Journal of Agricultural Technology 2015 Vol. 11(8): 2589-2596
Available online http://www.ijat-aatsea.com
ISSN 1686-9141

The Biological Control Agent of Water Primrose: *Theretrasilhetensis* (Walker) (Lepidoptera: Sphingidae)

Maneerat Meekhunthod[1*], Suvarin Bumroongsook[2] and Saen Tigvattananont[3]

[1,2] Department of Plant Production Technology, Faculty of Agricultural Technology King Mongkut Institute of Technology Ladkrabang, Bangkok 10520, Thailand
[3]17 Ngamwongvan Rd., ThasaiSubdistrict, Muang District, Nonthaburi 11000, Thailand

Meekhunthod M., Bumroongsookand S. and Tigvattananont S. (2015). The Biological Control Agent of Water Primrose:*Theretra silhetensis* (Walker) (Lepidoptera: Sphingidae). Journal of Agricultural Technology. 11(8): 2589-2596.

The water primrose is one of a widespread and damaging invasive plant species. The control of this weed is primarily depend on chemical control. No record has been reported on biological control agents. The water primrose hawk moth (WPH), *Theretra silhetensis* (Walker) and known as brown-banded hunter hawkmoth, consumes water primrose leaves during it larval stage. Therefore, the biology of this insect was studied.

The morphologyand life history of the water primrose hawk moth (WPH), *Theretrasilhetensis* (Walker) wascarried out both under laboratory and field conditions.The morphological characters of this insect was described and illustrated in this paper. The life cycle of WPH was studied under the laboratory conditions. In this experiment, larvae were fed with the leaves of the water primrose(WP). The adultsconsumed 20% of diluted honey solution. The WPH adults were found more active at night and oviposition activity took placeafter dark. The eggs were deposited singly on the underside of WP foliage. The average number of eggs laid per female was 94.13eggs (range60-135 eggs). The average egg incubation period was 3.18 days (range3.00-3.33 days). The larvae of WPH underwent 5 moults and the developmental time for the larval instar in it successive stages was 2.68±0.40, 2.10±0.14, 2.35±0.44, 2.90±0.78 and 5.02±0.52 days, respectively. The mean for the whole larval life including the prepupal period was 15.05±1.07 days. The pupal stage was 9.37±0.60 days. The longevity of mated males and females was 7.60±1.60 and 8.07±1.83 days, respectively. The head capsule width was 0.60±0.02, 1.01±0.01, 1.50±0.19, 2.23±0.11 and 3.14±0.14 mm. for the first to fifth of larval instars, respectively. Approximate length of larval dorsal horn were 1.41±0.10, 1.98±0.17, 2.75±0.25, 3.33±0.41 and 3.16±0.29 mm, respectively.The larvae of this species fed on the foliage of *Ludwigiahyssopifolia* weed (Onagraceae) and *Colocasiaesculenta* (Araceae).

Keywords: Hawk moth, Sphingidae, *Theretrasilhetensis* (Walker), Water primrose

Introduction

The twowater primrose species naturalised in Thailand were *Ludwigiahyssopifolia* and *Ludwigiaoctovalvis* in the family Onagraceae.

***Coressponding Author:** Maneerat Meekhunthod, **E-mail:**sb19831986@gmail.com

primrose, primrose willow (Randall, 2002). It is found in shallow, fresh water habitats, including ponds, swamps and ditches. It also grows in irrigated crops, fallowgardens, wastelands, roadsides, forest clearings, moist gardens, and pastures inhumid areas (Panchoand Kim, 1985).

The water primrose hawk moth (WPH), *Theretrasilhetensis* (Walker) (Lepidoptera) belongs to the family Sphingidaeinsubfamily Macroglassinae.It was originally named*Chaerocampasilhetensis* (Walker). The adultwere found throughout the year.There are many types of host plantsuch as *Arum, Calocasia, Caladium and Pistia*, these 4 species to the family Araceae. Also reportedly found in the genus.*Ipomoea* (Convolvulaceae), *Boerhavia* (Nyctaginaceae), *Ludwigia* (Onagraceae), Rosa (Rosaceae), *Trapa*(Trapaceae) and *Kochia*(Chenopodiaceae) (Inoue *et al*. , 1997)

Materials and methods

Sample collection: Nymphs and egg clusters of the hawk moths were collected from water primrosefrom Samutprakan and an experimental area of faculty of Agricultural Technology, King Mongkut's Institute of Technology Ladkrabang. Then, they were placed in plastic boxes sized 19×28.5×10 cm. The date and places of collection was recorded. Egg and larva parasitization was observed and recorded.

