



## BIONOMICS OF THE MOST ABUNDANT VIRGINOPARAE MORPH OF WOOLY APPLE APHIDS ON APPLE PLANTATIONS IN JAMMU PROVINCE OF J&K STATE

<sup>a</sup>Ruchie Gupta, <sup>b</sup>Tara, J.S. & <sup>b</sup>Sharma, R.K.

<sup>a</sup>Department of zoology, University of Jammu, Jammu Tawi-180006

<sup>b</sup>Temperate Sericulture Reseach Institute, Mirgund SKUAST-K

### ABSTRACT

Virginoparae morph is the most predominating morph of *Eriosoma lanigerum* Hausmann, wooly apple aphid that causes considerable loss to apple crop throughout the world. In the present study, life history of virginoparae morph of wooly apple aphid was studied during March to December months on apple host and the data on total life period (pre reproductive, reproductive and post reproductive periods) was recorded. Total progeny produced and total nymphal period was also calculated. The detailed biology of the pest has been recorded for the first time in Jammu province of J&K state on apple plants.

**KEY WORDS:** Bionomics, abundant, virginoparae, wooly apple aphid, Jammu

### INTRODUCTION

*Eriosoma lanigerum* Hausmann, commonly known as wooly apple aphid is one of the most destructive pest of apple plantations in the world. It is basically a native of America (Baker, 1915) but is now cosmopolitan in distribution except for the hotter parts of the tropics. The word “woolly” has its justification in a kind of white powdery secretion secreted by numerous glands on the body of aphid which gives it a general appearance of cotton wool covering often large colonies of these aphids. *Eriosoma lanigerum* is particularly a very serious pest in practically all the temperate regions and pockets of the world where temperate fruits are grown, causing reduced tree growth and contamination of fruit. Insect infests both root and shoot of the tree while first instar nymph can enter through the calyx and establish colonies inside the fruit (Essig, 1942). Earlier observations of the authors revealed that wooly apple aphid *Eriosoma lanigerum* Hausmann requires two alternate hosts i.e. primary and secondary hosts in some areas of the world like Europe, Canada, Japan and China where the pest reproduces by cyclic parthenogenesis on elm tree (*Ulmus campestris*) as its primary host and on apple, pear and some other trees as its secondary hosts (Bhardwaj and Bhardwaj (2005), Adlakha and Hameed (1972), Gautam and Verma (1983). In India because of the absence of primary host (*Ulmus campestris*), the pest has adapted itself to pass its entire life cycles only on its major host plant i.e. *Malus* sp. (Rahman and Khan, 1941; Lal and Singh, 1947; Singh, 1964; Thakur, 1970; Gautam and Verma, 1983; Bhardwaj, 1988; Gupta (2007). Various attempts had already been made by earlier workers to explain the characteristic features of this noxious pest from different parts of the world. In this

regard the present author also made efforts to record comprehensive details with respect to its diagnostic features, life cycle and other associated studies.

### MATERIALS & METHODS

Wooly apple aphid (*Eriosoma lanigerum* Hausmann) is an economically important and widely distributed pests of apple plantations in various districts (District Doda, Kishtwar, Poonch, Rajouri) of Jammu province. During present study, a stock culture of wooly apple aphids was maintained on apple nursery plants grown in the fields. Colonies were established on excised twigs under laboratory conditions from adult apterous virginoparae collected from the field. From the laboratory colonies, individual *Eriosoma lanigerum* were taken to be reared individually. This was done by placing a single apterous parthenogenetic adult on a damaged portion of an excised delicious apple twig confined within a sleeve cage (Asante et al. 1991). The twigs with caged aphids were kept in plastic vials half filled with water and placed in a jar. Each caged aphid was examined every 24 hours and the adult female and excess nymphs removed, leaving a single nymph on each twig. The development of each nymph was then studied daily under a microscope and exuviae were removed after each moult and aphids were also preserved in 80% alcohol for further morphometric studies. Morphological characters were measured using an ocular micrometer attached to a binocular microscope. Measurements include body length, body width, antennal length, and distance between cornicles in wooly apple aphids.

