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# Bionomics of the Australian Hawk Moth, *Theretra laterillii lucasii* (Walker) (Lepidoptera: Sphingidae)

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**Absract** *Theretra latreillii lucasii* (Walker) is an important insect pest of water primrose, *Ludwigia hyssopifolia* (G. Don). Eggs and larvae of *T. l. lucasii* were collected from *L. hyssopifolia* and raiseed in the entomological laboratory, King Mongkut's Institute of Technology Ladkrabang. The number of laid eggs was 200-240 eggs per adult female. The egg incubation period lasted 3.47±0.15 days. After egg hatching, *T. l. lucasii* larvae go through five instars of developmental stages. Duration time of 1st to 5th instars was 3.79±0.50, 4.27±0.57, 3.26±0.50, 3.06±0.32 and 6.59±0.61 days, respectively. The body length was 4.73±1.16, 11.2±1.08, 16.33±1.35, 27.13±1.96 and 53.27±9.19 mm for 1st to 5th instar, respectively. The head capsule for 1st to 5th instar was 0.59±0.08, 0.91±0.06, 1.10±0.030, 2.28±0.15 and 3.87±0.18 mm wide, respectively. The length in mm for dorsal horn of 1st to 5th instar was 2.13±0.72, 3.67±0.62, 5.13±0.58, 5.57±0.46 and 5.63±0.64 mm long, respectively. Adults are medium in sizes with prominent heads and big eyes. The female lived longer than the male (8.40±0.92 and 6.47±0.91days, respectively). The principal host plants of *T. l. lucasii* are *L. hyssopifolia* and *L. octovalvis* in family Onagraceae. Moreover, *Cayratia trifolia* in family Vitaceae were found to be the food plant for *T. l. lucasii*.

**Keywords:** head capsule width, dorsal horn, host plants

## Introduction

Australian hawk moth [*Theretra latreillii* (Macleay)] is classified in order Lepidoptera and family Sphingidae (Hawkeswood, 1993; Inoue *et al.*, 1997). *T. latreillii* is ranked in subspecies *lucasii*; therefore, its complete scientific name is *Theretra latreillii lucasii* (Walker). The adult *T. l. lucasii* can be found throughout the year. Normally, it is distributed on the plain to highland with the height up to 1700 m. The host plant of this hawk moth is in family Actinidaceae, Balsaminaceae, Begoniaceae, Dilleniaceae, Leeaceae, Lythraceae, Onagraceae and various plants in family Vitidaceae (Barlow, 1982; Inoue *et al*., 1993).

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There were reports of finding this moth species in India, Sri Lanka, Myanmar, Vietnam, China, Taiwan, Philippines and Australia (Barlow, 1982; Inoue *et al.*, 1993; Hawkeswood, 1993).

Hawkeswook (1993) reported that the Australian hawk moth was discovered in Brisbane, the southeast of Queensland, Australia in 1985. The $5^{th}$ instar larvae of moth in a green form consumed the leaves of *Impatiens balsamina* L. (Balsaminaceae). The remarkable characteristic of larvae is the eyespot appearing at the first abdominal segment. When the larvae reach mature stage, the larvae pupate in the soil. The length of pupa is 52.6 mm and 12.5 mm wide. The adult moth emerged from the cocoon at night. Difference in larval feed affected the pupal periods raised at 25-32 ℃: 14 days for larva feeding on *I. balsamina* leaves and 17 days when feeding with *I. wallerana* leaves.

Australian hawk moth, *Theretra latreillii lucasii* (Walker) was named in 1986. It was one of ten species in genus *Theretra* found in Thailand (Inoue *et al*., 1997). *T. l. lucasii* is a nocturnal species. Its larva is a very heavy leaf feeder and considered as a very useful biological agent for weed control. Larvae are always found on the water primrose and feeding on leaves of host plants. In Thailand, there are two species of water primrose which are *Ludwigia hyssopifolia* (G. Don) and *Ludwigia octovalvis* (Jacq.) (Matchacheep, 1995). Both species are considered annual weeds. They have taproot and are propagated by seed. They are found in rice fields, ridge, wetlands and plant plots. *L. hyssopifolia* are damaged by three species of hawk moths: *Pergesa acteus* (Cramer), *Theretra silhetensis silhetensis* (Walker) and *T. latreillii lucasii* (Walker). *T. l. lucasii* play an important role in infestation of *L. hyssopifolia* and this species of hawk moth can be often found on *L. hyssopifolia* more than the other species. From the literature review, there are few reports about this hawk moth species particularly biological research. The authors realise its importance of *T. l. lucasii* and focus the present study on bionomics of this hawk moth species. This useful information gained can be applied in biological control of weed in rice field in the further research.

## Materials and methods

### *Sample collection*

Eggs and larvae were collected from *L. hyssopifolia*. Each collected egg was placed in a petri dish (5.5 cm of diameter). The larvae were kept in plastic boxes (19x28x10 cm and 14x19x7 cm) provided with *L. hyssopifolia* leaves as food. The color and structural change of eggs and larvae during development was recorded and photographed.

