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REVIEW ARTICLE

A Catalogue of Tri-Trophic Associations of Arthropod Predators, Aphids, and Their Host Plants in Different Districts of Maharashtra, India

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ABSTRACT

The present article deals with the tri-trophic associations of aphidophagous arthropods in Maharashtra, India. The compiled data reveal 354 distinct tri-trophic associations involving 51 aphidophagous predator species (insects and spiders), 17 aphid species, and 26 host plant species across 14 districts of the state. Predators belong to two arthropod classes, Arachnida (Araneae: seven spider families) and Insecta (Coleoptera, Diptera, Hemiptera, Lepidoptera, and Neuroptera), encompassing both generalist and specialist feeding guilds. Coccinellidae emerged as the most species-rich and widely distributed group (23 species; 207 associations), followed by spiders (17 species; 65 associations) and Syrphidae (five species; 40 associations). Aphid–predator interactions were most frequent on *Aphis gossypii, Myzus persicae*, *Aphis craccivora, Lipaphis erysimi, Rhopalosiphum maidis*, and *Ceratovacuna lanigera*, primarily on economically important crops. Spatially, Kolhapur, Pune, Akola, and Aurangabad accounted for the majority of records, while nearly two-thirds of Maharashtra remains unexplored. Overall, the results indicate a functionally integrated but comparatively under-documented trophic network relative to northern Indian states. This consolidated account provides a critical baseline for ecological research, biodiversity assessment, and the development of region-specific integrated pest management strategies in Maharashtra.

KEY WORDS: Aphid, biodiversity, conservation, hover flies, lacewings, ladybirds, Maharashtra, predators, tri-trophic associations,

INTRODUCTION

Aphids (Hemiptera: Aphididae) are among the most destructive groups of phytophagous insects in agricultural and natural ecosystems. By feeding on plant phloem sap, they directly reduce plant vigour and productivity and indirectly cause damage through the transmission of numerous plant viruses. Their high reproductive potential, polyphenism, and ability to rapidly colonise host plants enable aphids to attain outbreak densities, particularly in intensively managed agroecosystems (Singh & Singh, 2022). Consequently, aphids infest a wide range of crops, including cereals, pulses, oilseeds, vegetables, fruit crops, ornamentals, and weeds, resulting in substantial economic losses worldwide (Singh *et al.*, 2023a).

Arthropod predators play a pivotal role in the natural regulation of aphid populations. A diverse assemblage of predatory insects and arachnids, including ladybird beetles (Coccinellidae: Coleoptera) (Singh, 2025a), hover fly larvae (Syrphidae: Diptera) (Singh, 2026), lacewings (Neuroptera) (Singh *et al.*, 2024a), minute pirate bugs (Anthocoridae: Hemiptera) (Singh & Srivastav, 2024), and spiders (Araneae) (Singh *et al.*, 2024b), actively exploit aphids as prey. Many of these predators are generalists, capable of responding numerically and functionally to aphid population increases, thereby contributing to the suppression of aphid outbreaks.

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Their effectiveness is often enhanced by their mobility, high feeding rates, and ability to persist in crop habitats even at low prey densities (Singh & Singh, 2016).

The interactions among host plants, aphids, and their arthropod predators constitute complex tri-trophic associations that play a pivotal role in structuring food webs within both natural and agroecosystems. Host plants regulate aphid distribution, abundance, and nutritional quality through traits such as phenology, secondary metabolites, and structural complexity, which in turn influence predator attraction, foraging efficiency, and performance. Aphid-mediated cues, including honeydew production and herbivore-induced plant volatiles, further facilitate prey detection by predators, thereby strengthening trophic linkages and enhancing biological control efficiency (Singh, 2003). Documentation of these tri-trophic associations provides a critical foundation for ecological research, biodiversity conservation, and sustainable pest management by elucidating pathways of energy flow, trophic connectivity, and mechanisms governing ecosystem stability and resilience (Abdala-Roberts *et al.*, 2019; Singh & Srivastav, 2025; Singh & Omkar, 2025). Detailed tri-trophic data clarify how host-plant diversity and habitat structure shape aphid population dynamics and predator community composition, enabling differentiation between generalist predators that provide broad-spectrum pest suppression and specialist species that contribute to ecological stability through targeted regulation of specific aphid hosts. Moreover, such records capture spatiotemporal variation, demonstrating how seasonal changes in plant availability and aphid abundance affect predator occurrence, prey selection, and predation efficiency (Aroun *et al.*, 2015). Collectively, these insights support ecological network analyses, improve predictions of ecosystem responses to environmental change, and reinforce the role of tri-trophic interactions in integrated pest management and long-term agroecosystem sustainability.

