
Morphological and Biological Studies on The Dark-bordered Hawk Moth, *Psilogramma increta* (Walker) (Lepidoptera: Sphingidae)

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Abstract The studies on morphological and biological aspects of the dark-bordered hawk moth, *Psilogramma increta* (Walker) (Lepidoptera: Sphingidae) were investigated both under laboratory and field condition. The morphological characteristics of egg, larva, pupa and adult are described and illustrated in this paper. The dark-bordered hawk moth is a pest of various ornamental trees. The larval food plants of the dark-bordered hawk moth was the African tulip tree (*Spathodea campanulata*), the cork tree (*Millingtonia hortensis*) and (*Dolichandrone serrulata*). Mating and took place at night lasted for 20 h. The results showed both sexes mated only once. Eggs were laid singly at night on the lower surfaces of young leaves of African tulip tree. The number of eggs laid by each female was 73 to 220 eggs. Duration of the egg stage (mean±SD) was 3.36±0.03 d (range 3.30-3.42 d). Mean development time for larvae reared under insectary conditions was 2.85, 3.48, 3.09, 3.00 and 7.40 d for instars 1-5, respectively. The mean head capsule width was 1.24, 1.69, 2.27, 3.88 and 6.55 mm for instars 1-5, respectively and corresponding mean larval dorsal horn lengths were 3.17, 4.27, 7.13, 11.30 and 9.73 mm, respectively. The total larval period, including the prepupal period were 19.83±3.29 d (range 17.33-23.12 d). The average pupal period lasted 12.73±0.98 d (range 11.71-15.67 d). The longevity of mated males and females was 5-6 and 6-7 d, respectively.

Keywords: Morphological, Biological and *Psilogramma increta*

Introduction

The dark-bordered hawk moth, *Psilogramma increta* (Walker) is moths belonged to the subfamily Sphinginae in the family Sphingidae order Lepidoptera. There are 2 species of these hawk moths found in Thailand including *Psilogramma increta* (Walker) and *P. menephron* (Inoue *et al.*, 1997). The dark-bordered hawk moth are presented and distributed from northern Pakistan (Muhammad *et al.*, 2014) and northwestern India eastwards across Nepal, Bhutan and Burma/Myanmar to Thailand, Laos and Vietnam,

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then north through Taiwan and eastern China to Korea and Japan (Komatsu and Inoko, 2000; Beck and Kitching, 2008). The adult of 2 species have similarities. Different character is male genital organ. The body parts of dark-bordered hawkmoth, *Psilogramma increta*) showed that head, thorax and abdomen are brown color. Beside of breast and between the breast and abdominal have sticker is black. The color pattern on wing is brownish similar to dry bark. The adult is active at night since 24.00 am to 01.00 pm. The hawk moths are common in the tropical rain forest. Inoue *et al.* (1997) report that the hawk moth found throughout the year. The hawk moth found mostly in tropical rain forest from flat ground level to at an altitude of 1700 metres above sea level. Host plants of the dark-bordered hawk moth include *Sesamum* (Pedaliaceae), *Verbena* (Verbenaceae), *Scrophularia* (Scrophulariaceae), *Osmanthus* (Oleaceae), *Perilla* (Labiatae) and *Lonicera* (Caprifoliaceae) (Vieira, 2008; Azuma, 2003).

The purposes of this research is to deliberately study about the Morphological and Biological on the Dark-bordered Hawk Moth, *Psilogramma increta* (Walker) (Lepidoptera: Sphingidae) and studies the host plants of the dark-bordered hawk moth was found 6 species in Thailand.

Materials and methods

Sample collection: Collection the larval of the dark-bordered hawk moth, from china doll, tree jasmine, yellow trumpetbush, African tuliptree and teakwas performed. Then, they were placed in plastic boxes sized 17×28×11 cm and small plastic boxes sized 14×19×7 cm. The date and places of collection was recorded. **Insect rearing in the laboratory:** The larvae and egg were all reared at room temperature (27-35°C). The African tuliptree leaves was provided as food for both laevae. Developmental and morphological characteristics of eggs, larvae, pupal and adults of the moths were recorded, measured and photographed (n=25).

Results

Morphology of the dark-bordered hawk moth, Psilogramma increta (Walker)

Egg: round, light green and smooth, a diameter 1.77-2.16 mm (range 1.97±0.11 mm.) (Fig 1).

