Flight and mud-puddling behaviour of a bee-mimicking clearwing moth (Lepidoptera: Sesiidae) in its natural habitat, with description of new species.

Marta Agnieszka Skowron Volponi¹§, Paolo Volponi²

¹Department of Molecular Biology, Faculty of Biology, University of Gdansk, Wita Stwosza 59, 80-308 Gdansk, Poland

²ClearWing Foundation for Biodiversity Research and Education, ul. Podczaszyńskiego 11/15 m 23A, 01-866 Warsaw, Poland

§Corresponding author. e-mail address: marta.a.skowron@gmail.com; telephone number: +48 660153420

Abstract

Unique footage of mud-puddling and flight behaviour of a new species of clearwing moth (Lepidoptera: Sesiidae) was realized in its natural habitat in Thailand. *Aschistophleps argentifasciata*, morphologically resembling a bee, imitates its model also in the way it flies. This behavioural mimicry, filmed both in real-time and slow motion, is described herein and shown in a supplementary video. A detailed morphological description of the new species, including male genitalia, differential diagnosis from closely related species and information on the habitat, time and conditions of occurrence are provided. This is the first video of the genus *Aschistophleps* ever realized and this species is the first country record of *Aschistophleps* for Thailand.

Keywords: Asia, insect, mimicry, mud-puddling, *Aschistophleps argentifasciata*, flight

Supplementary video: https://vimeo.com/219412201 password: thailand
Introduction

Members of the family Sesiidae are a classic example of Batesian mimicry. A new species of bee-mimicking clearwing moth, *Aschistophleps argentifasciata* (Figs 1-3), has been discovered in Thailand, being also the first record of the genus in this country. The genus *Aschistophleps* is characterized by the presence of two tufts of hair-like scales on the hind legs and elongated scales on fore and mid legs (Hampson 1892), which together give it a “hairy” bee-like appearance. It has been recently observed that morphological mimicry in clearwing moths can be complemented by behavioural aspects, such as imitating the flight path of bees and wasps (Skowron *et al.* 2015; Skowron Volponi & Volponi, unpubl. data) or sounds made by the mimicry models (Skowron Volponi & Volponi, unpubl. data). *A. argentifasciata* was observed and filmed flying in a bee-like manner in its natural habitat whilst mud-puddling (supplementary video). Many different hymenopterans were seen in the same area, including similar sized and shaped bees. The new species was seen several days in a row in the same area, but always only one or two individuals were present. This indicates that they do not occur in large numbers, in contrast to numerous bees flying in that location. In Batesian mimicry, being rare in comparison with the model is advantageous for the mimic, because it increases the chances of not being disguised by the predator (Matthews & Matthews 2010).

This publication includes a morphological description, differential diagnosis from closely related species, habitat, time and conditions of occurrence, notes on the mud-puddling and flight behaviour and a detailed video showing the sesiid’s true appearance and behaviour in its natural habitat.

![Fig. 1 Aschistophleps argentifasciata mud-puddling on moist pebbles. Note the black colouration of forewing cilia, veins and margins with white and creamy yellow scales on discal spot extending to coastal and anal margins.](image)
Materials and Methods

The study site was in the natural habitat of the new species, on a sandy field track with patches of grass, next to a periodically drying river. Its behaviour was filmed using Olympus STYLUS TG-3 Tough, Sony RX10 II and Sony α7R II cameras. Slow–motion videos were realized in 500 fps with the Sony RX10 II. Using an electronic thermo hygrometre placed in the shade, temperature and air humidity were measured. The type specimens were collected in Phetchaburi Province, Thailand without the use of synthetic attractants. Morphological details were studied with a Leica M80 stereomicroscope and photographed using a Leica M205A. Wingspan, body and antenna length were measured on a computer screen from photographs of mounted specimens taken next to a scale. Genitalia were prepared in the following steps: 1) maceration of the abdomen in boiling 10% KOH for app. 1 minute 2) genitalia dissection in 10% ethanol 3) dehydrating by passing through 30%, 60% and 100% ethanol and 4) mounting in Euparal.

Results

Aschistophleps argentifasciata sp. novum

Figs 1-4, Supplementary video

![Image of Aschistophleps argentifasciata](image)

*Fig. 2* Aschistophleps argentifasciata varies in the colouration of forewing scales and cilia. This individual had orange scales around anterior transparent area and on margins, as well as light brown cilia.

