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REVIEW ARTICLE

Predators and Parasitoids of Aphids (Aphididae: Homoptera) Infesting Potato Crops in India

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ABSTRACT

The present article enlists the predators and parasitoids of the aphids (Aphididae: Hemiptera) infesting potato crops and their distribution in different states and union territories of India. Most of them are found to prey/parasitise *Myzus persicae* (Sulzer) and *Aphis gossypii* Glover. The predators belong to the order Araneae (families Araneidae, Oxyopidae, and Philodromidae) within the class Arachnida, and three orders within the class Insecta: Coleoptera (Coccinellidae), Diptera (Syrphidae), and Neuroptera (Chrysopidae). A total of 43 species of predators from various taxa were recorded to feed 4 species of the potato aphids distributed in 12 states/ union territories of India. The highest number of predators belonged to the families Coccinellidae (27 species) and Syrphidae (8 species). Most of the tritrophic associations (triplets, predators-preys-host plants) of these predators were reported in Uttar Pradesh (20 triplets), Manipur (19 triplets), Maharashtra and West Bengal (10 triplets each), and other states/union territories with less than 10 triplets. All the parasitoids of potato aphids belong to two subfamilies, Aphelininae (Aphelinidae: Hymenoptera) and Aphidiinae (Braconidae: Hymenoptera) in India. A total of 15 parasitoid species were observed parasitising potato aphids across 10 states/union territories of India. The highest number of tritrophic associations (triplets) was recorded in Manipur (6 triplets), followed by Uttar Pradesh and Uttarakhand (5 triplets each), with fewer than 5 triplets reported from other regions. Notably, limited efforts have been made to document the natural enemies of potato aphids in India. A comprehensive and systematic survey is required to assess their diversity in unexplored regions, highlighting the need for comprehensive and systematic surveys to fully assess their diversity.

KEY WORDS: Aphelinidae, Aphidiinae, Biocontrol, Chrysopidae, Coccinellidae, Parasitoids, Potato aphids, Predators, Syrphidae.

INTRODUCTION

Potato (*Solanum tuberosum* L.), also known as "the king of vegetables", is the third most important food crop in the world after rice and wheat in terms of human consumption. It is one of the main commercial horticultural crops grown in nearly every state in India. Uttar Pradesh leads in potato cultivation, followed by West Bengal, Bihar, Gujarat, Madhya Pradesh, Assam, Haryana, and others (Chandel *et al*., 2008). Due to its high nutritional value and dry matter content per unit area and time, potato is recognized as one of the most important food crops. In 2008, the FAO designated it as a key crop for addressing global food security and poverty alleviation. The annual potato production of India is approximately 60 million tonnes (Singh & Dutt, 2024). However, potato cultivation faces significant challenges, particularly from pests and diseases, affecting the crop from the nursery stage to the harvest.

More than 100 species of insects attack potato plants. These pests damage potato plants by feeding on the foliage and attacking potato tubers. The common insect pests of potato tubers include white grubs, cutworms, potato tuber moths, termites, red ants, and mole crickets, while sap-feeding pests include aphids, leafhoppers,

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thrips, and whiteflies. Among the sap-sucking insects, aphids cause major damage to potato crops. Chandel *et al.* (2008) have reported five species of aphids as pests of potato crops: *Aphis fabae* Scopoli, *Aphis gossypii* (Glover), *Myzus persicae* (Sulzer), *Rhopalosiphoninus latysiphon* (Davidson, 1912) and *Rhopalosiphum rufiabdominalis* (Sasaki). However, Singh & Singh (2022a) & Singh *et al.* (2023a) listed 21 species of aphids to feed potato crops in India. Among them, only two species, *Aphis gossypii* Glover and *Myzus persicae* (Sulzer), are highly polyphagous and pestiferous (Singh, 2024a,b). High aphid populations of these species may have considerable direct effects on yield, but such populations are uncommon in commercial potato production (Chandel *et al*., 2008). These aphids produce profuse amounts of honeydew, a sweet and watery anal excretory material that provides a medium on which sooty mould grows that blackens the leaf and reduces the photosynthesis of the host plants and the yield of the crops (Singh & Singh, 2021). However, the major concern with aphids is usually their role as virus vectors. Both wingless and winged morphs transmit several plant viruses which cause significantly greater loss than damage caused by direct feeding injury (Singh & Singh, 2022b). Out of 620 plant viruses known in the bioscience, about one-third are arthropod-borne and more than 80 per cent are transmitted by aphids (Ghosh *et al*., 2017; Singh & Singh, 2021). *Aphis gossypii* Glover transmits at least 80 plant viruses (Singh & Singh, 2016) while *Myzus persicae* (Sulzer) transmits 182 plant viruses (Chan *et al*., 1991).