Larvae: The larval have dorsal horn on the 8th abdominal segment of all instars having as follows;

First instar: yellow head and thorax, green Abdomen blackish dorrsal horn with 2 bifid at the end and body length 8.0-19.5 mm. (average 13.77 mm) (Table 2)

Second instar: greenish yellow head, thorax and abdomen ,larval length 12.0-25.0 mm (average 19.87 mm), black dorsal horn 4.0-4.5 mm long (average 4.27 mm) and head capsule width 1.43-1.85 mm (average 1.69 mm).

Third instar: greenish yellow or somewhat brown, larvae 24.5-32.0 mm long (average 28.43 mm), head capsule width 2.01-2.63 mm(average 2.27 mm), dorsal horn length 6.0-8.0 mm (average 7.13 mm).

Fourth instar: green or greenish yellow body and white oblique line at lateral of abdomen, larval length 34.0-45.0 mm (average 39.43 mm), head capsule width 3.42-4.43 mm (average 3.88 mm), greenish yellow dorsal horn length 9.0-13.0 mm (average 11.3 mm), with small thorns.

Fifth: The larval have 2 from include from A is green leaves or green yellow and from B is brow or brow red (Fig 2). Beside abdominal have peritreme are filter apparatus is white except inside is black. The larval length 47.0-72.0 mm (average 58.67 mm). Head capsule width 6.02-7.01 mm (average 6.55 mm) and dorsal horn length 9.0-12.0 mm (average 9.73 mm).

Prepupa stage: larval molting to pupa.

Pupa: a pupal head having light green proboscis sheath in a semicircular shape, posterior end of pupa having a blackish brown and rough skin of cremaster with 2 cremastral hooks (Fig 3) and pupal length 38.0-60.0 mm (average 44.47 mm).

Adult: big sized moths, ciliate antenna in males, filiform type in females, head and thorax are grayish black, a black stripe on each side of ventral abdomen blackish grey color of anterior part of the abdomen with a long black strip in the middle. Front legs with tibial epiphysis tarsal formula is 5-5-5 and spur formula is 0-2-4. Male adult: body length 34.0-49.0 mm (average 42.0 mm), front wind length 35.0-45.0 mm (average 41.2 mm) and front wing width 13.0-19.0 mm (average 16.03 mm), hind wing length 20.0-26.0 mm (average 23.17 mm) and hind wing width 11.0-15.0 mm (average 13.43 mm), the antenna length 13.5-18.0 mm (average 16.2 mm) (Fig 4).

Female adult: body length 39.0-54.0 mm (average 45.07 mm), front wing 42.0-64.0 mm long (average 49.6 mm) and 17.0-26.0 mm wide (average 20.0 mm), hind wings 25.0-37.0 mm long (average 30.8 mm) and 13.0-27.0 mm wide(average 17.0 mm), antenna length 13.75-19.50 mm (average 16.61 mm) (Fig 5).

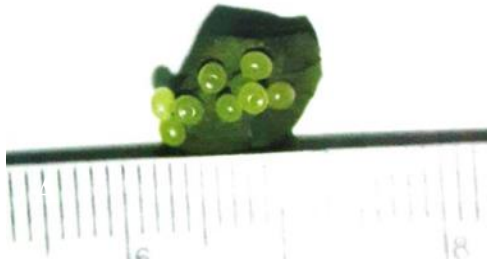


Figure 1. The eggs of *Psilogamma increta* are round, smooth skin and pale green color.



Figure 2. The larval have 2 forms ; A = green form
B = brown or reddish brown form



Figure 3. A pale green proboscis sheath at the anterior end and on the posterior end of pupa shown a rough and blackish brown cremaster with 2 cremastral hooks.



Figure 4. Adult male of *Psilogamma increta*.



Figure 5. Adult female of *Psilogamma increta*.



Figure 6. Host plants of *Psilogamma increta* are African tuliptree (A), cork tree(B) and *Dolichandrone serrulata* (C)

Biology of the dark-bordered hawk moth, Psilogramma increta (Walker)

The adult of dark-bordered hawk moth is a nocturnal insect. Mating took place 05.00-23.00 pm and lasted for 18 hours. Each female laid averaged 180-200 eggs on the upper side of leaves and leaf petioles of host plants include china doll, tree jasmine, yellow trumpetbush and African tulip tree (Fig 6). The egg incubation period was 3.30-3.42 days (average 3.36 days). The larva molt for 5 times as the 1st larvae hatch from eggs, they eat egg shell as a first meal before host plant leaves. All larval instar after molt will eat molt exuviae of themselves. The color head capsule is white. The molting head capsule of larval will shred and abandoned before and slowly molting at the body part during the process of larva in the pre-pupal stage to pupa, it will excrete waste from its body and finding place for the pupal stage. In nature, larvae will pupate into the soil or material leaf materials to build cocoon but in the laboratory they can enter the pupa stage without having cover. The age of each larval instar was 2.85, 3.48, 3.09, 3.00 and 7.40 days, respectively. The pupal stage lasted 12.73 days.

