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FINAL INSTAR CATERPILLAR AND METAMORPHOSIS OF *EUDOCIMA SMARAGDIPICTA* (WALKER) (LEPIDOPTERA: NOCTUIDAE: CALPINAE)

T. M. Leong
Central Nature Reserve, National Parks Board,
601 Island Club Road, Singapore 578775, Republic of Singapore
(*E-mail*: leong_tzi_ming@nparks.gov.sg, banjarana@gmail.com)

INTRODUCTION

Members of the genus *Eudocima* Billberg, 1820 are medium-sized moths (forewing length: 30–40 mm) characterised by forewings that are held roof-wise over their bodies when at rest, concealing hindwings with flash patterns (often yellow and black) that are only revealed when disturbed or upon taking flight. The forewing colouration is generally represented by a combination of different shades of brown, with some species exhibiting various extents of cream, green or purplish patterns. These contribute to the successful camouflage of the moths when perched upon natural substrates in the forest. The caterpillars within this genus also share consistent diagnostic morphological characters and defensive behaviour, as summarised by Holloway (2005). In recent decades, this group of noctuid moths has undergone both generic and subfamilial re-assignment. It had long been referred to as genus *Othreis* Hübner, 1823, in subfamily Ophiderinae of family Noctuidae (e.g., Barlow, 1982). Holloway (2005) confirmed the correct name as *Eudocima* and included it in tribe Calpini of subfamily Catocalinae. Most recently, Zaspel & Branham (2008) included the tribe in the subfamily Calpinae. In Borneo, there are 12 species of *Eudocima* (Holloway, 2005), and in Singapore, at least five species have been documented thus far, based on available literature, museum specimens and personal field encounters. This paper documents the final instar larva of *Eudocima smaragdipicta* (Walker, 1857) and its subsequent metamorphosis from an individual encountered in the Central Catchment Nature Reserve, Singapore.

Fig. 1. Final instar caterpillar of *Eudocima smaragdipicta* resting on the leaves of its hostplant, *Fibraurea tinctoria*. Its total length was 75 mm.

OBSERVATIONS

While conducting a routine faunal survey along the hill slopes of the Petaling Trail (MacRitchie Reservoir forest) on the afternoon (ca. 1700 hours) of 27 Dec.2008, a dark caterpillar was observed perched under a leaf of a forest climber that was entwined around a treelet beside the wooden boardwalk, about 2 m above the forest floor. It was carefully retrieved for subsequent rearing in captivity to monitor its development and determine its identity. Representative leaves of the same forest vine on which it was found were collected as food for the caterpillar and this host plant was subsequently identified as *Fibraurea tinctoria* (family Menispermaceae).

Fig. 2. Defensive posture of the caterpillar. Both ends of its body are elevated, while being supported by the three pairs of prolegs on abdominal segments four to six.

Fig. 3. Dorsal view of the caterpillar while adopting a defensive pose. The false eyespots of the third abdominal segment may serve to deter potential predators.

At rest, the caterpillar had an outstretched length of 75 mm and body width of 8 mm (Fig. 1). Its entire body was a velvety blackish-brown, with sparsely distributed small, blue dots. On its first and second abdominal segments, there was a pair of larger orange spots. Its third abdominal segment was adorned with a most visually striking pair of ocelli, consisting of a broad orange ring, centred with dark brown, and with smaller blue speckling in the middle. On its sixth and seventh abdominal segments, there was an irregular 'V'-shaped pattern (when viewed dorsally) that straddled from the base of the sixth segment diagonally towards the mid-dorsum of the seventh. This pattern was pinkish-orange, speckled with dark brown dots and bordered with wavy outlines. Its eighth abdominal segment rose to a gentle hump, topped with a reddish brown knob. Posterior to this, there was an elliptical, orange patch towards the rear.

In captivity, the caterpillar displayed a ravenous appetite and even the stiff, central mid-ribs of the leaves were not spared. When disturbed, the caterpillar would adopt a typical defensive posture (Fig. 2). Supported only by the prolegs of abdominal segments four, five and six, it would raise the anterior and posterior ends off the substrate. The head would be securely tucked downwards, in close contact with the base of the third abdominal segment. When viewed from above, the pair of false eyes produces a startling visual display (Fig. 3), a potential deterrent to an uninitiated predator.

