin, moving towards the dorsal side there is a narrow groove covered with shorter scales followed by a ridge of elongated scales dorsally, the tuft of elongated scales continues onto the proximal half of the 1st tarsomere only on the inner margin, on the hindleg outer side the scales are elongated only on the tibia, the 1st tarsomere is dorsally and externally smooth-scaled. *Scarlata* does not have a tuft of hair-scales on the midleg. In *Malayomelittia* the hindleg tuft is made of almost equally elongated scales dorsally and on both inner and outer sides of tibia and entire 1st tarsomere. *Aschistophleps* has a tuft of hairs on the midleg tibia and two small tufts on the hind leg which allows for the immediate differentiation from closely related genera. Overall, the hindleg tufts of the genera *Scarlata*, *Malayomelittia* and *Heterosphecia* are very conspicuous, made of dense, elongated scales. In the slender-bodied species of *Pyrophleps*, these tufts are much less impressive and scales less elongated.

In the field, representatives of the genus *Scarlata* can be differentiated from *Malayomelittia* and *Aschistophleps* by their posture, especially different ways of exposing the hind leg tufts. *Scarlata* species often spread out their wings (*Figure 2*; Suppl. video TC 02:50–03:05), showing the bright red hind legs with tarsi curled up, not using them much to move around. *Malayomelittia*, when puddling, always keeps its wings folded back against the body and rises the hind legs upwards, often moving them slightly to expose the conspicuous tufts (see Suppl. video in Skowron et al. 2015), but never uses them to walk, whereas *Aschistophleps*, keeping its wings folded against its body and hind legs on the outer side of the wings, uses the hind legs actively for locomotion. *Pyrophleps* species do not expose hindleg tufts significantly but keep the hind legs close to their slender abdomens and most of the time concealed beneath the wings.

From the similarly-coloured species of *Akaisphecia* Gorbunov and Arita (1995), *Scarlata* can be distinguished by the absence of a filiform appendix on the abdomen, structure of hind leg tufts, well-developed forewing transparent areas and morphology of male genitalia.

Composition: This genus consists of three species: *S. ignisquamulata* Kallies, 2018 *comb. nov.*; *S. nirvana* Skowron Volponi *sp. nov.* and *S. guichardii* Skowron Volponi *sp. nov.*

**Scarlata nirvana** *sp. nov.*

Figs 1, 2, 3A, 4B, 5.

*Type material*: Holotype ♂, pinned. Original labels: Malaysia: Pahang Merapoh, 04°39.04’N 102°01.80’E, 22 VII 2018, M.A. Skowron Volponi; Holotype ♂, *Scarlata nirvana* *sp. nov.*, des. M.A. Skowron Volponi et al. 2021; Genitalia slide ♂, no. MSV-17. Will be deposited in NHMUK.

**Wingspan**: 16.5 mm

**Head**: Antennae black dorsally and at tip, admixture of yellow and orange scales ventrally, setae at tip black; small patch of smooth white scales near base of antennae; vertex with slightly elongated black scales; ocelli black; frons smooth-scaled, black in upper half, white in lower half; labial palpi white with black tip, slightly elongated scales towards tip; proboscis long, functional, brown; pericephalic hairs white ventrally and laterally, black with some pale yellow dorsally.

**Thorax**: Patagia black; thorax dorsally scarlet red with a wide black longitudinal stripe and two very thin black lines bilaterally; laterally black with silver sheen; scarlet setae at wing insertions.

**Legs**: Fore coxa white with several black and orange scales ventrally; fore femur black; fore tibia with black elongated scales: some with a red tinge to
them; fore tarsi black with pale orange and white smooth scales at basal half; mid coxa black with silver sheen in basal half, white in distal half; mid femur black with individual beige and orange scales dorsally; mid tibia black with some elongated scales, spurs black, tarsomeres black with elongated white scales at base of 1st tarsomere and smooth creamy white scales at bases of tarsomeres 2–5; hind coxa white with some black scales; hind femur black; hind tibia entirely scarlet red with elongated scales dorsally and laterally forming a conspicuous tuft continuing to 1st tarsomere on inner margin, dorsal and outer part of 1st tarsomere smooth-scaled, scarlet in basal half and black in distal half; tarsomeres 2–5 smooth-scaled, black with admixture of pale orange scales at bases of tarsomeres 2 & 3 ventrally; upper spur white with some black scales; lower spur black ventrally and red dorsally, white scales at base of both spurs.

