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Life cycle of *Euxoa agricola* Boisduval, 1829 (Lepidoptera: Noctuidae) in Yasouj, Iran

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Abstract
This study was carried out on *E. agricola* life cycle in Yasouj from 2010 to 2011. The sampling was carried out weekly by two stage cluster sampling method in nature. For the life cycle studies, the eggs were collected from the nature and were developed in petri dishes and 15 × 20 plastic dishes under laboratory conditions (27 ± 1 º C and 24 ± 1 º C, 65% ± 10 RH and 16:8 L:D). The results indicate that the adults emerge gradually from hibernated larvae in April 2010. This moth has one generation a year. Incubation periods of eggs are 2.9 ± 0.1 and 3.8 ± 0.1 days; developmental periods of larvae are 17.1 ± 0.4 and 20.7 ± 0.4 and for pupae 9.3 ± 0.1 and 13.5 ± 0.2 days under temperatures of 27 and 24 º C at the laboratory conditions respectively. The total period from egg to adult was 27.8 ± 0.7 and 35.8 ± 0.5 days in 27 and 24 º C respectively at laboratory condition.

Keywords: *Euxoa agricola*, stem borer, *Gundelia tournefortii*, yasouj, ira

1. Introduction
Iran due to is located in the desert belt and geographical features has caused most of it placed in arid and semiarid climates [1, 16]. Approximate area of deserts country nearly 40 to 45 million hectare estimated [3]. Mountains and deserts of Iran have a variety of native plants, so with habitat characteristics these plants can be compared to planting and protecting them against damaging factors such as pests, can either to add the richness of the country's genetics reserves and either the resulting desertification activities to biological method more confidence [4, 12]. Artichoke with common name Tumbleweed and scientific name *Gundelia tournefortii* L. is a medicinal plant and belong to family of compositae [8].
This pasture plant, which widely in arid, semi-arid and semi-arid Africa and Asia have spread, is native to Iran [9, 10, 14]. Artichoke in semi-desert areas of Syria, Palestine, Jordan, Iraq, Azerbaijan, Armenia, Turkmenistan, Israel and Turkey are spread. This plant in grassland areas, tropical and northern coasts of Oman and Makrans' Baluchistan province, with an altitude of 1100 meters above sea level is seen. Artichoke is one of plant species that are valuable in the areas of natural resources and the mountains regions so that from flowers, leaves, stems and seeds are used as a food source for livestock feed [7, 11, 13].
One of the most important pests of artichoke is stem borer moth, *Euxoa agricola* Boisduval 1829, belong to subfamily Cuculinae and family Noctuidae [5, 6, 15]. This butterfly in literature with synonym names such as *Noctua agricola*, *Agrotis lycarum*, *Agrotis squalid*a, *Agrotis abdita*, *Euxoa abscondita* and *Euxoa osthelderi* also is known. The larvae of this insect feeding from leaves, young branches and inside stems of the artichoke and cause general weakness and reduced plant growth [17, 19].
In some causes the larvae attack the young plants artichoke and cause of wilt and death of plant. Pazuki and Wazrick [18] for the first time this moth, *Euxoa agricola* reported from Iran. Abaie [2], this stem borer moth, *E.agricola* as the most important pest this pasture plant (artichoke) reported. Due to such as climate condition, the establishment of the plant in areas with steep, low ecological needs of this plant, its application to prevent soil erosion and applications in pharmaceutical industry, the importance of this plant is more seriously [20].
So far no research has been done on this pest in Iran. Therefore, this study was conducted to investigate the life cycle of the stem borer moth, *E. agricola* in Kohgiluyeh va Boyerahmad province.

