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FINAL INSTAR LARVAE AND METAMORPHOSIS OF *ETERUSIA RISA RISA* AND *PROSOPANDROPHILA DISTINCTA DISTINCTA* IN SINGAPORE (LEPIDOPTERA: ZYGAENIDAE: CHALCOSIINAE)

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INTRODUCTION

Members in the family Zygaenidae are variously referred to as burnet moths (Barlow, 1982), smoky moths (Evans, 2007), or foresters (Zborowski & Edwards, 2007). There are approximately 1,200 species in this family, which has a worldwide distribution, with the highest diversity in tropical and subtropical Asia and the Palaearctic region (Niehuis et al., 2006; Yen et al., 2005b; Zborowski & Edwards, 2007). Zygaenid moths are largely diurnal in habit, with many species exhibiting aposematic colouration as clear warning of their potent defense strategy—release of highly toxic hydrogen cyanide (HCN) when disturbed (Tarmann, 2004; Niehuis et al., 2006). Currently, four subfamilies are recognised within this family: (i) Zygaeninae; (ii) Procridinae; (iii) Chalcosiinae and; (iv) Callizygaeninae, with the latter three possibly constituting a monophyletic group (Niehuis et al., 2006). In South and Southeast Asia, Chalcosiinae is well represented and this subfamily currently contains 370–400 species in about 70 genera (Yen et al., 2005b). In addition, members of this subfamily display significant sexual dimorphism (within species), polymorphism (between geographic populations) and convincing mimetic patterns (resembling butterflies or other moth families) (Endo & Kishida, 1999; Yen et al., 2005b). Within the forested areas of Singapore, I have had various encounters with a number of zygaenid caterpillars and successfully reared some to adulthood. Here, I briefly describe and illustrate the final instar larvae of two chalcosiines, namely: (i) *Eterusia risa risa* (Doubleday, 1844) and; (ii) *Prosopandrophila distincta distincta* (Guérin-Méneville, 1843).

Fig. 1. Lateral view of final instar larva (head towards right) of *Eterusia risa risa*, on its hostplant, sendudok (*Melastoma malabathricum*), found along Kent Ridge on 5 Nov.2007. Its total length was 18 mm. The spiracles on its abdominal segments (A1–A8) are a distinct black. The flanks on A4 and A5 are uniform dark brown.

OBSERVATIONS

On the 5 Nov.2007, a penultimate instar caterpillar of *Eterusia risa risa* was found on a leaf of the local shrub, sendudok (*Melastoma malabathricum*, family Melastomataceae) at chest level along the forest edge at Kent Ridge, in the National University of Singapore (NUS) campus. It had an initial length of 11 mm and width of 6 mm. On the following day, the caterpillar moulted to its final instar and consumed its exuvia by 7 Nov.2007. In captivity, this larva proceeded to feed on the leaves of sendudok and eventually attained a total length of 18 mm (Fig. 1). Its body was an overall light orange, with distinct black spiracles (visible from its first to eighth abdominal segments, A1–A8) and dark brown flanks at A4 and A5. On each segment, there were uniformly conical tubercles along the dorsum and flanks, each tipped with fine hairs (Fig. 2). The longest strands were located at the anterior and posterior ends. When the larva was not feeding, its head was largely concealed beneath its first thoracic segment (T1). If deliberately disturbed, the larva would demonstrate a defensive strategy consistent with this group of moths, by contracting its body and secreting clear droplets of cyanic fluid from within cuticular cavities along its segments. An example of this was documented for the larva of *Eterusia aedea formosana* Jordan, 1907, by Yen et al. (2005b: Fig. 53D).

In early Dec.2007, the larva eventually entered its pupal stage, weaving a silken cocoon along the mid-rib of a leaf and folding it upwards to partially conceal itself. Such cocoon construction is characteristic of the Chalcosiinae (Tarmann, 2004; Yen et al., 2005b). On the 20 Dec.2007, a male moth emerged, exhibiting an overall deep, sooty black on its wings, body, limbs, and antennae, with hints of metallic blue (Fig. 3). A striking red 'collar' was present behind its head. The apices of its antennae were elegantly curved inwards and agreed closely with those of a male *Eterusia risa risa* illustrated in Yen et al. (2005a: Fig. 4B). However, when this moth was disturbed, it would deliberately raise its wings to reveal the striking colours/patterns beneath its wings and on its thorax and abdomen (Fig. 4). Its thorax and tip of the abdomen were a shiny, metallic blue. Its abdomen was a deep blue with a broad yellow band, dotted with blue spots corresponding to the spiracles. This defensive action was consistently accompanied by the release of airborne chemicals that were perceived by the author as pungent odours and had a repulsive effect. The combination of displaying aposematic colours and releasing defensive chemicals are clear warnings of its unpalatability and potential toxicity.

