

## FINAL INSTAR CATERPILLAR AND METAMORPHOSIS OF THE HAWKMOTH, *THERETRA NESSUS* (DRURY) IN SINGAPORE (LEPIDOPTERA: SPHINGIDAE: MACROGLOSSINAE)

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### INTRODUCTION

Among the members in the genus *Theretra* Hübner, *Theretra nessus* (Drury, 1773), has been regarded as the largest species (Inoue et al., 1997). It has a widespread geographic distribution, having been recorded from India, Sri Lanka, Nepal, Myanmar, Thailand, Vietnam, west and south China, Japan, South Korea, throughout Sundaland to Australasia, New Caledonia, and introduced to Hawaii (Inoue et al., 1997; Pittaway & Kitching, 2009).

Early descriptions and illustrations of the diagnostic larva and pupa of *Theretra nessus* were published by Mell (1922), Bell & Scott (1937), and Dupont & Roepke (1941). The larvae are manifested as two colour morphs—either brown or green forms (Barlow, 1982; Pittaway & Kitching, 2009). Here, a final instar larva (brown form) from Singapore is illustrated and its successful metamorphosis summarised.



Fig. 1. Lateral view of final instar larva (brown form) of *Theretra nessus*, on its hostplant, *Dioscorea orbiculata* var. *tenuifolia* (Dioscoreaceae), a native climbing vine. It was encountered at the Bukit Timah Nature Reserve on the afternoon of 7 Nov.2009 (ca. 1700 hours). Its body length was 85 mm and tail horn length was 8 mm.

## OBSERVATIONS

While conducting a faunal survey at the Bukit Timah Nature Reserve on the afternoon of 7 Nov.2009 (ca. 1700 hours), a full grown sphingid larva (Figs. 1, 2) was encountered to be feeding on the leaves of a climber just above the forest floor, beside the main path towards the summit of Bukit Timah. This final instar larva was subsequently verified to be the brown form larva of *Theretra nessus* (see Pittaway & Kitching, 2009; I. J. Kitching, pers. comm.). The body length of the larva was 85 mm, while its tail horn length measured 8 mm.

Its body was an overall rusty, reddish-brown. From the third abdominal segment (A3) rearwards, its flanks were cloudy white, clearly demarcated from the reddish-brown dorsum by a pair of straight, dorso-lateral, grayish lines that converged at the base of the tail horn. The tail horn was a light, orange-brown and with a gentle downward curve. Its spiracles were orange-brown and dotted with white at both ends of the ellipse. At A1 and A2, dorsolateral pairs of false eyespots were present, with the anterior pair being the larger ellipse. These ocelli were chalky white and outlined with gray. Its thoracic legs were a uniform orange.

In captivity, this larva demonstrated a voracious appetite and consumed all of the leaves provided, even resorting to chewing up the remnant petioles thereafter. The host plant was subsequently identified to be *Dioscorea orbiculata* Hook.f. var. *tenuifolia* (Ridl.) Thapyai (family Dioscoreaceae) (A. T. Gwee, pers. comm.). This native species of climber has been previously recorded from Bukit Timah, as well as the Botanic Gardens' Jungle (Keng et al., 1998). It was first described by Henry N. Ridley in 1904, based on type specimens collected from Bukit Timah in 1891 (holotype), and 1892 (paratype).

By the evening of 9 Nov.2009, typical pre-pupal behaviour and colouration were observed. As the larva paced around with an increased urgency, its colours also darkened. By the same night, the anterior pairs of ocelli had become salmon-pink, while its flanks also became pinkish (Fig. 3). At the same time, dorsolateral black patches also began to appear between A2 and A7. On the morning of 10 Nov.2009, the larva had enshrouded itself with loose leaves, fastened with sparse silk. On the same night, it proceeded with the gradual release of fluids from within its body, accompanied by bodily contractions. By the morning of 12 Nov.2009, pupation was observed to be complete and the larval exuvia was removed for preservation.

The pupa (Fig. 4) was 71 mm long by 14 mm wide. It was an overall golden-brown, with darker brown on its flanks. The mid-ventral and mid-dorsal axes appeared to be largely devoid of the dark brown pigmentation. Its spiracles were brick red, with the anterior-most two encircled by prominent black spots. When the pupa was regularly inspected to monitor the progress of development, little or no abdominal contractions were observed, unlike that of other more responsive sphingids previously reared.



