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# Studies on the Biology and Predatory Potential of *Harmonia dimidiata*, a Major Predator of *Aphis pomi* De Geer on Apple Host in India

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## Abstract

Observations were made on young nursery plants and apple orchards to record the coccinellid predators of *Aphis pomi* De Geer on apple plants in Himachal Pradesh which is main apple growing state of India. Nine species of lady bird beetles were observed feeding on green apple aphid, *Aphis pomi* De Geer on the apple nursery plants of Mashobra locality of Shimla district and Ner Chowk locality of Mandi district of Himachal Pradesh, India. On the basis of general observations, it was found that the larvae of beetle *Harmonia dimidiata* (F.), are very active to feed on the nymphs of green apple aphid. Therefore, it was considered worthwhile to investigate the biology and feeding potential of this beetle on green apple aphid from biological control point of view.

## Keywords

Green Apple Aphid, *Aphis pomi* De Geer, Coccinellid Predators, Biological Control, Apple Host

## 1. Introduction

Apple plants are attacked by a number of insect pests. Among these, green apple aphid, *Aphis pomi* De Geer is considered a pest damaging apple nursery plants severely. This aphid pest was first reported by De Geer [1] from Sweden and has now been reported from all the apple growing regions of Europe, North America and Southwest Asia [2].

This insect pest infests apple plants throughout the year and poses a great

problem to the growers as serious losses occur in nurseries and orchards. If the apple aphid populations are not timely controlled, that may result in build-up of big aphid colonies resulting in reduced yield as well as damage to apple plants [3] [4] [5]. In India, this insect pest has been reported to infest apple plants in Himachal Pradesh [6] and Kashmir [7]. The worst affected are the apple nurseries where this pest is controlled by the use of insecticides [6]. Gautam and Kumari [8] studied the biology of green apple aphid *Aphis pomi* De Geer on apple host in Himachal Pradesh, India.

Many natural enemies have been reported in association with green apple aphid, *Aphis pomi* De Geer from different parts of the world [9] [10] [11] [12]. However, there is no record available on the natural enemies of green apple aphid in India. Keeping this in view, the study was undertaken to explore the effectiveness of biological control of this aphid pest by larvae of beetle *Harmonia dimidiata* in Himachal Pradesh which is the main apple growing state in India.

## 2. Materials and Methods

Studies on the biological control of green apple aphid were conducted in two localities *i.e.* Mashobra locality (31˚1'N latitude, 77˚1'E longitude and altitude 2286 m above sea level) of Shimla district and Ner Chowk locality (31˚32'N latitude, 76˚54'E longitude and altitude 878 m above sea level) of Mandi district. These studies were spread over three years from 2003 to 2006. These observations reconfirmed in the last three years also *i.e.* 2015 to 2017.

In the first year field observations were made to record the predators of green apple aphid in nature (apple nursery fields of Mashobra and Ner Chowk). After recording different predator species of green apple aphid, the effective predator was selected for life history studies. The temperature records of Shimla where biological studies of coccinellid predator was carried out during Mayto August months of these years were 22.76˚C mean maximum and 19.46˚C mean minimum in 2003, 22.21˚C mean maximum and 18.68˚C mean minimum in2004, 23.32˚C mean maximum and 19.18˚C mean minimum in 2005 and 24.03˚C mean maximum and 18.58˚C mean minimum in 2006. Mean relative humidity was 83.09% in 2003, 83.60% in 2004, 79.98% in 2005 and 71.78% in 2006 from May to August. The data on different developmental stages and their predatory potential were recorded and photographs were taken with the help of Nikoncamera.

Lady bird beetles were directly collected from apple nursery plants and reared under laboratory conditions at Himachal Pradesh University campus at Shimla (India). After egg hatching, 10 larvae of each coccinellid species were isolated in plastic petri dishes with filter paper on the bottom and then fixed number of nymphs and adults of green apple aphids were given to the larvae and the feeding potential of larvae was recorded. The larvae were observed every 24 hours to note their development and total number of aphids consumed. Pupalstages of the coccinellid *Harmonia dimidiata* were also maintained under the same condi-

tions and observed daily until adult emergence. The longevity and feeding potential of adults of *Harmonia dimidiata* were also recorded.

## 3. Results

Observations were made on young nursery plants and apple orchards to record the coccinellid predators of *Aphis pomi* De Geer. During summer when the infestation rate of green apple aphid was high on apple nursery plants and apple orchards, many natural predators were found preying on green apple aphid.