Forewing: Well-developed transparent areas with a blue sheen in sunlight; veins, margins and discal spot covered with black scales; scarlet red scales at base, along costal margin until about half the length of ATA and along cubital vein until about basal 1/3 of ATA; ATA densely covered with transparent scales, some transparent scales also in PTA and ETA; black scales from costal margin to vein R2. Each transparent cell in ETA divided by very thin longitudinal black stripes; ventrally scarlet scales along veins from base until discal spots; cilia black.

Hindwing: Transparent with black scales along veins, margins and on discal spot dorsally; some scarlet scales at basal part of margins and veins; some transparent scales in cell between veins 2A and 1A; ventrally scarlet red scales along veins from base until discal spots, along vein 2A and costal margin; 1A black; cilia black.

Abdomen: Scarlet red with black tergite margins dorsally and laterally; sternites 1–5 proximally black, distally white; sternites 6–7 black with faint white distal margin; sternite 8 black; anal tuft very small, black.

Male genitalia: Tegumen and uncus broad; uncus wider than tegumen, heart-shaped, with margins covered by very short sclerotized setae distally and slightly longer laterally; gnathos wide and triangular; valva elongated, arched costal edge with a distinct inward fold forming a tapered apex, short hair-like setae densely scattered on ventral margin and in apical area, more sparsely distributed near ventral margin and in medial part, small linear patch of short, well-sclerotized setae ventroapically; saccus short, triangular, rounded at tip; aedeagus simple, narrow, longer than valva.

Female unknown.

Differential diagnosis

This species is most similar to S. ignisquamulata. It can be differentiated primarily by the conformation of male genitalia (See Figure 3 in Kallies & Štolc 2018): triangular gnathos (rounded in S. ignisquamulata), shape of valva, especially the strongly arched coastal margin (straight in species compared), rounded tip of saccus (blunt in S. ignisquamulata), longer aedeagus. It additionally differs in details of colouration: labial palps with black tips (white with some brown scales in species compared), more black scales on thorax, less red scales on both fore- and hindwing, broader ATA and PTA, narrower hindwing discal spot. From S. guichardii sp. nov. it differs in the overall body colouration (mostly black in species compared) and conformation of male genitalia.

Etymology. This species is named after the Nirvana Asia Group, who co-financed the expedition to Malaysia during which this new species was discovered.

Behaviour, habitat and conditions of occurrence

Males of S. nirvana puddle on moist sand and rocks on river banks flowing through tropical rainforests in Malaysia. The sesiid often lands amongst hymenopterans, especially bees, but was not observed within butterfly aggregations nearby. Puddling behaviour of this species is most probably aimed at gaining salt because it readily licked sweat from human skin (Suppl. video TC 01:54–01:58). S. nirvana occurs on hot, sunny days only, with temperature ranging from 29°C to 32°C and air humidity 64–73%. S. nirvana holds its wings either folded back against the body, covering the hindleg tufts of elongated scales (tips of wings not overlapping, Figure 1), or spread out, exposing the scarlet red tufts on hindleg tibiae (Figure 2). The hind legs are not actively used for locomotion, however the sesiid taps the ground with the curled-up tarsi when moving around. When flying within a small area, e.g. whilst searching for a puddling spot, the sesiid traces rugged trajectories low above the ground (Suppl. video TC 00:13–00:25; 00:50–01:00,02:12–02:24). However, when covering a larger distance or escaping from a puddling spot,
S. nirvana flies in an almost vertical position, with the bright scarlet colouration of thorax, abdomen and hindleg tuft making it visible from a distance despite the moth’s small size. This peculiar position in flight resembles that of assassin bugs (Hemiptera: Reduviidae) often encountered in Malaysian rain-forests.

Observations: Merapoh: one individual end of April 2016; two individuals seen in two consecutive days in July 2018. Royal Belum State Park: one individual beginning of August 2018, second near end of August 2019. Only one specimen was collected as the other from Merapoh escaped rapidly, whereas those observed in the protected Royal Belum forest could not be captured but were filmed in detail.

