

RESEARCH ARTICLE

Entomological Investigation on *Aeolesthes sarta* (Solsky), A Major Pest on Walnut trees (*Juglans Regia* L.) in Kashmir Valley

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Abstract

Aeolesthes sarta (Solsky) (Coleoptera: Cerambycidae) is considered to be the most serious destructive Polyphagus pest infesting wide variety of forest plants and trees in different parts of the world. The present study was undertaken from 2009-2012 to study the biology of *Aeolesthes sarta* on walnut trees (*Juglans regia*) in 10 districts of Kashmir valley. In the present investigation, the pest was found to cause extensive damage to the stem and shoots of walnut trees in various areas and localities of Kashmir valley. During the present investigation, a detailed study of biology of this borer pest was carried out. The insect pest causes enormous damage to healthy young as well as old walnut trees. The district wise severity of damage by *A. sarta* on Walnut trees (*Juglans regia*) was observed to be Anantnag-31%, Budgam-40%, Kulgam-30.5%, Shopian-35.5%, Baramullah-33.3%, Pulwama-32.3%, Kupwara-38%, Bandipora-32.5%, Srinagar-30% and Ganderbal-32.6%.

Keywords: *Aeolesthes sarta*, *Juglans regia*, Kashmir valley, biology, borer pest, old walnut trees.

Introduction

Nature has endowed the Jammu and Kashmir with great diversity of fruit crops. Among the vast array of these fruits, the state is having monopoly in the production of quality walnut (*Juglans regia*) besides other fruit crops. Walnut cultivation is directly connected to economic prosperity of the people living in remote and far flung areas. Kashmir Walnut is used as cash crop as it fetches good amount of money to growers. Walnut Kernels are used as eatables as a supplement to diet. Walnut rind (skin) after separation from walnut seed is dried in open sun and is used as fuel. Manual breaking and kernel separation in large number of walnut processing units in Kashmir valley provides employment to women folk as well. Walnut wood is considered as a very high quality wood and is used for making costly furniture items, decorative items, rifle butts etc. The insect pests prevailing on it and their nature and extent of damage in Kashmir have not been fully explored so far and losses in yields due to their damage have remained unnoticed in the state. Therefore, based on the surveys carried out, entomological investigations assume a special significance, as very little is known not only on diversity of pests but also on nature of their biology, this study provides the biology of *Aeolesthes sarta* on walnut trees (*Juglans regia*) in 10 districts of Kashmir valley.

Materials and methods

Collection of pests: Collection of the insect pests in the adult stage was done in the field from the infested walnut trees and rearing was done in the laboratory.

The field studies were conducted during the year 2009-12 in 10 districts of Kashmir valley i.e., Budgam, Kupwara, Anantnag, Baramula, Shopian, Bandipora, Ganderbal, Kulgam, Pulwama and Srinagar.

Rearing of pests: Pest rearing was done inside rearing cages made up of mesh wire with the dimensions of 2 ft, 1½ ft and 1 ft length, breadth and height respectively. The adults collected from the trees were allowed to copulate inside the rearing cage. The larvae of the insect pest emerged were fed on the shoots and stem parts of the trees.

Experimental observations: All the observations of life history stages were recorded. The specimens were preserved later on by following the standard methods.

Results and discussion

Morphological studies: Adult and larval morphology of *Aeolesthes sarta* is given in Table 1 and 2. Morphological characteristics of pupa and pupal chamber of insect pest *Aeolesthes sarta* is given in Table 3.

Winter rest: Larvae of *Aeolesthes sarta* have been observed to undergo a period of rest during the winter months starting from September in Kashmir valley orchards up to March of following year. By this time the larvae of *Aeolesthes sarta* having already exhausted the stem internally, descend down into the roots and remain quiescent throughout the winter period during the winter quiescent period, the larva stops feeding in most cases.

Table 1. Morphological characteristics of adult insect pest *Aeolesthes sarta*.

Characteristics	Male	Female
Size	4.2 cm long and 1.2 cm breadth	4.5 cm length and 1.4 cm breadth
Colour	Dark grey Brown	Dark grey Brown
Shape	Moderately large, stout and elongated.	Moderately large, stout and elongated.
Antennae	Having pair of antennae larger in size to its body size	Having pair of antennae smaller to its body size
Mouth	prominent	Prominent
Mandibles	Brown, strong and powerful	Brown, strong and powerful
Eyes	Prominent, black and kidney shaped	Prominent, black and kidney shaped
Thorax	Pronotum darker in color and well developed	Pronotum darker in color and well developed
Prothorax	Distinct	Distinct
Mesothorax and metathorax	invisible	Invisible
Legs	Long, stout, equal in size and shape and powerful	Long, stout, equal in size and shape and powerful
Abdomen	Five visible segments, 1 st segment large, its middle portion protruding between hind pair of legs, second, third and fourth segment equal to one another but each smaller than first. Last segment triangular and tapering.	Five visible segments, 1 st segment large, its middle portion protruding between hind pair of legs, second, third and fourth segment equal to one another but each smaller than first. Last segment triangular and tapering.

