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Bio-diversity of *Episyrphus balteaus* De Geer in northern India

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Abstract

At large geographical scales, dense populations of various taxa are often associated with biodiverse regions. This trend has been observed in plants, invertebrates, amphibians, reptiles, birds, and mammals. However, it remains unclear whether aphids exhibit a similar pattern. Aphids are notably species-poor in tropical regions due to their evolutionary origins in temperate zones of the boreal hemisphere. In this study, three species of Homoptera were documented, with predators observed feeding on them in nursery plants located in the Bareilly region of Rohilkhand, Uttar Pradesh. The syrphid species *Episyrphus balteatus* De Geer and *Metasyrphus confrater* were recorded, both belonging to the family Syrphidae of the order Diptera, commonly referred to as flower flies. Observations primarily focused on *Episyrphus balteatus* De Geer, whose larval stages were found actively preying in the Rohilkhand region of Uttar Pradesh.

Keywords: Feeding Potential;, Homoptera; Syrphid Predator; *Episyrphus balteatus*

1. Introduction

Aphids are tiny bugs that belong to the order Homoptera and infect practically every plant. Aphids, also known as green flies and ant cows, are a significant group of insects that go by a variety of common names. Within the order Homoptera, they are classified as members of the class Insecta and Phylum Arthropoda, the superfamily Aphidoidea, and the family Aphididae.

They are often soft-bodied insects that feed on the sap of plants. As a result, their presence interferes with the normal growth of the plant. Aphids are mostly parthenogenetic insects that may colonize any part of a plant, including new leaves, twigs, inflorescences, fruits, and in rare circumstances, even the roots. Aphids are notorious for spreading plant diseases. They are also responsible for spreading numerous different plant viruses that cause illnesses.

They are also recognized as major pests of crops, horticulture plants, and many other kinds of forest plants and trees. They may be found all over the globe, with the greatest diversity of species occurring in temperate and subtropical climates. Aphids may have a significant impact on the economy due to their role as pests on a variety of agricultural and horticultural products, including oilseeds, cotton, wheat, vegetables, rice, and many other plant species.

They are an incredibly successful group that can be found all over the globe, spreading to tropical and subtropical areas, with the highest number of species in the warmer zones. They are found in a variety of habitats. There are around 4461 species of aphids that are known to exist across the whole planet (Remaudiere and Remaudiere 1997), and out of this total number of aphid species that are known to exist, more than 900 species have been documented taxonomically

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from India so far (Agarwala 2007). They can reproduce both sexually and asexually (also known as parthenogenesis), with equal success.

On the stem of a plant or the underside of a leaf, an aphid colony will often appear as a mass that is either green or black. It is possible for a population of aphids to rise to a few million individuals in a very short period of time, and then for that number to decrease in an even shorter period of time if the circumstances are not suitable.

Aphids are of significant interest to cytogeneticists because, during their life cycle, they engage in a variety of peculiar processes, such as cyclical parthenogenesis, heterocyclics, and polymorphism. As a result of these processes, aphids serve as an excellent model organism for cytogenetic research. Aphids use what's known as a cyclical parthenogenesis reproductive mechanism. Aphids may reproduce without males. It begins with a collection of generations that reproduce asexually via parthenogenesis and then moves on to a single generation that reproduces sexually.

The apple plant's growing terminals are the main target of aphis pomi attacks. Strong green apple aphid infestations cause the leaves of apple nurseries and young plants to curl, as well as stunt and distort the twigs. The generation of honeydew has a negative impact on apple photosynthesis, quality, and yield on fruit-bearing plants.

The term "Holo-cyclic" is used to describe organisms with this characteristic. These insect pests are able to quickly reproduce thanks to their parthenogenetic generations, while their sexual phase allows for genetic recombination. However, many aphid species no longer go through the sexual phase, and as a result, they are referred to be anholocyclic. Species with a large distribution range may exhibit either holo-cyclic or anholocyclic life cycles within a single population, depending on the environmental conditions (Wohrmann and Tomiuk, 1988).

2. Study area

Present study will be conducted on the aphid biodiversity of Rohilkhand Region of the district in Bareilly, Utter Pradesh, India. The Latitudinal of Bareilly (28°3670 ´N) and the Longitudinal is (79°4304´E) Bareilly Utter Pradesh in India. We know that One of the largest, most populous District in Rohilkhand Regions in (U.P.). In Bareilly District has a Population about 900,000 people, and mostly depends on the Crops Agriculture field is one the first and foremost important factor to determine the Field levels obviously, the type of area chosen and the extent of land used for each vegetable Plants, Flowering Plants, Fruits plants Crops and grasses is the most important for determination of Field area.