## RESULTS & DISCUSSION

Adult aphids are brown or greyish purple, medium sized, and 1.5 to 3.0mm. in length, live in colonies of various sizes and are covered by a white flocculent, waxy secretion given off as wooly mass of fine filaments through the pores of their skin, which makes them conspicuous from short distances; tarsi 2-segmented with two claws, antennae long, filiform, 6-segmented, mouthparts well developed, beak arising between front coxae, 4-winged, wings membranous, hind wings much smaller than front wings, M (Median vein) in front wing branched; cornicles indistinct, thoracic tubercles distinct, about 4-6, similar. Smaller lateral abdominal tubercles on either side, M in front wing not branched; sexual forms with mouthparts atrophied, not functional; wax glands abundant.

### Life cycle and associated biological studies

Biology of wooly apple aphid, *Eriosoma lanigerum* Hausmann has been studied extensively earlier by many workers in various parts of the world which includes Asante *et al.* (1991), Baker (1915), Monzen (1926), Mordvilko (1923), Nevaski (1925) and Theobald (1921). In India biology and other related studies has been reported by Thakur (1970), Gautam and Verma (1982, 1983a, 1983), Bhardwaj (1988), Lal and Singh (1947), Rahman and Khan (1941) and Fotedar and Kapur (1943). Despite, considerable work being undertaken on this abnoxious pest in India and in other parts of the world by large number of workers there are contradictory reports in the literature about the mode of reproduction of this pest *Eriosoma lanigerum* Hausmann (Rahman and Khan, 1941 and Fotedar and Kapur, 1943). In North America, cyclic parthenogenesis was the common mode of reproduction of this pest on elm tree (*Ulmus campestris*) which serves as a primary host and on apple or other related plants as secondary hosts (Baker, 1915). Many workers like Gautam and Verma (1981), Lal and Singh (1947), Rahman and Khan (1941) and Thakur and Dogra (1980) however has observed that in this subcontinent, because of unavailability of the primary host, elm tree (*Ulmus campestris*), the pest has adapted itself on apple or other host plants. During present investigations also, wooly apple aphid (*Eriosoma lanigerum*) has been observed to complete all stages of its life cycle on apple trees only in the study areas which authenticate the observations made by various earlier workers in India. The aphid is polymorphic having three distinct morphs, namely virginoparae, sexuparae and sexuals in its life cycle (Gautam and Verma (1981), Bhardwaj and Bhardwaj (2005). In the present investigations, the life history of virginoparae morph of wooly apple aphid consists of three phases namely pre-reproductive, reproductive and post-reproductive periods. The life history of virginoparae morph of wooly apple aphid was studied during March to December months on apple host and the data on total life period (pre reproductive, reproductive and post reproductive periods) was recorded. Total progeny produced and total nymphal period was also calculated.

### Virginoparae

Virginoparae morph of wooly apple aphid, *Eriosoma lanigerum* is most predominating and present throughout the year in the study area of the investigator except harsh winter months when the temperature is very low and trees are without foliage. During early summer, aphids become active. New nymphs soon settle in batches and start sucking the sap from fresh twigs and within 24 hours starts secreting wool on their bodies. The colonies are first seen on the leaf axils which eventually spread along the young shoots to other parts of the plant. During summer months, maximum infestation of this wooly apple aphid (*Eriosoma lanigerum*) was seen to exist on aerial parts of the apple plants. Similar observations were also given earlier by Gautam and Verma (1981) in Himachal Pradesh on apple plantations.

The life history of virginoparae morph of wooly apple aphid consists of three phases namely pre-reproductive, reproductive and post-reproductive periods.

### Pre-reproductive period

All the apterous virginoparae of wooly apple aphid undergoes four moults resulting five instars. During summers, moulting occurs at an interval of one to three days. Baker (1915) reported that in North America the wooly apple aphid also undergoes four moults and the time interval between the two moults depends upon the environmental conditions such as temperature and humidity. Gautam and Verma (1981) had earlier described that the moulting of virginoparae morph occurs at an interval of 2 to 4 days.