Table 2. Morphological characteristics of larval stages of insect pest *Aeolesthes sarta*.

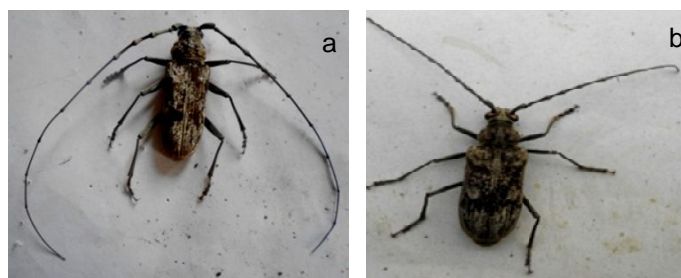
1 st Instar	
Size	5½ mm in length and 2 mm in breadth
Color	white creamy yellow
Duration	4 months (aprox.)
2 nd Instar	
Size	3.1-6 cms and breadth is 1-1.2 cms.
Color	creamy white
Duration	8 months (aprox.)
3 rd Instar	
Size	9-11 cm in length and 1-1.5 cm in breadth
Color	pale yellow color
Duration	4 months (aprox.)

However, the meager feeding has been observed in some cases which are indicated by the accumulation of small quantity of frass at the base of the plant harboring the resting larva. Over wintering has also been reported by Beeson and Bhatia (1939), Hussain and Khan (1940) and Ahmad *et al.* (1977) in various cerambycids. The overwintering period of IInd stage larva of *Aeolesthes sarta* varies from 7-8 months from September of the current year to April of the following year.

Emergence of adult: The emergence of adult insect pest begins during second week of April and is continued till last week month May. The emergence of the adult beetles is synchronized with increase in temperature and humidity and thus, emergence period varies from year to year as it is related to environmental factors. However, marked difference in the emergence patterns of some of these beetles have been reported from ecologically different places.

Batocera rufomaculata, a very important *Polyphagous cerambycide* shows marked difference in the emergence patterns in north and southern parts of India. In south India, it is observed to emerge twice in a year first during month of May and second during month of October. In northern India, emergence in the same beetle is however, continued between March-August has been recorded by Beeson and Bhatia (1939). Similar observations regarding *Cerambyx dux*, another long horn beetle is also on record. Jolles (1932) reported that this beetle has been recorded to emerge late in Malta by Saliba (1977). The emergence of adults of *Aeolesthes sarta* takes place latter by 15-20 d in the study area under investigation due to earlier increase in temperature and humidity in rest of country than study area (Kashmir valley) as emergence period of *Aeolesthes sarta* was observed in the month of May, outside of Jammu and Kashmir state, in India by Stebbing (1914) (Plate 1).

Plate 1. a. Male and b. female of *Aeolesthes sarta*.



Pairing and copulatory behavior of *Aeolesthes sarta*: After emergence, routine encounters between male and female partners causes sexual alertness in male member results in it's mounting on female (Plate 2).

Plate 2. Antennae in males directed upwards during copulation.



It mounts the female from behind by moving directly forward on to its dorsum, the female beetle soon adopts the resting position, its prothoracic legs being extended laterally forward while meso and metathoracic legs are stretched away from the body during the act, the front and middle legs of male encircle around the pro and mesothorax of the female and the posterior legs are directed behind to hold the abdomen while the tarsi rest on the host plant surface for balancing just prior to copulation, male beetle slightly bends the tip of its abdomen for insertion of aedeagus while joined the male continues tapping the female Pronotum and scutellum. The male antennae were observed directed slightly backward but in upright position whereas, the female antennae were observed directed slightly away from the body in antero-posterior direction. The copulation that lasts for about 10-30 min was observed during night hours from dusk to dawn. The beetles after emergence have their reproductive organs not fully developed and for this reason they soon begin a maturation feeding on the bark and young shoots of the host plant. This observation that there is a period of feeding between emergence and first mating confirms the earlier report of Beeson and Bhatia (1939) in other cerambycids. The time interval between emergence and copulation in case of *Aeolesthes sarta* is 8 h-2d. The maturation feeding before copulation was observed on Bark of *Juglans regia*. Time duration of copulation was observed 5-25 min (Ahmed *et al.*, 1977). Copulatory behavior of *Aeolesthes sarta* has been observed by Ahmad *et al.* (1977) in Pakistan which reveals that this act continues 5-25 min and these beetles are monogamous i.e. one male fertilizes one female (Plate 2).

