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Studies on morphology of the life statges and larval behaviour of fruit piercing moth of *Othreis fullonia* (Clerk) (Lepidoptera: Noctuidae) on *Punica granatum*

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Abstract
The fruit piercing moths of genus *Othreis are* very harmful for various fruit crops such as pomegranate, citrus, guava, papaya, mango, sapota etc. The studies on life stages of these pest will help to investigate the delicate and vulnerable stages of life cycle to suggest their management pracices. The present study on the morphology of life stages of *Othreis fullonia* (Clerk) from egg to adult death and larval behaviour was carried out in the laboratory at room temperature. The egg, pupa stages are non-feeding, the larvae of *O. fullonia* feeds on leaves of *Tinospora cordifolia* (Guduchi or Giloy) where as adult feeds on ripening fruits of various above said fruit crops. The complete life cycle of *O. fullonia* from eggs to deaths is of 45-60 days with an average of 53.15 ± 4.36 days in the case of males and 47- 62days with averages of 55.30 ± 4.31 days in the female. Eggs hatching start at night and early morning and hatching completes in 3.42 days. The eggs measure about 0.98 to 1.005 mm in diameter. Total larval duration in days from first, second, third, fourth, and fifth instar 2.07 ± 0.16, 1.87 ± 0.04, 3.06 ± 0.02, 3.11 ± 0.02, 4.79 ± 0.05 in days and total larval period was 13.5 to 17 days respectively. The length, width of larvae and width of head capsule of first, second, third, fourth, and fifth instar larvae was 4.33 ±0.29, 0.72 ±0.07 and 0.44 ±0.07, 11.75 ±0.22, 1.2 ±0.10 and 0.76 ±0.09, 21.53 ±0.41, 2.15 ±0.16 and 1.34 ±0.10, 32.76 ±1.11, 3.97 ±0.16 and 2.05 ±0.08, 52.19 ±0.46, 8.05 ±0.11 and 4.05 ±0.15 respectively. The Pupae were reddish and blackish in colour and the total pupation period was of 13.11 ±0.81 days and the total adult duration in male and female was 23.05 ±1.25 and 24.83 ±0.91days respectively. The adult of *O. fullonia* was in colour and of medium size. The male was smaller than the female.The colour of the moth was orange, reddish-brown and greyish-brown in colour. This is the first study of this type from Marathwada, which help to trace the vulnerable and delicate stage of the life stages of *O. fullonia.*

Keywords: *Othreis fullonia* (clerk), life stages, morphology, larval behavior

Introduction
The Genus *Othreis (Eudocima)* feeds at night by piercing the skin of the ripening fruits with their strong proboscis and sucking the juice. Internal injury consists of a bruised dry area beneath the skin. Secondary rots develop at the puncture site (Atachi *et al*., 1989) [1]. *Othreis spp*. is a destructive pest of several different fruits in tropical and subtropical countries including India, Southeast Asia, Africa, Australia, and South Pacific (Waterhouse and Norris 1987). The *Othreis* spp. are a serious pest on various fruits such as pomegranate, citrus, guava, papaya, grapes, carambola, eggplant, litchi, mango, and tomato,etc. The life stages of genus *Othreis* instars are feeding on shrubs, vines, and trees near the adult feed orchids regions. (Denton *et al*., 1989)**.** The *O.fullonia* feed on *Tinospora cordifolia*. The present study investigated the life stages of fruits piercing Moths *O. fullonia* (Clerk). the pest on the fruits of Pomegranate (*Punica granatum*) family *Punicaceae.*The genus *Othreis* is far the most harmful noctuid moths which normally feed on mature and ripening of various fruits by piercing the rind using specially adapted proboscis to sucking the juice of fruits.The genus *Othreis* is a polyphagous pest. The cultivation of horticultural area is increased in Maharashtra now a day's such various fruits crops to take a yield of such pomegranate, mango, sapota, custard apple, papaya, grapes, guava, tomato, etc. The immature caterpillar of *Othreis* larvae cannot eat fruits but feeds leaves of unrelated trees, shrubs, and vines often located well away from the adult feeding places (Denton *et al*., 1989). And these plants are mostly belonging to the family Menispermaceae. The Genus *Othreis* fruit piercing moth pest is rather difficult to control. Mote *et al*. (1991) reported up to 57% of pomegranate fruit suffered damage by fruit piercing moths, including *E. fullonia.*

Materials and Methods
The life cycle of fruit piercing moths, *O. fullonia* were studied from the egg, larvae, pupa and adult. The Adults *O. fullonia* collected from the orchards of Pomegranate from various parts of Marathwada district from 8:00 pm to 11:00 pm. Moths were collected with the help of torches and insect collecting hand nets. Moths were kept in double coating air mesh fabric black polyester cloth wood cages size 27×27×52 cm. In cages kept on the upper side the movable glass for the observation of feeding, mating, and oviposition and hanging up fresh ripened pomegranate fruits for feeding. The laid eggs are put on moist blotting paper in petri plate for hatching. After the emerged larvae put on *Tinospora cordifolia* leaves. Eggs were measured with the help of an ocular micrometer and morphological study observed under the stereoscopic binocular microscope and measurement of larvae with help of the vernier scale. Inside the laboratory maintain 22°c to 28°c temperature and humidity over 60 % to 75 %. The larval feeding used plastic trays size 38×30×7cm and lastly, the pupae were transferred in adults emerging cages size 60×42×48cm. Regarding the life span of moths female and male ten samples were observed in the laboratory.