The newly born nymph is pale reddish, lacking waxy covering on its body. Nymph becomes very active and runs around in search of a suitable place to establish on the plant. This stage lasts for  $4.0 \pm 0.21$  days ranging from 3.0-5.0 days. Similarly 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> instar nymphs lasts for an average of  $5.20 \pm 0.22$ ,  $2.55 \pm 0.13$  and  $3.50 \pm 0.15$  days respectively. The embryos get fully developed in the 4<sup>th</sup> instar and the final moult give rise to adult individual. Gautam and Verma (1983) studied the average duration of all the instars during winter and summer months and reported that the instar stages took comparatively more time during winter months. Total pre-reproductive period ranged from 13.0-19.5 days with an average of  $16.50 \pm 0.86$  days.

### Reproductive period

The reproductive period of virginoparae morph in the area of the investigator on apple plantation varies for about 10 to 20 days with an average of  $14.75 \pm 1.08$  days as seen by the present author whereas Gautam and Verma (1983) had observed that reproductive period varied between 9 to 25 days. Reports regarding the number of nymphs produced by the females are also on record. Op. cited author observed the number of nymphs produced by a single female varies between 24 to 95 whereas Bhardwaj and Bhardwaj (2005) had reported the same as about 125 nymphs and Butani and Jotwani (1975) has mentioned as 116 nymphs in Himachal Pradesh. However the present author during her studies has seen that a female can produce an average of  $52.60 \pm 6.51$

nymphs in its life time that ranged from a minimum of 31.0 to a max. of 105 nymphs per day.

**TABLE 1:** Duration of different instars of virginoparae morph of woolly apple aphid and total life cycle duration of the virginoparae morph

Nymphal period (in days)	Range		Mean	SEM
	Min.	Max.		
1 <sup>st</sup> Instar	3.0	5.0	4.0	0.21
2 <sup>nd</sup> Instar	4.0	6.0	5.20	0.22
3 <sup>rd</sup> Instar	2.0	3.0	2.55	0.13
4 <sup>th</sup> Instar	3.0	4.0	3.50	0.15
Period between last moult and beginning of the reproductive period	1.0	1.5	1.25	0.15
Total pre-reproductive period (in days)	13.0	19.5	16.50	0.86
Reproductive period (in days)	10.0	20.0	14.75	1.08
Post-reproductive period (in days)	2.0	4.0	3.20	0.24
Total life period	25.0	43.0	32.12	1.91
Total progeny produced	31.0	105	52.60	6.51

The present investigator has however, found that all life cycle stages of this apterous virginoparae of *Eriosoma lanigerum* are seen on the apple trees throughout the summer. Some similar observations have also been made earlier by Asante (1999) and Gautam and Verma (1983).

#### Post reproductive period

The post reproductive period of virginoparae is  $3.20 \pm 0.24$  days as recorded by the present author in the study area. The investigator observed that the total life cycle duration of virginoparae morph stage takes 25 to 43 days averaging  $32.12 \pm 1.91$  days. But with regard to total life cycle duration certain variations by earlier workers has already been recorded such as Bhardwaj and Bhardwaj (2005) had reported that virginoparae morph completes its life cycle within 24 to 37 days. Asante *et al.* (1999) had mentioned 16.8 days required for completion of this morph. Gautam and Verma (1983) recorded 29.83 days of total life period of virginoparae morph. These variations observed in the life cycle of virginoparae morph by various authors may be because of varied climatic conditions in the area of the morph which certainly affects the life cycle of the insects. Gautam and Verma (1983) had described that the total progeny produced by virginoparae morph in the whole life period was higher in summer as compared to winter. This may be because of the effect of temperature and nutrition as during winter the apple plants remains mostly in dormant stage. Efficient sap flow during summers possibly results in high fecundity rate of this pest. However the development of this morph gets retarded with commencement of winter and complete nymphal hibernation is recorded from December to February. Some similar observations had also been made by some earlier workers like Theobald (1921), Mordvilko (1923), Nevaski (1925) and Monzen (1926), who recorded nymphal hibernation during severe winters. Contrary to this, Gautam and Verma (1983) mentioned that the nymphal population was retarded during winters but no nymphal hibernation was found during winter season. During summer months maximum infestation is on the aerial parts of apple plantations in the study areas.

