

Morphology and Biology of *Apopestes Spectrum* Esper, 1787 (Lep: Noctuidae) on Stinking Bean Trefoil, *Anagyris Foetida* L. (Leguminosae) in Kermanshah Province

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ABSTRACT

Stinking bean trefoil, *Anagyris foetida* L. (Leguminosae) is a unique shrub species in the forests of Gilanegharbe city, in Kermanshah province. The moth's larvae named *Apopestes spectrum* Esper, 1787 (Lep: Noctuidae) would damage the leaves by feeding them. This study was conducted in 2014 in order to examine some aspects of morphology of different life stages and its biology under natural and in vitro conditions. This insect had 5 instars and a generation under region conditions in a year. Instars separation was done by measuring head capsule width and body length. Instars and head capsule growth coefficient was consistent with Dayar's rule and larval head capsule growth coefficient was equal to 1.347. The last instar appearance was in the second half of April under natural conditions. Adults insects appeared late in the first half of May. Aestivation and hibernation of this pest was in the form of adult in shelters located in the mountains. Maximum contamination for a shrub was counted up to 20 larvae.

KEYWORDS: Stinking bean trefoil, *Anagyris foetida*, *Apopestes spectrum*, Dayar's rule, Gilanegharbe, Kermanshah

INTRODUCTION

Anagyris foetida L. (Leguminosae) is a rare shrub species which in English is known as Stinking bean trefoil, Purging trefoil, Stinking wood and Bean trefoil. Its leaves are dark green and trifoliate; compound leaf made up of 3 similar leaflets. Its inflorescence is cluster and yellow. Ripe seeds are purple, bean-shaped, very hard and toxic (Mifsud, 2014).

Local names of this shrub in Persian are Ghareghage and Gharetaj.

This Mediterranean species is usually observed with spot and often at altitudes below 1,400 meters (Jaziraei and Ebrahimi Rastaghi, 2003).

The most important habitat of Stinking bean trefoil shrub is Gilanegharbe forests in Kermanshah with the area of approximately 930 hectares between longitudes of 45° 58.86' to 46° 1.66' and latitudes of 34° 4.86' to 34° 6.7' which has some unique botanical characteristics, so that the shrub growth begins in early November and during winter is green, and at the end of June becomes yellow (personal observations).

A beautiful habitat of Stinking bean trefoil is seen in landslide of Kasekaran village of Gilanegharbe and landslide of Dalahoo in Kermanshah. The shrub flowers in the middle of winter that vitalizes sleeping mountain face and doubles charm and beauty of its habitat (parvin, 2003). For this reason it seems that it has the potential to attract scientific and travel tourism.

The extract of different parts of this plant has medicinal, insecticide and fungicide properties (Mifsud, 2014, Righi *et al.*, 2008, Rula & Talal, 2011 and Zargari, 1997) and its wood is used in handcrafts and producing a variety of baskets (Akan, 2013).

The larvae of one species of moths is pest of this shrub and damages it in its growing zones, that was identified and was studied its morphology and biology during this research. *Apopestes spectrum* L. larvae feed on leaves of host and eat whole the leaf in last instars.

Afrouzian *et al.* (2007) reported damage of *Apopestes spectrum* on the *Ammodendron* shrub, *Ammodendron persicum* (Leguminosae) for the first time in South Khorasan province of Iran. *Genista pilosa*, *Sytisus scoparius* and *Spartium junceum* of Leguminosae family have been mentioned as the host of this pest. This pest is distributed in East Asia, India, Turkmenistan, and Tajikistan (Afrouzian *et al.*, 2007).

Also this moth is collected by using light traps in Iran and its distribution region is the provinces of Tehran and Fars (Kazemi, 2014). *A. spectrum* has one generation in a year and not only observed in the areas with Mediterranean climate, but also feeds in semi-arid areas on *Retama raetam* (Papilionaceae). Its flight period is April to June (Kravchenko *et al.*, 2004).

