

Life history of sexuparae and sexual morphs of woolly apple aphid (*Eriosoma lanigerum* Hausmann)

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Abstract. The life history of sexuparae and sexual morphs of woolly apple aphid (*Eriosoma lanigerum* Hausmann) is reported from Simla Hills. Sexuparae are alate parthenogenetic viviparae and produce the sexuals (males and oviparae). The reproductive potential of sexuparae is much lower as compared to that of virginoparae. Sexuals are apterous and have degenerated mouth parts. An ovipara lays only one egg. All these morphs undergo four moults resulting in five instar stages.

Keywords. Woolly aphid; sexuparae; sexuals; morphs; virginoparae; *Eriosoma lanigerum*.

1. Introduction

Woolly apple aphid (*Eriosoma lanigerum* Hausmann) is a native of North America where it undergoes a regular alternation of a bisexual generation with a series of parthenogenetic generations (Baker 1915). Elm is the primary host of this insect pest while apple and related plants are secondary hosts. However, in other apple-growing regions of the world, the behaviour and biology of woolly apple aphid differ considerably because of the absence of its primary host elm (*Ulmus americana*) and also due to different environmental conditions.

In India, this pest has completely adapted to apple plants and causes great damage every year. Although the biology of virginoparae morphs (apterous parthenogenetic females) has been studied by some workers (Rahman and Khan 1941; Lal and Singh 1947; Gautam 1981), very little is known about the biology of sexuparae and sexual morphs of this insect pest. The present authors had reported the occurrence of sexuparae and sexual morphs in Simla Hills (Gautam and Verma 1982) and this paper deals with the life history of these morphs.

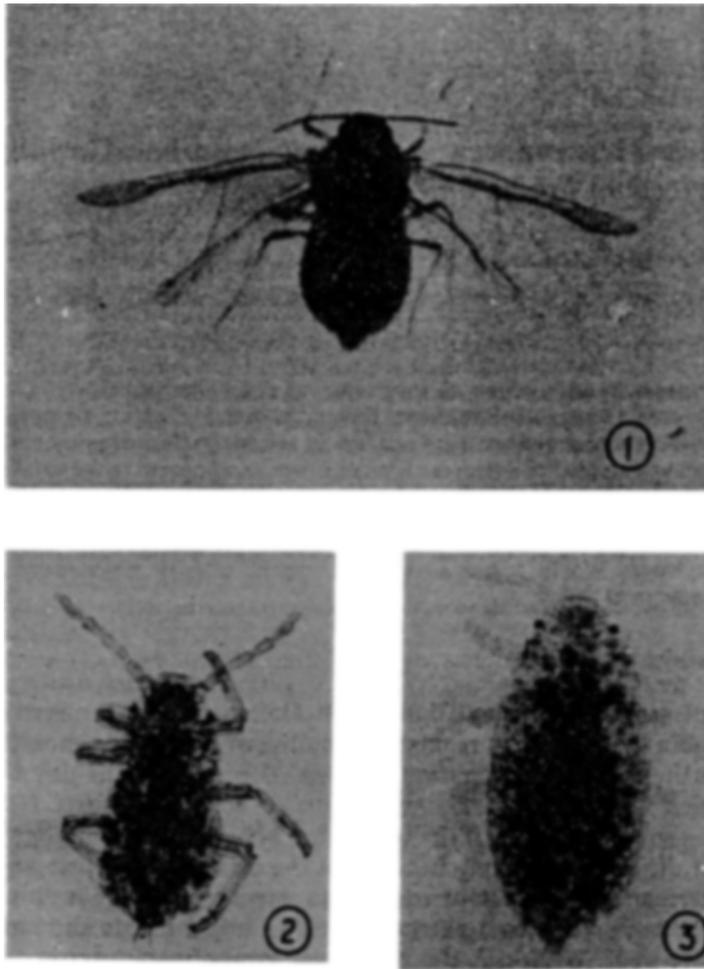
2. Material and methods

The culture of woolly apple aphid was maintained on apple nursery plants in the laboratory and the life history of sexuparae and sexual morphs was studied under 8 L : 16D photoperiod from August to October. The temperature ranged from 19 to 23.5°C (mean temperature 21.78°C) during this period. The various aspects of life history of these morphs were recorded daily at 0800, 1200 and 1600 hrs. The number of instars of these morphs was determined by examining the exuviae with a magnifying lens. During reproductive period, the progeny produced by a female was also recorded daily.

3. Results and discussion

3.1 Sexuparae

In the fields (apple orchards), sexuparae appear from late July to November with



Figures 1-3. *Eriosoma lanigerum*. 1. Sexupara ($\times 20$) 2. Male ($\times 75$) 3. Ovipara ($\times 75$).

maximum population in September-October. These are alate, parthenogenetic, viviparous and male-female producers. Each individual undergoes four moults and the last moult gives rise to adult alate sexupara. It is difficult to differentiate the first and second instars of the alate sexuparae from that of apterous virginoparae as the wing pads are not clearly visible even with magnifying lens but in the third and fourth nymphal instars; the wing pads are very prominent and these two morphs can be differentiated on the basis of this morphological character.