### *Insect rearing*

All collected eggs and larvae were reared in entomological laboratory, King Mongkut's Institute of Technology Ladkrabang at room temperature. The larvae were reared until become pupae. After emergence, the adult were transferred to a glass box (30x30x30 cm) provided with 3% of honey solution. The sex of adult was recorded. Some of sample were used for study morphological characteristic of egg, larval instar, pupa and adult. Egg and body length, head capsule width and dorsal horn length at the 8$^{th}$ abdominal segment of each larval instar were observed, measured and photographed. In addition, measurement of body size of pupa, both male and female adults, length and width of wings and length of antenna length were collected individually. For life cycle study of the moth, the development of each stage: egg, larva, pupa and adult was recorded.

## Results

### *Morphological and biological characteristic of T. l. lucasii*

*T. l. lucasii* undergoes a complete metamorphosis consists of four different stages: eggs, different larval instars, pupae and adults. Some morphological and biological feature are described as follow:

#### Eggs

Egg is light green, smooth and spherical in shape (Fig. 1). The diameter is 1.48 ±0.20 mm.

#### Larvae

After hatching, the caterpillar underwent five different larval stages. From the 1$^{st}$ to 3$^{rd}$ instars, the body color has changed from yellow to light green. Two forms (green and brown) of larvae were discovered in the 4$^{th}$ instar. In the last instar, three forms of larvae (green, brown and dark brown) were noticed (Fig. 2). One of the most notable characteristic of *T. l. lucasii* larvae is a pair of eyespot at the dorsal part of the first abdominal segment (Fig. 2) which was first observed in the 2$^{nd}$ instar larvae and then gradually getting bigger until the last instar larvae. The dorsal horn is a remarkable feature of the Australian hawk moth, appeared at the dorsal side of the eighth abdominal segment of all instar larvae (Fig. 2). The data related to larval development including developmental time, body length, head capsule width and dorsal horn length were illustrated in Table 1. Developmental time for each successive instar

larvae was 3.79±0.50, 4.27±0.57, 3.26±0.50, 3.06±0.32 and 6.59±0.61 days for the 1st to 5th instar larvae, respectively. The average body length of larvae for 1st to 5th instar was 4.73±1.16, 11.2±1.08, 16.33±1.35, 27.13±1.96 and 53.27±9.19 mm, respectively. Larval head capsule width in mm was 0.59±0.08, 0.91±0.06, 1.10±0.030, 2.28±0.15 and 3.87±0.18 in 1st-5th larval instar. Dorsal horn length of the 1st to 5th instar larvae was 2.13±0.72, 3.67±0.62, 5.13±0.58, 5.57±0.46 and 5.63±0.64 mm, respectively.

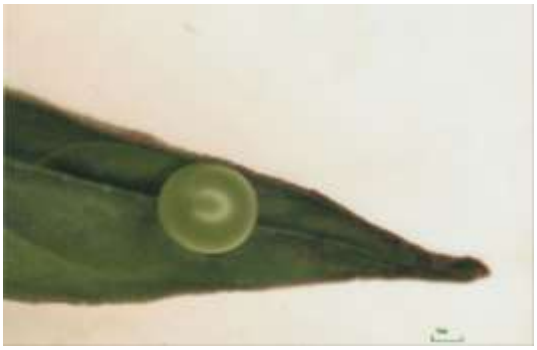

**Figure 1.** A spherical egg of the Australian hawk moth

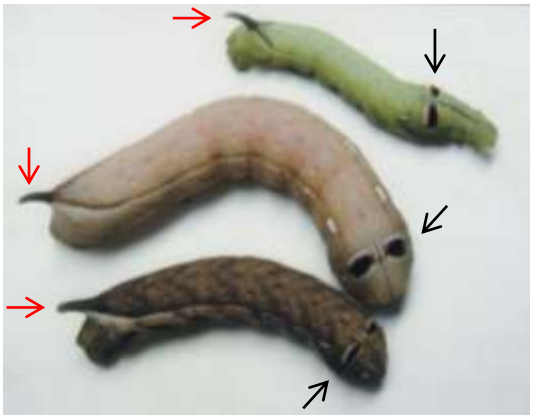

**Figure 2.** Green form (top), brown form (center) and dark brown form (bottom) of the fifth instar larvae of *T. l. lucasii*. Eyespot and dorsal horn are indicated by black and red arrows, respectively.

**Prepupae**

In the early stage of 5th instar, larvae stop consuming their host plants and move faster to find the right place for encapsulating. When the larvae enter the

late stage, the bodies were constracted and become shorter to prepare for being pupae. Duration time took 2.80±0.316 days.

**Pupae**

Pupae were brownish black color with a brown proboscis sheath at the anterior end of pupal head (Fig. 3). The sizes of pupae were 49.33±4.29 mm long (Table 1.). Duration time took 11.65±0.88 days.