This study was conducted in order to identify the species of Stinking bean trefoil phyllophagous moth and study its morphology, some aspects of biology and its damage in 2014 in order to decide on its proper management by using the results of this study, and therefore take an important step toward preservation and development of Stinking bean trefoil shrub in the west of Iran.

MATERIALS AND METHODS

This research was performed in Gilanegharbe city of Kermanshah province in Iran (Figure 1).

In order to study apparent characteristics of phyllophagous moth larvae, samples were taken once every five days regularly. A number of last instars (third, 4th and 5th instar) were

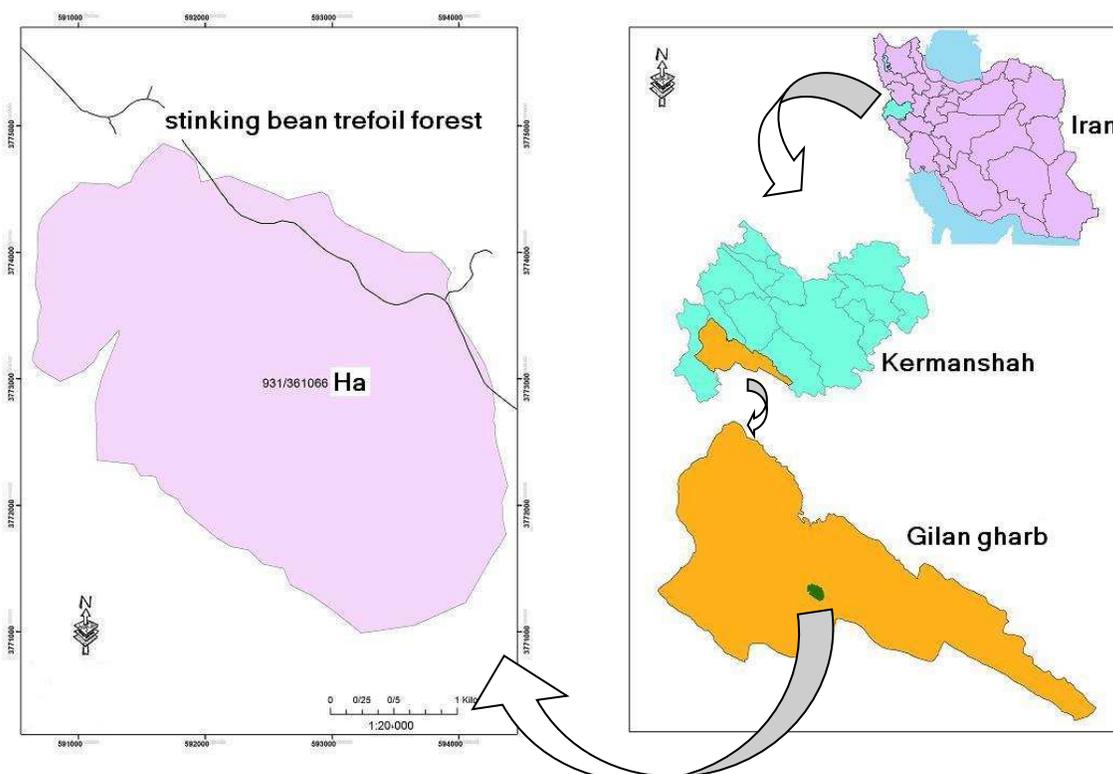


Figure 1. Area and location of *A. foetida* forest in map of city, province and Iran.

collected and grown in transparent cylindrical plastic containers with a cross section diameter of 10 cm and a height of 7 cm and surrounded doors of them with appropriate mesh fabric, under natural conditions, at the Department of Natural Resources of Gilanegharbe city, and the larvae were provided with plenty of fresh leaves of stinking bean trefoil to feed every day, and thus the biology of this species was studied too (Figure 2). Weather statistics related to days of sampling was taken from weather station near the habitat of stinking bean trefoil.



