EXTERNAL MORPHOLOGY AND DEVELOPMENT OF THE HAWK MOTH, MACROGLOSSUM BELIS (LINNAEUS) (LEPIDOPTERA : SPHINGIDAE)

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Abstract- The common hawk moth Macroglossum belis) Lepidoptera : Sphingidae) wasstudied under laboratory conditions as well as in the field. Morphology of hawk moth, the egg, larval instars, prepupa, pupa, and adults was described and illustrated in this paper.Developmental characteristics of each life stage are described. In an experiments in with larvae were reared with noni leaves, Morindacitrifolia L. (Rubiaceae). Males and females were fed with 30% of honey solution. The female hawk moth laid 65-94 eggs/insect. Eggs were deposited singly on the underside or upperside of noni foliage. The egg incubation period was averaged3.26 days. The mean duration time of five larval instars of hawk moth was 1.90, 1.69, 1.45, 1.80 and 3.81 days, respectively. The total larval period including prepupal stage was 12.36 days. The pupal stage lasted 10.65 days. The longevity of males and female was 9.00 and 9.80 days, respectively.The mean head capsule width for the instar 1-5 was 0.61, 0.97, 1.44, 2.10 and 3.49 mm, respectively. The larval caudal horn lengths were 1.45, 2.46, 4.44, 7.06 and 8.29 mm, respectively.

Keywords- development, external morphology, host plants, Macroglossum belis(Linnaeus)

I. INTRODUCTION

There are 25 species of hawk moths in Thailand. Macroglossum belis(Linnaeus ,1758) is a moth belonged to family Sphingidae. The synonym for M.belis is Spninx belis Linnaeus, 1758; Macroglossum pyrrhula Boisduval, 1875; M. opis Biosduval, 1875. The adults were found almost throughout the year from the ground level up to an altitude of 2,450 meters)[1]. The common name is commonhummingbird hawk moth[2]. Adults are nocturnal. The reports stated that insect species distributed in India, Sri Lanka, Nepal , Vietnam, China , Taiwan, Japan, Indonesia and Thailand[1][3][4]. Their host plants are Paederia seandens (Lour.) (Rubiaceae)[1] and Strychnos angustflora Benth.) Loganiacea[3]. Saprosma sp and Hamiltonia sp in the family Rubiaceae were found as host plants of M. belis. In India, larval feeding on Strychnos nux-vomica, Saprosoma indicum and Spermadictyon suaveolans [5].

II. EXPERIMENTAL DETAILS

2.1. Materials and Procedures

Field population of M. belis were collected from Noni plants at the KMITL university plantationand placed in plastic boxes for further studies under the laboratory conditions. Both newly emerged male and female of M. belis were led to mate in the plexiglass box(40x60x40 cm) with a 30% solution of honey in a glass dish 9 cm in diameter. A young seedling of noni plant was placed inside the cage for female egg deposition. These eggs were collected dailyand placed in a petri dish singly. Color change of eggs was observed and recorded. When the egg hatched, the larva was fed with noni leaves till it underwent a pupa stage. Body length and skull width of different larval instars were recorded. Morphological features of these larva were measured and recorded. As it turned to an adult, the length and width of wings was measured. Frenulum and fantail character to separate male and femaleof this insect species.

III. RESULTS AND DISCUSSION

3.1. External Morpphology

Summarization of developmental time, head capsule width and caudal length is in Table 1. Table 2-3 described the description of males and females.

Eggs: The egg is light green color and rounded with a diameter of 1.08 mm. It has a reflective surface.

1st instar larva: It has a small body. The head is yellow whereas thorax and abdomen are with a black caudal horn with two lobes at the tip(Fig. 1). The horn basewas brownish red. The developmental time was 1.90 days.

2nd instar larva: The head is yellow. The thorax and abdomen are black. . The last pair of prolegs are pale yellow. The body length is 10.34 mm. The caudal horn length is 2.46 mm with a black bifid tip. time for The developmental this larval stage was 1.69 days. 3rd instar larva: Head, thorax and abdomen are light green. The black dorsal horn with a bifid tip. The body length is averaged 16.00 mm, dorsal horn length 4:00 to 5:50 mm (average 4.44 ± 0.29 mm) and skull width from 1.10 to 1.50 mm (average 1.44 ± 0.08 mm).The developmental this larval stage was1.45 days.