Due to ecological disorders caused by pesticides, biological control is considered as the most promising practice for sustainable agriculture (Singh, 2001). There are several arthropods that either feed (predators) or parasitise (parasitoids) aphids in nature keeping their population under control. These natural enemies are one of the important basic components in the food chain and food web within all agroecosystems. Several species of parasitoids and predators have been used in the biological control of aphids throughout the world (Singh & Singh, 2016). The richness in species of natural enemies of insects and their populations play critical effects in the stability of agroecosystems (Cardinale *et al*., 2006). Therefore, the tritrophic associations between plants, pest insects and the associated natural enemies provide an essential basis for planning an effective biocontrol method (Singh, 2003; Del-Claro, 2004).

The global trend in aphid biocontrol emphasizes the conservation of local natural enemies, which requires a comprehensive understanding of the aphid-predator/parasitoid assemblages in a given region (Pons *et al*., 2018). Preserving these naturally occurring biocontrol agents in agricultural fields may enhance their effectiveness in regulating aphid populations. Therefore, studying tritrophic interactions (predator/parasitoid-aphid-plant) is essential. However, existing data remain fragmented, consisting of isolated species records, limited life cycle studies, and scattered information on the biology and ecology of a few species at the national level. This article aims to document the natural enemies of potato aphids across different states and union territories of India. The findings highlight that large parts of the country remain unexplored for aphid natural enemies. This checklist serves as a valuable resource for taxonomists, researchers, academicians, conservation managers, and policymakers, facilitating their effective integration into natural and biological control programmes against aphid pests.

MATERIAL & METHODS

The present checklist is based on the primary data of published literature on predators and parasitoids, e.g. books, book chapters, journals, proceedings of conferences, review articles and a few authentic theses up to January 31, 2025. In most of the recent literature, there are several errors in the scientific names of the predators/parasitoids as well as their aphid hosts and food plants because of their modified status and other nomenclatural decisions and clarifications. The names of aphids, as well as plants that were misspelt in the original records, have been corrected where we logically ascertained the intended species. In the present checklist, attempts have been made to provide the valid scientific names of the predators/parasitoids following GBIF (2025), aphids following Favret (2025), and the plants, following WFO, 2025. Synonymy of only aphid predators/parasitoids are given and for the synonymy of aphids and host plants, cited sources may be consulted.

RESULTS & DISCUSSION

Singh & Singh (2022a) and Singh *et al.* (2023a) listed 21 species of aphids infesting potatoes in India. However, the perusal of literature reveals that only four aphid species are preyed upon by 43 predator species, while seven aphid species are parasitized by 15 parasitoid species across different taxa in 12 states and one union territory of India.

A. Predators of potato aphids

The data presented in Table 1 indicate that a total of 43 predator species have been recorded preying on four species of potato aphids out of the 21 aphid species documented (Singh *et al*., 2023a). These predators belong to the one arachnid order, Araneae (families Araneidae, Oxyopidae, and Philodromidae), and three insect orders: Coleoptera (family Coccinellidae), Diptera (family

Table 1: Number of species of predators belonging to the different taxa preying on different number of aphid species infesting potato crop distributed in number of states/states/union territories of India

Order	Families of predators	Number of			
		Predator species	Aphid species	Tritrophic associations	States/union territories
Araneae	Areneidae	3	1	3	2
	Oxyopidae	1	1	1	1
	Philodromidae	1	1	1	1
Coleoptera	Coccinellidae	27	3	39	10
Diptera	Syrphidae	8	3	12	9
Neuroptera	Chrysopidae	3	1	3	6
	Total	43	4	59	12

