FIRST RECORD ON THE BIOLOGY OF *AEOLESTHES HOLOSERICEA* FABRICIUS, 1787 (COLEOPTERA: CERAMBYCIDAE), AN IMPORTANT PEST ON APPLE PLANTATIONS (*MALUS DOMESTICA* BORKH.) IN INDIA

Ruchie Gupta* and J. S. Tara*

* Department of Zoology, University of Jammu, Jammu (Tawi) - 180006, J & K, INDIA. E-mail: ruchiegupta18@gmail.com

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ABSTRACT: Detailed bionomics of Apple longicorn borer, *Aeolesthes holosericea* Fabricius has been recorded for the first time in India on apple plantations. The insects were reared in the laboratory at temperature ranging between 10.84°C-32.87°C and relative humidity of 26%-80% on apple billets. Larvae being wood borers cause considerable damage to apple trees. There are seven instar stages. Larvae of apple longicorn beetle while feeding on the apple trees took about 17.23±0.21 months and 13.66±3.31 days to develop from first instar to mature larva. This period included the overwintering period of 4-5 months. Adult longevity for male and females were 10.55±0.44 days, 17.23±0.21 months and 13.66±3.31 days and days respectively. The pest has a total life span of approximately two years (25.16±1.83 months). So far, no report is available on culture of *Aeolesthes holosericea* Fabricius under laboratory conditions to facilitate evaluation of developmental stages against known control measures and the life cycle and ethology of this insect pest is indispensible for developing its control measures in the present area of study. It is also impractible to study the complete life cycle of *Aeolesthes holosericea* in its natural condition because regular tracking of feeding and boring larvae within the tree trunk and cutting of the tree for each observation till the completion of life cycle is not feasible. Therefore a need was felt to develop a simple method of rearing *Aeolesthes holosericea* in laboratory conditions in order to identify susceptible stages to effective control methods.

KEY WORDS: *Aeolesthes holosericea*, longicorn, *Malus domestica*, biology, new, stem borer.

Aeolesthes holosericea (Fabr.) is recorded as a polyphagous pest infesting wide variety of forest plants and trees. Stebbing (1914) reported it from eight host plant species and Beeson (1941) reported thirty seven species as its host plants. Rahman and Khan (1942) described bionomics of this pest on cherry plant. Ambethgar (2003) studied the infestation and development of *Aeolesthes holosericea* on neem (*Azadirachta indica*) by inoculation of the grubs on its live stems in laboratory and Tara et al. (2008) reported it from apples in District Doda of J&K State. *Aeolesthes holosericea* Fabricius is one of the most destructive borers of apple plantations causing severe damage to the apple trees in Jammu, India. Realizing the importance of the problem, detailed study of biology of apple stem borer was taken into consideration.

MATERIALS AND METHODS

Collection of borer infested logs of apple trees were made from different localities of Jammu province to record the borer attack and damage. Infested and collected logs were caged in the laboratory as well as in the fields to record the emergence of adults and for recording other related observations about the pest life cycle. The emerging adults were released in pairs for mating and for recording

the fecundity and longevity of females in the laboratory. Eggs laid by each female was counted and kept for hatching in Petri plates. The grubs were reared on freshly cut twigs (billets) of apple trees by releasing them in artificially made slits on the bark and the later instars in artificially prepared galleries in the sapwood of apple trees. Grubs were transferred to fresh billets every month. Duration of each grub stage was calculated accordingly for each instar by changing the size of wood according to the size of growing instar stages. Similar method of studying biology of another allied species *Aeolesthes sarta* on poplar has been adopted by Ahmad et al. (1977). Morphometric measurements were recorded for all life stages of *Aeolesthes holosericea* using standard graphic paper method. Since the pest under study is a borer and though the author has tried to determine the number of larval instars by rearing the pest in artificially prepared galleries and channels in the sapwood of apple trees but despite rearing them under laboratory conditions, Dyar's law has also been applied to confirm the number of larval instars passed by *Aeolesthes holosericea* on apple plantations (*Malus domestica* Borkh.) in the area of investigator. Duration of different stages in the lifecycle was also calculated and analyzed statistically.