**Scarleta guichardii** sp. nov.
Figs 3B, 6.

*Type material:* Holotype ♀, pinned. Original labels: SABAH: Poring Hot Springs 8.5.1973, K.M. Guichard; Brit. Mus. 1974–219; Fig’d in Smaller Moths of SE Asia – Robinson, Tuck & Shaffer, 1994; NHMUK010605230, genitalia slide no. NHMUK010316681 (NHMUK, misidentified as *Aschistophleps ruficrista* Rothschild, 1912).

**Wingspan:** 14 mm

**Head:** Antennae including setae at tip black; frons and vertex black; compound eyes black; labial palps white in basal ¼, black with some orange scales in distal ¼.

**Thorax:** Black and smooth-scaled, black setae at wing insertion. Figs 7

**Legs:** Forelegs black with white coxae; midlegs black, hind legs dorsally black with tufts of scarlet hair-like scales on tibia and inner margin of 1st tarsomere; tarsomerces 2–5 black.

**Forewing:** Transparent with broad black discal spot (protruding slightly into ETA), black scales on margins, veins and running from costal margin to vein R2; each transparent cell in ETA divided by very thin longitudinal black stripes; several scarlet scales around discal spot ventrally; cilia black.

**Hindwing:** Transparent with black scales along veins; broad black scaling on margins, in distal part of cell between veins 1A and 2A, as well as on discal spot, which protrudes into cell between veins Cu₁ and Cu₂.

**Abdomen:** black, tergites with narrow white margins. Male genitalia: Tegumen broad, slightly narrowing towards uncus, uncus oval, about as wide as tegumen with margins covered by very short sclerotized setae; gnathos triangular-shaped, rounded at tip; valva elongated with slightly arched coastal margin, inward fold subapically, small round patch of sclerotized short setae at apex, longer setae densely scattered along ventral margin into medial area but sparsely along coastal margin; saccus short and rounded basally; aedeagus simple, narrow, longer than valva.

Female unknown.

**Differential diagnosis**

*S. guichardii* is superficially most similar to *M. ruficrista*, from which it can be distinguished by the remarkably different morphology of the male genitalia. Without performing dissections it is possible to distinguish males of these two species by several external features: very long antennae in *M. ruficrista* (about length of forewing) and shorter in *S. guichardii* (about 2/3 of forewing); forewing discal spot has black extensions into ETA in *S. guichardii* (clearly separated from ETA in *M. ruficrista*); hindwing discal spot is broader in *S. guichardii* and extends to cell between veins Cu₁ and Cu₂; structure of the hind leg tuft: smooth scales externally on 1st tarsomere in *S. guichardii*, elongated scales on entire tibia and 1st tarsomere in *M. ruficrista*. From congeners it can be immediately distinguished by the mostly black colouration of the entire body (excluding the red hindleg tibia tufts). Male genitalia resemble those of *S. nirvana* and *S. ignisquamulata* but the uncus is narrower and more oval-shaped, whereas the gnathos and valva have an intermediate shape between that of the two congeneric species.

Etymology. This species is named after Kenneth Guichard, a hymenopterist who collected the holotype in 1973, probably whilst searching for wasps.

**Habitat and conditions of occurrence**

Only one museum specimen, herein designated as holotype, is known. The original label states that the specimen was collected in Poring Hot Springs (Sabah, Malaysia) in May. Poring Hot Springs are located in the Ranau District at an elevation of 550 m. Poring has a tropical climate with plenty rain year-round and temperatures between 20°C and 29°C. There are three rivers in the area providing potentially good habitats for puddling behaviour of insects, including sesiids.
Concluding remarks

**Taxonomy**

In 1892, Hampson described the genus *Aschistophleps* stating that it has “(...) mid legs with terminal tufts of hairs on the tibiae; hind legs with two strong tufts on the tibiae, and first tarsal joint strongly tufted”. Despite numerous taxonomic changes having been introduced in this genus over the years, as well as the description of multiple new species of the tribe Osminiini, it seems Hampson’s generic description is still valid. The apomorphic character of *Aschistophleps* is the double tuft on the hind legs instead of one continuous tuft/blade of elongated scales, as in closely related genera. This criterion is currently met by three species only: *A. lampropoda* Hampson, 1892, *A. longipoda* Arita & Gorbunov 2000 and *A. argentifasciata*; Skowron Volponi, 2018 and all of the remaining species currently listed under *Aschistophleps* should be transferred to different genera. *Scarlata ignisquamulata*; Kallies & Štolc, 2018 has such distinct genitalia morphology that it does not belong in either *Aschistophleps* or *Pyrophleps* and the discovery of the two new species described herein has helped to identify its distinguishing features. Further species previously included in *Aschistophleps*, have been recently transferred to the new genus *Aurantiosphecia*; Skowron Volponi, 2020.