2. Materials and Methods
For the morphological studies, the twenty numbers of each biological stage (eggs, larva,

pupa, adults) were selected. All the stages were examined and photographed with an Olympus SZ40 wide zoom camera attached to an Olympus SZ-PT binocular stereo zoom microscope. Data was collected from Yasouj in south of Iran (30ºN, 50ºE) from 2010 to 2011. The sampling was done weekly by the two stage cluster sampling method in nature. One hundred eggs were collected from the nature and moved to Laboratory. In the Lab, each egg separately was inserted in a Petri dish of 8 cm in diameter and the data was recorded, daily. After the first instars larva, the seconds was transferred to cylindrical containers (10×12 cm) with the fresh leaves of *G. tournefortii*. The containers were examined daily from larva to pupa. After the emergence of adults, the each pair was transferred to larger cylindrical containers (10×30 cm) with honey solution and fresh flowers of *G. tournefortii*. The Laboratory conditions were (27±2 ºC and 24±2 ºC, 60% ±10 RH and 16/8 L: D).

2.1 Statistical analysis
To compare the developmental time for biological stages with the help of software SPSS16, One-way analysis of one-way variance used.

3. Results
Oviposition observed just in the nature and our treatments that provided with the flowers and honey solution did not succeed in the lab. Females laid their eggs singly, only on the underside of the leaves. A butterfly settles on a leaf, then turns its abdomen to underside and inserts one egg on one leaf. At first, the egg is green light color then gradually change brown and at last become grayish. The egg is oval shaped. It is 1.2 ± 0.1 mm in length and 0.5 ± 0.1 mm in diameter. The egg incubation period was 2.9 ± 0.1 days and 3.8 ± 0.1 days frequently at 27 ºC and 24 ºC (Table 1, 2 and 3).

Table 1: Number of instars larvae base on measuring length and width head capsule.

Number of Samples	Diameter of Head Capsules (mm)		Body Length (mm)		Larval Instars
	Average	Range	Average	Range	
66	0.151	0.13 – 0.16	1.51	1.30 - 1.80	1
59	0.251	0.22 – 0.26	2.78	2.42 – 3.10	2
75	0.395	0.32 – 0.41	4.63	3.81 – 5.62	3
59	0.824	0.70 – 0.93	7.67	5.43 – 9.10	4

Table 2: Developmental time for biological stages of *E. agricola* at 27 º C

Stages / Instar	Days
Egg	2.9 ± 0.1
First Instar Larva	3.5 ± 0.1
Second Instar Larva	3.5 ± 0.1
Third Instar Larva	4.5 ± 0.1
Fourth Instar Larva	5.5 ± 0.1
Total Larval Period	17.1 ± 0.4
Pre- pupation	1.5 ± 0.1
Male Pupae	10.3 ± 0.2
Female Pupae	8.2 ± 0.1
Egg to Adult	28.6 ± 0.7
Longevity of Adult Male	12.5 ± 0.8
Longevity of Adult Female	9.5 ± 0.6

Table 3: Developmental time for biological stages of *E.agricola* at 24 ºC

Stages / Instar	Days
Egg	3.8 ± 0.1
First Instar Larva	4.5 ± 0.1
Second Instar Larva	4.5 ± 0.1
Third Instar Larva	4.5 ± 0.1
Fourth Instar Larva	7.2 ± 0.1
Total Larval Period	20.1 ± 0.5
Pre- pupation	2.3 ± 0.1
Male Pupae	16.1 ± 0.6
Female Pupae	11.5 ± 0.2
Egg to Adult	32.7 ± 0.5
Longevity of Adult Male	15.6 ± 0.4
Longevity of Adult Female	11.5 ± 0.4