Syrphidae), and Neuroptera (family Chrysopidae). Their distribution is limited to 12 states and union territories of India (Table 1). Notably, in several potato-growing states, including Assam, Chhattisgarh, Gujarat, Haryana, Jharkhand, Madhya Pradesh, Odisha, and Punjab, no predator species have been recorded preying on aphids in potato crops (Fig. 1). The highest predator diversity was observed in Uttar Pradesh (13 species, 20 tritrophic associations), followed by Manipur (11 species, 19 triplets), and Maharashtra and West Bengal (each with 10 species and 10 triplets). Fewer than 10 predator species were recorded in the remaining states (Fig. 1). Among the aphid species, *Myzus persicae* (Sulzer) was the most frequently preyed upon, with 38 predator species recorded, followed by *Aphis gossypii* Glover, which was preyed upon by 15 species (Table 2).

I. Class: Arachnida

a. Order: Araneae: The order Araneae comprises spiders which are an extremely precious component of the earth's ecosystem being predatory devouring mostly insects and keeping their population under check. Unlike insect predators, their potential as biocontrol agents is not exploited (Singh *et al.*, 2023b). Recently, Singh *et al.* (2024a) reported 79 species of aphidophagous spiders in India preying on 53 species of aphids infesting 59 species of plants. Table 1 enlists only 5 species of spiders belonging to 3 families known to prey only *Myzus persicae* (Sulzer) feeding on potatoes in India, particularly in Karnataka and West Bengal. Minimal attempts have been

Table 2: Number of species of predators belonging to different taxa preying different species of aphid infesting potato crop distributed in different number of states/union territories of India

Aphid species		Predator species	States/union territories
1.	*Aphis craccivora*	3	1
2.	*Aphis gossypii*	15	4
3.	*Myzus persicae*	38	12
4.	*Rhopalosiphum maidis*	1	1
5.	Unidentified aphid	2	1
	Total	43	12

Fig. 1: Map showing the number of species of predators of potato aphids in different states/union territories of India. No species of the predators was recorded in the red shaded states/union territories of India

made to record these aphidophagous spiders in India, and an intensive and extensive survey plan is necessary to record them in unexplored areas.

i. Family: Araneidae

1. ***Cyclosa hexatuberculata*** **Tikader**, **1982**
   - *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)
     - Karnataka (Natikar & Balikai, 2018)
2. ***Neoscona theisi*** **(Walckenaer**, **1841)**
   - *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)
     - Karnataka (Natikar & Balikai, 2018)
3. ***Neoscona*** **sp.**
   - *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)
     - Karnataka (Natikar & Balikai, 2018); West Bengal (Nayak *et al*., 2019)

ii. Family: Oxyopidae

1. ***Oxyopes*** **sp.**
   - *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)
     - Nagaland (Amlari *et al.,* 2021); West Bengal (Nayak *et al*., 2019)

iii. Family: Philodromidae

1. ***Tibellus oblongus*** **(Walckenaer**, **1802**
   - *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)
     - West Bengal (Nayak *et al.,* 2019)

II. Class: Insecta

a. Order: Coleoptera, **Family: Coccinellidae:** Among Coleoptera, aphidophagous ladybird beetles are globally distributed. Although some species within this family are considered pests, more than 260 species are entomophagous, feeding on notorious soft-bodied insects such as aphids, mealybugs, scale insects, and whiteflies. These predatory species have been extensively utilized as biological control agents in both classical and applied biocontrol programs targeting aphids and other soft-bodied insect pests (Kumar & Omkar, 2023). Table 1 demonstrates that 27 species of these beetles feed on 3 species of potato aphids distributed in 10 states/union territories of India with 39 predator-prey-food plant associations (triplets). Most of the species of these ladybird beetles are reported from Uttar Pradesh (10 species, 15 triplets) followed by Manipur (8 species, 13 triplets), Maharashtra (6 species, 6 triplets), Jammu & Kashmir (5 species, 6 triplets), West Bengal (5 species, 5 triplets) and less species in other states. Among the potato aphids, *Myzus persicae* (Sulzer) and *Aphis gossypii* (Glover) serve as food for 21 and 12 species of predators, respectively. Detailed predator-prey records of potato aphids are given below.