RESULTS AND DISCUSSION

BIOLOGICAL STUDIES:

Emergence of the pest: Adult beetles start emerging in the field through an oval emergence hole from the pupal chamber during April and continued to June in the area under investigation on apple plantations. Though earlier observations of Stebbing (1914), Rahman & Khan (1942) and Atwal & Dhaliwal (1999) reported the emergence of this beetle on *Shorea robusta*, apple and cherry from April to October, April to July, May to October and in their respective fields. However the emergence of *Aeolesthes holosericea* on *Hardwickia binata* and *Terminalia belerica* in Madhya Pradesh occurred during February- March (Khan, 1989).

Pairing: In *Aeolesthes holosericea*, males approached females directly, recognized them by visual clues. In laboratory during rearing, it was observed that there exists a competition among males for the possession of female. Males run swiftly, waving their antennae and fight among themselves. Females usually preferred large males to mate and their preference decreased from larger to smaller sized males. It is also seen that a single male mates with more than one female. In the longicorn under present investigation in Jammu region, male and female copulate and start egg laying after 3.20±0.20 (2-4 days) days after emergence. Copulation lasts for an average of 66.5±3.94 minutes which ranged from a minimum of 55.0 minutes to a maximum of 80.0 minutes. However, Stebbing (1914) recorded that the beetles copulate for one to two minutes.

Oviposition: Selection of oviposition site by female *Aeolesthes holosericea* is a tedious job as larval host selection by females of *Aeolesthes holosericea* is very critical, as the grubs are legless and incapable of locating the host trees, thus females located suitable oviposition site by olfaction. It selects crevices and injured areas on the bark and more often previously attacked parts of the stem for egg laying. Similar behaviour was also recorded by Rahman & Khan (1942) on cherry plants.

Females make minute incisions on the injured edges of the bark into which they push their eggs. Single female lays 62.50±4.16 eggs under laboratory conditions. Number of eggs ranged from a minimum of 45.0 to a maximum of

83.0. Eggs are laid singly or in pair of two to five under the cracks and crevices of the bark. Earlier observations on egg laying behaviour of female *Aeolesthes holosericea* given by Rahman and Khan (1942) reveals that the eggs are laid under the cracks or crevices in the bark in clusters of 4 to 8 on cherry plant which is contrary to females of same species that lay about 200-300 eggs on *Hardwikia binata* and *Terminalia belerica* in Madhya Pradesh as reported by Khan (1989).

Eggs are laid in a longitudinal pattern with the surface having petiole facing outwards. Eggs are oval, creamy yellow translucent, of paper like consistency and measures 2.21 ±0.12 mm (mean±SE) in length and 0.75-1.15 mm in width.

Incubation and Hatching: The incubation period of *Aeolesthes holosericea* Fabricius was observed to ranged between 09.0-12.0 days with an average of 10.55±0.44 days. Present observations are in accordance with those of Hanks (1999), who reported that eggs of most Lamiine species hatch in 10.9±1.3 days. Secretions of incubated grubs moisten the egg shell which helped in grub eclosion. Moisture played an important role in the hatching of grubs, as eggs removed from egg sites when placed in glass tubes shrinked and failed to hatch. The movement of the grubs resulting in the bursting of egg shell from the micropylar end and crawled out leaving the egg shell in the main stem without exposing themselves and made their way into the main stem through the pith of primary branches. The incubation period of *Aeolesthes holosericea* Fabricius, was observed to range between 7-12 days and 2-3 days by Rahman & Khan (1942) on cherry plants and Khan (1989) on *Hardwickia binata* and *Terminalia belerica* in Pakistan and Madhya Pradesh respectively.

Feeding and Tunneling behavior of grubs: Newly hatched grubs small, few mm in length, delicate and possesses needle like Mandibular region. Immediately after hatching the grubs start feeding on phloem and cambium while the later instars made their way into the heartwood through sap, excavating a zig-zag round feeding tunnel downwards. Grubs chew several sub tunnels from the main feeding tunnel to expel the excreta and to aerate it for physiological processes. These sub tunnels open to the exterior through a circular hole, often covered with extruded frass. Cell sap is always oozing out through circular holes. Grubs excavate large numbers of sub tunnels in the main stem as compared to thin branches of infested trees. Feeding tunnel is filled with large amount of fibrous matter/ chewed wood.

