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FINAL INSTAR LARVAE AND METAMORPHOSIS OF THE HAWKMOTH, *PSILOGRAMMA INCRETA* (WALKER) IN SINGAPORE (LEPIDOPTERA: SPHINGIDAE: SPHINGINAE)

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INTRODUCTION

The hawkmoth, *Psilogramma increta* (Walker, 1865) has a South and East Asian distribution, ranging from north Pakistan and northwest India, east through Thailand, Vietnam, China, Taiwan, Korea to Japan, and south to southwest India and Sri Lanka, Sumatra and Borneo (Beck & Kitching, 2008). There have also been records for Singapore, as testified by existing voucher specimens at the Zoological Reference Collection (ZRC) of the Raffles Museum of Biodiversity Research (RMBR), National University of Singapore. I also had opportunities to rear the diagnostic caterpillars of this sphingid from various localities in Singapore and witnessed their metamorphosis to the adult moths. A summary of the larval and pupal characters are presented here.

Fig. 1. Lateral aspect of final instar of *Psilogramma increta* on its hostplant, African tulip (*Spathodea campanulata*), encountered on Kent Ridge on 24 Dec.2007. Its body length was 95 mm and the tail horn was 14 mm long.

OBSERVATIONS

One of the earlier local encounters with the caterpillars of *Psilogramma increta* was within the Central Catchment Nature Reserve, when a final instar (green form) larva was found on the leaves of a young African tulip treelet (*Spathodea campanulata*, family Bignoniaceae) on the summit of Bukit Peirce on the afternoon of 3 Feb.2006. Attempts were made to rear this larva, but it was quickly found to have been parasitized by tachinid flies and thus preserved as a larval voucher (ZRC.LEP.155, total length: 80 mm, tail horn: 11 mm). However, there was also a possibility that the larva may have been *Psilogramma menephron* (Cramer, 1780), which has very similar larval and adult forms.

Subsequently, another final instar larva of *Psilogramma increta* was discovered (24 Dec.2007), this time along Kent Ridge (within the National University of Singapore campus), also on an African tulip treelet, growing just beside the road. Its body was green, with white diagonal markings repeated for each abdominal segment (Figs. 1, 2). The spiracles were black, with distinct white margins. Along the dorsal margin of the second thoracic segment, a neat row of seven white tubercles was clearly visible (Fig. 3). This larva had a total body length of 95 mm, with a tail horn 14 mm long. Its tail horn was remarkably straight, tapering only slightly towards its apex. The entire horn was adorned with numerous small spines, alongside aggregations of larger, robust spines (Fig. 4). The supra-anal flap and the posterior margins of its anal prolegs were also clearly armed with conical tubercles, almost forming a posterior shield.

Approximately 24 hours after the caterpillar from Kent Ridge was collected, it began to exhibit symptoms of the onset of pupation (Figs. 5, 6). Its feeding behaviour had halted entirely, and it began pacing around in a restless fashion, seeking a safe site to pupate. All previous traces of green on its body had vanished entirely, having changed to a purplish brown shade. On its dorsum, the symmetrical markings that were once white became mustard yellow instead (Fig. 6). Between 26–29 Dec.2007, the larva underwent the laborious process of physical shrinkage and release of fluids. It was only on the 30 Dec.2007 that pupation was observed to be complete. The cast off exuvia was cleaned and preserved.

The new pupa had a translucent, golden yellow glow that progressively darkened in the following days. The most striking feature of the pupa of this sphingid is the wondrous form of its proboscis sheath, which projected as a tube away from its body, with its bulbous end resting along the midline between the legs (Fig. 7). Such a structure may be likened to an elephant's trunk, or comparable to the handle of a jug. This pupa was later measured and found to have a total length of 58 mm, width: 15 mm, proboscis sheath length: 19 mm. Subsequently, the adult moth emerged on the evening of 22 Jan.2008 and was liberated at Kent Ridge on the same night. Its empty pupal case was cleaned and preserved (ZRC.LEP.154).

Fig. 2. Dorsal aspect of final instar of *Psilogramma increta* from Kent Ridge (as in Fig. 1).

Fig. 3. Head close-up of final instar of *Psilogramma increta* (as in Figs. 1, 2). Note dorsal row of white tubercles across its second thoracic segment.

Fig. 4. Lateral close-up of posterior tail horn of final instar of *Psilogramma increta* (as in Figs. 1, 2). Note arrangement and distribution of small and larger spines over its entire length.

Fig. 5. Lateral aspect of prepupal *Psilogramma increta* from Kent Ridge, as first noted on 25 Dec.2007. The previously green portions of its body have turned purplish-brown. The caterpillar also became increasingly restless as it crawled around in search of a suitable site to pupate.