The adult alate sexuparae have six segmented antennae bearing secondary rhinaria on the last four segments. The compound eyes are multifaceted and dark black. There are two pairs of wings; the forewings possess a prominent pterostigma. The media is forked and not traceable near the base (figure 1). The hind tarsi are two segmented; the proximal segment is triangular with two long hairs and the distal segment bears a pair of claws.

The average duration of first, second, third and fourth nymphal instar is 3.95, 2.7, 2.75 and 4.25 days respectively. The total nymphal period ranges from 12-15 days (average 13.65) (table 1). The adult individuals live for 4 to 7 days (mean value 5.4 days) and the progeny produced ranges from 4 to 8 sexuals (average 5.3

Table 1. Duration of developmental stages, total longevity and fecundity of sexuparae and sexual morphs of woolly apple aphid on apple plants (8L:16D).

Morph*	Nymphal period (in days)				Total nymphal period (in days)	Adult life period** (in days)	Total life period (in days)	Progeny produced by a female
	First instar	Second instar	Third instar	Fourth instar				
Sexupara	Mean SE***	2.70 ±0.15	2.75 ±0.15	4.25 ±0.20	13.65 ± 0.29	5.40 ±0.34	19.05 ± 0.49	5.30 ±0.40
Ovipara	Mean SE	1.20 ±0.11	1.55 ±0.16	2.20 ±0.24	7.40 ± 0.13	5.50 ±0.80	12.90 ± 0.80	One egg
Male	Mean SE	1.65 ±0.18	2.25 ±0.11	1.65 ±0.13	7.00 ± 0.34	3.30 ±0.34	10.30 ± 0.47	—

* Data represented for ten individuals of each morph. ** In case of ovipara, it is the period between the last moult and the egg laying. *** (±) Standard error about the mean.

nymphs). The total life period of sexupara ranges from 17 to 22 days (average of 19.05 days) (table 1). The abdomen of the sexupara gets shrunk after laying the sexuals. The fecundity rate of sexupara recorded in the present investigations is very low as compared to that of virginopara (Gautam 1981) and this may possibly be because of the physiological changes in sexuparae due to morph differentiation.

3.2 Sexuals

Sexuals (males and oviparae) are the progeny of sexuparae. These are apterous and undergo four moults before they become sexually mature. Mouth parts are degenerated (atrophied) and the antennae are five-segmented in all the instars (nymphs as well as adults) of both the morphs. The last two segments of antennae possess primary rhinaria. In the sexuals, eyes are three-faceted and the tarsi of all the legs are one-segmented having three pairs of long capitate hair, a pair of long hair and a pair of claws. Males (figure 2) are smaller in size and the body is dark brown whereas oviparae (figure 3) are reddish brown and in both the sexual morphs, the antennae and legs are transparent with yellowish tinge.

In males, the average duration of first, second, third and fourth nymphal instar is 1.45, 1.65, 2.25 and 1.65 days respectively. The total nymphal period ranges from 6 to 9 days (mean value 7 days). The total life period ranges from 8-12 days with an average value of 10.3 days (table 1). Males are very active as compared to oviparae.

In oviparae, the average duration of first, second, third and fourth nymphal instar is 2.45, 1.2, 1.55 and 2.2 days respectively. The total nymphal period ranges from 7 to 8 days (mean value 7.4 days). The period between the last moult and the egg laying ranges from 3 to 11 days (mean value 5.5 days) and the total life period ranges from 10 to 16 days with an average value of 12.9 days (table 1). Earlier, Fotedar and Kapur (1943) also reported that in Kashmir valley a male survives for about 12 days and an ovipara lives for about 20 days.

Ovipara lays only one egg which in the adult ovipara occupies the whole abdomen and dies in the process of egg laying. The egg is reddish brown when freshly laid but turns dark brown later on.

The sexuals (nymphs as well as adults) have degenerated mouth parts but still they survive and undergo so many physiological changes during their development such as moulting, maturing etc. According to Dunn (1959), the sexuals of *Pemphigus bursarius* L. are also arostrate and survive presumably on the stored reserves of the body. These sexuals undergo moulting before they become sexually mature. Hille Ris Lambers (1966) also discussed that in Eriosomatinae, the oviparae have no functional mouth parts, show a negative growth through a number of moults and after mating with similar dwarf males, lay only one egg while in Fordini, the oviparae die with one egg inside the body.

In North America, where this insect pest has holocycle on elm (primary host) and apple plants; the sexuparae are produced on apple plants, from where these migrate to elm and produce sexuals there (Baker 1915). However, in India this pest has completely adapted to its secondary host (apple plants) and the sexuparae produce sexuals on these plants.

Fluiter (1948) reported that the sexuparae of woolly apple aphid may also produce, besides males and oviparae, the intermediates with fully developed mouth parts like those of viviparac or half developed mouth parts. However, in the present investigation the progeny produced by a sexupara consisted of males and oviparae only.

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