Types

Holotype ♂, pinned (Fig. 3). Original labels: “Thailand: Phetchaburi, 11 II 2017, Skowron Volponi M.A.” “Holotype, Aschistophleps argentifasciata sp. n., Des. Skowron Volponi M.A. 2017”. Will shortly be deposited in the Natural History Museum in London.

**Description**

Wingspan: 12-14.5 mm

Body length: 6.5-8 mm

Antenna length: 3.5-4 mm

Antenna: strongly clavate, black dorsally, yellow with some black scales ventrally, several larger black and white scales at base, needle-like seta at apic

Head: frons smooth-scaled with several white setae, grey with white thin stripes on lateral margins; vertex with elongated scales, black with blue sheen; labial palpi long and upturned with elongated scales black basally and white medially on ventral side, creamy yellow apically (Fig. 1, suppl. video TC 00:43-00:48); proboscis long, orange; pericephalic hairs white ventrally and creamy yellow to orange with several black hairs dorsally; compound eyes brown; ocelli black.

Thorax: covered with white hair-like scales on background of smooth black scales with metallic sheen, faint, dashed orange line running longitudinally on mesothorax medially (Fig. 1); patagia white; patch of white scales laterally; long white and black hairs at wing insertion.

Abdomen: tergites 1-3 and 6-7 black; tergite 4 black with slight silver sheen; tergites 5 and 8, as well as posterior margin of 4th and 7th tergite, black with intense silver sheen in sunlight (suppl. video TC 00:22-00:23, 01:12-01:16); sternite 1 black; sternite 2 black with several creamy yellow scales on distal margin; sternites 3-6 black with white stripe on distal margins; sternites 7-8 black; anal tuft small, black.

Legs: fore and mid femur smooth-scaled, grey; fore and mid tibia and 1st tarsomere tufted with hair-like scales: mixture of black with metallic sheen, white and creamy yellow to orange (suppl. video TC 00:42-00:49); fore and mid tarsomeres 1 and 5 black, 2-4 creamy yellow to orange proximally, black distally; hind femur smooth-scaled, black with silver sheen; hind tibia with two tufts of hair-like scales separated by smooth (black dorsally and white
ventrally) scales medially (Figs 1-2): tufts black with metallic sheen, band of white scales on proximal tuft, some creamy yellow to orange scales ventrally on tufts and spurs, distal tuft extending to 1st tarsomere; tarsomeres black with several orange scales.

Forewing: transparent with black (Fig. 1) or black and orange scales (Fig. 2) distinctly marking contour of entire anterior transparent area (ATA); also black scales along veins and margins; admixture of white and yellow to pale orange scales on discal spot extending to coastal and anal margins (Fig. 1); transparent areas densely covered with semi-hyaline scales; cilia either black or light brown.

Hindwing: transparent with black scales along veins, margins and at base; discal spot very narrow with semi-hyaline scales; transparent areas without semi-hyaline scales; cilia black.

Male genitalia (Fig. 4): tegumen narrow; uncus with brown setae on apical margin ventrally; saccus broad, rounded basally; valva quadrangular, broadened in distal half, covered with setae.

Female unknown.

Variability. One A. argentifasciata observed in the wild had orange scales around ATA and on coastal margin, lacked black scales on veins of forewing and had pale brown cilia (Fig. 2). There are also slight differences in size.

Differential diagnosis

A. argentifasciata can be immediately distinguished from A. metachryseis Hampson 1895 and A. murzini Gorbunov & Arita 2002 by the transparent wings (opaque forewings in species compared). From A. lampropoda Hampson 1893 it differs in wing and hind leg tuft colouration (yellow hyaline wings; yellow and orange tufts in A. lampropoda). Male genitalia conformation is most similar to A. longipoda Arita & Gorbunov 2000, but it differs in the shape of the valva and saccus. Moreover, it can be distinguished by the entire body colouration (thorax, abdomen and legs orange in A. longipoda). Superficially, A. argentifasciata is most similar to A. xanthocrista Gorbunov & Arita 1995 but it differs in the colouration of labial palpi (mainly black in species compared), pericephalic hairs (black with admixture of brown and white in species compared) and abdomen (nearly entirely black
dorsally and white ventrally in species compared), more developed external transparent area of forewing and the male genitalia: shape of valva, uncus and saccus.

**Distribution and habitat.**

Phetchaburi, Thailand. Two locations 50 km apart in Phetchaburi, at elevations ca 130 m and ca 350 m. The type specimens were found mud-puddling on wet sand, in close proximity to a small, periodically drying river, in an area surrounded on one side with a rainforest and the other by mixed cultivations (mostly lime, banana, papaya and pineapple).