1. ***Adalia decempunctata*** **(Linnaeus**, **1758)**
   - *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)
     - Himachal Pradesh (Thakur & Chandla, 2013)
2. ***Adalia tetraspilota*** **(Hope**, **1831)**
   - *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)
     - Himachal Pradesh (Trivedi & Rajagopal, 1988; Thakur & Chandla, 2013); Jammu & Kashmir (Khan & Shah, 2017)
3. ***Brumoides suturalis*** **(Fabricius**, **1798) [syn.** ***Brumus suturalis*** **(Fabricius**, **1798)]**
   - *Aphis (Aphis) gossypii* Glover, 1877
     - Uttar Pradesh (Raj, 1989)
   - *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)
     - Uttar Pradesh (Raj, 1989)
4. ***Cheilomenes sexmaculata*** **(Fabricius**, **1781) [syn.** ***Menochilus sexmaculatus*** **(Fabricius**, **1781)]**
   - *Aphis (Aphis) gossypii* Glover, 1877
     - Manipur (Nonita *et al*., 2002); Uttar Pradesh (Raj, 1989)
   - *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)
     - Bihar (Ahmad *et al.*, 2012; Parween *et al.,* 2023); Himachal Pradesh (Thakur & Chandla, 2013); Karnataka (Natikar & Balikai, 2018); Manipur (Shantibala, 1989; Nonita *et al*., 2002); Nagaland (Amlari *et al.,* 2021); Uttar Pradesh (Raj, 1989); West Bengal (Nayak *et al.,* 2019)
   - Unidentified aphids
     - Maharashtra (Bagal & Trehan, 1945)
5. ***Coccinella septempunctata*** **Linnaeus**, **1758**
   - *Aphis (Aphis) gossypii* Glover, 1877
     - Manipur (Nonita *et al*., 2002); Uttar Pradesh (Raj, 1989; Tiwari *et al.,* 2024a)
   - *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)
     - Himachal Pradesh (Thakur & Chandla, 2013); Jammu & Kashmir (Bhat, 2017; Khan & Shah, 2017); Manipur (Shantibala & Singh, 1985; Nonita *et al.,* 2002); Meghalaya (Azad Thakur & Barwal, 1987); Uttar Pradesh (Raj, 1989; Omkar & Srivastava, 2003); West Bengal (Nayak *et al.,* 2019; Maji *et al.*, 2023)
   - Unidentified aphid
     - Maharashtra (Bagal & Trehan, 1945)
6. ***Coccinella transversalis*** **Fabricus**, **1781**
   - *Aphis (Aphis) gossypii* Glover, 1877

- Manipur (Nonita *et al.,* 2002); Uttar Pradesh (Raj, 1989; Tiwari *et al.,* 2024 a)

• *Myzus (Nectarosiphon) persicae* (Sulzer

- Bihar (Ahmad *et al.*, 2012; Parween *et al*., 2023); Manipur (Shantibala & Singh, 1985; Nonita *et al*., 2002); Uttar Pradesh (Raj, 1989; Tiwari *et al.,* 2024a); West Bengal (Nayak *et al*., 2019)

7. *Coccinella undecimpunctata* Linnaeus, 1758

• *Aphis (Aphis) craccivora* Koch, 1854

- Jammu & Kashmir (Bhat, 2017)

• *Aphis (Aphis) gossypii* Glover, 1877

- Uttar Pradesh (Chaudhary & Singh, 2012; Tiwari *et al.,* 2024 a)

8. *Coelophora bissellata* Mulsant, 1850 [syn. *Lemnia bissellata* (Mulsant, 1850)]

• *Aphis (Aphis) gossypii* Glover, 1877

- Manipur (Nonita *et al.,* 2002)

• *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)

- Manipur (Nonita *et al.,* 2002)