Fig. 2. Dorsal view of final instar larva (as in Fig. 1). Note the white, elliptical eyespots at the 1<sup>st</sup> and 2<sup>nd</sup> abdominal segments (A1 and A2).

On the night of 28 Nov.2009, the pupa was inspected and found to have darkened significantly, especially at the region of the wing cases (Fig. 5, in comparison with Fig. 4a). The pupa had also acquired a translucent sheen, which allowed its proboscis and labial palps to be seen at the head region. Its underlying three pairs of limbs were also visible. The texture of the pupa was also rather fragile and papery thin to touch.

In the early morning of 29 Nov.2009 (ca. 0140 hours), the moth had emerged from within the pupa and had clambered onto an upright branch, on which to dry and spread its wings (Fig. 6). At 0147 hours, the wings were already being elongated steadily, and by 0151 hours, the wing tips had surpassed the end of the abdomen. Once the wings had largely straightened out, they were then held back over its dorsum for approximately half an hour (Fig. 7). During this time, its underwing colour/patterns could be documented and its sex confirmed. This moth was determined to be a female, as the typical hook-like retinaculum at the base of the forewing (often found in males) was absent. Moreover, the frenulum at the leading edge of the hindwing was examined and found to comprise a bunch of bristles, rather than a single, fused spine. From the lateral perspective, the abdominal spiracles, represented by a uniform row of black dots, could be readily observed.

While the wings were being held back, the moth was observed to carefully uncoil its proboscis, then wind it back again, for a number of times, reminiscent of a clock spring (Fig. 8). This exercise was intended to align both halves (left and right) of its proboscis, in preparation for the optimal function of sipping nectar (I. J. Kitching, pers. comm.). At times, a clear fluid was observed within the coils of the proboscis, possibly exuded from the mouth of the moth to facilitate proboscis alignment. At 0227 hours, initial movement of the wings indicated that they were about to be folded forwards and this swift motion proceeded shortly after (Fig. 9).

The female moth (Fig. 10) was subsequently preserved as a voucher specimen at the Zoological Reference Collection (ZRC) of the Raffles Museum of Biodiversity Research (RMBR), National University of Singapore with measurements of its body length (BL) and forewing length (FW) obtained. It was catalogued as ZRC.LEP.265 (BL: 50 mm, FW: 48 mm). At the ZRC, there are three earlier specimens (one female, two males) of *Theretra nesus* from Singapore. These include: ZRC.LEP.262 (male, BL: 65 mm, FW: 52 mm, coll. T. P. Teo, 23 Mar.1979, Kampong Java Road); ZRC.LEP.263 (female, BL: 56 mm, FW: 54 mm, coll. T. P. Teo, 18 May 1988, Toa Payoh North); ZRC.LEP.264 (male, BL: 59 mm, FW: 50 mm, coll. J. W. H. Yong, 1 Jan.1991, Kent Ridge). In addition, there is also a historical specimen of this species from Peninsular Malaysia—ZRC.LEP.261 (male, BL: 63 mm, FW: 55 mm, coll. H. M. Pendlebury, 1923, Perak, Batang Padang, Jor camp). Outside Singapore, TML has also encountered this species in Borneo, at the Bukit Kana field research station (Bintulu Division, Sarawak, East Malaysia) on the night of 21 Mar.2007 (ca. 2215 hours).



Fig. 3. Pre-pupal colouration, photographed on 9 Nov.2009 (2359 hours). The anterior ocelli (A1, A2) have turned salmon-pink, while dorsal, black patches have appeared uniformly along the dorsolateral margin. The flanks have also progressively acquired a pinkish hue (compare with Fig. 1).



Fig. 4. Ventral (a), lateral (b), and dorsal (c) views of pupa. The pupa was 71 mm by 14 mm. Pupation was complete by the morning of 12 Nov.2009.



Fig. 5. Ventral view of pupa, prior to imminent eclosion. Note the significantly darkened wing cases (compare with Fig. 4a). At this point, the pupal cuticle had become noticeably translucent, rendering its well-formed proboscis, labial palps, and three pairs of limbs clearly visible at its anterior. Photographed on 29 Nov.2009 at 0121 hours.