4th instar larva: The body length is 23.80 mm, caudal hornlength 7.06 mm and head capsule width 2.10 mm. The larva has two color forms: a green form and a brownish black form. The developmental time is 1.80 days.

The green form: The head, thorax and abdomen are greenish yellow (Figure 2) with a white lateral line on each side starting from the second segment of the thorax to the base of caudal horn. The caudal horn situated on the 8th abdominal segment is black and covered with tiny black spine except the yellow tip (Fig. 3)

The brown form: The dosal side is black and the body color is light yellow(Fig. 4). At the center of the dorsal side there is a dark band and with a white lateral line on each side starting from the first or second segment of the thorax to the base of caudal horn. one by the start of the first segment of the thorax horn . The head is brownish yellow and black legs .Below the lateral white lines, there is a black stripe. The ventral parts of thorax and abdomen are dark black. An anal shield color is toward yellow(Fig. 5).

5th instar larva: The body has a length of 27.00 to 70.00 mm (average 51.04 ± 15.84 mm). Caudal length
is 8.29 mm, head capsule width 3.49mm. White spots scattered all over thorax and abdomen. There are 2 color form: green and brownish pink(Fig. 6 and 7)

At the late prepupal stage, it excret liquid with shrunken body and no sign of movement(Fig. 8)

Pupa: The pupa is brown with 34.12 mm long(Fig. 9). The brown proboscis shealth covered the hawk moth proboscis located at the frontal part of insect head(Fig. 10).Chrysalis at the age of eight days, it colour is dark brown to black . The ventral end of the pupa, there is a genital aperture which is the opening of reproductive organs at the ninth abdominal segment for male(Fig. 11), and two apertures for females on the eighth abdominal segment called the bursa copulatrix (copulatory pouch of the female) and the lower openings of the fallopian tube (aperture of oviduct)(Fig. 12).

3.2 Description of Males and Females

Description of males: The body is 26.40 mm long with big compound eyes and ciliate antenna(Fig. 13). The labial palp covered with green and dark hairs. The proboscis length is 27.90 mm with tibial spur formula 0 – 2 – 4 and tarsal formula 5 – 5 – 5. It has a frenulum on hindwing(Fig. 14). It has an opened fantail.

Description of females: The body is 29.73 mm longwith a crescent shaped fantail and filiform antenna(Fig. 15). The wingspan is 50.80 mm wide, forewing length 25.33 mm and hingwing length 14.45 mm(Fig. 16).

Table1. Growth and Developmatal stages of M. belis

stages	Developmental time(day)	Head capsule width(mm)	Caudal horn length(mm)
egg	3.26±0.19		
1st instar	1.90±0.09	0.61±0.01	1.45±0.08
2nd instar	1.69±0.17	0.97±0.04	2.46±0.07
3rd instar	1.80±0.38	1.44±0.08	4.44±2.29
4th instar	1.80±0.38	2.10±0.05	7.06±0.46
5th instar	5.52±0.50	3.49±0.08	8.29±0.72
pupa	10.65±6.12		
male	9.90±1.60		
female	9.80±2.46		

Table 2 The length of body, antenna and proboscis in mm of males and females

sex	Body length	Antennal length	Proboscis length
male	26.40±1.07	11.24±0.19	27.90±0.08
female	29.73±0.83	11.43±0.11	29.57±0.01

Table 3 Sizes in mm of forewing, hindwing and wingspan of M. belis

sex	Body length	Antennal length	Proboscis length
male	26.40±1.07	11.24±0.19	27.90±0.08
female	29.73±0.83	11.43±0.11	29.57±0.01

Fig. 1 The first instar larva

Fig. 2 The 4th instar larva(green form)