**Figure 3.** Pupae of *T. l. lucasii*

**Adults**

Common characteristics

The body color of adult moth is brown. Forewing and hindwing are brown and brownish black, respectively. The adult male and female are similar in color (Fig. 4). The big compound eyes are dark brown. Tibia of a foreleg has a special organ called tibial epiphysis for cleaning antennae. The tarsal formula is 5-5-5 and tibial spur formula is 0-2-4. *T. l. lucasii* adults are nocturnal. Mating occurred at night and the female lay eggs on the leave of *L. hyssopifolia*.

Male characteristics

The male body size is 39.2±3.36 mm long. Forewing are 33.53±2.88 mm long and 14.07±1.61 mm wide. Hindwing are 21.33±1.85 long and 13.18±1.19 mm wide. At the hindwing, there is a brown frenulum. The male antennae are ciliate type, 15.27±1.31 mm long. The length of proboscis is 37.58±2.99 mm. The measurement data of male is presented in Table 2.

Female characteristics

The female body length is 36.93±4.11 mm. Forewing are 33.60±2.97 mm long and 14.27±1.36 mm wide. Hindwing are 21.70±1.87 long and 12.73±1.04 mm wide. More than one hairy frenulum at the hindwing of female was observed. Simple filiform antennae are 13.25±0.87 mm long. The length of

proboscis is 35.6±2.53 mm. The measurement data of female is presented in Table 2.

**Figure 4.** Male (top) and female (bottom) adult of *T. l. lucasii*.

**Table 1.** Developmental stages of *T. l. lucasii* (mean ± SD) (N=30)

| Growth stage | Duration time (days) | Body length (mm) | Head capsule width (mm) | Dorsal horn length (mm) |
|---|---|---|---|---|
| Egg | 3.47±0.15 | - | - | - |
| 1st instar | 3.79±0.50 | 4.73±1.16 | 0.59±0.08 | 2.13±0.72 |
| 2nd instar | 4.27±0.57 | 11.2±1.08 | 0.91±0.06 | 3.67±0.62 |
| 3rd instar | 3.26±0.50 | 16.33±1.35 | 1.10±0.03 | 5.13±0.58 |
| 4th instar | 3.06±0.32 | 27.13±1.96 | 2.28±0.15 | 5.57±0.46 |
| 5th instar | 6.59±0.61 | 53.27±9.19 | 3.87±0.18 | 5.63±0.64 |
| Pupa | 11.65±0.88 | 49.33±4.29 | - | - |
| Adult | 7.43±1.33 | 38.07±3.87 | - | - |

**Table 2.** Sizes in mm of adult male and female of *T. l. lucasii* (mean ± SD) (N=30)

| Length of insect parts | Male | Female |
|---|---|---|
| Body | 39.20±3.36 | 36.93±4.11 |
| Forewing | 33.53±2.88 | 33.60±2.97 |
| Hindwing | 21.33±1.85 | 21.70±1.87 |
| Antenna | 15.27±1.31 | 13.25±0.87 |
| Proboscis | 37.58±2.99 | 35.6±2.53 |

## Discussion

Australian hawk moth (or pale brown hawk moth) *Theretra latreillii lucasii* is a hawk moth species in the genus *Theretra* that is found 10 species in Thailand (Inoue *et al.*, 1997). *T. l. lucasii* is an important pest for water primrose *L. hyssopifolia* which is a common weed in rice fields, ridge or wetland (Matchacheep, 1995). Larvae of *T. l. lucasii* are leaf feeders of *L. hyssopifolia*. Therefore, it is considered as a very useful biological agents for weed control. However, very few previous studies on the morphological and biological study of *T. l. lucasii* has been reported. Thus, the present research will focus on morphological and biological characteristic of *T. l. lucasii* and its host plants.

The life cycle of *T. l. lucasii* consists of egg, larva, pupa and adult. Larvae have 5 successive instars. The lengths of body part which are body length, head capsule width and dorsal horn length was used to determine the growth of different developmental stages of larvae. The lengths of body part gradually increase from $1^{st}$ to $5^{th}$ instar. This is in agreement with other hawk moth species, *Hippotion celerio* (Jeenkoed *et al.*, 2016) and *Macroglossum* spp (Kliangklao *et al.*, 2015). Interestingly, a pair of eyespot and a dorsal horn that appear at the top dorsal part of the first and eighth abdominal segments, respectively are the feature characteristic in these hawk moth species. The duration time of each instar larvae and pupae is similar to that of *H. celerio* (Jeenkoed *et al.*, 2016). On contrast, *T. l. lucasii* adult, in general, the male is larger than the female which is not corresponding to adult of *H. celerio* (Jeenkoed *et al.*, 2016). In addition, the difference between male and female is frenulum characteristic at the hindwing. The adult *T. l. lucasii* are nocturnal hawk moth and their mating behaviour occurred at night similar to hawk moth *H. celerio* which are in the same family Sphingidae (Jeenkoed *et al.*, 2016). The main host plants of *T. l. lucasii* are *L. hyssopifolia* and *L. octovalvis* in family Onagraceae. Furthermore, *Cayratia trifolia* in family Vitaceae were found to be the food plant which *T. l. lucasii* can consume.

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