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DIVERSITY STUDY OF APHIDS FAUNA OCCURRED IN MAJOR KHARIF AND RABI CROP ECOSYSTEMS IN BAREILY REGION

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ABSTRACT

One of the most numerous bug species in the world is the aphid. Aphids are very prolific because they mostly reproduce parthenogenetically. Numerous aphid species have intricate life cycles that alternate between sexual and asexual generations as well as host plants. While feeding, an aphid excretes a distinctive sweet liquid called honeydew that draws wasps, butterflies, some moths, even infamously some types of ants. Aphids primarily feed by extracting cell sap from the leaves of plants. It primarily impacts plants by weakening and deforming the host plant, slowing growth, secreting copious amounts of honeydew, and spreading plant viruses to various crops, necessitating crop management techniques. A wide group of insects are called aphids. The majority of aphid species are known to feed on only a small number of host plants and are host-specific. *Aphis craccivora Koch* is one of the aphid species that primarily feeds on a variety of crops, such as cowpea, groundnut, pigeon pea, green gram, black gram, soybean, broad bean, and pea, impacting the growth and market value of these crops by draining cell sap from different plant parts.

KEY WORDS: *Aphids, Bug Species, Homoptera, Agricultural Crops, Cytogeneticists.*

INTRODUCTION

Aphids are a kind of tiny bug that belongs to the order Homoptera that infects 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 Arthopoda, 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 colonise 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 recognised as major pests of agricultural 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 from India so far (Agarwala 2007). They are able to 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, heteroecious, 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 term "Holocyclic" 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 holocyclic or anholocyclic life cycles within a single population, depending on the environmental conditions (Wohrmann and Tomiuk, 1988).

The cytogenetical processes in aphids are quite complicated, and many of them are still contentious while being intriguing. Viviparity, telescoping of generations, the holocentric structure of the chromosomes, and the tiny size of the chromosomes all make it exceedingly challenging to conduct cytological examinations on these organisms.

Aphids lay parthenogenetic eggs, which mature by a single cell division and result in the formation of a single polar body. These eggs are fertilised by the female. The formation of chiasmata and pairing of homologous chromosomes is said to take place during the maturation of a parthenogenetically growing egg, according to one perspective about this issue. Following this step, the homologues split apart, but the nuclear membrane has not yet been damaged. This process is referred to as endometriosis, and it is believed to be responsible for the occurrence of genetic recombination (Cognettif 1961b).

On the other hand, Blackman (1978) reports that the maturation division of parthenogenetic eggs in aphids is of the apomictic type. This means that there is no synapsis of homologous chromosomes, which results in an ordinary mitosis-like division that produces offspring that are genetically identical to their mother.

Sex determination in aphids is of the “XX-XO” type, and it is unusual in that it is the behaviour of the sex chromosomes during the maturation of parthenogenetically developing oocytes that decides the sex of the developing oocyte. Aphids have sexual reproduction, so the sex of the developing oocyte is not determined by its parents. Only parthenogenetic females are produced from the eggs of sexual females since none of the eggs are fertilised. During the process of a single maturation division, an egg has to shed fifty percent of the sex chromatin that was inherited from its mother in order to be capable of producing a male.

During the growth phase of the presumptive oocyte, the X chromosomes are said to be paired end-to-end to form a condensed C-shaped bivalent, as stated by Orlando (1974). After this, the X chromosomes are said to go through a division of the meiotic type all on their own on the maturation division spindle. After the results of the pairing process have been separated, one of the X chromosomes will travel to the end of the spindle while the other will split equationally with the autosomes. This will result in the male egg containing just one chromatid of the original X bivalent.

In putative male oocytes, Blackman and Hales (1986) observed the creation of a spherical nucleolar body to which X chromosomes stay connected. This phenomenon was discovered by Blackman and Hales. Some aphid species have been shown to contain various X chromosome systems, including X_1, X_2O, in addition to the XO sex chromosome composition that has been described before (Blackman, 1988; Hales, 1989).

RESEARCH METHODOLOGY

Material for the aphid species was gathered for this cytological investigation from the, Rohilkhand villages of Bareilly, Uttar Pradesh in India. In and around the villages of the Rohilkhand Region of Bareilly the samples of aphids are gathered from a variety of plants. Additionally, natural and horticultural plants were examined for aphids.

