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OBSERVATIONS ON THE MATURE CATERPILLAR AND PUPA OF THE HUMMINGBIRD HAWKMOTH, *MACROGLOSSUM SITIENE* WALKER (LEPIDOPTERA: SPHINGIDAE: MACROGLOSSINAE)

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INTRODUCTION

Moths in the genus *Macroglossum* (family Sphingidae) are commonly referred to as 'hummingbird hawkmoths' owing to their striking resemblance to the expertly controlled flight of the New World birds, as they hover from flower to flower with pin-point precision and highly rapid wing beats. These small- to medium-sized moths even have specialised, elongated scales fanning out from the tips of their abdomens, analogous to the tail feathers of hummingbirds, which may assist in fine-tuning their aerial maneuvers. This generic name was first erected by Scopoli in 1777 and is currently one of the most speciose genera of hawkmoths, containing at least 84 species (Kitching & Cadiou, 2000). Its occurrence is predominantly Southeast Asian, with 76 species recorded from this region (Beck & Kitching, 2008). In Singapore, at least seven species of *Macroglossum* have been recorded, including *Macroglossum sitiene* Walker, 1856. This species has been documented from northeast India, Sri Lanka, Thailand, Vietnam, south China, Taiwan, south Japan, Peninsular Malaysia, and Sumatra (Inoue et al., 1997). Thus far, it has not been reported from Borneo and eastwards (Beck & Kitching, 2008). Encounters with the caterpillars of this species in Singapore and their successful metamorphosis are described herein.

OBSERVATIONS

The earliest encounter with the caterpillar of this species was in Dec.2005, when the second author found a larva feeding on the 'noni' shrub, *Morinda citrifolia* (family Rubiaceae), at Kew Drive. It was reared through to metamorphosis and the resultant male was preserved as a voucher specimen at the Zoological Reference Collection (ZRC) of the Raffles Museum of Biodiversity Research (RMBR), National University of Singapore. It was catalogued as ZRC.LEP.57 and was measured to have a forewing length of 21 mm, and body length of 30 mm.

Fig. 1. Dorsal (a) and ventral (b) views of a male *Macroglossum sitiene*, reared from a caterpillar found in Kew Drive (early Oct.2006). The specimen (ZRC.LEP.58, forewing length: 20 mm, body length: 28 mm) pupated on 11 Oct.2006 and subsequently emerged on 25 Oct.2006. Note the trilobate fantail, characteristic of males.

Fig. 2. Close-up of right underwing of male *Macroglossum sitiene* (ZRC.LEP.58) to view the retinaculum (R) and frenulum (F).

In early Oct.2006, a second larva was again found by the second author from the same locality, on the same hostplant and reared till metamorphosis. It pupated on 11 Oct.2006 and emerged on 25 Oct.2006 (pupal period: 14 days). The emergent male was also preserved and measured (ZRC.LEP.58, forewing length: 20 mm, body length: 28 mm). In the forewing of this species, there is a distinct dark, sharply angular L-shaped pattern on the proximal part of its forewing (Fig. 1). On the underwing of males, both the retinaculum and frenulum (characteristic of virtually all moths), may be readily observed upon closer inspection (Fig. 2). In males, the elongated specialised scales at the end of the abdomen are arranged as three distinct tufts that give the impression of a fan tail.

While conducting a nocturnal survey at the Sungei Buloh Wetland Reserve (SBWR) on 5 Sep.2008, we found two final instar caterpillars, also on *Morinda citrifolia* growing beside mangrove habitat. One of the caterpillars is shown in Fig. 3. Its dorsum was bluish-green, with enlarged, closely spaced, yellow dots at the anterior end of most body segments, giving the impression of transverse, broken, yellow lines across the dorsum of the body.

Its flanks were more of a pale, aquamarine blue, clearly demarcated from the dorsal colouration by a pair of dorsolateral lines that ran from its head to the base of its tail horn. This dorsolateral line was yellow near the head region but fades to white towards the posterior region, where it was also thickest. There were also uniformly distributed yellow dots all over its body, although those on its dorsum were larger than those on the flanks. Its spiracles were brownish-orange. Its tail horn (Fig. 4) has a very subtle, upward curve and was adorned with short spines throughout. The proximal half was pale blue, while the distal portion was leaf green.