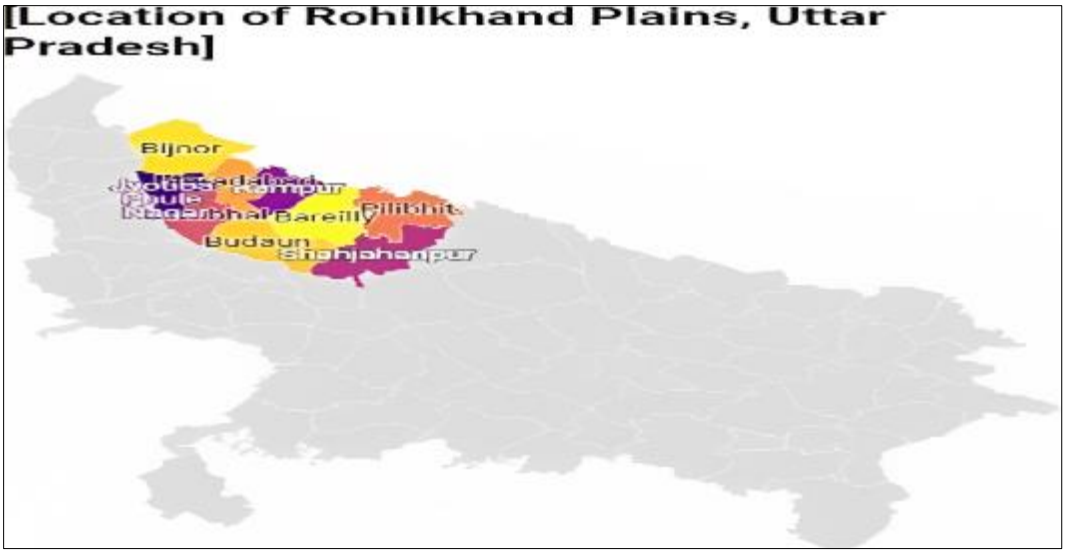

Figure 1 Rohilkhand, Uttar Pradesh Map

For this cytological examination, samples of the aphid species were collected from the Rohilkhand villages of Bareilly, Uttar Pradesh in India. Aphid samples are collected from a range of plants in and around the villages of the Rohilkhand Region of Bareilly. Aphids were also checked for on horticultural and wild plants.

Samples of aphids and their host plants were collected from the fields and placed in plastic bags with rubber bands to keep them from escaping. Carefully removing a twig from the diseased host plant required the use of scissors.

3. Materials and methods

Three species of Homoptera (aphids) were identified as the primary prey. The study focused on two syrphid species, *Episyrphus balteatus* De Geer and *Metasyrphus confrater*, with detailed observations on the larval stages of *Episyrphus balteatus* due to its significant predatory activity.

3.1. Equipment and Tools

- Sweep nets and aspirators were used for collecting specimens.
- A stereomicroscope was utilized for identifying syrphid eggs, larvae, and aphids.
- Climate-controlled chambers were employed for rearing *Episyrphus balteatus* in the laboratory.

3.2. Data Collection

3.2.1. Aphid Sampling:

- Aphid populations were monitored weekly through direct counts on nursery plants.
- A soft brush was used to collect aphids, and their population densities were recorded to track seasonal variations.

3.2.2. Predator Monitoring

- Activities of syrphid flies, such as egg-laying and larval predation, were observed directly-field.
- Eggs, larvae, and pupae were collected from the underside of leaves and examined in the laboratory.

3.2.3. Life Cycle Studies

- The developmental stages of *Episyrphus balteatus* (egg, larva, pupa, and adult) were studied in controlled laboratory conditions.
- The duration of each life stage was recorded along with environmental parameters like temperature and humidity.

4. Results

In the inspection from May 2024 to 9 December 2024, it has been evident from the observation of young forcing houses and crop yielding plants that the acid flies cause more infection in green apples, pears because during this period the colour of the apples is green and during this period the larvae of *Episyrphus balteatus* De Geer, a member of the Syrphidae family in the order Diptera, have been seen preying on aphids. As the population of the acid flies increases, the eggs of the aphid fly start reacting more and more in number. The infection increases in proportion to the density of the acid flies and the number of eggs. Aphids, which appear like white chalk, are easily seen sticking to the surface of green leaves. This fly lays eggs on the underside of the leaves and singly or in groups, especially during the day or in clear weather. These larvae steal food and consume their food by sucking it. After this, the feeding capacity increases significantly.