Aphid samples were gathered from the fields together with their host plants in polythene bags that were secured with rubber bands to prevent them from escaping. Scissors were used to carefully cut away a twig from the infected host plant.

The material was kept in it gradually to avoid upsetting the aphid colony, together with its ant companions, parasites, and predators, if any were present. These were delivered to the lab for additional cytological processing. The gathered material was used to create the cytological slides (aphids). The specimens (alatae, apterae, and nymphs) were kept in 70% alcohol side by side for each and every sample that was collected for use in taxonomic identification. After gathering all aphid material in 70% alcohol, all the unidentified host plants were also collected, transported to the lab, and kept as herbarium in order to be identified at a later time.

The similar process was used for the outstation collection. Daily cytological slides were created using these samples, which were collected from the field. The aphids were removed from their host plants using a fine camel brush. The ideal aphids for cytological preparations are live ones. Additionally, these aphids were preserved in a 3:1 mixture of glacial acetic acid and methanol for potential usage in the event of a shortage. Every sample of the aphid population had its samples of alatae, apterae, and nymphs collected and kept in glass jars with 70% alcohol. Because storage fluid should have the ability to have high penetration, 70% alcohol is chosen for good preservation. The aphids were put on slides and forwarded for taxonomic identification at that point. The majority of the plants were also kept (as herbarium specimens) in case future identification was necessary.

Data Analysis

The Shannon-Wiener index, which is sensitive to changes in the abundance of rare species in a community, and the Simpson index, which is sensitive to changes in the most abundant species in a community, were employed to examine the diversity of predaceous insects (Solow, 1993). The total number of species (S) and the total number of individuals of all species (N) in a habitat serve as the foundation for the simplest species richness index. In order to support the investigation, the Shannon diversity index and Simpson's index were computed.

RESULTS AND DISCUSSION

Total 1810 aphid specimens were gathered from different Kharif and Rabi crop agro-ecosystems in the Bareilly region during the study period. The information gathered showed that seven different species of aphids were found in the Bareilly region in various crop agro-ecosystems.

Our findings revealed a variety of aphid species and the associated predatory fauna that were present in different kharif and Rabi crop agro-ecosystems. During the examination at the area near Bareilly, seven different kinds of aphids and sixteen different species of related predatory fauna were discovered. Our findings indicated that a variety of agro-ecosystems may be the cause of the extensive predatory fauna seen in the Bareilly region.

Our findings showed that a number of predatory species, including Lady bird beetles, Syrphid flies, Mallada, Green lace wings, and 11 different species of spiders (*Neoscona sp., Eriovixia sp., Clubiona sp., Oxyopes pankajii, Leucauge adorn, Thomisus sp., Hyllus semicupreus, Tetragnatha* Spiders of various kinds were active during the course of the examination, and an effort was made to identify these significant predatory arthropods. Our findings are consistent with those of (Naikwadi *et al.*, 2015), who noted the presence of four spider species in the kharif agro-ecosystem in the Bareilly district: *Neoscona sp., Oxyopes pankajii, Thomisus sp., and Pseusetia sp.* The *Neoscona sp.* and *Oxyopes pankajii* species that were found throughout the inquiry supported the conclusions.

Table 1: Agro ecosystem wise activity of Aphids and associated predatory fauna in *kharif* & *Rabi* crops in Bareilly district