*M. ruficrsta*, another species which was included in the genus *Aschistophleps*, was initially described as *Aegeria ruficrsta* by Rothschild (1912). The species was found in 1909 on Borneo: Rock Road, Kuching, Sarawak. *M. ruficrsta* has perplexed entomologists for years since its discovery and its generic placement has changed multiple times. These transfers have been performed, however, without studying details of the species’ morphology; Robinson et al. (1994) wrote: “this species is immediately recognizable by the stunning carmine tufts on the hind legs”, but we now know that red colouration of the hindleg tufts occurs not only in different species of Sesidae, but in several genera. The dissection of *M. ruficrsta* genitalia allowed for proper assignment of this perplexing sesiid. Comparisons of specimens from the NHM collection, including the holotype, with *Malayomelittia pahangensis* Skowron, 2015 revealed striking similarities of these two species and solid differences from all other Osminiini, indicating they constitute a separate lineage. It had already been apparent in the original description of *M. pahangensis* that it does not belong in the genus *Heterosphecia*; however, the lack of any other species confirming the existence of a separate lineage led a reviewer to insist on including it in *Heterosphecia*. This gap has now been filled after the re-examination of old specimens of *M. ruficrsta*. The close relationship of these two Malaysian species is not surprising, as Peninsular Malaysia used to be connected to Borneo, being part of Sundaland 21–17,000 years ago (Woodruff 2003). Additionally, re-examination of known *Heterosphecia* species and DNA barcode analysis showed that *Heterosphecia bantanakai* Arita & Gorbunov, 2000 is in fact a junior synonym of *H. hyaloptera* Hampson, 1919 syn. nov. These findings will be further discussed in an upcoming paper.

**Mimicry**

*Malayomelittia pahangensis* is a fascinating example of bee mimicry, which is both morphologically and behaviourally complex (Skowron et al. 2015; Skowron Volponi et al. 2018). It has been recently suggested, however, that some clearing moths may imitate insects other than hymenopterans. *Akaisphecia melanopuncta* Gorbunov and Arita (1995) is a pyrrhocorid bug mimic (Quicke et al. 2018) and at the same time, the first known example of hemipteran mimicry in the family. *Scarlata nirvana*, with its flashy scarlet colouration and characteristic flight posture does not resemble any sympatric hymenopteran but, especially in flight, seems to imitate aposematically coloured assassin bugs (Hemiptera: Reduviidae). Reduviids are venomous and either predaous or hematophagous (with some rare phytophagous cases in South America). They use their venoms not only on their prey but also to defend themselves (Walker et al. 2016). Their warning signals have been exploited in the evolution of Batesian mimics, e.g. the Malaysian mantis *Hymenopus coronatus* Olivier, 1792, which before growing into a nearly perfect imitation of an orchid, in its first instar looks like a small red-and-black assassin bug (Gurney 1951). The same colour pattern is followed by *S. nirvana* (as well as the closely related *S. ignisquamulata*). These sesiids, red and black with white accents, are very similar to harpactorine reduviids such as *Eulyes amoenae* Guérin, 1838 and *Vesbius purpureus* Thunberg, 1783 (Reduviidae: Harpactorini), both of which occur in Malaysian rainforests and could possibly have served as evolutionary models for *S. nirvana*. I believe it is necessary to observe a live individual and consider the natural body posture and behaviour of a species in order to determine its possible mimicry model. Only pinned specimens of *S. guichardii* and *M. ruficrsta* have been examined.
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No potential conflict of interest was reported by the author(s).

Supplementary material

Supplemental data for this article can be accessed here, and a video can be found at: https://vimeo.com/704171296

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