Insect rearing in the laboratory: The nymphs and egg were all reared at room temperature (27-35^{o}C) at the entomological laboratory, King Mongkut's Institute of TechnologyLadkrabang. The water primroseleaves was provided as food for both adults and nymphs. Developmental and morphological characteristics of eggs, nymphs and adults of the moths were recorded, measured and photographed (n=30).

Results and discussion

The morphology of the *T. Silhetensis*

Egg: Eggs of hawk moth species, 1.12 – 1.25 mm long and 1:00 – 1.12 mm wide, were globular, light green color and smooth surface (Table 1).

The 1stInstar: It has a cylindrical body, 3:50 to 9:00 mm long.Its head, thorax and abdomen were light green. A horn has two lobes at the distal end of black tip.There was a white line along the body from throax to dorsal horn base ondorsal part of its body slightly down on the lateral side.The head capsule width was from 0.56 to 0.63 mm and a dorsal horn 1.25 to 1.50 mm long (1.41 ± 0.092 mm.)(Figure1 and 2)

Table 1. Developmental stages of *T.silhetensis (Walker)*

Growth stages	Duration time (days)	Head capsule width (mm)	Dorsal horn length (mm)
egg	3.18±0.07		
1st instar	2.68±0.40	0.60±0.02	1.41±0.09
2nd instar	2.10±0.14	1.01±0.01	1.98±0.17
3rd instar	2.35±0.44	1.50±0.19	2.75±0.25
4th instar	2.90±0.78	2.23±0.11	3.33±0.41
5th instar	5.02±0.52	3.14±0.14	3.16±0.29
pupa	9.37±0.60		
adult	5.25±1.73		
female	8.07±1.83		
male	7.60±1.60		

[1]Values are means of thirty replicates ± SD

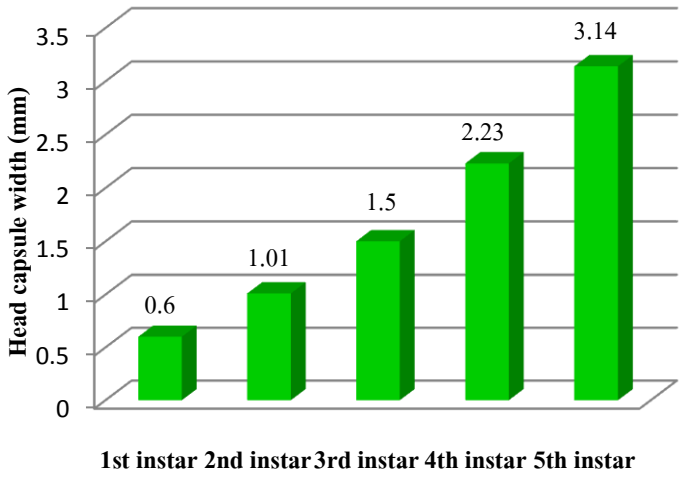

Fig 1. Head capsule width of thewater primrose hawk moth

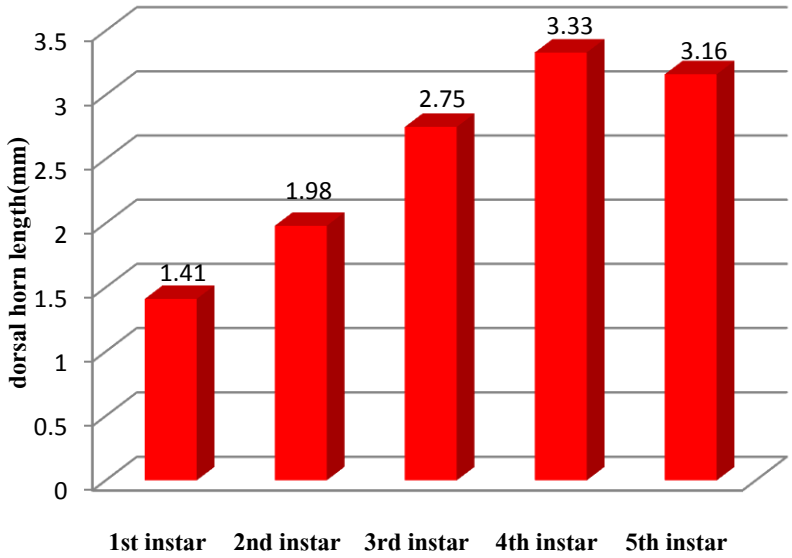

Fig 2. Dorsal horn length of thewater primrose hawk moth

The 2nd instar: First instar moulting into second instar, a newly hatched larva was green color on its head, thorax and abdominal parts. The yellowish brown horn had two lobes at its white tip. Each of the abdominal segment 1-7 had a pair of small black eye spot on each side of the body.