9. *Harmonia eucharis* (Mulsant, 1853)

• *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)

- Meghalaya (Azad Thakur & Barwal, 1987)

10. *Hippodamia variegata* (Goeze, 1777) [syn. *Adonia variegata* (Goeze, 1777)]

• *Aphis (Aphis) craccivora* Koch, 1854

- Jammu & Kashmir (Bhat, 2017)

• *Aphis (Aphis) gossypii* Glover, 1877

- Uttar Pradesh (Tiwari *et al*., 2024 a)

• *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)

- Jammu & Kashmir (Bhat, 2017; Khan & Shah, 2017)

11. *Horniolus guimeti* (Mulsant, 1850) [syn. *Scymnus guimeti* Mulsant, 1850]

• *Aphis (Aphis) gossypii* Glover, 1877

- Karnataka (Puttarudriah & Channa Basavanna, 1956)

12. *Mallada desjardinsi* (Navás, 1911) [syn. *Anisochrysa boninensis* (Okamoto, 1914); *Mallada boninensis* (Okamoto, 1914)]

• *Aphis (Aphis) gossypii* Glover, 1877

- Uttar Pradesh (Raj, 1989)

13. *Micraspis allardi* (Mulsant, 1866)

• *Aphis (Aphis) gossypii* Glover, 1877

- Uttar Pradesh (Raj, 1989)

• *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)

- Uttar Pradesh (Raj, 1989)

14. *Micraspis discolor* (Fabricius, 1798) [syn. *Verania discolor* (Fabricius, 1798)]

• *Aphis (Aphis) gossypii* Glover, 1877

- Manipur (Nonita *et al.,* 2002)

• *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)

- Bihar (Ahmad *et al.*, 2012; Parween *et al*., 2023); Manipur (Shantibala, 1989; Nonita *et al.,* 2002); West Bengal (Chakrabarti *et al.*, 2012; Nayak *et al.,* 2019; Maji *et al.*, 2023)

15. *Micraspis vincta* (Gorham, 1895)

• *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)

- Manipur (Shantibala & Singh, 1985)

16. *Nephus ancyroides* Pang & Pu, 1988 [syn. *Scymnus (Pullus) latemaculatus Motschulsky*, 1858]

• *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)

- Maharashtra (Bhandare, 2022)

17. *Oenopia kirbyi* Mulsant, 1850

• *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)

- Meghalaya (Azad Thakur & Barwal, 1987)

18. *Oenopia quadripunctata* Kapur, 1963

• *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)

- Manipur (Shantibala & Singh, 1985)

19. *Oenopia sexareata* (Mulsant, 1853) [syn. *Coelophora sexarcata* Mulsant, 1853)]

• *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)

- Meghalaya (Azad Thakur & Barwal, 1987)

20. *Oenopia* sp.

• *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)

- Manipur (Shantibala & Singh, 1985)

21. *Propylea dissecta* (Mulsant, 1850)

• *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)

- West Bengal (Nayak *et al*., 2019)

22. *Scymnus (Pullus) pyrocheilus* Mulsant, 1853

• *Aphis (Aphis) gossypii* Glover, 1877

- Uttar Pradesh (Raj, 1989; Chaudhary & Singh, 2012)

23. *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)

- Uttar Pradesh (Raj, 1989)

24. *Scymnus coccivora* Ayyar, 1925

• *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)

- Maharashtra (Bhandare, 2022)

25. *Scymnus loewii* Mulsant, 1850

• *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)

- Maharashtra (Bhandare, 2022)

26. *Scymnus nubilus* (Mulsant, 1850)

• *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)

- Maharashtra (Bhandare, 2022)

27. *Scymnus* sp.