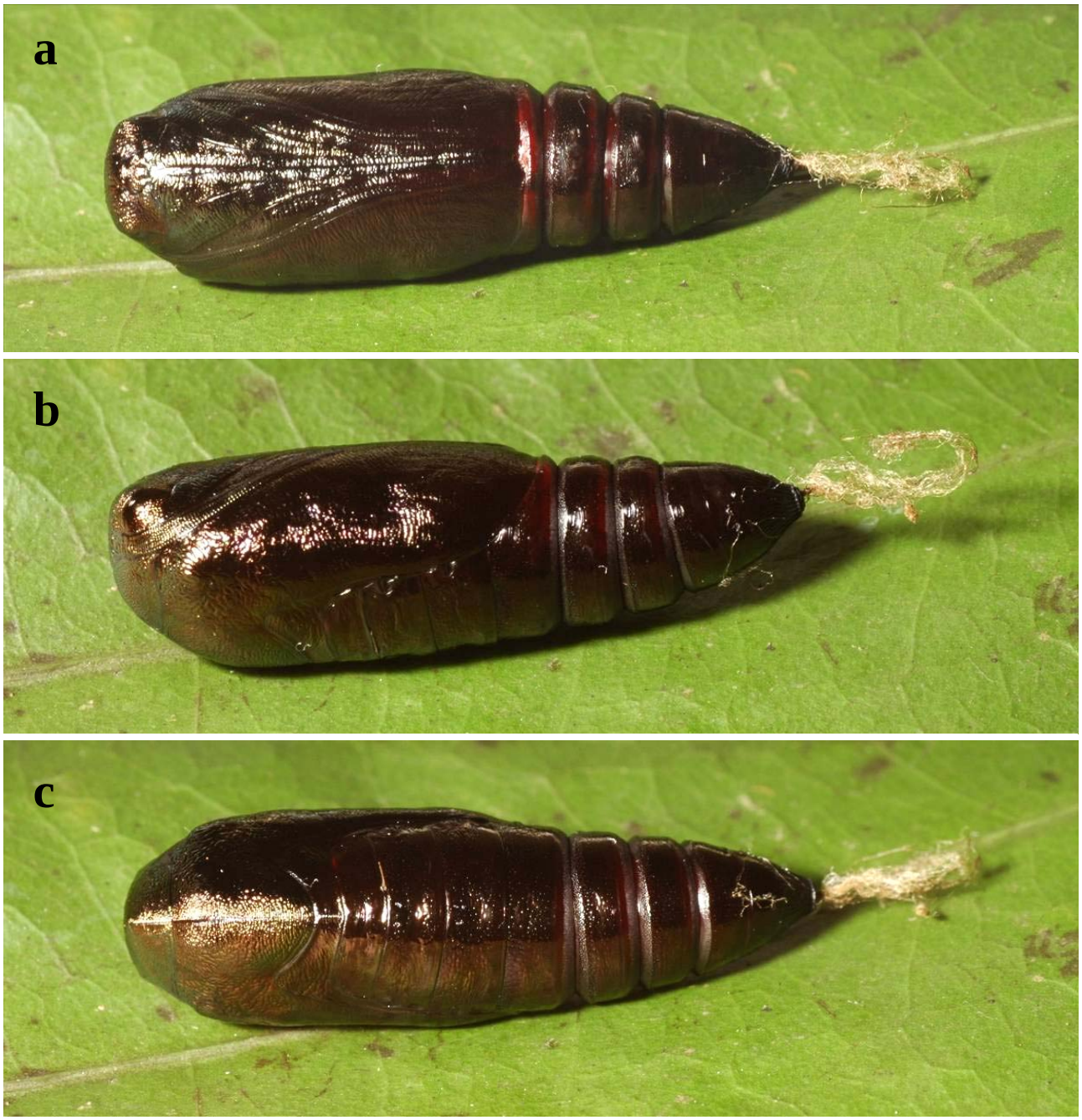

Fig. 4. Views of the pupa: a, ventral; b, lateral; c, dorsal, which was measured to be 30 mm long by 10 mm wide. Remnants of fine silk from the original cocoon are attached to the cremaster (posterior end).