The 3rd instar: The body size was 13-25 mm long; head capsule width 1.37-1.62 mm wide; the dorsal horn, 2.00-3.25 mm long. Head, thorax and abdomen were light green including true legs and prolegs. Horn color was towards yellowish brown. Pairs of eyespots were in line with the white line that ran along the length of the body. The eyespot color was black situated in the middle and a white band around the black spot. A small white dots scattered throughout the thorax and abdomen.

The 4th instar: Ahead, thorax and abdomen were light green including prolegs. The dorsal horn was yellowishand brown color. Eye spots were green or yellowish green and surrounded with 2 rings. An outer ring around the eye towards the outside was black color. An inner ring was a white band. A small white dots distributed throughout the thorax and abdomen.

The 5th instar: Before pupation, It did not eat and had shortened its body. The pupation began as the larva did not eat and moved its body all the time to find the right place for the pupation. At the end, it would stand still and prepare to be a pupa.

Pupa:The pupa was brown and gray with 39-43 mm long and later turned dark brown to black with a tapered distal end of cremastral hook.
Adult: Male body length was 29.50 to 37.75 mm. (32.78 ± 2.16 mm.); proboscis 27.50 - 34.50 mm long (30.82 ± 2.027 mm.) and wings are brownish-gray. The front wings were dark brown to black with diagonal stripes along the wing. The hind wings were also dark brown to black. It had big brown compound eyes, brown and white antenna. The antenna in male was ciliate type with hair along it. The one in female was filiform type, smooth and no panel of hairs. It had 3 pair of legswith tarsal formula 5-5-5 and spur formula 0-2-4. The adult female was 29-37 mm long (33.87 ± 2.11 mm.); proboscis 30-33 mm long (31.46 ± 0.96 mm.).

Biology of hawk moths (*T. silhetensis)*

Mating of WP adults occurred at night in the end-to-end position. After mating, the female laid 60-135 eggs/insect all over young and mature leaves of water primrose. Egg incubation period was 3.00 to 3.33 day (average 3.18 ± 0.07 days). Newly hatched larvae ate their own egg shell which was the first meal for them. After this, the larvae ate plant leaves for living. Molting occurred for four times and each successive instar lasted for 2.68 ± 0.39, 2.10 ± 0.14, 2.35 ± 0.44, 2.90 ± 0.78 and 5.02 ± 0.51 days, respectively. Water primrose used as a larval host plant which naturally grew along the edges of pennywort plantation. *T. silhetensis*is as an insect pest of this weed should be investigate as an alternative way of chemical substitution for water primrose control in commercially pennywortgrowing areas. When larvae were fully grown, they would plunge themselves to pupate in the soil. Waste material is usually located on the ground like leaves, dried or fresh plant leaves were used to cover pupal body. The pupa duration lasted for 9.37 ± 0.60 days before adult emergence. Adult were provided with 20% of sugar solution. The longevity of males and females was 7.60 ± 1.60 and 8.07 ± 1.83, respectively together with WP adult detailed in Table 3.It was observed in Samutprakan and Bangkok where it had water primrose invasive and was found worldwide and more diverse in the tropical regions(Holm *et al*. 1979; Swarbrick, 1997) (Table 4).

Food plants of this larval hawk moth (*T. silhetensis*) are water primrose *Ludwigiahyssopifolia and L. octovalvis* infamily Onagraceae. Other host plants (Araceae, Convolvulaceae, Nyctaginaceae, Rosaceae, Trapaceae, Chenopodiaceae, Vitaceae)were recorded by Inoue *et al*. , (1997) (Table 5).