This male specimen was subsequently preserved as a voucher specimen at the Zoological Reference Collection (ZRC) of the Raffles Museum of Biodiversity Research (RMBR), NUS and catalogued as ZRC.LEP.191 (body length: 18 mm, forewing length: 23 mm). The preserved specimen agreed well with illustrations of other male specimens of this subspecies (Endo & Kishida, 1999: 58—moth 1; Yen et al., 2005a: Fig. 7A).

Fig. 2. Dorsal view of final instar larva (head towards right) of *Eterusia risa risa* (as in Fig. 1).

Fig. 3. Dorsal view of adult male *Eterusia risa risa* (ZRC.LEP.191, body length: 18 mm, forewing length: 23 mm), freshly emerged on 20 Dec.2007. Note the pronounced apical curvature and ornamentation of its antennae.

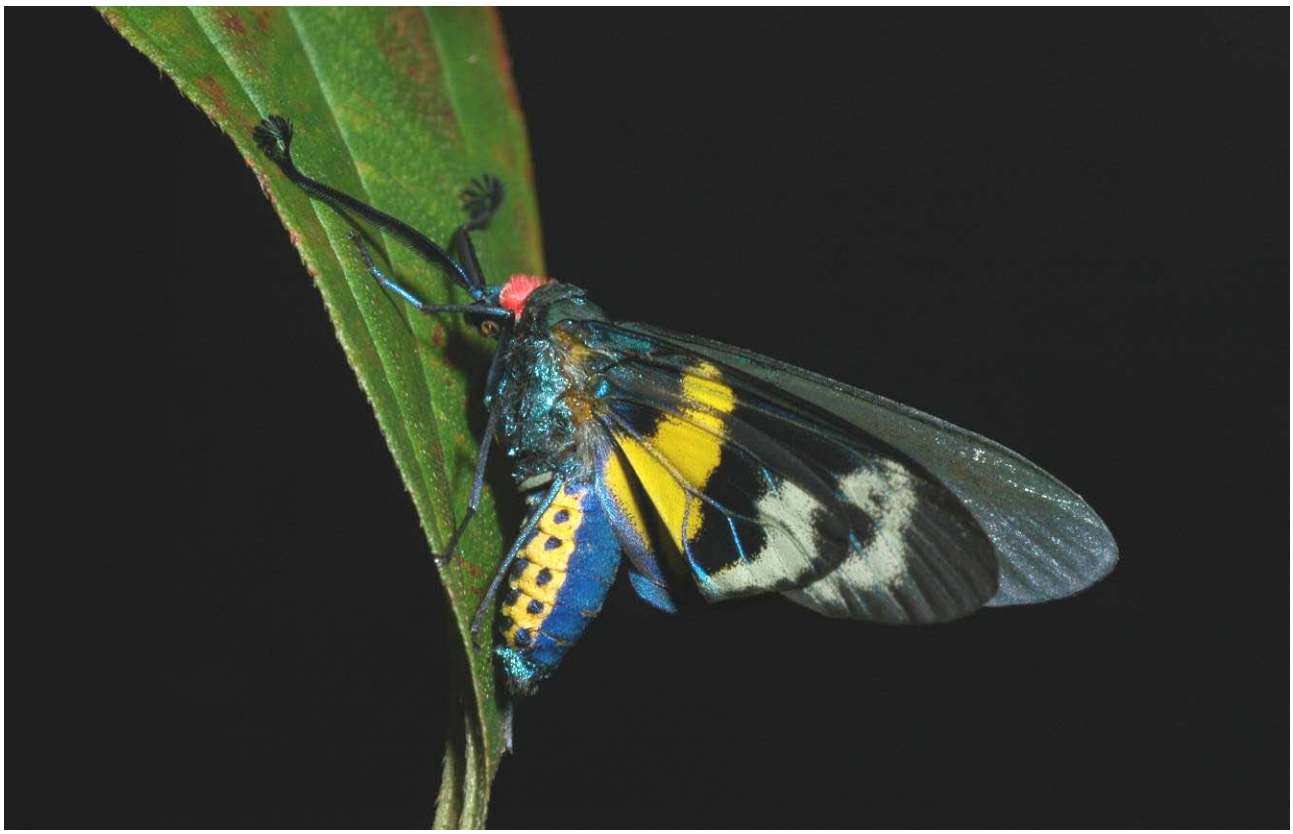

Fig. 4. Lateral view of male *Eterusia risa risa* (ZRC.LEP.191) in defensive posture, with wings raised to reveal the aposematic colouration of its wing undersides, thorax, and abdomen. An unpleasant odour was also emitted by the moth each time this posture was adopted.

Fig. 5. A single, parasitic tachinid fly emerged from the cocoon of *Eterusia risa risa* on 22 Dec.2007.

Fig. 6. A female *Eterusia risa risa* (ZRC.LEP.192, body length: 25 mm, forewing length: 28 mm) found on Kent Ridge, National University of Singapore on 30 Dec.2008 at ca. 1330 hrs. An offensive odour was also emitted by this moth when it was handled.

In addition to the successful rearing and metamorphosis of this larva, additional larvae were also found from the same foodplant at the same site on 12 Nov.2007. Two caterpillars (one penultimate, one final instar) were raised and both eventually pupated within their respective cocoons in curled up leaves. One of them emerged (male) in mid Dec.2007 and was subsequently liberated along Kent Ridge, whereas the other failed to complete its metamorphosis, as it had been parasitised. To my dismay, an adult tachinid fly emerged instead from the cocoon on the 22 Dec.2007 (Fig. 5)! From an evolutionary perspective, the parasitoids of zygaenids would have to be relatively specialised, as they must be capable of detoxifying hydrocyanic acid, and a broad diversity of Hymenoptera (Chalcididae, Ichneumonidae, Braconidae) and Diptera (Tachinidae) have indeed adapted in this way (Tarmann, 2004).