Nine species of lady bird beetles were recorded feeding on green apple aphid, *Aphis pomi* De Geer on the apple nursery plants of Mashobra locality of Shimla district and Ner Chowk locality of Mandi district of Himachal Pradesh. These coccinellid species belonging to Family Coccinellidae of order Coleoptera are *Cheilomenes sexmaculata* (F.), *Coccinella septempunctata* (L.), *Coccinella transversalis* Fabricius, *Coelophora bissellata* Mulsant, *Coelophora saucia* (Mulsant), *Harmonia dimidiata* (F.), *Hippodamia variegate* (Goeze), *Oenopia sauzeti* Mulsant and *Priscibrumis uropygialis* (Mulsant). In the present study, the life cycles of *Harmonia dimidiata* (F.) was studied and feeding potential of this species was recorded under laboratory conditions because the larvae of this beetle were very active in feeding on nymphs and adults of green apple aphid.

This species of coccinellid laid eggs on the underside of the leaves infested with green apple aphid. Eggs were laid upright in clusters of twelve or more. Both adults and larvae of this species were observed feeding on the green apple aphid. Data on the duration of different stages and feeding potential of larvae and adults of *Harmonia dimidiata* (F.) was recorded.

The eggs of this beetle, which are laid on the underside of leaves, are orange yellow colored. Duration of egg hatching of this species lasts from 3 to 5 days (mean 4.15 days ± 0.22 SE) (**Table 1**). The developing larvae are red and black with shape like tiny alligators (**Figure 1(a)**). Larvae complete their development on apple nursery plants infested with green apple aphid. The duration of larval period of this species ranges from 14 to 18 days (mean 15.80 days ± 0.44 SE) (**Table 1**). Duration of pupal stage of this species ranges from 7 to 9 days (mean 7.85 days ± 0.24 SE) (**Table 1** & **Figure 1(b)**).

Adults become active after they emerge from pupa and start searching food (**Figure 1(c)**). The adult of this species is shiny black and orange in colour and consumes more than 100 aphids per day during its adult period. Duration of total period from egg stage to adult form lasts from 24.5 to 31 days (mean 27.80 days ± 0.64 SE) (**Table 1**). The adult life span ranges from 38 to 50 days (mean 44.10 days ± 1.31 SE) (**Table 1**). The total life span of this species ranges from 67.5 to 78.5 days (mean 71.90 days ± 1.85 SE) (**Table 1**). The larva of this species consumes 743 to 879 aphids (mean 804.30 aphids ± 16.15 SE) during its whole larval development (**Table 2**). Total number of aphids consumed by adult during its life span ranges from 3925 to 5200 (mean 4506.50 aphids ± 150.27 SE) (**Table 2**).

**Table 1.** Duration of different developmental stages of lady bird beetles* feeding on green apple aphid.

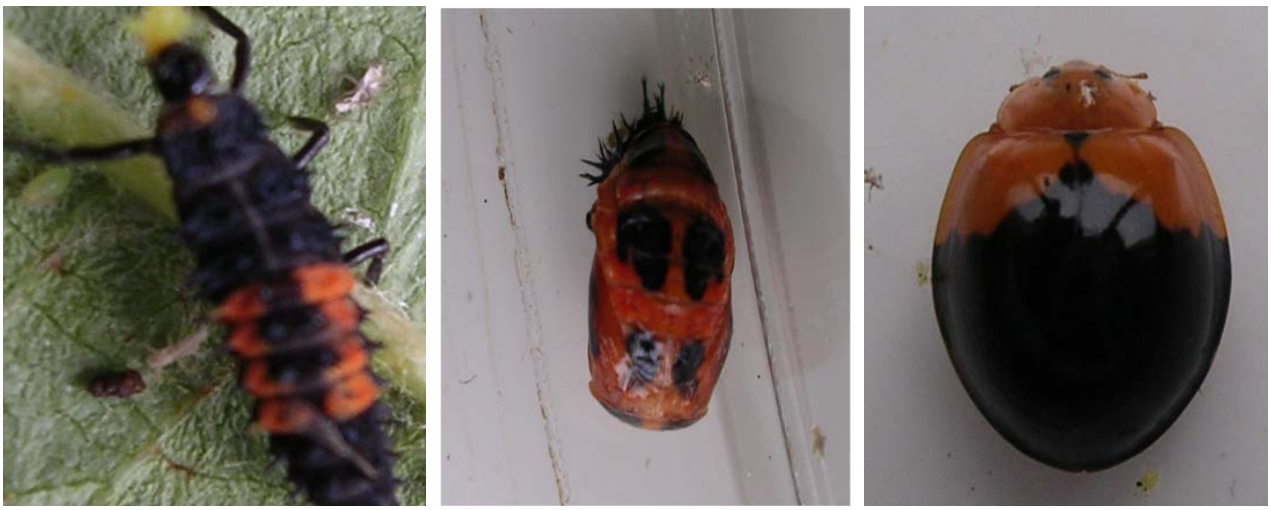
| Name Of species | Duration of different stages (in days) | | | | | |
|---|---|---|---|---|---|---|
| | Egg | Larva | Pupa | Total period up to Adult Emergence | Adult Life Span | Life Span (in Days) |
| *Harmonia dimidiata* (F.) | 4.15 ± 0.22 | 15.80 ± 0.44 | 7.85 ± 0.24 | 27.80 ± 0.64 | 44.10 ± 1.31 | 71.90 ± 1.18 |