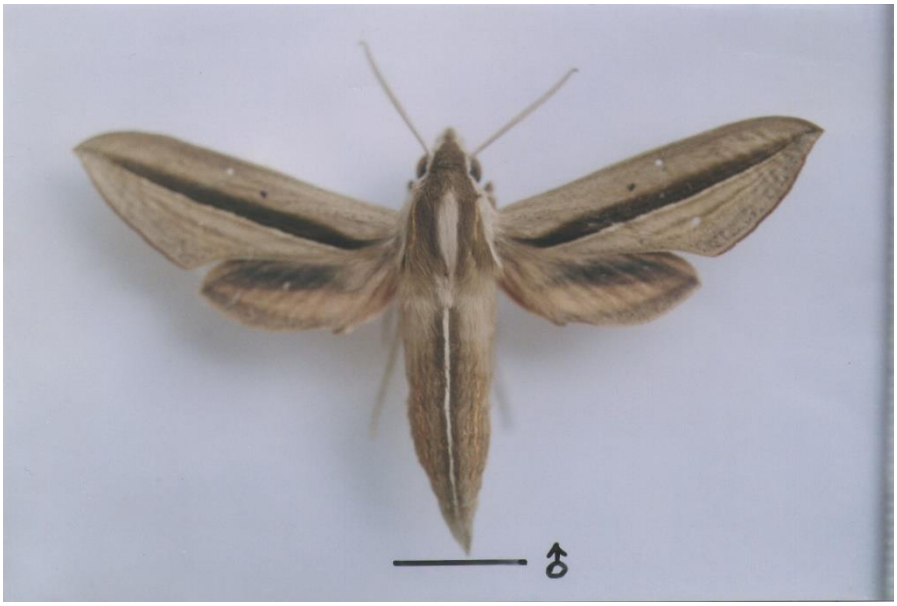

Figure 3. The male of *T. silhetensis*

Figure 4. The female of *T. silhetensis*

Table 3. Sizes in mm of both male and female of hawk moths

T.silhetensis(Walker)	Female	Male
Body length	33.87±2.11	32.78±2.16
Wingspan length	66.00±3.89	65.78±2.86
Proboscis length	31.46±0.96	30.82±2.03

Table 4. Distribution of water primrose hawk moths in Thai provinces from observation and recorded in foreign coutries from literature review

Hawk moth species	Thailand	Foreign coutries
T.silhetensis(Walker)	Bangkok, Samutprakan	Africa, Sudan, Egypt, Congo, Central America, South America and the Caribbean (Holm *et al*. 1979)American Samoa, Western Samoa, Mariana Islands, Micronesia, Fiji, Cook Islands, French Polynesia, Guam, Islands, Palau and the Solomon Islands (Swarbrick, 1997).

Table 5. Host plants of *T. silhetensis*

Hawk moth species	Host plant	Plant family
T. silhetensis	*Ludwigiahyssopifolia*	Onagraceae
	L.octovalvis	Onagraceae
	Arum sp	Araceae
	Caladium sp	Araceae
	*Pistia*sp	Araceae
	Calocasiaesculenta	Araceae
	Ipomoea sp	Convolvulaceae
	Boerhavia sp	Nyctaginaceae
	Rosa sp	Rosaceae
	Trapa sp	Trapaceae
	Kochia sp	Chenopodiaceae
	Parthenocissus quinquefolia	Vitaceae

Conclusions

The WP hawk moth is belonged to family Sphingidae and found worldwide and more in tropical regions. It can be found in all part of Thailand. The adult mating occurred at night and the female laid eggs on leaves of host plants. Each females lay 83-135 eggs/insect.Eggs are pale green and oval shape.Egg incubation period was about 3days.The total larval stages was 15.05 ±. 1.07 days, including pre- pupa stage. The pupa took 9.37 ± 0.60 days whereas the lifespan of both male and female was not much different.

Ludwigia spp and *Colocasia esculenta* are the principle larval host plants of WP hawk moth which larvae of WP hawk moths are active feeders. It could be a potential biological control agent for water primrose control and be benefit to growers in term of reduction of chemical usage cost.

Acknowledgement

Thanks go to Ms. Pimchanok Kinjun for insect rearing assistance and data collection.

References

Holm L, Pancho JV, Herberger JP, Plucknett DL. (1979). A geographical atlas of world weeds. John Wiley & Sons, Inc., New York

Inoue, H., Kennet, RD., Kitching, IJ. (1997). Moths of Thailand. Chok Chai Press, Bangkok.

Pancho JV, Kim JS. (1985). Reproductive biology of weeds in vegetables in the highlands of Benguet, Luzon, Philippines. Philippine Journal of Weed Science 12:75-98.

Randall, R.P. (2002). A Global Compendium of Weeds.Shannon Books, Australia.

Swarbrick, JT. (1997). Weeds of the Pacific Islands.Technical paper no.209. SouthPacific Commission, Noumea, New Caledonia.