**Behaviour**

*A. argentifasciata* flies in a temperature between 29°C and 35°C and 30-61% air humidity. It was seen seven times, in February and March 2017, between 12:00 pm and 2:30 pm (hottest time of the day) and returned to the same spot several days in a row. Each time the sesiid was observed, it came to mud-puddle, either on moist sand or pebbles, between sparse herbs (suppl. video TC 00:12-00:49, 01:07-01:15). Sometimes two individuals puddled very close to each other. When puddling, the sesiid was quite calm and stayed relatively long in one area, flying from one spot to another low above the ground, searching for the best place to land. It stayed for a maximum of over two hours in the same area. It landed both in full sunlight and in the shade. *A. argentifasciata* was once observed during cloudy weather and continued mud-puddling even when it began to slightly rain. It was also seen several times resting on a grass-stalk in the same area.

Similarly to *Heterosphecia pahangensis* Skowron 2015 from Peninsular Malaysia, *A. argentifasciata* displays bee-mimicking behaviour. It flies in a zig-zag, making a buzzing sound (suppl. video TC 01:17-01:27) and hovers before landing, even for several seconds. In flight, it leaves its hind, tufted legs hanging downwards and keeps its abdomen characteristically bent downwards between the 5th and 6th segment (suppl. video TC 01:28-02:44), thus exposing the silver, light-reflecting 5th segment. Whilst mud-puddling, it changes places from time to time, and when taking off calmly, it pushes itself away from the ground using its fore and mid legs, unfolding its wings at the same time, then hovers for a moment before unhurriedly flying forwards (suppl. video TC 02:15-02:44). However, when startled, the sesiid will take off very rapidly, pushing itself away with much force, often losing balance for a moment in the air and swinging its body from left to right to gain the proper position, sometimes unfolding its wings after taking off, whilst already in the air (suppl. video TC 02:59-03:15). Ants occurring in the same location would often scare off the puddling sesiid (suppl. video TC 02:45-02:57). In contrast to the closely related *H. pahangensis* and *Pyrophleps ellawi* Skowron Volponi 2017, the hind legs of *A. argentifasciata* are functional and used for locomotion during mud-puddling. However, they do not seem very strong and are hardly used when the sesiid takes off.

**Etymology**

The name *argentifasciata* from latin *argentum* [silver] and *fascia* [band] corresponds to the characteristic silver sheen of the 5th tergite of the abdomen, which is exposed in flight.

**Discussion**

It is thought that fragmentary behavioural data are recorded for no more than 5% of the described insect species (Matthews & Matthews 2010). In the case of Sesiidae, this number is
surely much lower, taking into consideration that these insects are often lured and caught with the use of synthetic pheromones, then immediately killed and pinned. Perhaps the most characteristic feature of A. argentifasciata, from which it has been named, is the silver band on the 5th segment of the abdomen, which is exposed during flight and well visible even from a certain distance (suppl. video TC 00:22-00:23, 00:31-00:33, 01:12-01:16, 01:38-01:40, 02:07-02:13, 02:27-02:37). What is interesting, this band is only visible on live individuals, the abdomen of a pinned specimen seen through a microscope is black. When applying light from an angle, a slight sheen of the black scales is visible, however this cannot be compared to the distinct colouration visible in sunlight, whilst the insect is flying. Thus, this characteristic would remain unnoticed if A. argentifasciata was not observed in the wild.

Colouration of the entire body and hind leg tuft density and conformation are features which are often lost on pinned Sesiidae.

Moreover, filming sesiids in the wild can provide valuable information on their previously unknown behaviours, such as mud-puddling or interactions with other animals. Videos realized in slow motion are particularly useful to visualize the conformation of the clearwing moth’s body in flight, which is impossible to notice in real time.

The authors hope it will become a standard to enrich morphological descriptions of new species of insects with photographs and videos realized in their natural habitat, thus giving a better insight into the insect’s biology, behaviour and actual appearance.

Acknowledgements

The first author received funding through a doctoral scholarship registration number 2016/20/T/NZ8/00541 from the National Science Centre in Poland. This study was partially funded by task funds no. DS 530-L140-D242-17 and DS 530-8645-D691-17. The ClearWing Foundation for Biodiversity Research and Education made a financial contribution to this study. Microscopic photographs were taken in the Department of Invertebrate Zoology and Parasitology, University of Gdansk, Poland. Thank you to Stefano Volponi for his help in designating the new latin name.

References


Hampson GF (1895) Descriptions of New Heterocera from India. The Transactions of the Entomol. Soc. Lond. (4th ser.), 282