*Mean value for 10 individuals, ± standard error about the mean.

**Table 2.** Predatory potential of larvae and adults of *Harmonia dimidiata* (F.) feeding on green apple aphid *Aphis pomi.*

| Name of species | Number of aphids consumed by larval instars | | | | Number of aphids consumed by larvae | Number of aphids consumed by adults |
|---|---|---|---|---|---|---|
| | I | II | III | IV | | |
| *Harmonia dimidiata* (F.) | 36.20 ± 1.03 | 58.10 ± 1.69 | 241.50 ± 13.08 | 468.50 ± 10.48 | 804.30 ± 16.15 | 4506.50 ± 150.27 |

*Mean value for 10 individuals, ± standard error about the mean.



(a) (b) (c)

**Figure 1.** Larva, pupa & adult of *Harmonia dimidiata* (F.).

## 4. Discussion

So far, no studies are available in literature on the biological control of green apple aphid in India. Since this aphid pest has very high reproductive potential, it is desirable to have basic information about biology and feeding potential of predators of green apple aphid occurring in apple growing regions where infestation of this aphid pest is very high. Present investigations revealed that green apple aphid is preyed upon by a number of predators belonging to Coccinellidae. These predators are found to reduce the populations of green apple aphid drastically.

The number of predators of *Aphis pomi* varies from one region to other region. Carroll and Hoyt [9] reported that in Washington, thirty nine predators and two parasitoids were found attacking green apple aphid, *Aphis pomi* De Geer while Bouchard *et al.* [10] reported 60 predators and parasites of this aphid species from Quebec.

Nine species of lady bird beetles were found predating upon green apple aphid *Aphis pomi* De Geer on the apple nursery plants of Mashobra locality of Shimla district and Ner Chowk locality of Mandi district of Himachal Pradesh. Both larvae and adults of lady bird beetles were found feeding on *Aphis pomi* De Geer in the field as well as on the plants which were maintained in pots under laboratory conditions. The most prominent coccinellid species feeding on green apple aphid are *Cheilomenes sexmaculata* (F.), *Coccinella septempunctata* (L.), *Coelophora bissellata* (Mulsant), *Coelophora saucia* (Mulsant), *Coccinella transversalis* Fabricius, *Harmonia dimidiata* (F.), *Hippodamia* variegate (Goeze), *Oenopia sauzeti* (Mulsant) and *Priscibrumus uropygialis* (Mulsant). Of these, *Cheilomenes sexmaculata* (F.), *Coelophora bissellata* Mulsant (F), *Coelophora saucia* (Mulsant) and *Harmonia dimidiata* were found to be the effective for the biological control of *Aphis pomi* De Geer in apple nurseries in Himachal Pradesh. Carroll and Hoyt [9] reported eight lady bird beetle species preying on *Aphis pomi* in Washington, and according to them, *Coccinella transversogtata* was most abundant and voracious.

Present investigations on the life cycle and feeding potential of *Harmonia dimidiata* F.)], indicate that this species is the effective predators of *Aphis pomi* De Geer in Himachal Pradesh, India. The larvae of this species were found to be poor feeder at initial instar stages but these become voracious feeder in the last instar stage. The predatory potential of the larva of *Harmonia dimidiata* is greater (743 to 879 aphids) (**Table 2**). Similarly, adult of this species consumes more aphids during its life span (3925 to 5200 aphids) (**Table 2**). *Menochilus sexmaculatus* remains in a given area for a sufficient period of time to complete at least one generation, making it very effective against *Schizaphis graminum* [13].

Effectiveness of this coccinellid predator against green apple aphid indicates of their great potential for management of this aphid pest. These natural predators effectively control the populations of this aphid and should be reared for their availability in the whole year. It is advantageous that as along with the protection of the apple plant, there would be reduction in the use of insecticides for the control of this aphid pest.

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