Figure 2. growing containers of *A. spectrum* larvae.

Also morphology of egg, different instars, pre-pupa, pupa and adult were determined on the basis of at least twenty samples. Farm characteristics of different life stages of the insect and egg incubation period were recorded.

Egg size measurement was done by using graph paper (that the size of its each cell was $0.2 * 0.5 \text{ mm}^2$). In order to determine larval different ages, head capsule width was measured by a stereomicroscope equipped with a scaled loop and the length of the body was measured by a ruler, Dayar's rule was used in connection with coefficient of larvae head capsule growth about larval stages.

In order to check pre-pupae, one and two days cocoons were cut by a blade, pre-pupae were removed and in addition to recording apparent characteristics, their length of bodies was measured.

In order to determine the exact time of pupation under natural environment conditions, three larvae of 5th instar were released on three different branches of stinking bean trefoil shrub in the natural environment and to protect the larvae against predator birds and ease of their control, half a meter at the end of a branch that the larvae were released on it, was enclosed with appropriate mesh fabric and pupation start time (spinning cocoon) and also appearance time of moths were recorded (Figure 3).



Figure 3. Releasing the last instar of *A. spectrum* on branches of host shrub.

Also, after moths' appearance, their wingspan was measured.

In order to estimate the average number of adults per shrub, along with stinking bean trefoil fall in the late of June, 50 shrubs were selected randomly in habitat level and the number of cocoons under tree crown (that after the fall had been under the tree and because they were big and white, they were well distinct and significant and their number was an index of population of pupae and adults) were counted.

In order to observe natural enemies, different instars and pupae were collected from the environment and were kept in separate containers until appearance time of moths.

RESULTS AND DISCUSSION

- Morphology characteristics of different life stages of *A. spectrum*:

Eggs were relatively large, spherical, green, and their average size was 3.4 ± 0.1 mm * 2.1 ± 0.1 mm. egg was initially light green, but after a few days, its color changed to dark green and close to hatching time, its color was milky green (Figure 4).

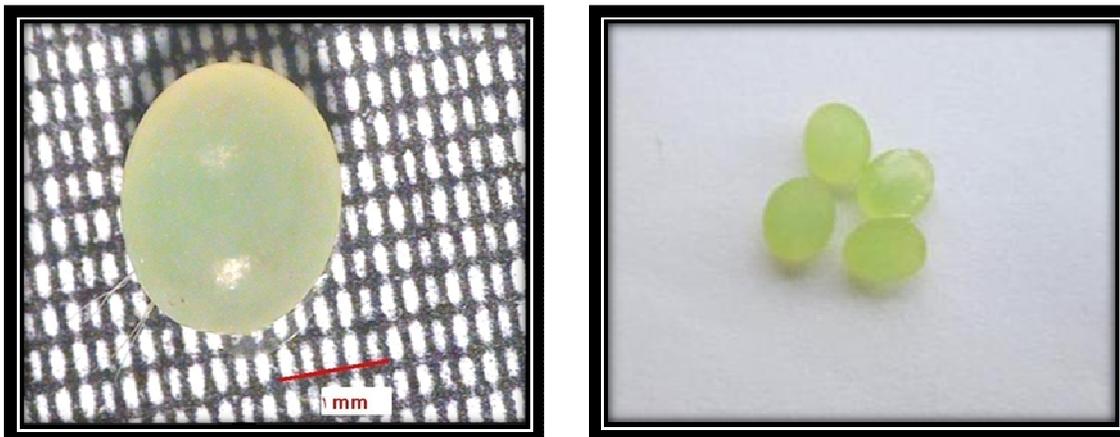


Figure 4. Eggs of *A. spectrum*.