Results and Discussion

The present study concludes that the complete life cycle of *O. fullonia* was completed from eggs to deaths is 45-60 days, with an average of 53.15±4.36 days in the case of males and 47-62 days with averages 55.30±4.31 days in the female. All the measurement shows in table 1.

Eggs (Plate I (A))

The freshly laid eggs were translucent and circular but the ventral region flat and attached to the substratum. Colour pale yellow and but after some time become yellowish white. They measure about 0.98 to 1.005 mm in diameter. The duration of eggs hatching is 3.29 days. Eggs hatches within 3 to 4 days. (Kumar and Lal, 1983) [7].

Larvae: There are six larval instars observed in life cycles. The study of *O. fullonia life* stages shows that there is variation in weight, size, colour, and characteristics as follows.

First Instar (Plate I (B))

The hatched larvae were semilooper, transparent and pale yellow in colour. It becomes green in colour after feeding. The head was light brown in colored and large size. Well-developed mouthparts and thorax well devolved a pair of the lesson each segment. Abdomen ten segmented, prolegs were in 4, 5, 6 and 10 segments. The third segment rudimentary and not use to walking.The hump-like structure present at eighth abdominal segmentdue to lack of prolegs. The body segments are distinct and on the dorsal side black round spot and inside round long hairy setae arise. The average duration of this instar was 2.07 ±0.16 days.

Second Instar (Plate I (C))

The larvae greenish-black in color but later on, it becomes brownish-black. The Head was black in colour. The body was soft concave dorsally and flat ventrally. The long hairy setae disappeared in the second instar. White dots appeared second and third thoracic region. A pairly found orange spots on the first three segments of the abdominal region of the lateral side. The anal hump on eight abdominal segments and eight whitish spots present. The average duration was 1.87 ±0.04 days.

Third Instar (Plate I (D))

The head was black and the larvae also black. The spiracles were present on one pair on prothorax and eight pairs on abdominal segments and were surrounded by 3-4 whitish-blue spots. The small undeveloped similar eye spot appeared on the second and third each. Eyespot black colourd present at central portion and yellow in the lower side and whitish on the upper side. Hump gray colourd and black lines and small spots present. The average duration of the third instar larva was 3.06 ±0.02 days. Denton *et al*. (1989) the duration of the third instar was 2 to 3 days.

Fourth Instar (Plate I (E))

The body was black in colour.Thoracic segments and two parallel lines of gray colour were running dorsally portion side of abdomen from fourth segments. The three white spots were present on the segment of each The three white spots were found on each segment on these lines. The hump region reddish on the top and a single vertical white strick at the lateral region. Last segment well-developed pair of anal legs. The eyespot was well developed and similar. And they half white and half were yellow, at central there was blue in Colour. The average duration was 3.11±0.02days. The blue spots line was present on the dorsal margin of the thorax region.

Fifth Instar (Plate I (F))

The fourth and fifth larvae were similar in appearance but some colour variation was seen. The body of all segments of the abdomen reddish in colored. The eye spot was large and bright in colour. Red colour parallel line present on the dorsal and lateral side. The prolegs were reddish black in colourd and thoracic legs were blackish in colour. The anal legs were black reddish colourd. The hump was reddish in colour. Each 4 th, 5th, and 10th abdominal segments bear a pair of thick prolegs. The average duration of this instar larva was 4.79 ±0.05 days.

Pupae (Plate I (G))

The pupae were obtect type and dark brown and blackish-brown in colour. The anterior end blunt and posterior were conical. The 2nd to 8th abdominal segments possess a pair of lateral spiracles. The male and female pupae can be differentiated, male genital pore situated midventrally on the 9 th and 10 th abdominal segments, whereas female genital pore on 8 th and 10th segments and pupation duration was 10 to15 days where as Hargreaves (1936) [4] reported 10 to 14 days with an average of 13.11 ±0.81days. The emergence starts after sunset at 6:30 pm and continues up to the early morning. The adult moths emerged very small size. Emerge moths are active and they get to fly one another region.