On the 30 Dec.2008, the initial signs of pre-pupal colouration and behaviour were seen. The anterior set of orange spots and ocelli turned yellow, the caterpillar stopped feeding and began to weave a fine layer of silken threads around itself, attaching leaf debris onto this loose cocoon. The next day, the anterior markings and previously blue dots faded further to a pale, ivory-white. By the morning of 2 Jan.2009, the pupa was completely formed. On the same evening, the thin cocoon was carefully teased apart to examine, measure and photograph the pupa (Fig. 4). The exuvia of the last instar was also removed and preserved.

The resultant pupa was 30 mm long by 10 mm wide. It was a dark, copper-brown, with an overall metallic sheen. There were distinct constrictions between the abdominal segments. The cremaster at the abdominal tip was employed to fasten itself onto the silken cocoon. On the night of 14 Jan.2009 (ca. 2300 hours), the adult moth emerged (Figs. 5, 6). Its forewings displayed the diagnostic colour and pattern of *Eudocima smaragdipicta*, as published by Barlow (1982: Pl. 35-2) and Holloway (2005: Pl. 17-4). The female moth was then preserved as a voucher specimen (together with its corresponding pupal case) in the Zoological Reference Collection (ZRC) of the Raffles Museum of Biodiversity Research (RMBR), Department of Biological Sciences, National University of Singapore (ZRC.LEP.87, forewing: 31 mm, body length: 28 mm).