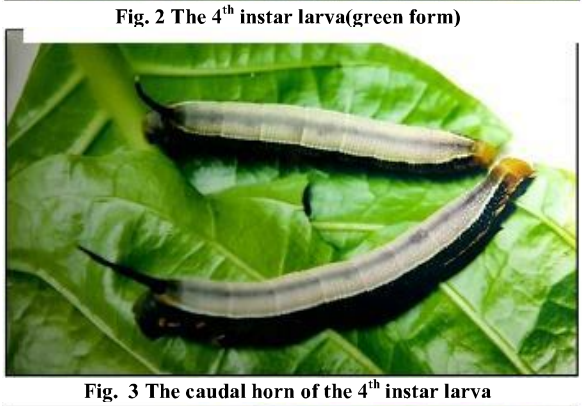

Fig. 3 The caudal horn of the 4th instar larva

Fig. 4 The 4th instar larva(brown form)

Fig. 5An anal shield

Fig. 6The 5th instar larva(green color)

Fig. 7The 5th instar larva(brownish pink color)

Fig. 8 A late prepupal stage

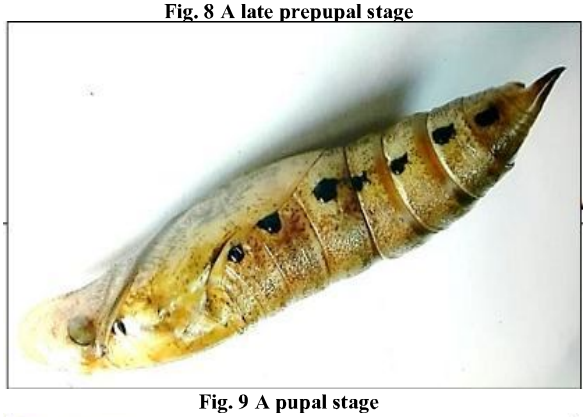

Fig. 9 A pupal stage

Fig. 10 Proboscis shealth of the pupa(arrow point)

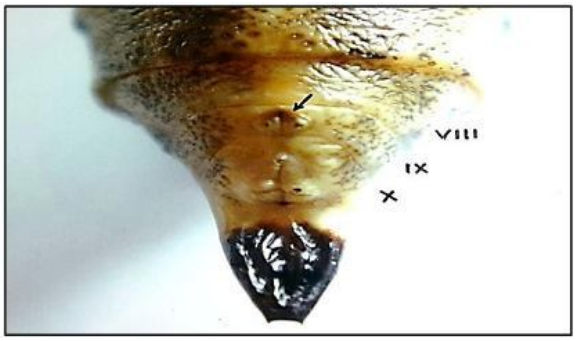

Fig. 11The genital opening of male pupa

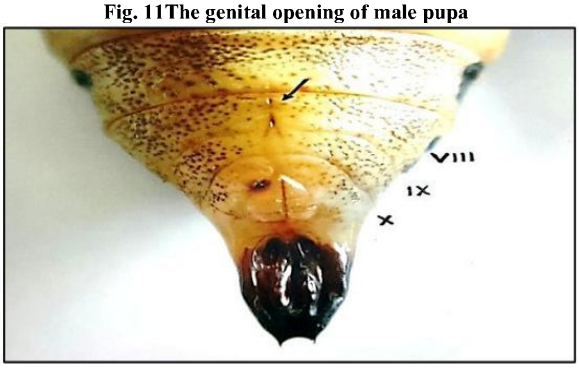

Fig. 12 The female genital aperture of pupa

Fig. 13 The M.belis male with an open fantail

Fig. 14 The fore- and hind-wing of the male with a frenulum

Fig. 15 A female with a crescent-shaped fantail

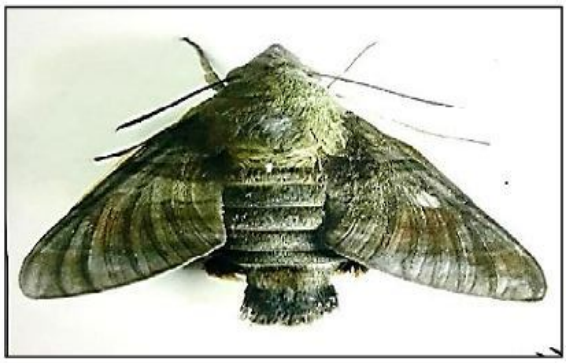

Fig. 16The fore- and hind-wing of female M.belis with a tegula(arrow point)