#### Nature and extent of damage

Virginoparae morph of *Eriosoma lanigerum* Hausmann has been observed as one of the most destructive pests of apple plantations in districts of Jammu Province. Detailed investigations revealed that the pest remains active throughout the year. Attack primarily starts from the underground roots which later spreads to the trunk, branches, stem, twigs, leaf petioles and fruit stalks. Both nymphs and adults cause severe damage to apple plants by sucking cell sap from the aerial and subterranean parts of the plant. Continuous sucking of the cell sap by the nymphs and adults results in swelling on such points which ultimately leads to the formation of nodule like structures or galls on the aerial and underground parts of the plants. On stem such galls result in roughening of the bark. Formation of galls upset the normal physiological functions of the plant. Findings of the author supports earlier observations of various authors including Rahman and Khan (1941), Lal and Singh (1947), Thakur (1970), Nair (1970), Adlakha and Hameed (1972), Butani (1979), Sachan and Gangwar (1980), Gautam and Verma (1983), Atwal and Dhaliwal (1999) and Bhardwaj and Bhardwaj (2005). As a result of woolly apple infestation, the growth and vigour of the plant are adversely affected due to non-transportation of food material as the galls act as a sink. On aerial parts of the apple plants the galls are formed on succulent tissues, cut ends, injured parts, crevices and cracks. These galls also spoil the appearance of apple trees and nursery stocks which reduces the value of infested nursery plants. The damage caused by this pest *Eriosoma lanigerum* Hausmann on apple plantations in the area under investigation is more serious in nursery stocks and young orchards and comparatively less, in grown up trees. Due to desapping caused by this pest, the affected tree gives a sick appearance; loose vigour which ultimately retards the growth of the tree as a result of which the fruiting capacity of the tree is greatly impaired. Such plants subsequently become prone to the attack of other serious pests like borers. Sometimes young plants may also die because of severe woolly apple aphid infestation in the area of the study.



**Fig. 1, 2. Virginoparae adult aphids ; Fig. 3-7. Damage done to apple plantations ; Fig. 8 Gall formation by the aphids**

#### REFERENCES

Adlakha, R.L. and Hameed, S.F. (1972) Wooly apple aphid, *Eriosoma lanigerum* (Hausmann), in Kullu Valley. *Pesticides*, 6: 13-22.

Asante, S.K. (1997) Natural enemies of wooly apple aphid, *Eriosoma lanigerum* (Hausmann): a review of the world literature. *Plant Protection Quarterly*, 12 (4): 166-172.

Asante, S.K. (1999) Seasonal abundance of wooly apple aphid, *Eriosoma lanigerum* and its important natural enemies in Armidale, New South Wales. *Plant Protection Quarterly*, 14 (1): 16-23.

Asante, S.K., Danthanarayana, W. and Heatwole, H. (1991) Bionomics and population growth statistics of apterus

virginoparae of wooly apple aphid *Eriosoma lanigerum*, at constant temperatures. *Entomologia Experimentalis et Applicata*, 60(3): 261-270.

Baker, A.C. (1915) The wooly apple aphid. *U.S. Department of Agricultural Entomology- Report*, 101: 1-55.

Bhardwaj, S. (1988) Biology of wooly apple aphid, (*Eriosoma lanigerum* Hausman) with special reference to gall formation, morph determination and apple varietal resistance. *PhD Thesis submitted to H.P. University Shimla*: 17.

Bhardwaj, S., Chander, R. and Bhardwaj, S.P. (1995) Movement of wooly apple aphid (*Eriosoma lanigerum*) on