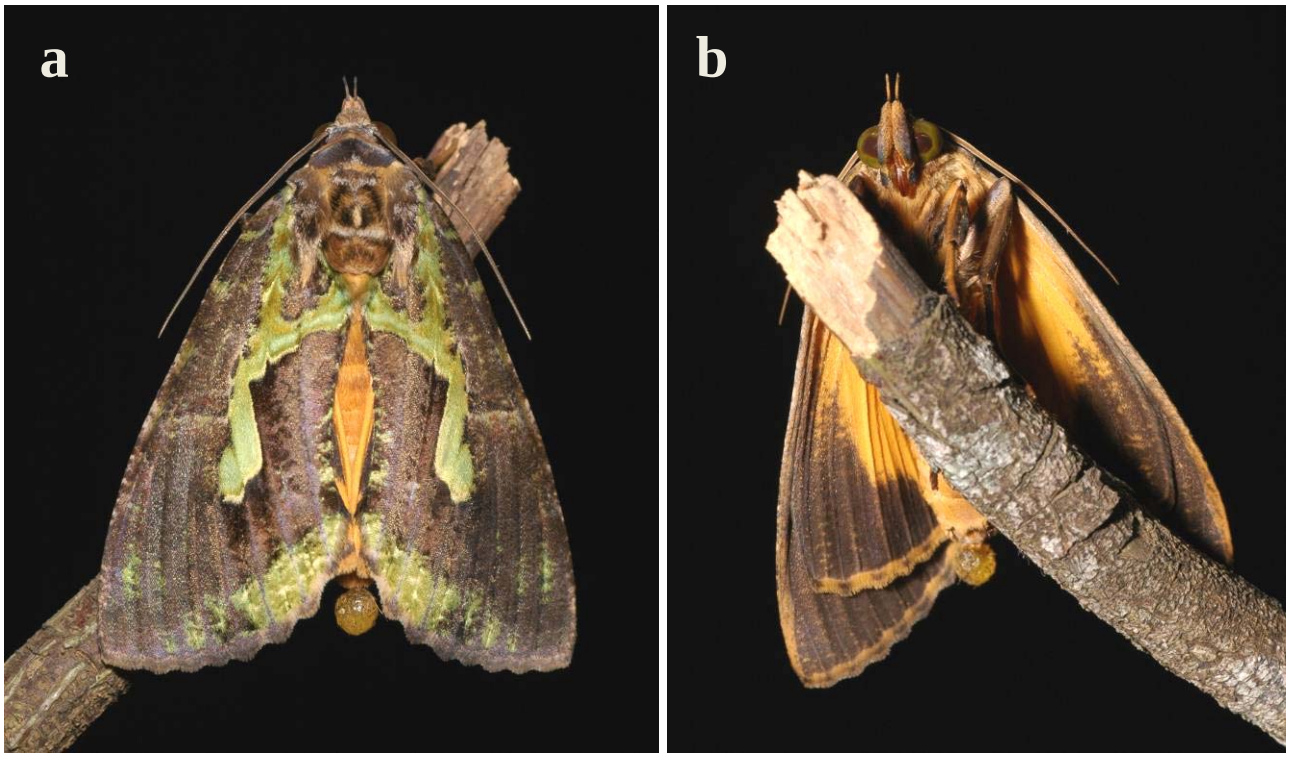

Fig. 5. Dorsal (a) and ventral (b) views of the adult female (ZRC.LEP.87, forewing: 31 mm, body length: 28 mm) freshly emerged on 14 Jan.2009 (ca. 2300hours).

DISCUSSION

The earliest published record of *Eudocima smaragdipicta* for Singapore was by Francis Walker (1859), who listed the species as '*Ophideres*' *smaragdipicta*, in the family 'Ophideridae'. In the entomology collection of the ZRC, the earliest specimens of this moth date back to two examples collected by R. Morrell in the early 1950s. A male specimen (ZRC.LEP.92, forewing: 35 mm, body length: 30 mm) was bred in Jan.1951 and has an associated eclosed pupa that agrees with the present one (ZRC.LEP.87) in terms of size, shape and form. Another male specimen collected by Morrell was obtained from fruit bait set in 'Nee Soon' on the 27 Jun.1952 (ZRC.LEP.98, forewing: 32 mm, body length: 29 mm). Unfortunately, both of Morrell's specimens are faded, possibly the result of excessive exposure to light while on public display.

There are at least three specimens from the Bukit Timah area: ZRC.LEP.93 (male, forewing: 34 mm, body length: 33 mm, coll. H. K. Lua, 22 Jan.1989, Hindhede Drive), ZRC.LEP.94 (male, forewing: 33 mm, body length: 30 mm, coll. H. K. Lua, 9 Apr.1989, Hindhede Drive), ZRC.LEP.95 (female, forewing: 32 mm, body length: 29 mm, coll. unknown, 29 Nov.1989, Bukit Timah Nature Reserve, Jungle Fall valley). A more recent specimen was obtained from the Central Catchment Nature Reserve (ZRC.LEP.68, male, forewing: 33 mm, body length: 29 mm, coll. T. M. Leong, 19 Aug.2004, Bukit Kallang office). In recent nocturnal faunal surveys, moths belonging to this species have been

Fig. 6. Lateral close-up of emergent female *Eudocima smaragdipicta* (as in Fig. 5).

encountered along night transects. On 24 Mar.2009, an individual was photographed by Mishak Shunari (National Parks Board) and Foo Sai Khoon (HSBC Volunteer) along Sime Track of the MacRitchie reservoir forest at ca. 2045 hours. On 4 Apr.2009, another individual was documented by Chan Kwok Wai (survey volunteer) at Taban Loop of the Bukit Timah Nature Reserve at ca. 2300 hours.

Thus far, the only known larval hostplant for this noctuid moth is the climber *Fibraurea* (Robinson et al., 2009). Whether or not it feeds on other members of the family Menispermaceae remains to be determined, but other species of *Eudocima* have been documented as accepting a wide variety of genera in this liana family. Their ecological role as hosts for ectoparasites also remains poorly understood but in northern Queensland (Australia), for example, the mid-instar larvae of six species of *Eudocima* moths were found to be specifically targeted hosts by a particular species of eulophid wasp (Jones & Sands, 1999).

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