Egg laying: The insect pest was observed laying eggs in groups comprising of number varies from 1-4. The eggs were observed being laid near or in the already present crevices of walnut bark. The pest needs no need of new crevice formation as walnut bark surface is rough. However, the report of Ahmad *et al.* (1977) record that *Aeolesthes sarta* lays eggs in cluster of 4-13 eggs was not confirmed under present study by the author (Plate 3).

Plate 3. Egg laying.



Incubation period: The eggs hatched within 10-15 d after being laid by the insect pest in and adjacent of the crevices. The color of eggs changed from creamy white to pale white with the passage of time. The size of the egg observed was 2-3 mm in length and 0.1-0.2 mm in breadth at 20-25°C and relative humidity about 62% min and 96% max. Thus, the incubation period 12-13 d under temperature below 35°C reported in *Aeolesthes sarta* by Ahmad *et al.* (1977) was not confirmed by the present author under investigation.

Hatching: The first instar larva emerges from the egg case by gnawing away an irregular hole with the help of its mandibles and wriggles out by enlarging the slit through the peristaltic movements. Emergence leads in an irregular split at least half way down the egg capsule length. The newly hatched larva soon starts excavating the stem without exposing itself.

Post hatching and feeding behavior of larva: The newly hatched grub is about less than 1 cm. The head is slightly brownish while rest of the body is creamy white in color just after hatching, it starts feeding on the pith around the oviposition cavity for few days, converting into fine powdery frass. Till this stage, the larva can easily be exposed when the bark was lifted. During latter stage, it starts feeding along the transverse plane, moving deeper into central region of the stem. The larva excavates deeply in the sap wood it cuts more fibers, than it can actually consume and these fibers in the form of wet frass is periodically thrown out through the circular frass ejection holes made through the bark by the larva at intervals of some inches during the construction of some gallery construction within the stem. These frass ejection holes in the early stages of larval growth are close to each other but latter when larva matures and grows in size, larger ejection holes are formed which are widely apart on the stem. Through these holes not the frass exudes out, but even the sap of the host tree also oozes out and flows down along the stem. These symptoms are clear indication that larva is boring inside the stem. The frass varies in color between reddish brown to yellowish brown.

Besides, being used for frass ejection, holes also aerate the internal galleries chewed by the grubs. As the larva descends downwards, the tunnel is blocked by the excreta mixed with large amount of fibrous matter, which has not passed through the alimentary canal of the grub. In many cases, the frass is so tightly packed that in several instances it could be broken off in large lumps.

Larval food: Bulk of the diet of larva of *Aeolesthes sarta* and also of other cerambycids is cellulose. How the cellulose is utilized and which are the enzymes associated with this purpose, the present author has not carried on any work on this. However, the work by Ripper (1930) and Saliba (1977) suggests that cerambycide larvae and other wood eating insects digest cellulose either by specific cellulose digesting enzyme or through the help of certain symbionts residing in the digestive tracts. Saliba (1977), Chararas and Chipoulet (1983), Kukor *et al.* (1986) showed that cellulose is manufactured in the intestinal epithelium of larger cerambycids. Ripper (1930) demonstrated the presence of cellulose in *cerambyrx cardo*. It is, however assumed that some specific cellulose enzymes are present in *Aeolesthes sarta*.

Duration of larval stage: The larval period of *Aeolesthes sarta* which it passes inside the walnut trees (*Juglans regia*) has been observed to be between 15-16 months including the long winter resting period in present study area. Review of existing literature reveals that a lot of variations exist in the longevity of larval life of not only *A. sarta* but also of other cerambycids in general. Ahmad *et al.* (1977) observed in Pakistan about the larval life of *A. sarta* lasting about 10 months whereas Farashiani *et al.* (1987) in Iran observed the larval life of *A. sarta* lasting about 22 months. Similarly, Jolles (1932) observed that the larval period of *cerambyx dux* in Israel was around 15-16 months, whereas the larval period of same species in Malta Islands ranged between 26-28 months (Saliba, 1972).