The larvae were Eruciform, with three pairs of thoracic legs and five pairs of abdominal legs. Phyllophagous moth had 5 instars that the number of larval ages and head capsule growth coefficient was consistent with Dayar's rule and larval head capsule growth coefficient was equal to 1.347.

First instar of this moth had 9.12 ± 0.23 mm length and was green and without any strip or pattern. It had an yellow and long tail swelling on dorsal surface of penultimate abdominal segment with a length of about 3.5 mm, larva head capsule was green and its width was 1.25 ± 0.02 mm. This Larva after hatching carried its egg shell about 2 hours (Figure 5).



Figure 5. First instar of *A. spectrum* with its egg shell.

Body length of the second instar was 20.42 ± 0.84 mm and the width of its head capsule was 2.01 ± 0.01 mm.

The second instar had some yellow, black and white stripes on body and also a number of black spots were visible on head capsule, which were visible in next instars similarly. On dorsal surface of 2th to 5th instars were seen three white strips throughout the body, the middle white stripes in the center of dorsal surface was

wider than two other white side stripes. Between the white stripes and around them were seen 4 shiny black stripes throughout larva body that 2 upper stripes located around the central white stripe were wider than 2 side stripes. In the lateral surface of larva body was seen a long yellow strip with black spots and patterns that in the center of lateral surface of each segment two black spots are more specific. In lateral surface of larva body, below mentioned yellow strip, was seen a black stripe with a longitude white line in the center, within this stripe there were 3 black spots in segments of thorax and abdomen, that the spots were surrounded with a white ring. A long yellow stripe was observed Below this stripe and between sternal and lateral surface of larvae body too. Larvae sternal surface was white or light green. Head capsule was white and were observed from the front view three rows of black spots on it that upper row included 4 spots and was more specific than lower rows.

Body length of third instar was equal to 32.25 ± 2 mm and the width of its head capsule was 2.45 ± 0.05 mm. Body length of 4th instar was 41.25 ± 2.4 mm and the width of its head capsule was 3.37 ± 0.12 mm. Body length of 5th instar was 60.7 ± 4 mm and the width of its head capsule was 4.0 ± 0.01 mm (Figure 6).



Figure 6. Last instar of *A. spectrum*.

Last instar, after full feeding on leaves of twigs, webbed a large cocoon around itself and entered pupation. In this stage, the larva was curved, shorter and thicker than the last instar and its length body was 4.9 ± 0.1 cm (Figure 7).



Figure 7. Prepupa of *A. spectrum* .

Pupae were formed in a white cocoon webbed by the last instars on host trees' twigs. Pupa was first brown in the cocoon and gradually and during pupation its color would change to black brown. Pupa length was 33.5

± 0.5 mm and its body width on the head was equal to 8.5 ± 0.5 mm. Cocoons were white and large and their length was 45.5 ± 0.5 mm and their width was 18 ± 0.5 mm (Figure 8).



Figure 8. Pupa (right) and pupal cocoon (left) of *A. spectrum*

Adult moth was brown, its wingspan was 7.79 ± 0.06 cm and body length was 3.55 ± 0.036 cm, its antenna was long and filiform. Moth at rest puts wings on the body. Compound eyes were large and black, front wings were narrower and longer, but back wings were shorter and wider. The front wings were brown and were observed on them from proximal to distal of each wing 4 rows of zigzag lines as follows (Figure 9):

A- The first row at the beginning of a wing included a black zigzag line.

B- The second row in the middle of a wing included two adjacent black zigzag lines; back line was darker and the front line was lighter. Between these two lines at the outer side of each wing, a bean-shaped curved brown spot was observed that the spot was quite distinct and clear with its white margin.

C- The third row in one- third of the wing end included two zigzag lines that the first was light black and the second was white.

D- The fourth row on end side of the wing included a black zigzag line that was dash and slash. The back wings were brown and without any pattern, and basal and middle part of the wing was brighter than the end of it. At the end and the base of back wings were observed a lot of brown long cilia.