S. No	Agro	Name of Aphids	Name of Predatory fauna found

	ecosystem	species	
	Kharif crop		
1.	Cotton	*Aphis gossypii* (Glover)	Lady bird beetle, Syrphid fly, Mallada, Green lace wing, Spiders (*Neoscona* sp., *Eriovixia* sp., *Clubiona* sp., *Oxyopes pankajii)*
2.	Cowpea	*Aphis craccivora (Fabricius)*	Lady bird beetle, Syrphid fly, Spiders (*Neoscona* sp., *Leucauge decorate)*
3.	Okra	*Aphis gossypii* (Glover)	Lady bird beetle, Syrphid fly, Mallada, Spider (*Neoscona* sp., *Eriovixia* sp., *Thomisus* sp.)
4.	Sorghum	*Rhopalosiphum maidis* (Fitch)	Lady bird beetle,Syrphid fly, Mallada, Green lace wing, Spiders (*Neoscona sp., Hyllus semicupreus, Tetragnatha sp., Eriovixia sp., Oxyopes pankajii)*
5.	Bean	*Aphis craccivora* (Fabricius)	Lady bird beetle, Syrphid fly, Spiders (*Neoscona* sp., *Leucauge decorate)*
	Kharif & Rabi crop		
6.	Citrus	*Aphis (Taxoptera) citricidus* Kirkaldy	Lady bird beetle, Syrphid fly, green lace wing, *Mallada, Spiders (Neoscona sp., Eriovixia sp., Araneus sp., Cyrtophora cicatrosa)*
	Rabi Crops		
7.	Sunflower	*Aphis gossypii* Glover	Lady bird beetle, Spiders (*Neoscona* sp., *Eriovixia* sp., *Clubiniona* sp.)
8.	Wheat	*Hysteroneura setariae*	Lady bird beetle, Spider *(Neoscona* sp., *Eriovixia* sp.)
9.	Mustard	*Lipaphis erysimi* Kaltenbach	Lady bird beetle, Syrphid fly, Spiders (*Neoscona* sp., *Clubiona* sp., *Thomisus* sp.)
10.	Safflower	*Uroleucon compositae* Theobald	Lady bird beetle, Syrphid fly, green lace wing, Spiders (*Neoscona* sp., *Eriovxia* sp., *Leucauge decorate)*

Similar findings were made by (Menon and Thangavelu, 1979), who documented the presence of several predators in the cotton ecosystem, including coccinellids, mantids, syrphid flies, and Chrysoperla species. *A. craccivora* on cowpea was shown to be connected with the predatory fauna *C. sexmaculata, C. transversalis, C. septumpunctata*, *Hormonia octomaculata, Paragus serratus*, and *I. scutellaris*, according to Joshi *et al.*, 1997.'s paper. The present findings were supported by *C. sexmaculata, C. transversalis, and I. scutellaris*, which were observed during the experiment. Similar findings were made by (Ramya and Thangjum 2016), who discovered *C. sexmaculata and C. transversalis* in citrus ecosystems along with other species. Three coccinellid predators and nine spiders were reported by an earlier researcher (Basappa 2011) in sunflower habitats, and (Naikwadi *et al*,.2015) also identified coccinellids and spiders in the sunflower environment in the Bareilly district, supporting the present findings.

According to Magurran A.E. 1988, diversity indices evaluate both species richness and evenness, i.e., they identify both. It has been determined that the Shannon-Wiener index (H) (1.54), the Simpson index (D) (0.75), and the evenness index (0.79), which measures how evenly species are distributed in the sample, are responsive to changes in the number of unusual species in a community. According to the diversity indices, the abundance of aphid species in the Kharif and Rabi crop Agro-ecosystem in the region of Bareilly may be a result of the ideal climatic conditions, including temperature, humidity, water, and an enough number of hosts. The Wiener index value (1.54) in the current study indicates the presence of uncommon species in the aphid population. The greatest evenness measure, which indicates evenly distributed species in a sample, was most prevalent (0.79).

Table 2: Relative abundance of aphid fauna in kharif and Rabi crops agro-ecosystem diversity in Bareilly region

Species	No. of specimen recorded	Relative Abundance	pi lnpi	Month (Number of species found)						
				July (17)	Aug (496)	Sept (208)	Oct (28)	Nov (606)	Dec (1342)	Jan (498)
Aphis gossypii	167	0.09	-0.220	0	48	12	0	4	12	2
Aphis	543	0.30	-0.361	5	152	61	6	107	81	89

craccivora										
Rhopalosiphum maidis	54	0.03	-0.105	0	41	13	0	0	35	0
Aphis (*Taxoptera*) *Citricidus*	209	0.12	-0.249	4	7	18	8	99	11	0
Hysteroneura setariae	13	0.01	-0.035	0	0	0	0	7	137	13
Lipaphis erysimi	150	0.08	-0.207	0	0	0	0	86	395	145
Uroleucon compositae	674	0.37	-0.368	8	248	104	14	303	671	249
	Shannon-Wiener index (H) = 1.545									
	Simpson index (1-D) = 0.75									
	Evenness index (E) = 0.79									