Despite their importance, region-specific information on aphids, their predators, and associated host plants remains fragmented and incomplete in many parts of India. Preparing a comprehensive checklist for a particular region is crucial for documenting species diversity, host associations, and tri-trophic interactions. Such checklists provide baseline data for biodiversity assessment, facilitate comparisons across regions, and support ecological and biogeographical studies. Importantly, they also serve as foundational tools for integrated pest management programmes by identifying key natural enemies and their potential roles in crop protection under local agroecological conditions.

MATERIALS & METHODS

The present checklist of tri-trophic associations involving aphidophagous arthropods in Maharashtra was compiled through an extensive review of published books, peer-reviewed journals, authenticated theses, and reliable online databases available up to 31 January 2026. Earlier literature, including some comparatively recent sources, often contains taxonomic inconsistencies in the nomenclature of predators, aphids, and host plants, primarily due to rapid advances in systematic research and subsequent revisions to classifications. In view of the continuous expansion of studies on predator–prey interactions, accompanied by frequent additions of new species records and nomenclatural updates, rigorous taxonomic standardisation was undertaken. Accordingly, aphid names were verified and standardised following the Aphid Species File (https://Aphid.Speciesfile.org), host plant nomenclature was updated using World Flora Online (https://www.worldfloraonline.org), and arthropod taxonomy was validated in accordance with the Global Biodiversity Information Facility (https://www.gbif.org), thereby ensuring accuracy, consistency, and contemporary relevance of the compiled dataset.

Maharashtra (15°35′–22°02′ N; 72°36′–80°54′ E; 307,713 km²) lies in western–central peninsular India, covering much of the Deccan Plateau. Formed on May 1, 1960, it is bordered by Chhattisgarh, Telangana, Karnataka, Goa, the Arabian Sea, Dadra and Nagar Haveli and Daman and Diu, Gujarat, and Madhya Pradesh, and comprises 36 districts. The state has a 720 km coastline and three biogeographic zones, Western Ghats, Deccan Plateau, and West Coast, supporting diverse ecosystems. It experiences a tropical monsoon climate, with annual rainfall of 400–6,000 mm and temperatures averaging 25–27°C. Major rivers include the Bhima, Godavari, Krishna, Narmada, Tapti, Wardha–Wainganga, Purna, and Konya. Forests cover about 20% (61,579 km²) of the state, with 6 national parks, 48 wildlife sanctuaries, and 6 conservation reserves (3.03% of the area), recognized for rich biodiversity and previously documented by several authors (Singh, 2022).

RESULTS & DISCUSSION

A critical appraisal of the available literature indicates that the earliest documentation of aphid–predator–host plant (tri-trophic) associations in Maharashtra dates back to the work of Bagal & Trehan (1945), who reported interactions involving two coccinellid predators, *Cheilomenes sexmaculata* and *Coccinella septempunctata*. Following this pioneering contribution, there appears to have been a nearly five-decade hiatus during which aphidophagous arthropods remained largely undocumented in the state. Systematic survey programmes resumed only in the early years of the twenty-first century, yielding records of several tri-trophic associations involving ladybird beetles, lacewings, and spiders across different districts of Maharashtra (Sathe & Bhosale, 2001; Rabindra *et al.*, 2002; Vennila *et al.*, 2007; Kare, 2007; Gade *et al.*, 2010; Rao & Shivanhar, 2012; Verghese, 2013; Nagamallikadevi *et al.*, 2013; Panchal *et al.*, 2013; Nagrare *et al.*, 2015; Tambe & Kadam, 2015; George