Abdomen was big and light brown and covered with cilia. Sternal surface of thorax and abdomen were light brown and covered with cilia, legs were long and brown and the head was brown and covered with abundant cilia too.



Figure 9. Adult of *A. spectrum*

BIOLOGY

Larvae activity on the host shrub was from early April to late April and then entered a cocoon on twigs for pre-pupation stage. The first pupa was formed on 23 April and the first adults appeared on May 3, 2014. Adult appearance would continue until May 20, 2014. Moths' exit from cocoons was often during the night. Adults after leaving the pupa had no activity, such as feeding or mating and tended to hide in dark places and hideouts. Aestivation and hibernation of this insect was as adults in shelters in the mountains. Based on counting of fell cocoons under 50 shrubs that were selected randomly after the fall, the average number of cocoon beneath each shrub was obtained 2.7 ± 0.38 . The insect had one generation a year in the city Gilanegharbe conditions.

The incubation period of this moth eggs lasted 6.43 ± 0.06 days in terms of average temperature of 24.3 ± 0.71 ° C and an average relative humidity of 29.125 ± 3.6 percent.

5th instars after feeding the leaves, first pasted a number of stinking bean trefoil leaves to each other then span a relatively large white cocoon inside of the leaves and entered it for pre-pupation and pupation stages (Figure 10). Pre-pupation and pupation period of the moth lasted 25 ± 0.5 days in terms of average temperature of 24.39 ± 0.52 ° C and an average relative humidity of 30.03 ± 1.6 percent.



Figure 10. Pupal cocoon of *A. spectrum* within leaves on host shrub.

- Feeding and damage impacts

Upon hatching, the larvae were observed on the leaves of their host and fed them. The larvae first fed the leaf epidermis, but from the second instar fed whole the leaf. Most feeding was by 4th and 5th instars, which were larger and had stronger mandibles. The larvae of the last instars fed all the leaves even nervure and nothing was left (Figure 11 right).

First and second instars often fed leaves inside a tree crown and third to 5th instars fed the leaves around a tree crown. In some cases up to 20 larvae were counted on a shrub, that under this conditions upper twigs were bare due to larvae feeding and it seemed that the shrub was grazed by livestock (Figure 11 left).



Figure 11. Feeding Larva of *A. spectrum* on leaves (right) and damage impacts on host shrub (left).

-Host plants

Despite that in various sources was mentioned the damage of this pest on several plant species but feeding of *A. spectrum* larvae was only observed on Stinking bean trefoil leaves in Gilanegharbe region and according to conducted research's, no feeding of pest larvae was observed on other hosts including other forest species or farm crops in the region.

- Natural enemies

With growing the last instars and also pupae, no parasitoid case was observed on mentioned life stages in the region. However, regarding large size of the last instars and feeding them around the shrub crown, it seems that some species of birds are predator of larvae and play an important role in reducing pest population.

DISCUSSION

Damage of *A. spectrum* larvae were reported on other hosts previously (Afrouzian *et al.* 2007 and Kravchenko *et al.* 2004), but in this study the shrub of *A. foetida* L. (Leguminosae) was introduced for the first time as a host of this pest in Iran and its biology and morphology on *A. foetida* shrub were studied.

The results of this study are consistent with the results of the study of Afrouzian *et al.* (2007), in terms of larvae feeding of a shrub of Leguminosae, location and manner of pupation and time of adult appearance too. Under the city Gilanegharb conditions, adults appear in mid-May and spend summer and winter in dark and cave-like places.

The results of this study are consistent with the results of the study of Kravchenko *et al.* (2004), in terms of number of moth generation.

The adults are attracted to the light. In order to control this Pest it is suggested, to install appropriate baited traps in habitat level and hunting adults to prevent its oviposition in late March and early April, in order to reduce its population. Also collecting newly formed cocoons on host shrubs and destroying them will play an important role in reducing the pest population in the following year.

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