On the 30 Dec.2008 (ca. 1330 hrs), an adult female *Eterusia risa risa* was encountered by Tan Swee Hee and Kelvin K. P. Lim (RMBR) along the third floor corridor of Block S5, Science Faculty, National University of Singapore. While being handled, this moth also released a rather bitter, medicinal odour, similar to that previously emitted by the male specimen (ZRC.LEP.191). This female was retained as a voucher specimen (Fig. 6, ZRC.LEP.192, body length: 25 mm, forewing length: 28 mm). The tips of its antennae were also curved inwards and were comparable to those illustrated for the female of the subspecies in Yen et al. (2005a: Fig. 4A). The preserved specimen agreed most closely to that featured by Endo & Kishida (1999: 58—moth 2). Comparisons of the male and female specimens clearly demonstrate marked sexual dimorphism in this species. The female is noticeably larger, with longer and broader wings. There is a pale, proximal band on its forewing and an extensive orange area on its hindwing. Five of its abdominal segments are yellow in colour.

There appears to be no prior hostplant records for *Eterusia risa risa* and this documentation of *Melastoma malabathricum* may be added to the list for the genus *Eterusia* (Robinson et al., 2009). The hostplants of at least two other *Eterusia* species have been compiled and they include three genera for *Eterusia aedea*: (i) *Buddleja* (Scrophulariaceae); (ii) *Camellia* (Theaceae); (iii) *Lagerstroemia* (Lythraceae); and one genus for *Eterusia taiwana*: *Symplocos* (Symplocaceae) (Robinson et al., 2009).

On the 11 Nov.2008, a final instar larva of *Prosopandrophila distincta distincta* (Figs. 7, 8) was found on the leaves of sendudok (at eye level) just outside the Central Nature Reserve office at Bukit Kallang, MacRitchie Reservoir forest. This caterpillar was a uniform light chocolate brown and measured 20 mm long by 8 mm wide. Its spiracles on T1 and from A1 to A8 were a prominent black. Each segment was adorned with low, rounded tubercles tipped with soft setae. Its defensive response was similar to that observed for the larvae of *Eterusia risa risa*, with the simultaneous secretion of clear exudates from neatly arranged cuticular cavities along its body.