et al., 2016). A marked intensification and diversification of aphidophagous predator surveys became evident during the period 2020–2024, when multiple investigators undertook focused and region-specific studies across several districts of Maharashtra, substantially expanding the documented diversity of aphidophagous arthropods and their tri-trophic associations (Ghuge *et al.*, 2020; Kale *et al.*, 2020; Shaikh *et al.*, 2020; Surwase *et al.*, 2020; Gaikwad *et al.*, 2021; Mounika *et al.*, 2021; Pranav *et al.*, 2021; Sawarkar, 2021; Bhandare, 2022; Bhandare & Chaugale, 2022, 2023a, b; Udtewar *et al.*, 2022; Muley & Chavan, 2024).

The synthesis of tri-trophic associations documented from Maharashtra (Table 1) reveals a rich and taxonomically diverse assemblage of aphidophagous predators within the state. A total of 52 predator species, representing both insect and arachnid taxa, were recorded in association with only 19 aphid species (including one unidentified) infesting 26 host plant species across agricultural and semi-natural habitats. These interactions collectively account for 367 distinct predator–aphid–host plant combinations, highlighting the structural complexity and ecological breadth of aphid-based food webs in Maharashtra. The recorded associations span 14 districts, reflecting substantial spatial heterogeneity in predator diversity and aphid–plant linkages across the state.

Taxonomically, the predator complex comprises representatives of two major arthropod classes. Members of Arachnida are exclusively represented by the order Araneae, encompassing seven spider families: Araneidae, Clubionidae, Lycosidae, Oxyopidae, Salticidae, Tetragnathidae, and Thomisidae, known for their generalist predatory behaviour and important role in regulating aphid populations in cropping systems. The insect predators belong to five orders of Insecta, namely Coleoptera (Coccinellidae), Diptera (Syrphidae), Hemiptera (Geocoridae), Lepidoptera (Pyralidae), and Neuroptera (Chrysopidae and Hemerobiidae). Together, these predator groups encompass both specialist and generalist feeders, contributing to aphid suppression through complementary foraging strategies and temporal activity patterns. The diversity and extent of these tri-trophic linkages underscore their ecological significance in maintaining trophic connectivity, enhancing ecosystem resilience, and supporting biological control services in Maharashtra's agroecosystems.

Among the recorded predator groups, Coccinellidae emerged as the most species-rich (24 species) and geographically widespread family, followed by spiders (17 species) and Syrphidae (5 species), highlighting their predominant role in aphid population suppression across agroecosystems. In contrast, predators belonging to Hemiptera, Neuroptera, and Lepidoptera were represented by comparatively fewer species (1-3 species) and tritrophic linkages, indicating more specialised feeding habits or narrower ecological niches. Overall, the tri-trophic assemblage documented from Maharashtra exhibits relatively lower taxonomic diversity, despite encompassing multiple functional guilds, when compared with northern states and union territories such as Uttar Pradesh (1,098 tritrophic associations involving 70 predator species; Singh, 2025a, b), Uttarakhand (760 associations, 135 predator species; Singh & Srivastav, 2025), Jammu & Kashmir (716 associations, 71 predator species; Singh *et al.*, 2025), West Bengal (612 associations, 125 predator species; Singh & Shukla, 2026a), and Himachal Pradesh (354 associations, 87 predator species; Singh & Shukla, 2026b).

Table 1: Number of species of predators belonging to different taxa preying on different number of aphid species infesting different number of host plant species and triplets in Maharashtra.