Neoscona was the most active genus in the kharif agro-ecosystem during the current inquiry, which is consistent with the earlier finding of (Naikwadi *et al.*, 2015), who in his studies had reported the highest occurrence of Neoscona sp. in the kharif agro-ecosystem at Bareilly. The current observations on coccinellids are consistent with those made by Ramya and Thangjum in 2016, who identified *C. sexmaculata* and *C. transversalis* in citrus habitats alongside other species. Three coccinellid predators and nine spiders were reported by an earlier researcher (Basappa 2011) in sunflower habitats, and (Naikwadi *et al.*, 2015) also identified coccinellids and spiders in the sunflower environment in the Bareilly district, supporting the present findings.

CONCLUSION

Our findings are consistent with those of (Nagrare *et al.*, 2015), who found fifteen species of spiders from a rainfed cotton agroecosystem, with six families represented: Araneidae, Oxyopidae, Thomisidae, Salticidae, Tetragnathidae, and Theridiidae, the latter of which is primarily dominant. In the cotton agro-ecosystem, *Neoscona theisi*, *Oxyopes pankaji*, and Thomisus spectabilis have also been recorded to appear often. Our findings on the Shannon biodiversity index of aphids and associated predatory fauna were consistent with those of (Basappa 2011), which found that the sunflower ecosystem was home to 48 species of natural enemies, 07 parasitoids, 24 insect predators, 09 spiders, and 08 predatory birds.

The existence of *Cheilomenes sexmaculata* (Fabricius), found prominent predatory fauna, followed by *Ischiodon scutellaris*, was suggested by the cowpea ecosystem's biodiversity index.

Similar findings were made by (Ali *et al.*, 2013), who noted the population density of the faba bean and cowpea aphid, *Aphis craccivora* Koch, and its related predators. *Coccinella undecimpunctata L., Chrysoperla carnea Steph., Paederus alfierii (Koch.), Orius sp., Syrphus sp., Scymnus sp.*, and *Cydonia vicinaisis* were the most frequent predators found in faba bean and cowpea fields (Muls.).

Seven different aphid species and sixteen different predator species were identified during the course of the inquiry. Seven aphid species, including *Aphis gossypii* (Glover), *Aphis craccivora* (Koch), Rhopalosiphum maidis (Fitch), *Aphis* (Taxoptera) *citricidus* (Kirkaldy), *Lipaphis erysimi* (Kaltenbach), *Hysteroneura setariae* (Thomas), and *Uroleucon compositae,* were observed from various (Theobald). Data on aphid species revealed that *U. compositae*, which made up 37.24 percent, had a diverse fauna. *A. craccivora, A. (Taxoptera) citricius, A. gossypii*, *L. erysimi*, *R. maidis*, and other species were then listed after it. In the neighbourhood of Bareilly, the aphid species *H. setariae* (0.72%) was noted with minimal fauna. Among the sixteen species of predators, *C. sexmaculata* contributed the most (53.17%), followed by Neoscona species, *C. transversalis* species, *Mallada* species, Illeis species, Eriovixia species, *Oxyopes pankajii* species, *Chrysoperla* species, *Thomisus* species, and *Tetragnatha* species. However, over the course of the examination, 0.49 percent of the spider species *Hyllus semicupreus, Araneus sp*., and *Cyrtophora cicatrosa* were observed. According to the aphid species' Shannon diversity index, *U. compositae* was the most numerous species (-0.368), followed by *A. craccivora. A. (Taxoptera) citricidus, A. gossypii*, and *L. erysimi*, on the other hand, displayed intermediate population abundance. *R. maidis* and *H. setariae,* on the other hand, had lower densities in the population of aphid fauna. However, the area around Bareilly showed a high Shannon biodiversity index for the aphid population (H'=1.545). *C. sexmaculata* displayed the greatest population abundance among predators, according to the Shannon Diversity Index (-0.336), followed by *I. scutellaris*.

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