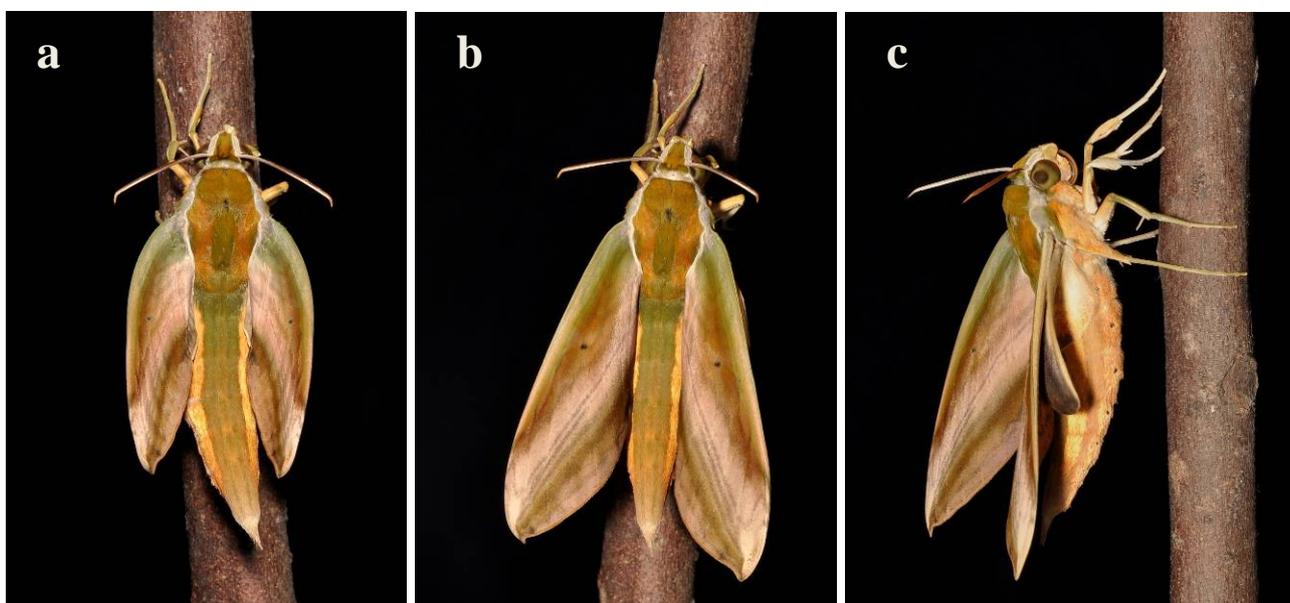


Fig. 6. Freshly eclosed adult moth on 29 Nov.2009 at 0147 hours: (a), 0151 hours (b), and 0153 hours (c). Note the progressive inflation and elongation of its wings.

Compilations of larval hostplant records for this hawkmoth reveal a clearly polyphagous diet, with at least 18 plant genera representing 13 families documented thus far (Inoue et al., 1997; Pittaway & Kitching, 2009; Robinson et al., 2009). For the genus *Dioscorea*, at least eight species have been documented as larval hostplants for *Theretra nessus* (I. J. Kitching, pers. comm., Dec.2009).

In Singapore, the larvae of *Theretra suffusa* (Walker, 1856), have been previously reared and photographed (Leong & D'Rozario, 2009). Hopefully, local encounters with the larvae of other members of *Theretra* may provide us further opportunities to document and compare the varied larval/pupal morphologies within this sphingid genus.

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Fig. 7. Lateral view of eclosed female moth, with wings still held backwards. The typical hook-like retinaculum at the base of the forewing (characteristic of males) was absent in this individual. Photographed at 0156 hours.



Fig. 8. Lateral close-up of head region. While the wings were held back, the moth repeatedly uncoiled and recoiled its proboscis in a deliberate manner, in order to unite the left and right halves of this suctorial mouthpart. Photographed at 0216 hours.



Fig. 9. Dorsal view of moth, at 0227 hours (a), and 0229 hours (b), when the wings began to fold downwards and forward.



Fig. 10. Successfully eclosed female (ZRC.LEP.265, body length: 50 mm, forewing length: 48 mm) with outspread wings. Photographed at 0314 hours.

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