In the final instar stage, *Episyrphus balteatus* De Geer larvae exhibit intense feeding behavior. The freshly laid eggs of this syrphid fly are pale white, gradually darkening to greyish before hatching. These oval-shaped eggs hatch in about two days during summer (mean 4 days ± 0.00 SE) and require 4 to 6 days in autumn (mean 2.65 days ± 0.15 SE) (Table 1).

The larvae of *Episyrphus balteatus* (Fig. 1) are translucent, revealing the black internal organs. The larval stage includes three instars, lasting 8 to 10 days in summer (mean 7.80 days ± 0.27 SE) and 12 to 17 days in autumn (mean 16 days ± 0.59 SE). Fully developed larvae remain transparent and form a puparium during pupation. Pupae are initially whitish, transitioning to greyish-white. They are broad at the anterior end and taper toward the posterior. The pupal stage spans 8 to 10 days in summer (mean 8.60 days ± 0.18 SE) and 15 to 19 days in autumn (mean 15.80 days ± 0.56 SE) (Table 1).

The adult *Episyrphus balteatus* (Fig. 2) is highly active and one of the most abundant aphidophagous syrphid species, observed throughout spring, summer, and autumn. Adults live 28 to 40 days in summer (mean 31.20 days ± 1.51 SE) and 45 to 65 days in autumn (mean 53.20 days ± 1.51 SE). The entire life cycle, from egg to adult, lasts 40 to 55 days in summer (mean 49.59 days ± 1.52 SE) and 77 to 96.7 days in autumn (mean 88.07 days ± 1.70 SE) (Table 1).

Feeding potential studies reveal that each larva consumes 350 to 440 aphids in summer (mean 415.55 aphids ± 8.23 SE) and 455 to 642 aphids in autumn (mean 549.59 aphids ± 18.65 SE). Statistical analysis using a t-test showed p-values below 0.05 for both lifespan and feeding potential differences, indicating significant variations between the seasons. As a result, the null hypothesis (Ho) was rejected, confirming a significant seasonal impact on life span and larval aphid consumption.

Table 1 Perpetuation of Distinct Intervening Stages

Name of Species	**Season**	**Egg (Days)**	**Egg ±SE**	**Egg Skew**	**Egg Kurt**	**Larva (Days)**	**Larva ±SE**	**Pupa (Days)**	**Pupa ±SE**	**Adult (Days)**	**Adult ±SE**	**Total Life (Days)**	**Total Life ±SE**	**Aphids Consumed**	**Aphids Consumed ±SE**
Episyrphus balteatus (De Geer)	Summer	2	±0.00	-0.234	-1.154	7.9	±0.27	8.5	±0.16	31.1	±1.41	49.5	±1.50	415.5	±8.21
	Autumn	2.55	±0.13	-0.101	-0.197	15	±0.51	15.3	±0.55	53.2	±1.51	86.05	±1.73	549.5	±18.65