- apple plant in relation to weather parameters. *Indian Journal of Agricultural Sciences*, 65(3): 217-222.
- Bhardwaj, S.P. (1999) Red mite in apple- present and future strategies for its control. *National Seminar on Himalayan Horticulture vision, 2020*: 28.
- Butani D.K. (1979) Insects and fruits. Periodical Expert Book agency, New Delhi: 273-275.
- Butani, D.K. and Jotwani, M.J. (1975) Trends in the control of insect pests of fruit crops in India. *Pesticides Annual*, 9(4): 139-149.
- Essig, E.O. (1942) Woolly apple aphid infesting apple cores. *Journal of Economic Entomology*, 35: 281.
- Fotedar, M.R. and Kapur, A.R. (1943) First record of the seasonal forms and oviparous reproduction of woolly aphids, *Eriosoma lanigerum* (Hausmann) from Kashmir, India. *Current Science*, 12: 84-85.
- Gautam, D.C. and Verma, L.R. (1982) Occurrence of sexuparae and sexual morphs of woolly apple aphid, (*Eriosoma lanigerum*, Hausmann) in Shimla Hills, India. *Current Science*, 51: 481-483.
- Gautam, D.C. and Verma, L.R. (1983) Seasonal biology and reproductive behaviour of woolly apple aphid. *Indian Journal of Horticulture*, 41: 119-123.
- Gautam, D.C. and Verma, L.R. (1983a). Life history of sexuparae and sexual morphs of woolly apple aphid, *Eriosoma lanigerum* (Hausmann). *Proceedings of Indian Academy of Sciences (Anim. Sci.)*, 92: 247-251.
- Gupta, R. (2007) Diversity, damages and Biology of Insect pests of Apples in District Doda, J&K. *M.phil dissertation submitted to Department of Zoology, University of Jammu*
- Rishi, N.D. (1979) Records of aphid fauna (Homoptera-Aphididae) from Jammu and Kashmir, India. *Symp. Recent Trends in Aphidological Studies, Bhubaneswar*. Abstract, 52.
- Lal, K.B. and Singh, R.N. (1945) Control of woolly aphid by *coccinella semipunctata*. *Indian farming*, 6: 24-25.
- Lal, K.B. and Singh, R.N. (1947) Seasonal history and field ecology of the woolly aphid in the Kumaon Hills. *Indian Journal of Agricultural Sciences*, 17: 211-218.
- Misra, C.S. (1920) The American blight or The Woolly Apple Aphid, *Eriosoma lanigerum* (Hausmann). *Agricultural Journal of India*, 15: 627.
- Monzen, K. (1926) The woolly apple aphid, *Eriosoma lanigerum* Hausmann in Japan with special reference to its life history and susceptibility of the host plant. *International Entomological Congress Zurich*, 2: 249-275.
- Mordvilko, A.K. (1923) Woolly apple aphid, *Eriosoma lanigerum* and other *Eriosoma*. *Proceedings of Russian Academy of Sciences*: 40-42.
- Nair, M.R.G.K. (1970) Insects and mites of crops in India: 1-227.
- Nevaski, V.P. (1925) The biology of *Eriosoma lanigerum* and its control in Turkistan. *Central Asiatic Experimental Station for Plant Protection*, 97.
- Nicholas, A.H., Spooner, R.N. and Vickers, R.A. (2005) Abundance and natural control of the woolly aphid *Eriosoma lanigerum* in an Australian apple orchard IPM program, *Biocontrol*, 50(2): 271-291.
- Rahman, K.A. and Khan, A.W. (1941) Biology and control of woolly aphids *Eriosoma lanigerum* (Hausmann). *Indian Journal of Agricultural Sciences*, 11: 265-278.
- Rahman, K.A. and Khan, A.W. (1941) Biology and control of woolly aphids *Eriosoma lanigerum* (Hausmann). *Indian Journal of Agricultural Sciences*, 11: 265-278.
- Sachan, J.N. and Gangwar, S.K. (1980) Insect Pest of Apple in Meghalaya. *Bulletin of Entomology*, 21: 113-121.
- Singh, C. (1964). Temperate fruit pests. *Entomology in India. Entomological society of India, New Delhi*: 216.
- Thakur, J.R. (1970) Biology of woolly apple aphid, *Eriosoma lanigerum* (Hausmann). (Homoptera: Aphididae) and its control by the soil as well as the foliar application with particular stress on timings. M.Sc. Thesis, Punjab University, Chandigarh.
- Thakur, J.R. and Dogra, G.S. (1980) Woolly apple aphid, *Eriosoma lanigerum* Hausmann research in India. *Tropical Pest Management*, 26: 8-12.
- Thakur, J.R. and Gupta, P.R. (1998) Management of woolly apple aphid, *Eriosoma lanigerum* (Hausmann) in apple orchard ecosystem. *Pest Management and Economic Zoology*, 6(2): 93-100.
- Theobald, F.V. (1921) The woolly aphid of apple and elm (*Eriosoma lanigerum* Hausmann). *Journal of Pomology*, 2: 20.