Class/ Order/ Family of the aphidophagous predators		**Number of**				
		Predator species	Aphid species	Plant species	Triplets	Districts
Arachnida/Araneae						
1. Araneidae		5	7	8	20	2
2. Clubionidae		1	2	2	2	1
3. Lycosidae		2	1	6	12	1
4. Oxyopidae		1	2	2	4	2
5. Salticidae		3	2	7	14	2
6. Tetragnathidae		2	3	3	4	1
7. Thomisidae		3	2	9	9	3
	Total Araneae	**17**	**7**	**15**	**65**	**3**
Coleoptera	Coccinellidae	24	17	47	216	14
Diptera	Syrphidae	5	10	19	43	12
Hemiptera	Geocoridae	1	1	6	6	1
Lepidoptera	Pyralidae	1	1	1	1	8
Neuroptera	Chrysopidae	3	12	20	35	13
	Hemerobiidae	1	1	1	1	11
	Total	**52**	**19**	**26**	**367**	**14**

The tri-trophic associations (triplets) of the aphid predators were recorded from 14 districts of Maharashtra out of 36 districts. The maximum number of triplets was observed in Kolhapur (122 triplets), followed by Pune (100 triplets), Aurangabad (61 triplets), Akola (57 triplets), and 5-15 triplets from the rest of the 10 districts (Figure 1). About two-thirds of the area of Maharashtra is unexplored regarding tri-trophic associations of aphidophagous arthropods. The aphidophagous predator assemblages were most strongly associated with *Aphis gossypii*, which supported the highest number of predator species (22 species) and formed 40 predator–aphid–host plant triplets on a wide range of economically important crops, including brinjal, cotton, okra, soybean, sunflower, and tomato. This was followed by *Aphis craccivora*, which was attacked by 17 predator species and accounted for 53 tri-trophic associations on major pulse and oilseed crops such as chickpea, cowpea, faba bean, groundnut, hyacinth bean, pigeon pea, and soybean. Similarly, *Myzus persicae* supported 16 predator species, forming 83 triplets on brassica vegetables and oilseed crops, as well as brinjal, chilli, radish, tobacco, and potato. Other ecologically and economically important aphids included *Lipaphis erysimi*, which was associated with 15 predator species forming 62 triplets primarily on brassica vegetables and oilseed crops; *Rhopalosiphum maidis*, supporting 14 predator species and 22 triplets mainly on cereal crops; and *Ceratovacuna lanigera*, which was preyed upon by 11 predator species on sugarcane. The remaining aphid species exhibited narrower predator associations, each supporting between one and ten predator species across a variety of cultivated and wild host plants (Table 2).

Among host plants, sorghum supported the highest predator diversity, with 26 species, largely mediated through infestations of *Rhopalosiphum maidis*. Cabbage and cauliflower also harboured rich predator assemblages, supporting 22 and 19 predator species, respectively, predominantly associated with *Lipaphis erysimi* and *Myzus persicae*. Cotton sustained 19 predator species, mainly linked to *Aphis gossypii*, while radish supported a comparable diversity (19 predator species) associated primarily with *Liphapis erysimi* and *Myzus persicae*. Other important host plants, including mustard, okra,