Larval instars and development: Determination of number of larval instars of *Aeolesthes holosericea* Fabricius on apple trees (*Malus domestica* Borkh) in Jammu Province was made difficult by the almost continuous range of head capsule width measurement ranging between 1.20-12.0 mm. On the basis of data recorded in the field and larvae reared in the laboratory, seven larval instars were identifiable on apple trees. Larvae of apple longicorn beetle while feeding on the apple tree in the area of present author took about 17.23±0.21 months and 13.66±3.31 days to develop from first instar to mature larva. This period included the overwintering period of 4-5 months. The developmental period of each larval instar was progressively longer than the preceding instar. Rahman & Khan (1942) observed the larval period of *Aeolesthes holosericea* ranged between 27 to 32 months at Lyallpur on cherry and apple plants whereas Singh et al. (1987) observed 9-10 months of larval period in *Aeolesthes holosericea* Fabricius on *Shorea robusta* respectively. In contrast, observations regarding larval duration

of *Aeolesthes holosericea* by Khan (1989) recorded an average larval duration of 27-32 days on teak and *Hardwikia binata*.

Pupal duration: Pupae of *Aeolesthes holosericea* take 1.50±0.22 (mean±SE) months and 11.16±3.36 (mean±SE) days respectively. The matured larvae widened the central feeding tunnel, prepared an elliptical chamber (Pupal cell) in the wood at a distance of about 12-16mm from the surface, measuring about 56.60±2.56 mm in length and 30.20±3.0 mm in width and block the larval gallery opening into the pupal cell with fibrous frass. Pupa is naked. Pupation takes place during September and October. The imago thus formed remains quiescent inside the same pupal chamber throughout winter. However the observations of Rahman & Khan (1942) revealed that pupation in *Aeolesthes holosericea* on cherry and apple in Pakistan takes place either in October- November or in March- April and the beetles that emerged from the puparia formed in October, remained with in the tunnels throughout the winter and in spring while those beetles that emerge from puparia in April, rest for only six weeks and duration of pupal period was observed as 3 to 150 days on apple and cherry in Pakistan, however on *Hardwikia binata* and *Terminalia belerica*, Khan (1989) reported pupal duration of 40-100 days in *Aeolesthes holosericea* in Madhya Pradesh and about 40 to 100 days on cherry (Atwal and Dhaliwal, 1999).

Winter rest: Larvae and immature adults have been observed to undergo rest during winter months from November to March on apple plantations as a host in the area of the author. While the first year larvae undergo rest for overwintering only whereas in the second year, the imago thus formed remains quiescent inside the same pupal chamber throughout winter to avoid harsh weather conditions which prevailed in the study region. For the purpose it uses an elliptical chamber prepare by the larva itself in the core of wood by enlarging the depth of its gallery. Mouth of the chamber is plugged with coarse wood fibres. Average winter rest duration in *Aeolesthes holosericea* in present study area is 4.45±0.16 months and 10.55±0.44 days . Similar winter rest observations with some variations in case of *Batocera rufomaculata* (another cerambycid beetle) has been recorded earlier by Beeson & Bhatia (1939), Hussain & Khan (1940) and Palaniswamy et al. (1979). Adults start emerging from the trees after mid March.

The resting period of the imago of the pest under consideration as observed in the field may coincide with the emergence of adults with favourable field conditions prevailed in the area of author whereas during November, December, January and February (winter months), apple plantations remains without foliage and the temperature of the area even falls down below O°C because of heavy snowfall. This observation of the author has been substantiated by the earlier recorded findings of Rahman & Khan (1942) for *Aeolesthes holosericea* on cherry in Pakistan. These authors further found that if the larvae of this beetle attained its full maturity by October they underwent rest for 3 to 25 days only but if they obtain maturity during November, the larvae underwent a hibernation period of 4½ to 5 months before pupating (i.e. it would pupate in March- April of the subsequent year). Similar resting period in *Aeolesthes sarta* has been recorded by Ahmad et al. (1977) in Pakistan on Poplar and for *Carilia virginea* (another cerambycid) by Starzyk (1977) in Poland.

Adult emergence: The total life cycle of the borer, till emergence of adults, gets completed in approximately two years (25.16±1.83 months) in Jammu and

Kashmir. Longevity of adult male and female longicorn is recorded as 32.8±2.65 days and 15.8±1.6 days respectively.