Adult (Plate I (H))

The adult of *O. fullonia* orange-brown body in colour, medium-sized. The Male is small than the female. The head red-brown colour. The abdomen was orange with a greenish tinge. The length of the forewing 43.17 to 52.15 mm and width 18.09 to 22.65 mm. Length of the hind wings 26.33 to 33.24 mm, while width 19.85 to 26.11 mm. The wing venation of both sexes was similar. The hind wings orange and yellowish with two black curved patches. On the hind wing the surrounding 6 small white spots present. Correct to hind wing and fore wing containing 6 white spots arranged in a peripheral semicircular dark band. A centrally located kidney-shaped spot is well evident on each on each hind wing of both the sexes. The adult moth is nocturnal in its habitat. Observation on the feeding behavior of the moths in the laboratory reveals that often feed at night. The proboscis is very long and tapers at the tip. After emerging from the pupa, females have a pre oviposition period of 4 to 6 days. Mating of the adult moths occurs at night and oviposition generally occurs in the early morning.

Table 1: Showing weight, length, width, headwidth, and average life span of *Othreis fullonia* (Clerk).

Sr no.	Stages	Body Weight (g)	Body Length (mm)	Body Width (mm)	Head CapsuleWidth (mm)	Average life span in (Days)
						Mean
1	1 st Instar	0.001±1.68	4.33±0.29	0.72±0.07	0.44±0.07	2.07±0.16
2	2 nd Instar	0.002±1.16	11.75±0.22	1.2±0.10	0.76±0.09	1.87±0.04

3	3 rd Instar	0.113±0.01	21.53±0.41	2.15±0.16	1.34±0.10	3.06±0.02
4	4 th Instar	0.428±0.01	32.76±1.11	4.01±0.13	2.06±0.08	3.11±0.02
5	5 th Instar	1.343±0.07	52.19±0.46	8.07±0.10	4.05±0.15	4.79±0.05
6	Pupa	1.334±0.10	26.22±0.66	9.51±0.35	6.40±0.07	13.11±0.81
7	Adult	0.604±0.09	31.03±0.58	8.46±0.21	5.71±0.07	23.05±1.25
						24.83±0.91

The behaviour

The first instar larvae very active after hatching and they move searching the food for a period of timing 3 hoursand then the larvae feed fastly on leaves of *Tinospora cordifolia.* First and second instar moving in the backside of the leaf after the time of feed at day time. Larvae colour changes from stages to stages. Larvae at the time of moulting they stop feeding. The feeding time of feeding large larvae disturbs to smaller. The fifth instars at the time pupae making them slowly active. Fifth instar larvae ceased feeding and get started the white silk spun in to drown the leaf of cocoon made white silk spun between dried leaves of *Tinospora cordifolia* then cocoon the larva was undergone for pupation within 24 hours. The cocoon attachment to make help of the tail. The larvae move to the dark side place inside the leaf for making pupae and Adults emergefor days of 11 to 15. After that pupae are making the pupae is small and big because of male and female addition and some time to food capacity. Adult moth is very small in size and the colour of moth was orange, reddish-brown, and grayish-brown in colour.The adult is for flying and they search for food for feeding.

Conclusion

The observations on life cycle parameters, behavior, and morphology is helpful for the identification of pest and their management. The results revealed may provide information important for predicting the field population of *O. fullonia.* The investigation on biological characteristics of *O. fullonia* provides information on the fecundity (reproduction), survival and development which will give a primary step to initiate the management measures. In this way we can invent the vulnerable and delicate stages of the life cycle of *O. fullonia* and also develop chemical, biological, and integrated management strategies on various fruit crops.

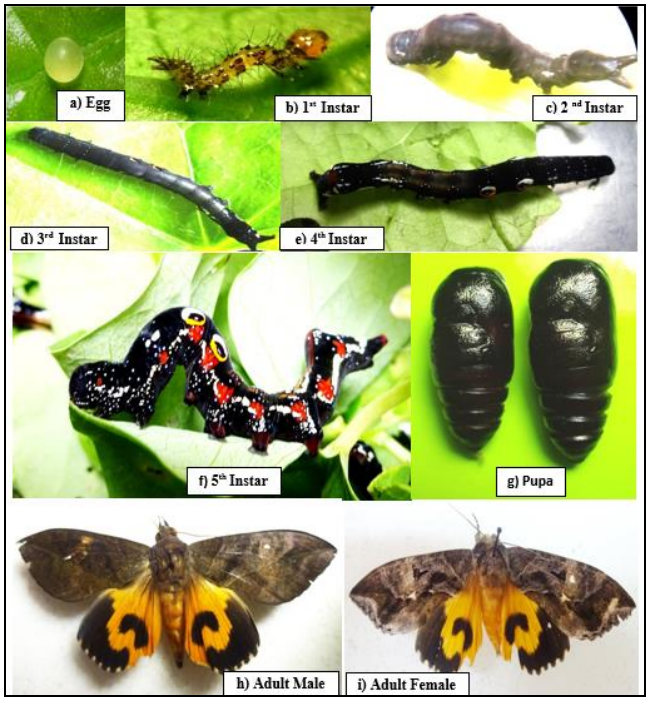

Fig 1: Plate I the various stages of life cycele of *Othreis fullonia*

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