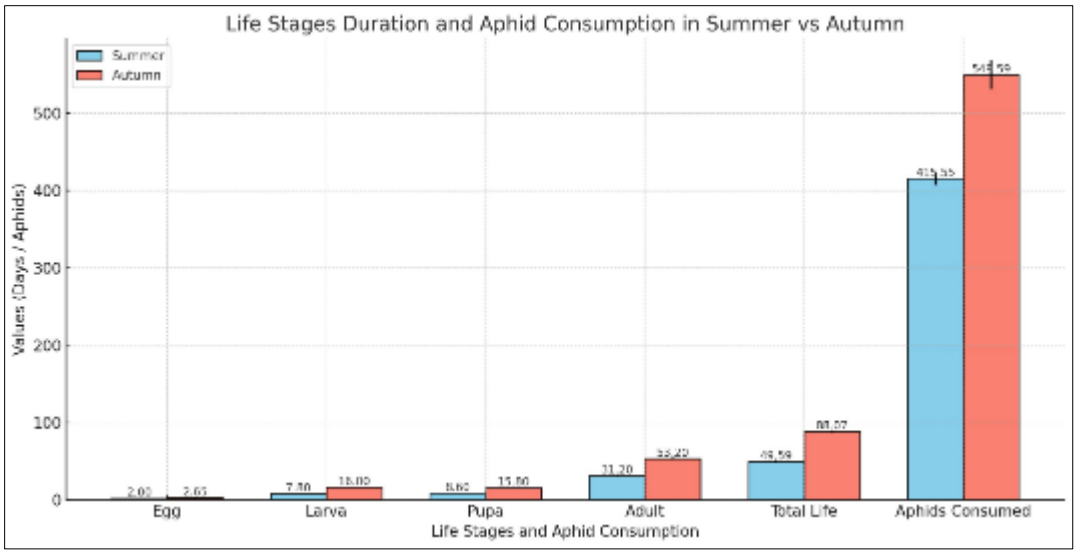

Figure 2 Life stage Duration and Aphids Consumption

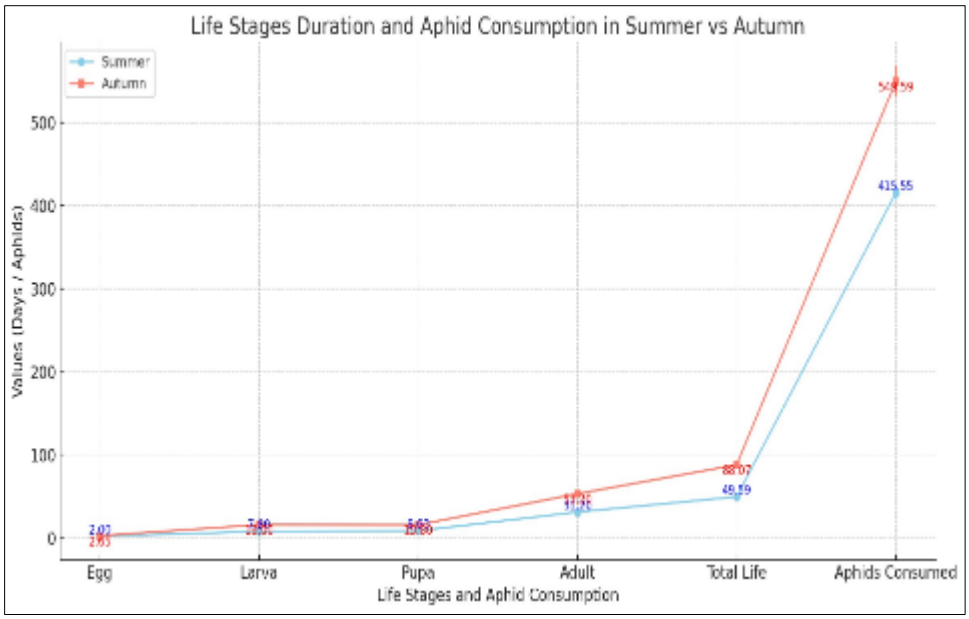

Figure 3 Life stage Duration and Aphids Consumption in Summer vs Autumn

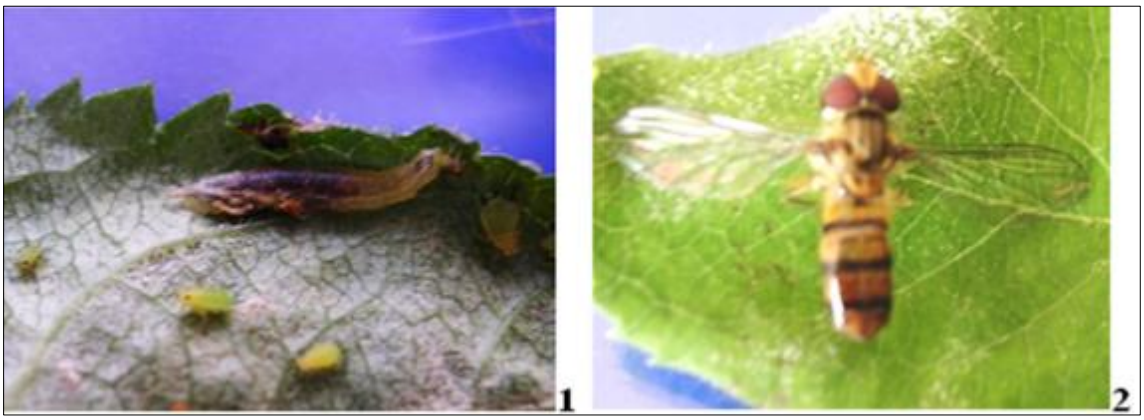

Figure 4 and 5 Larva and Adult fly of *Episyrphus balteatus* De Geer

5. Conclusion

This species' first instar of larvae was a poor eater, but following instar stages saw an increase in their ability to eat. In their last instar, the larvae turn into ravenous eaters, devouring a hundred aphids every day. In this method, the syrphid fly larvae control the growing infestation of apple aphids, prevent catastrophic harm to the apple nursery plants. In the summer, the larvae of *Episyrphus balteatus* De Geer ingested on average 420.59 aphids, while in the fall, they ate on average 549.50 aphids.

Current research suggests that this species of syrphid flies should be raised extensively for use in biological control of the aphid pest of apple nurseries and young plants, Aphis pomi De Geer, in Rohilkhand, Uttar Pradesh state India.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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