This larva commenced cocoon construction (within an up-curled leaf) and pupation on the 16 Nov.2008. On the 28 Nov.2008, the adult moth had emerged and was determined to be a female. Its body and wings were adorned with deep blue patterns and stripes against a creamy white base colour (Fig. 9). From the ventral perspective, the underside of its abdomen was a striking yellow with black bands on each segment (Fig. 10). The specimen was subsequently preserved (Fig. 11, ZRC.LEP.195, body length: 19 mm, forewing length: 25 mm) and found to be comparable with the female example of *Prosopandrophila distincta distincta*, as depicted in Endo & Kishida (1999: pg. 58–moth 15). At the ZRC, there is another Singapore specimen of a female *Prosopandrophila distincta distincta* (ZRC.LEP.194, body length: 17 mm, forewing length: 23 mm), collected by Robert C. H. Teo (National Parks Board) from Pulau Ubin in 2004. The larval hostplants, *Melastoma malabathricum*, as well as *Melastoma polyanthum*, have been previously documented for *Prosopandrophila distincta* (see Robinson et al., 2009). Another Asian zygaenid documented to consume this genus of larval foodplant is *Soritia pulchella* (Kollar, 1844), which is known to feed on *Melastoma normale* in India (Robinson et al., 2009).

Fig. 7. Lateral view of final instar larva (head towards right) of *Prosopandrophila distincta distincta*, found on sendudok, *Melastoma malabathricum*, at Bukit Kallang on 11 Nov.2008. The caterpillar was 20 mm long and 8 mm wide. Its spiracles (T1, A1–A8) are distinctly coloured black.

Fig. 8. Dorsal view of final instar larva (head towards right) of *Prosopandrophila distincta distincta* (as in Fig. 7).

Fig. 9. Dorsal view of female *Prosopandrophila distincta distincta* (ZRC.LEP.195), emerged on 28 Nov.2008.

Fig. 10. Ventral view of female *Prosopandrophila distincta distincta* (as in Fig. 9).

Fig. 11. Dorsal view of preserved female *Prosopandrophila distincta distincta* (as in Figs. 9, 10; ZRC.LEP.195, body length: 19 mm, forewing length: 25 mm).

Within the Chalcosiinae, a fairly large proportion of the various populations in south and southeast Asia have been described at the subspecific level (Endo & Kishida, 1999). In *Eterusia risa* (Doubleday, 1844), four subspecies are currently recognised: (i) *Eterusia risa risa* (Doubleday, 1844)—Borneo, Malay Peninsula, Singapore; (ii) *Eterusia risa javanica* (Hering, 1922)—Java, Bali; (iii) *Eterusia risa transitaria* (Hering, 1922)—Sumatra; (iv) *Eterusia risa palawanica* Yen, in Yen et al, 2005a—Palawan (Philippines) (Endo & Kishida, 1999; Yen et al., 2005a).

In *Prosopandrophila distincta* (Guérin-Méneville, 1843), six subspecies are recognised: (i) *Prosopandrophila distincta distincta* (Guérin-Méneville, 1843)—Malay Peninsula, Singapore; (ii) *Prosopandrophila distincta albina* (Jordan, 1907) —south Myanmar; (iii) *Prosopandrophila distincta drataraja* (Moore, 1859)—Java; (iv) *Prosopandrophila distincta indistincta* (Swinhoe, 1892)—Borneo; (v) *Prosopandrophila distincta osseata* (Walker, 1864)—Sumatra; (vi) *Prosopandrophila distincta oenone* (Butler, 1883)—Nias (Indonesia) (Endo & Kishida, 1999; Yen et al., 2005b). *Prosopandrophila distincta xanthina* (Jordan, 1907) (known from Cambodia) was previously regarded as a subspecies (Endo & Kishida, 1999), but was recently elevated to specific rank by Yen et al. (2005b), based on clear morphological differences. On the other hand, *Prosopandrophila oenone* (Butler, 1883), once considered a distinct species, has now been relegated to subspecific status (Yen et al., 2005b).

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