Table 1. Head capsule and dorsal horn sizes (mm) of the dark-bordered hawk moth.

Instar	Head capsule width (mm)	Dorsal horn length (mm)
	Mean±SD	Mean±SD
1	1.24±2.01(1.03-1.91)	3.17±0.31(2.50-3.50)
2	1.69±0.11(1.43-1.85)	4.27±0.32(4.00-4.50)
3	2.27±9.15(2.01-2.63)	7.13±0.58(6.00-8.00)
4	3.88±0.25(3.42-4.43)	11.30±1.37(9.00-13.00)
5	6.55±0.35(6.02-7.01)	9.73±0.78(9.00-12.00)

Host plants of the dark-bordered hawk moth, Psilogramma increta (Walker)

The host plants of the dark-bordered hawk moth, *Psilogramma increta* (Walker) was found 6 species in Thailand: china doll, tree jasmine, yellow trumpetbush (Family Bignoniaceae) and teak (Family Lamiaceae) (Table 2).

Table 2. Larval host plants of the dark- bordered hawk moth, *Psilogramma increta* (Walker) in Thailand.

Plant family	Host plant species	Common name
Bignoniaceae	<i>Radermachera sinica</i>	china doll, serpent tree or emerald tree
	<i>Millingtonia hortensis</i>	tree jasmine or Indian cork tree
	<i>Tecoma stans</i>	yellow trumpetbush or yellow bells
	<i>Dolichandrone serrulata</i>	-
	<i>Spathodea campanulata</i>	African tuliptree, fountain tree, pichkari or Nandi flame
Lamiaceae	<i>Tectona grandis</i>	Teak

Discussion

The Sphingidae of the dark- bordered hawk moth, *Psilogramma increta* (Walker) were monographed by Bell and Scott (1937), and this still remains the most comprehensive account for the former is found throughout mainland Southeast Asia, from Sri Lanka, north to Assam, then east through Myanmar, Thailand, Vietnam, SE China (Hainan, Guangdong), and Hong Kong to the main island of Taiwan and the Yayeyama Islands of Japan, and also south through the Tenasserim to northwestern Sumatra (Sumatera Utara). Pittaway and Kitching (2013) reported that this species occurs from Kashmir and northwestern India eastwards across Nepal and Myanmar to Thailand, Laos and Vietnam, then north through Taiwan and eastern China to Korea and Japan. *Psilogramma increta* is replaced in the Western Ghats, southern India, and Sri Lanka by *P. vates* (Hundsdoerfer *et al*, 2011; Pittaway, 2013); in Peninsular Malaysia and the Greater Sunda Islands, Indonesia, by *P. edii* (Eitschberger, 2003; Eitschberger and Ihle, 2013), and by other species in the other islands of Indonesia and farther east. However, the status of many of these species, which are mostly based on minor and often inconsistent differences in wing pattern and genital morphology, remain to be critically assessed.

Conclusion

The dark-bordered hawk moth, *Psilogramma increta* is a nocturnal hawk moth. The mating took place at night and takes 18-20 hours. The female laid eggs 180-200 eggs/female and these eggs were found singly on on the upperside of leaves and leaf petioles of host plants. The age of eggs is averaged 3.36 days. Larvae fed with African tuliptree leaves. There are 5 larval instars which each instar have distinctive characteristics however all instars have dorsal horns located on the 8th abdominal segment. The head capsule width and dorsal

length of instar 1-5 was increased in the later instars. The life span of larvae was 19.83 days. The pupal stage was 12.73 days. The of male and female adults slived for 5.75 and 7.00 days, respectively.

Host plants of the dark-bordered hawk moth, *Psilogramma increta* (Walker) in Thailand were found 6 species such as *Radermachera sinica*, *Millingtonia hortensis*, *Tecoma stans*, *Dolichandrone serrulata* and *Spathodea campanulata* (Family: Bignoniaceae) and *Tectona grandis* (Family: Lamiaceae).

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