3.3 Biology of M. belis

The caterpillars of M. belis eat noni leaves (Morinda citrifolia L.). It is a a destructive caterpillar like M. sitiene, M. gyrans and. M. corythus. Eggs and larvae of this hawk species are often found in March and April. After mating, adults lay eggs singly with no cover on both young and old leaves of noni plants. When the larvae hatch from eggs, it will eat its egg shell as the first meal. The first instar will consume young noni leaves. The first three instar will eat their own exuviae and left only head capsules. The fourth instar can take more old leaves as food. The body size of the fifth instar are larger and longer. At the end of this larval stage called early prepupal stage, it will not eat and move so fast to find a place for pupation. The insect would spin silk to attach surrounding materials to build up a cocoon. It will excrete some liquid, shrink its body and shows no sign of movement which was called the late prepupal stage. It undergoes a complete metamorphosis with five instar larvae and five moults. In nature, the larvae will pupate near the soil surface of the noni growing areas. Its coccoon is made of leaves and small twigs and dirt. The adults use their proboscis to take up nectar from flowering plants and being the pollinators at the same time. Under the laboatory condition, it undergo papation without cocoon. The adults are fed with 30% of honey solution.

M. belis is a small hawk moth and classified in the group of hummingbird hawk moth. The common name is common hummingbird hawk moth. They are nocturnal and use their proboscis to get nectar from several species of flowering plants. As a result, they are known as a good pollinator. Their host plants are in the family rubiaceae, loganiaceae[3]. Besides M. belis, there are other species of hawk moths found infested on noni plants in Thailand such as M. sitiene, M. gyrans and. M. corythus [6].

CONCLUSIONS

M. belis (Linnaeus) is a hawk moth in the family Sphingidae, order Lepidoptera. Noni is a principle host of this insect species.In natural conditions, the adult will lay eggs singly on both young and old

leaves of noni plants. The egg was laid on the underside of the leaf and has no cover on it. The number of eggs that was laid 65-94 eggs /female and egg incubation period was averaged 3.26 day. There was five larva instar and each instar lasted for 1.90, 1.69, 1.45, 1.80 and 3.81 days, respectively. The total larval period was 12.36 days.

The average age of pupa was 10.65 days. Both male and female adults aged 9.00, and 9.80 days, respectively. The skull width of each larval instar was 0.61 , 0.97 , 1.44 , 2.10 and 3.49 mm, respectively , while the length of caudal horn was 1.45 , 2.46 , 4.44 , 7.06 and 8.29 mm, respectively.

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REFERENCES

[1]. H.Inoue, R.D. Kennett and I.J. Kitching. "Moths of Thailand, Volume Two – Sphingidae."Chok Chai Press, Bangkok. 149 pp, 44 col. Pls, 1997.

[2]. I.JKitching, R. Kendrickand P. Smetacek. "A list of hawkmoth species (Lepidoptera : Sphingidae) of India, Nepal, Bhutan and Srilankra, including their common names. http://www.flutters.org/home/docs/hawkmoths of India. pdf.", 2014.

[3]. R.C.Kendrick."The genus Macroglossum Scopoli 1777 (Lepidoptera : Sphingidae, Macroglossinae)in Hong kong."Hongkong EgyptianBank volume 2, no.1,pp. 13 – 2, 2010.

[4]. S.H.Yen, , I.J. Kitching and C.S. Tzen. "A new subspecies of hawkmoth from Lanyu, Taiwan, with a revised and annotated checklist of the Taiwanese sphingidae (Lepidoptera)." Zoological Studies volume 42 no. 2, pp.292 – 306, 2003.

[5]. 5Wikipedia.Sphingidae.[Online.]Available.https://en.wikipedia.org/wiki/Sphingidae, 2016.

[6]. .Kliangklao, S. Tigvattananont, S.Bumroongsook. "Distribution and Life History of Hawk Moths on Noni Plants in Thailand." International Journal of Agricultural Technology volume 11 no.,8 pp. 2505-2513,2015.

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