In captivity, both larvae displayed a voracious appetite for the leaves of their foodplant. On the 7 Sep.2008, they began to display characteristic prepupal symptoms, with the bodies turning purplish-brown and the yellow dots increasing in intensity. The dorsolateral line became pinkish (especially noticeable at the posterior) while the distal half of the tail horn turned orange brown (Fig. 5). Shortly after, they became increasingly restless and began to weave leaves together with silken threads to enshroud themselves. It was possible to keep track of the pupation process by peering in between the gaps of the leaves (Fig. 6) and the well formed pupae were distinguishable by 9 Sep.2008. Sphingid moths generally pupate in the ground amongst leaf litter, but they will use fresh leaves to enshroud themselves if reared in captivity, as was witnessed in this particular case.

When freshly pupated, there was a light translucent sheen on the pupal skin, but this progressively intensified to become a golden-brown within the next few days. Ventrally, there was a straight, black stripe from the base of its proboscis sheath to the wing tips (Fig. 7a). Laterally, each of its spiracles was surrounded with black (Fig. 7b). Dorsally, a black symmetrical mark was present on the head region (Fig. 7c). The length of the pupa was 37 mm and the width on 15 Sep.2008 was 10 mm.

The eventual emergence dates of the moths were one day apart, the first on 20 Sep.2008 and the second on 21 Sep.2008. The pupal period was between 11 and 12 days. Both were females (ZRC.LEP.59, forewing: 21 mm, body length: 29 mm; ZRC.LEP.60, forewing: 22, body length 30 mm, Fig. 8). Unlike the male, the fan tail of a female has an even, curved margin (lunulate).

Fig. 3. Last instar larva of *Macroglossum sitiene* on its hostplant, *Morinda citrifolia* (family Rubiaceae), encountered on the night of 5 Sep.2008 at the Sungei Buloh Wetland Reserve. Its body length was 51 mm, and tail horn length, 12 mm.

Fig. 4. Close-up of posterior tail horn, illustrating the uniformly distributed, short spines along its entire length. Note also the brownish-orange spiracles and the yellow margin of the supra-anal flap.

Fig. 5. Prepupal colouration and behaviour began to manifest on 7 Sep.2008. The caterpillar's entire body turned purplish brown, with the yellow dots becoming darker (almost orange). The dorsolateral stripes (previously white, Figs. 3, 4) running from the base of its tail horn had now become pinkish. The distal portion of its tail horn (previously green) was now an orange-brown instead.

Fig. 6. The progress of pupation was monitored by peeking through the golden-brown silken threads attached onto adjacent leaves. The process was completed by 9 Sep.2008, after which the pupa was measured and photographed (Fig. 7).