The forgoing discussion and observations of the author suggest that the larval life of *Aeolesthes sarta* and other cerambycids is not only very long but also highly variable, ranging from few months to years. The author concludes that the life cycle of this long horn is dependent on two factors firstly it is the food which is responsible for the difference in the total duration. Here, apparently it is the varied nutritional value of the food which is responsible for variation in larval span. The second feature which effects the duration of life cycle is the temperature. During winter, the larva undergoes a period of inactivity during the life cycle. They have minimum or no feeding during these periods of inactivity in the larval life add to its longevity. The life cycle of *A. sarta* takes two years (Ahmad *et al.*, 1977; Maslov, 1988; Orlinskii *et al.*, 1991; Vorontso, 1995).

Plate 4. Larval stages (1st, 2nd and 3rd).



Number of larval instars: To study the number of larval instars directly of infested *Juglans regia* trees is impossible because of their big size and toughness of wood. To ascertain the number of larval instars, the author cut the small blocks of various sizes of the branches of walnut tree and put the male and female pair of *Aeolesthes sarta* in separate rearing cages along with the blocks of walnut. The author has ascertained the three larval stages of the pest concerned from the blocks of walnut (Plate 4).

Pupation: Depending upon environmental conditions, during the month of August 2011, the larvae of *A. sarta* have undergone the pupation (Plate 5). The last stage larva clears portion of larval gallery of frass just below the soil surface, thus forming the pupal chamber (Plate 6). The upper end of this pupal chamber is plugged by fine compacted frass and the other end which is towards the root system by coarse wood fibers. The chamber is internally covered by intercalated fibers and the indented surface is loaded with fine powder from the stem tissue. When the larva is fully mature and the pupal chamber is ready, the larva changes into prepupa. Its activities get slackened, become shorter and thicker and stops feeding. The color changes to somewhat pale yellow and becomes dull in texture.

Plate 5. Pupa.



Plate 6. Pupa in pupal chamber.



Table 3. Morphological characteristics of pupa and pupal chamber of insect pest *Aeolesthes sarta*.

Pupa	
Size	30-40 mm in length and 11-15 mm in breadth.
Color	creamish yellow
Shape	Stout and elongated
Antennae	very long , pass over thorax making a spiral coil over respective meso thorax legs
Pronotum	Distinct with prominent downwardly curved spine on either side
Prothorax and mesothorax legs	Folded over wing pads ventrally
Spiracle	Spiracle oblong, visible only in 1 st five abdominal segments. Abdominal segment devoid of ventral setae except for last setae.
Setae	1 st and 2 nd abdominal segments profusely beset with reddish setae dorsally. Setae gradually decrease in subsequent segments.
Duration	10-20 d
Pupation	August (2011)
Pupal chamber	
Size	6-7 cm and dia ranging from 1.8-2 cm
Duration of pupa in pupal chamber	7-8 months, September 2011 to April 2012
Emergence of adult	2 nd week of April to last week of May.

Table 4. Total duration of life cycle of insect pest *Aeolesthes sarta* on *Juglans regia* in study area.

Month	From	To	Duration
Incubation period	20 th April	30 th April	10 d
Larvae			
1 st Instar	April 2010	August 2010	4 months (aprox.)
2 nd Instar	September 2010	April 2011	8 months (aprox.)
3 rd Instar	Ending April 2011	August 2011	4 months (aprox.)
Pupation to emergence	August 2011	April 2012	8 months (aprox.)
Total duration			24 months and 10 d (aprox.)

The pre pupa appears to be motion less except for showing some abdominal movements. The pupae appeared at the end of the prepupal stage. The larva always pupated with head upwards within the chamber and the body is placed lateral in position from where the adults subsequently gnaws its way out. The pupa is naked with antennae arranged in almost complete single coil and is of white color. It is extremely sensitive to disturbance in its early stages and does not survive if removed from its cell. The pupal period varies from 10-20 d depending upon the prevailing environmental conditions (Table 3). The adults emerge out from the respective pupal chambers when temperature start rising above 20°C in the month of March-April in next season. The newly formed adults of *A. sarta* remained in their pupal chambers (7-8 months) from September of current year (2011) to March-April of the following year (2012). The actual adult emergence took place in the month of April (2012) (Table 4).

Conclusion

Aeolesthes sarta (Solsky) is one of the most serious destructive pests infesting *Juglans regia*. The walnut trees are important by virtue of their economical, nutritional, medicinal values. Therefore, the preliminary biological studies on the *A. sarta* assume a special significance. To prevent further species distribution of *A. sarta*, the movement of pest must be restricted.

At present there is no official confirmation of such a pest distribution in the region. There is a need to carry out the studies at molecular levels also. The control of *Aeolesthes sarta* (Solsky) should be holistic, utilizing biological control practices. The ongoing threat of the further spread of *Aeolesthes sarta* (Solsky) requires a region wide campaign.

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