Adult: Beetle large, stout and elongate measuring 38.0 to 45.0 mm with an average of 39.20± 1.87 (mean±SE) mm in length and 10.0 to 13.0 mm with an average of 10.65± 0.71 (mean±SE) mm in width; mostly dark brown or reddish brown densely covered with a golden brown pubescence when the elytra of the beetle are presented in different positions to the light, it gives them the appearance of being coated in the silk.

Sexual dimorphism distinct as males are smaller in size than females and possesses very long antennae, much longer than the general body length whereas the antennae of females are shorter. Similar observations regarding sexual dimorphism in *Aeolesthes holosericea* have been reported by Khan (1989) on *Hardwikia binata* and *Terminalia belerica* in Madhya Pradesh.

Contrary to this, Rahman & Khan (1942) have quoted that males are smaller in size with small antennae as compared to females that are larger in size and possess big antennae. However author's observations are in support of those on the sexual dimorphism in *Aeolesthes sarta*, another longicorn on poplar given by Ahmad et al. (1977), who also recorded that males are smaller and possessed much larger antennae than females that have smaller antennae.

Damage: Present investigator during her studies on apple plantations in Jammu region of J&K State found that *Aeolesthes holosericea* is a destructive pest of apple trees. Frass coming out of the live holes on the trunk and branches is the main symptom of attack. The nature and extent of damage caused by grubs and adults to host plants is entirely different from each other. Grubs, being wood borers excavated tunnels in the wood and lead the infested plants to die; however adult beetles debark the tender twigs of plant only. Adults are nocturnal and do not cause much damage to the apple plantations. They just feed upon the bark of the trees. The most serious and harmful stage of *Aeolesthes holosericea* is the grub or the larval stage that causes irreparable damage to apple plantation in the area of the investigator . Larvae make longitudinal or transverse galleries. The pest can be located easily from the frass that comes out of the holes in the branches or in the main trunk. Rahman and Khan (1942) have also recorded similar type of mode of damage caused by *Aeolesthes holosericea*. They reported that larvae make galleries inside the tree and feed on sapwood. The op. cited authors even observed that a single larva could kill the young apple tree. Stebbing (1914) also recorded that as soon as the mandibles of the larva become stronger, they eat out the sapwood and make large, broad and flat, irregularly shaped longitudinal or transverse galleries.

Galleries made by the pest under study are about 12 inches or more in length, 3 inches in width and about an inch deep. Present author further recorded that the grub makes two to four openings or aeration holes on the main trunkor branches. When the larva is about half grown, it leaves outer sapwood and bores down into heartwood, from where it enters into older heartwood and carves out a chamber, more or less parallel to the long axis of the tree, which is wider than the tunnel leading to it. This chamber is wider and forms the pupal chamber. Infestation caused by this pest in apple growing areas of Jammu and Kashmir has been found to be high at some places **.** The author during her studies has recorded 65 to 70 larvae in a single robust branch of an apple tree.

As a result of larval feeding and the consequential damage to the woody tissue, vitality of the apple trees thus reduces greatly. During severe infestation, parts of

the attacked apple tree start drying and ultimately become unproductive which at last lead to the death of the tree. The continuous flow of cell sap through the bores made by grubs deprived the plants from minerals/ nutrients and water; altered host plant physiology and finally affect growth and yield of apple plants in the area of the author. Current observation reveals that the damaged apple trees are vulnerable to attack by other insects and infestation of the borer spreads to adjoining trees also. The intensity of damage caused by an insect species in general varies among different host plant species (Solomon, 1974; Yang et al., 1995) and the damage inflicted by cerambycid borers to host plants is well documented by some earlier workers viz. Linsley (1959, 1961), Donley (1978), Donley & Terry (1977), Sharma & Tara (1984), Goodwin & Petit (1994) and Goodwin (2005a,b).

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Table 1. Duration of different stages in the life cycle of *Aeolesthes holosericea* Fabricius on apple plantations in Jammu province.

STAGE	DURATION	
	MONTHS	DAYS
Incubation period		10.55±0.44
Larval period	17.33±0.21	13.66±3.31
Pupal period	1.50±0.22	11.16±3.36
Winter rest	4.45±0.16	5.56±0.29
Total life cycle	25.16±1.83	
Adult longevity (Male)		32.8±2.65
Adult longevity (Female)		15.8±1.6

Table 2. Morhometric measurements of different stages of *Aeolesthes holosericea* Fabricius.