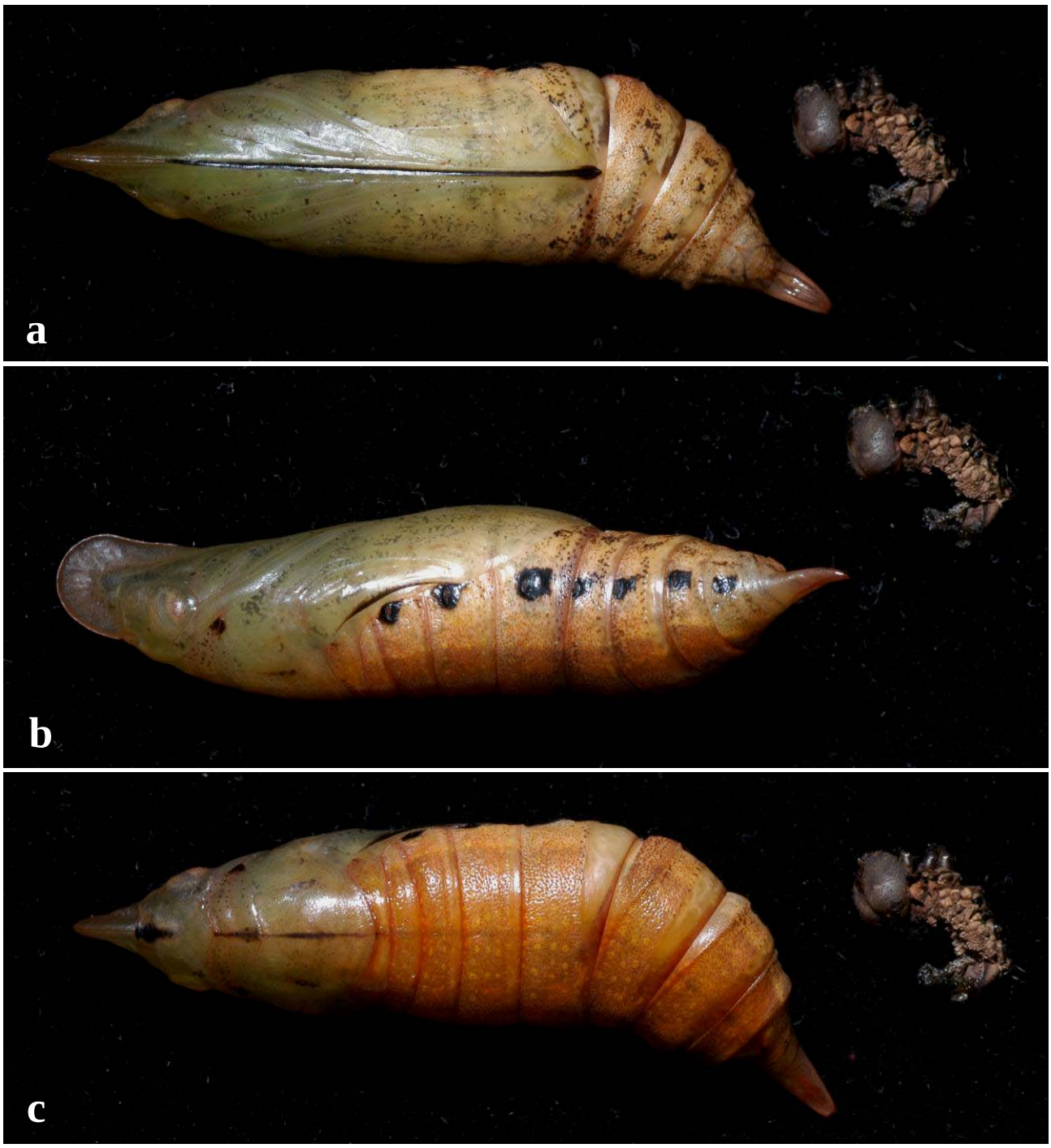

Fig. 7. Ventral (a), lateral (b) and dorsal (c) perspectives of the freshly formed pupa, pictured with the exuvia of its final instar. This initial translucent sheen later became a golden-brown colour in the following days. On its venter, there was a straight, thin, black stripe running from its proboscis sheath to its wing tips. Along its flanks, the lateral spiracles were each marked with black. On its dorsum, a narrow symmetrical marking was present on its forehead. The pupa was 37 mm long and 10 mm wide.

The earliest accounts of the caterpillars of this species were by Mell (1922), based on specimens from South China. Apart from *Morinda citrifolia*, the larvae of *Macroglossum sitiene* have also been known to eat leaves of the climbers, *Morinda umbellata*, as well as *Paederia scandens* and *Paederia tomentosa* (also in the family Rubiaceae) as caterpillar foodplants (Pittaway & Kitching, 2008).

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Fig. 8. Adult female *Macroglossum sitiene* (ZRC.LEP.60, forewing: 22 mm, body length: 30 mm) freshly emerged on the late night of 21 Sep.2008. Its frenulum was visible on both sides of its wings. Note the lunulate fan tail, characteristic of females (compare with Fig. 1, male).

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