The present study determined 4 instars larvae based on length and head capsule measurements that adapted with Dayar's law. The first instar body was white to cream and its head capsule was black. It was 1.51 ± 0.1 mm in length and 0.7 ± 0.1 mm in wide (Fig. 1B). The first instar head capsule range was 0.13 – 0.16 mm. The second instar larva was light green. The second instar was 2.78 ± 0.2 mm in length and 1.6 ± 0.2 mm in wide and head capsule range was 0.22 - 0.26 mm. The third instar was 4.63 ± 0.1 mm in length, 1.9 ± 0.2 mm in wide and its head capsule range was 0.32 - 0.41 mm. The fourth instar was 7.67 ± 0.3 mm in length, 3.2 ± 0.1 mm in wide and its head capsule range was 0.70 - 0.93 mm. The larval development time was 17.1 ± 0.4 and 20.7 ± 0.4 days frequently at 27 ºC and 24 ºC (Table 2 and 3). In prepupal period, the larva stops feeding and settle down motionless. Its color changes from grey to brown. The prepupa size decreases with 3.2 ± 0.2 mm in length and 5.3 ± 0.4 mm in wide. The prepupa development time was 1.5 ± 0.1 and 2.3 ± 0.1 days frequently at 27 ºC and 24 ºC (Tables 2 and 3). Pupa was found either light brown or dark brown in color (Fig. 1C). In this study, it was found that male's pupae are smaller and lighter than female's pupae. The male's pupa was 4.2 ± 0.1 mm in length and 1.1 ± 0.05 mm in wide, while the female's pupa was 4.5 ± 0.2 mm in length and 1.2 ± 0.04 mm in wide. The male's pupa weight was 3.02 ± 0.4 mg while female's pupa weight was 4.5 ± 0.1 mg. Its development time was 9.3 ± 0.1 days and 13.5 ± 0.2 days frequently at 27 ºC and 24 ºC (Tables 2 and 3). The adults are small moths, gray colors, with dark transverse lines on front wings. The hind wings are gray with short hairs. The main difference between males and females is the spots on the hind wings. Each hind wing of males has four black spots while the females have only three black spots (Fig. 1A). The adult males and females were similar in sizes. The antenna was 11 ± 0.2 mm in length. Wingspans were 56.3 ± 0.5 mm. The body was 18.4 ± 0.2 mm in length and 3.5 ± 0.2 mm in wide. The adults head capsule was 3.1 ± 0.2 mm. The male longevity was 12.5 ± 0.8 and 15.6 ± 0.4 days frequently at 27 ºC and 24 ºC. The female longevity was 9.5 ± 0.6 and 11.5 ± 0.4 days frequently at 27 ºC and 24 ºC. The total development time from egg to adult was 27.8 ± 0.7 and 35.8 ± 0.5 days frequently at 27 ºC and 24 ºC (Table 2 and 3).

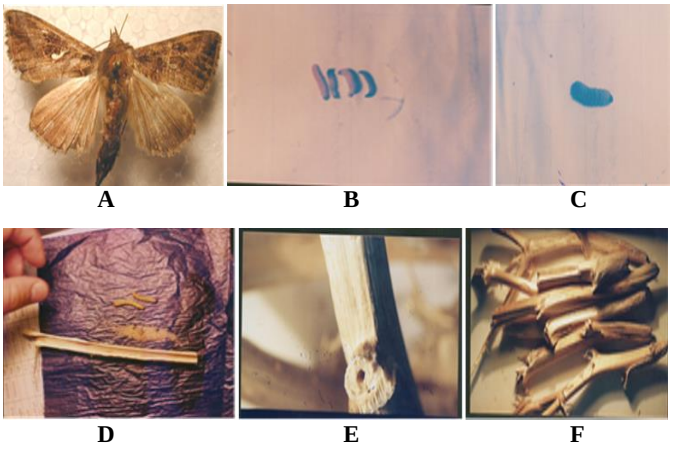

Fig 1: Biological stages of *Euxoa agricola*. (A) Adult Male; (B): Larvae (C) Pupa; (D) Damage; (E) Hole for enter larvae; (F) Place of overwintering of larvae

4. Discussion

This was the first study on *E. agricola* in Iran. The morphological study showed that *E. agricola* is distributed in the south of Iran. Non oviposition in laboratory makes some problems on culturing this butterfly for laboratory investigations, genetically studies and life tables. It seems the main reason that makes this problem is the adult need to feed on different flowers for ovary and pheromones development. The laying of more than one egg on one leaf can be due to few hosts or invasion population.

5. Conclusion

The present study concludes life cycle of *euxoa agricola* (Lepidoptera: Noctuidae). This moth has one generation a year. The total period from egg to adult was 27.8 ± 0.7 and 35.8 ± 0.5 days in 27 and 24 º C respectively at laboratory condition.

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