Fig. 6. Dorsal aspect of prepupal *Psilogramma increta* from Kent Ridge. Note how the stripes on its back have become mustard yellow.

Fig. 7. Anterior lateral close-up of *Psilogramma increta* from Kent Ridge, freshly pupated on 30 Dec.2007. Note the translucent, amber proboscis sheath, which houses the developing haustellum. The faint outline of the proboscis may be seen within this sheath.

While conducting a nocturnal faunal survey in the Nee Soon Swamp Forest (Central Catchment Nature Reserve) on 25 Apr.2009, yet another final instar larva (green form) of *Psilogramma increta* was found on an African tulip sapling, at ca. 2145 hours. The larva was sitting about 2.5 m from the ground and was collected for subsequent rearing and documentation. In captivity, the larva continued to feed and attained a total length of 62 mm. Its tail horn was 11 mm long. In the pre-dawn hours of 29 Apr.2009, the first manifestations of pre-pupal colouration and behaviour were noted. By the evening of 1 May 2009, it had successfully completed its transition to the pupal phase. Consistent with the earlier pupa observed, the entire pupa was a clear, amber colour. Darkening occurred in a progressive wave, with its wing cases being the last portion to acquire the brown, tanned appearance (Fig. 8). The typical pupa of *Psilogramma increta* is a rich, chestnut brown, with its cremaster and proboscis sheath almost ebony (Fig. 9). This particular pupa was 50 mm long, 11 mm wide, with a proboscis sheath 14 mm long.

Fig. 8. Ventral (a) and lateral (b) views of the recently formed pupa of *Psilogramma increta* reared from a final instar larva found at the Nee Soon Swamp Forest (encountered on the night of 25 Apr.2009, feeding on African tulip). Note the still translucent, amber colour of its wing cases, which were the last portion to darken. Photographed on 1 May 2009 at ca. 2100 hours.

Fig. 9. Ventral (a), lateral (b), and dorsal (c) views of the darkened and hardened pupa (as in Fig. 8). This pupa was 50 mm long and 11 mm wide. Its proboscis sheath was 14 mm long. Measured and photographed on 8 May 2009.

On the morning of 13 May 2009, there was a noticeable darkening of the wing cases of this pupa. The adult moth eventually emerged on the same night, and was determined to be a female (Fig. 10). To illustrate its potential camouflage capabilities, this moth was perched on the greyish bark of a tree and photographed, demonstrating how well its wing and body colour/patterns enable it to blend naturally (Fig. 11). The moth was subsequently preserved as a voucher specimen (ZRC.LEP.153, body length: 39 mm, forewing: 42 mm). Its corresponding pupal case was also preserved.

The diagnostic caterpillar and pupa of *Psilogramma increta* have been well described earlier (Mell, 1922). Thus far, at least six different plant genera (in six families) have been documented hostplants for this sphingid (Inoue et al., 1997). At the RMBR, additional specimens of adult *Psilogramma increta* from Singapore have been deposited (BL = body length, FW = forewing length): ZRC.LEP.146 (female, BL: 55 mm, FW: 66 mm, coll. F. N. Chasen, 11 Jan.1923, 'Singapore'), ZRC.LEP.148 (male, BL: 43 mm, FW: 44 mm, coll. Tay Soon Cheng, 1 Oct.1980, Bukit Timah Campus), ZRC.LEP.149 (female, BL: 43 mm, FW: 48 mm, coll. H. K. Lua, 1990s, Kent Ridge), ZRC.LEP.150 (female, BL: 42 mm, FW: 47 mm, coll. Victor, 15 Jul.1992, Kent Ridge).

In addition, there are also voucher specimens of locally collected *Psilogramma menephron*: ZRC.LEP.71 (male, BL: 40 mm, FW: 39 mm, coll. Vilma D'Rozario, 2 Feb.2005, Kew Drive), ZRC.LEP.147 (male, BL: 45 mm, FW: 48 mm, coll. T. P. Teo, 12 Oct.1979, Kampong Java Road), ZRC.LEP.151 (male, BL: 43 mm, FW: 44 mm, coll. T. M. Leong & H. H. Tan, 16 Apr.2004, Science Faculty, National University of Singapore, outside Raffles Museum of Biodiversity Research).

Fig. 10. Female *Psilogramma increta* (ZRC.LEP.153, body length: 39 mm, forewing: 42 mm), shortly after successful emergence from its pupal case (as in Figs. 8, 9) on the night of 13 May 2009.

Fig. 11. While at rest on a tree trunk, *Psilogramma increta* is able to camouflage itself against the bark and is not easily discernible, especially from a distance. This hawkmoth is the same individual as in Fig. 10.

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