• *Aphis (Aphis) craccivora* Koch, 1854

- Jammu & Kashmir (Bhat, 2017)

b. Order: Diptera, Family: Syrphidae: Among the Diptera, the family Syrphidae, commonly known as the hover flies, are the most common aphid predators and are globally distributed. Most hover flies provide dual ecological services: as adults, they contribute to crop pollination (Joshi *et al*., 2023), while their larvae serve as biological control agents by feeding on various soft-bodied insects, including aphids, mealybugs, scale insects, whiteflies, and thrips. Consequently, they play a crucial role in the natural regulation of these insect populations (Kumar & Omkar, 2023). Table 1 demonstrates that a total of 8 species of hover flies feed on 3 species of potato aphids. All these species are recorded feeding on *Myzus periscae* (Sulzer), mostly in different states/union territories of India. Detailed predator-prey records of potato aphids are given below:

1. *Betasyrphus serarius* (Wiedemann, 1830) [syn. *Syrphus serarius* Wiedemann, 1830]

• *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)

- Maharashtra (Bhandare, 2022)

2. *Episyrphus balteatus* (De Geer, 1776) [syn. *Syrphus balteatus* De Geer, 1776]

• *Aphis (Aphis) gossypii* Glover, 1877

- Jammu & Kashmir (Bhat & Bhagat, 2017); Manipur (Nonita *et al*., 2002); Uttar Pradesh (Raj, 1989; Tiwari *et al.,* 2024a); Uttarakhand (Bisht *et al.,* 2006)

• *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)

- Himachal Pradesh (Thakur & Chandla, 2013); Jammu & Kashmir (Bhat & Bhagat, 2017); Maharashtra (Bhandare, 2022); Manipur (Shantibala & Singh, 1985; Nonita *et al.*, 2002); Sikkim (Raychaudhuri *et al.,* 1979; Agarwala *et al.,* 1982); Uttar Pradesh (Raj, 1989; Tiwari *et al.,* 2024a); Uttarakhand (Ghosh *et al*., 1985; Bisht *et al.,* 2006); West Bengal (Agarwala *et al*., 1982; Nayak *et al*., 2019)

3. *Eupeodes* sp.

• *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)

- Himachal Pradesh (Thakur & Chandla, 2013)

4. *Ischiodon scutellaris* (Fabricius, 1805) [syn. *Xanthogramma scutellare* (Fabricius, 1805)]

• *Aphis (Aphis) gossypii* Glover, 1877

- Manipur (Nonita *et al.,* 2002); Uttar Pradesh (Raj, 1989)

• *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)

- Maharashtra (Bhandare, 2022); Manipur (Nonita *et al.,* 2002); Uttar Pradesh (Raj, 1989; Tiwari *et al*., 2024a); Uttarakhand (Ghosh *et al.,* 1985)

5. *Paragus serratus* (Fabricius, 1805)

• *Aphis (Aphis) gossypii* Glover, 1877

- Manipur (Nonita *et al*., 2002)

• *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)

- Manipur (Nonita *et al*., 2002); Uttar Pradesh (Tiwari *et al.,* 2024 a)

• *Rhopalosiphum maidis* (Fitch, 1856)

- Bihar (Kumar & Ahmad, 2017)

6. *Scaeva pyrastri* (Linnaeus, 1758)

• Myzus (Nectarosiphon) persicae (Sulzer, 1776)

- Himachal Pradesh (Thakur & Chandla, 2013)

7. *Sphaerophoria indiana* Bigot, 1884

• *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)

- Uttarakhand (Debnath, 1991)

8. *Sphaerophoria scripta* (Linnaeus, 1758)

• *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)

- Uttarakhand (Ghosh *et al.,* 1985)

c. Order: Neuroptera, Family: Chrysopidae: Neuroptera includes lacewings, mantis flies, antlions and their relatives and both adults and larvae are predatory. They are widely distributed and generalist predators of soft-bodied insects. Recently, Singh *et al.* (2024b) enlisted 32 species of aphidophagous neuropterans from India belonging to four families. However, members of only one family Chrysopidae, commonly known as green lacewings, were recorded to prey on potato aphids in India. Among them, only 8 species of lacewings prey on 3 species of potato aphids in 9 states/union territories of India (Table 1) as mentioned below:

1. *Chrysoperla zastrowi sillemi* (Esben- Petersen, 1935)

• *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)

- Himachal Pradesh (Thakur & Chandla, 2013); Jammu & Kashmir (Khan & Shah, 2017);