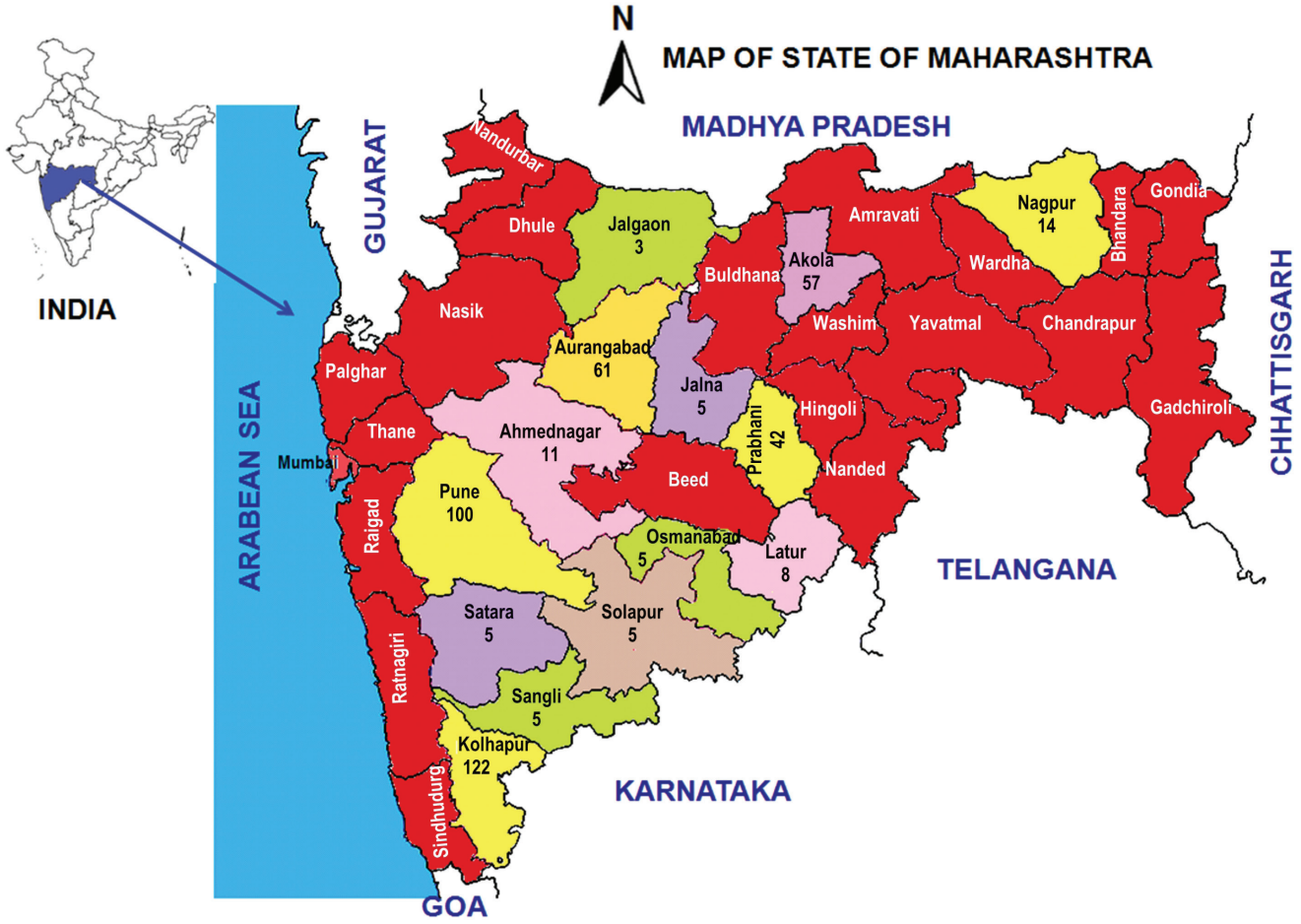

Figure 1: Number of tri-trophic associations (triplets) of aphidophagous arthropod predators in different districts of Maharashtra. No record is available in red shaded districts.

Table 2: Number of species of aphids infesting different numbers of host plant species consumed by different numbers of predator species along with tri-trophic associations (triplets) in different number of districts in Maharashtra.