STAGE	BODY LENGTH (Mean±SE)	BODY WIDTH (Mean±SE)	
		Anterior width	Middle Width
Egg	2.21 ±0.12	0.95±0.05	
First instar	4.70±0.47	1.10±0.06	0.58±0.08
Second instar	13.42±0.52	5.42±0.61	3.85±0.34
Third instar	22.33±0.76	8.0±0.36	6.0±0.36
Fourth instar	28.28±0.28	9.0±0.57	7.0±0.48
Fifth instar	34.25±0.81	11.87±0.95	8.37±0.46
Sixth instar	43.50±2.67	12.50±1.43	9.10±0.96
Final instar	59.73±1.42	13.12±0.44	9.5±0.56
Pupa	40.81 ± 1.54	14.75±0.95	-
Adult male	33.0± 1.34	9.2 ±0.40	-
Adult female	39.20± 1.59	10.25±0.33	-

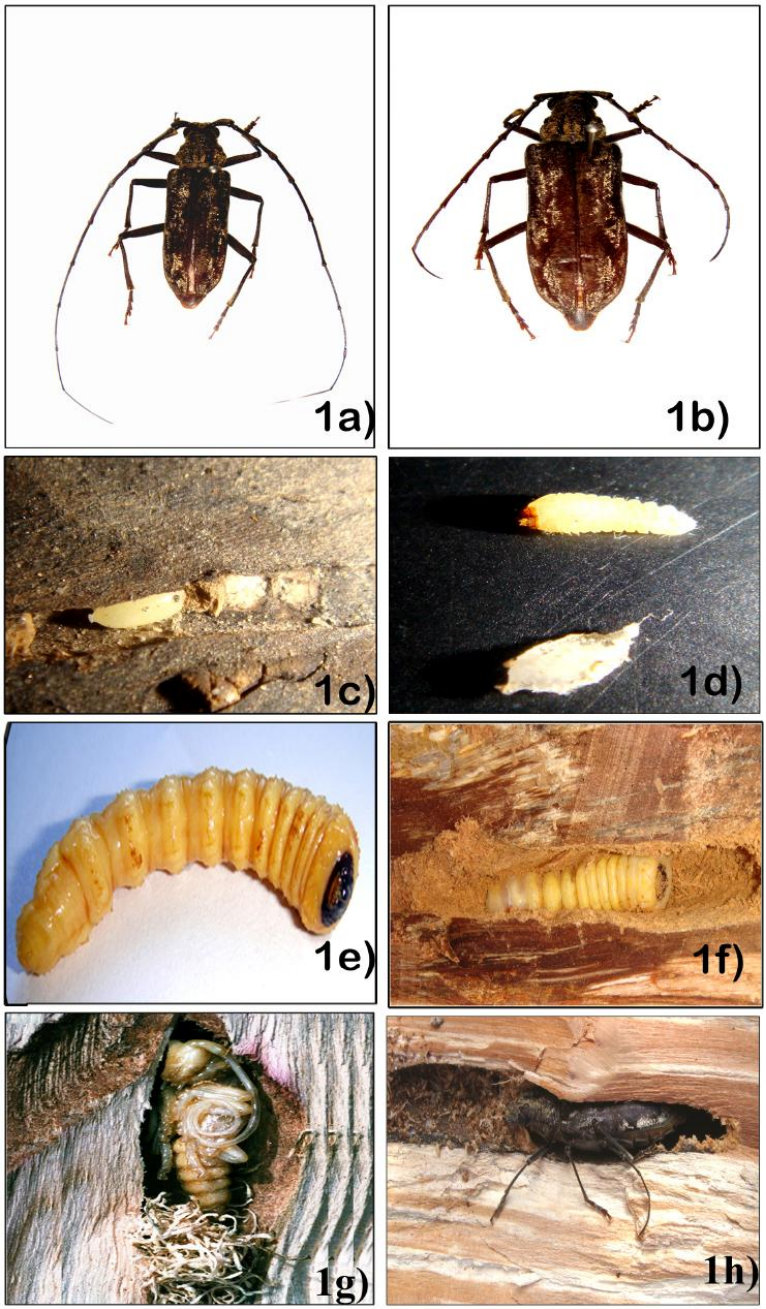

Figure 1. a) Adult male, b) Adult female, c) Freshly laid egg, d) First instar larva, e) Mature larva, f) Prepupa, g) Pupa, h) Imago.