Maharashtra (Bhandare, 2022); West Bengal (Nayak *et al*., 2019)

2. ***Chrysoperla* sp.**
   - *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)
     - Karnataka (Natikar & Balikai, 2018)
3. ***Mallada desjardinsi* (Navás, 1911) [syn. *Anisochrysa boninensis* (Okamoto, 1914); *Mallada boninensis* (Okamoto, 1914)]**
   - *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)
     - Uttar Pradesh (Raj, 1989)

B. Parasitoids of potato aphids

The parasitoids of potato aphids belong to two families of the order Hymenoptera, the Aphelinidae (Superfamily Chalcidoidea) and Braconidae (Superfamily Ichneumonoidea). A total of 15 species of the parasitoids were recorded parasitising 7 species of potato aphids in 10 states/union territories of India (Table 3). Among the aphids infesting potato, *Myzus pericae* (Sulzer) and *Aphis gossypii* Glover were reported to be parasitised by 12 and 2 species of the parasitoids each in 10 and 3 states/union territories of India (Table 4). Most of the tritrophic associations (triplets, parasitoids-hosts-host plants) of these parasitoids are reported from Bihar (4 parasitoid species, 7 triplets) followed by Jammu & Kashmir, Manipur and Uttar Pradesh (4 parasitoid species, 5 triplets in each) and less than 5 triplets in other regions (Fig. 2). Interestingly, no parasitoid species of potato aphids were recorded in several potato-growing states. Indeed, there have been limited efforts to document these parasitoids across most states and union territories of India. A comprehensive and systematic survey is essential to identify their distribution in unexplored regions.

a. Order: Hymenoptera

i. Family: Aphelinidae: The Aphelinidae is a small group of chalcidoid wasps containing 60 genera and a little over a thousand species (GBIF, 2025). The family is a major source of biocontrol agents of economically important insect pest species such as coccoids, aphids and aleyrodids (Homoptera) (Singh & Singh, 2016). The members of its subfamily Aphelininae, tribe Aphelinini are exclusively aphid parasitoids (Starý, 1988). A total of 16 species of *Aphelinus* and a single species of *Protaphelinus* are recorded to parasitise aphids in India (Hayat, 1998). However, only 4 species of *Aphelinus* are recorded to parasitise a single species, *Myzus persicae* (Sulzer) on potato crops in only 6 states of India (Table 3). A detailed checklist is given below:

1. ***Aphelinus abdominalis* (Dalman, 1820)**
   - *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)
     - Himachal Pradesh (Thakur & Chandla, 2013)
2. ***Aphelinus albipodus* Hayat & Fatima, 1992**
   - *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)
     - Bihar (Parween *et al.,* 2023)
3. ***Aphelinus asychis* Walker, 1839**
   - *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)
     - Assam (Hayat, 1998); Meghalaya (Hayat, 1998); Tamil Nadu (Hayat, 1998); Uttar Pradesh (Hayat, 1998)
4. ***Aphelinus gossypii* Timberlake, 1924 [syn. *Aphelinus kashmiriensis* Hayat, 1972]**
   - *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)
     - Bihar (Ahmad & Singh, 2007; Parween *et al.,* 2023); Uttar Pradesh (Tripathi & Singh, 1997; Tiwari *et al.,* 2024b)

ii. Family: Braconidae, Subfamily: Aphidiinae: Das & Chakrabarti (2023) have catalogued 157 aphidiine species parasitising several aphid species in India. Out of these, 11 species are described/recorded from India parasitising 7 species of the aphids infesting potato crops in 8 states/ union territories of India (Table 3). The maximum number of parasitoids is known to parasitise *Myzus periscae* (Sulzer) (12 species of parasitoids) followed by *Aphis gossypii* Glover (2 species of parasitoids). Other species are parasitised by a single species of parasitoids. A total of 21 tritrophic associations (parasitoid-aphid host-host, triplets) were observed. A detailed checklist is given below:

1. ***Aphidius colemani* Viereck, 1912**
   - *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)

Table 3: Number of species of parasitoids belonging to different taxa parasitising on different number of aphid species infesting potato crop distributed in number of states/states/union territory of India

Order	Families of predators/ Parasitoids	Number of			
		Parasitoid species	Aphid species	Tritrophic associations	States/union territories
Hymenoptera	Aphelinidae	4	1	4	6
	Braconidae	11	7	17	8
	Total	15	7	21	10

Table 4: Number of species of parasitoids belonging to different taxa parasitising different species of aphid infesting potato crop distributed in different number of states/ union territories of India

Aphid species		Parasitoid species	States/union territories
1.	*Aphis craccivora*	1	1
2.	*Aphis fabae*	1	1
3.	*Aphis gossypii*	2	3
4.	*Aphis nasturtii*	1	1
5.	*Aphis solanella*	1	1
6.	*Myzus persicae*	12	10
7.	*Neomyzus circumflexus*	1	1
	Total	15	10

Fig. 2: Map showing the number of species of parasitoids of potato aphids in different states/ union territories of India. No species of the parasitoids was recorded in the red shaded states/union territories of India

- Bihar (Kumar, 2013); Himachal Pradesh (Trivedi & Rajagopal, 1988); Jammu & Kashmir (Khan & Shah, 2017); Karnataka (Trivedi & Saxena, 1988); Manipur (Singh & Singh, 1986; Subhrani *et al.,* 2006)

2. *Aphidius matricariae* Haliday, 1834

• *Aphis (Aphis) gossypii* Glover, 1877

- Manipur (Nonita *et al*., 2002; Subhrani *et al*., 2010)

• *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)

- Manipur (Nonita *et al*., 2002; Subhrani *et al*., 2010)

3. *Aphidius similis* Stary & Carver, 1980

• *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)

- Sikkim (Agarwala *et al*., 1980)

4. *Aphidius* sp.

• *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)

- Himachal Pradesh (Thakur & Chandla, 2013)

5. *Binodoxys indicus* (Subba Rao & Sharma, 1958) [syn. *Trioxys indicus* Subba Rao & Sharma, 1958]

• *Aphis (Aphis) gossypii* Glover, 1877

- Bihar (Ahmad & Singh, 1997; Ahmad *et al*., 2020); Manipur (Nonita *et al*., 2002; Subhrani *et al*., 2006); Uttar Pradesh (Shuja-Uddin, 1973; Tiwari *et al*., 2024b)

• *Aphis (Aphis) fabae* Scopoli, 1763

- Jammu & Kashmir (Chakrabarti & Debnath, 2009)

• *Aphis (Aphis) nasturtii* Kaltenbach, 1843

- Bihar (Ahmad *et al*., 2020)

• *Aphis (Aphis) solanella* Theobald, 1914

- Jammu & Kashmir (Chakrabarti & Debnath, 2009)

• *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)

- Bihar (Ahmad & Singh, 2007); Manipur (Nonita *et al*., 2002); Uttar Pradesh (Singh & Tripathi, 1987; Singh *et al*., 1999)

6. *Binodoxys sinensis* Mackauer, 1962

• *Neomyzus circumflexus* (Buckton, 1876)

- Meghalaya (Samanta, 1986)

7. *Diaeretiella rapae* (McIntosh, 1855)

• *Aphis (Aphis) craccivora* Koch, 1854

- Jammu & Kashmir (Bhagat & Ahmad, 1991)

8. *Ephedrus plagiator* (Nees, 1811)

• *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)

- Sikkim (Agarwala *et al*., 1980)

9. *Lipolexis oregmae* (Gahan, 1932) [syn. *Lipolexis pseudoscutellaris* Pramanik & Raychaudhuri, 1984; *Lipolexis scutellaris* Mackauer, 1962]

• *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)

- Uttar Pradesh (Rafi *et al*., 2010)

10. *Praon volucre* (Haliday, 1833) [syn. *Praon myzophagum* Mackauer, 1959]

• *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)

- Himachal Pradesh (Ghosh & Agarwala, 1982)

11. *Toxares zakai* Shuja-Uddin, 1974

• *Myzus (Nectarosiphon) persicae* (Sulzer, 1776)

- Jammu & Kashmir (Khan & Shah, 2017)

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