Aphid species		Number of			
		Predator species	Host plant species	Triplets	Districts
1.	*Acyrthosiphon pisum*	3	3	3	2
2.	*Aphis citricidus*	9	1	9	1
3.	*Aphis craccivora*	16	12	49	6
4.	*Aphis gossypii*	21	10	39	5
5.	*Aphis nerii*	9	3	13	2
6.	*Aphis punicae*	1	1	1	1
7.	*Aphis spiraecola*	1	2	2	1
8.	*Brevicoryne brassicae*	4	1	4	2
9.	*Ceratovacuna lanigera*	11	1	11	11
10.	*Hysteroneura setariae*	3	1	3	1
11.	*Lipaphis erysimi*	14	7	61	4
12.	*Myzus persicae*	16	13	83	2
13.	*Rhopalosiphum maidis*	13	4	25	4
14.	*Rhopalosiphum padi*	1	1	1	1
15.	*Sitpbion miscanthi*	2	1	2	1
16.	*Therioaphis trifolii trifolii*	1	1	1	1
17.	*Uroleucon carthami*	1	1	1	1
18.	*Uroleucon compositae*	10	1	10	4
19.	Unknown aphids	2	19	38	1
Total		**51**	**26**	**354**	**14**

safflower, and sugarcane, supported moderate predator diversity (13–17 species), associated mainly with *Liphapis erysimi*, *Myzus persicae*, *Uroleucon compositae*, and *Ceratovacuna lanigera*, respectively. The remaining host plants supported between one and twelve predator species across multiple aphid taxa, collectively highlighting the heterogeneous but structured nature of tri-trophic interactions in Maharashtra agroecosystems.

Overall, the diversity and assemblage structure of aphidophagous predators in Maharashtra indicate the presence of a complex, well-integrated trophic network operating within the state's agroecosystems. The numerical dominance and wide distribution of Coccinellidae, spiders, and syrphid flies underscore their central role in the natural regulation of aphid populations, while the concurrent occurrence of other predator groups reflects a multi-guild predator community with complementary ecological functions. The synthesis of these records establishes a robust baseline on regional predator diversity, aphid prey spectra, and host-plant associations, thereby providing a valuable framework for ecological and biogeographical studies, biodiversity conservation planning, and the formulation of region-specific integrated pest management strategies.

A detailed account of tri-trophic associations of aphidophagous predators is listed below.

I. Class: Arachnida: Order Araneae

The order Araneae encompasses spiders, which constitute an important group of generalist predators that primarily prey on insects and play a significant role in population regulation and the maintenance of ecosystem stability (Singh *et al.*, 2023b). Despite their recognised ecological significance, spiders have received comparatively less attention as biological control agents than insect predators. Recent evidence, however, highlights their considerable contribution to aphid regulation; Singh *et al.* (2024b) documented 79 species of aphidophagous spiders in India, collectively associated with 53 aphid species infesting 59 host plant species. These findings underscore the substantial yet underappreciated role of spiders in suppressing aphid populations and reinforcing trophic linkages within agricultural and natural ecosystems.

Table 3 summarises available records of aphidophagous spiders belonging to seven families associated with aphids infesting diverse host plants in Maharashtra. A total of 17 spider species, several identified only to the generic level, were documented, collectively interacting with seven aphid species occurring on 15 host plant species and forming 65 predator–aphid–host plant triplets. Among the recorded families, Araneidae was the most species-rich, represented by five species, followed by Salticidae and Thomisidae with three species each, whereas the remaining families were represented by one or two species. Certain taxa exhibited relatively broader prey and host associations; in particular, *Eriovixia* spp. and *Neoscona* spp. were associated with six to seven aphid species infesting eight to nine host plant species. The records further indicate that spider predation was predominantly documented on *Lipaphis erysimi* infesting brassica vegetables and oilseed crops (33 triplets), followed by *Aphis gossypii* on cotton (13 triplets) and *Rhopalosiphum maidis* on sorghum (eight triplets). Overall, the available data suggest a relatively narrow recorded prey spectrum and limited documentation of spider–aphid associations in Maharashtra. The crop- and aphid-specific nature of these records implies that aphidophagous spiders remain underexplored in the state, emphasising the need for comprehensive and systematic surveys across a wider range of agroecosystems and geographic regions.

A detailed account of the tri-trophic associations involving aphidophagous spiders in Maharashtra is presented below, organised family-wise.

Table 3: Number of species of araneid arachnid (siders) predators belonging to different families preying on different number of aphid species infesting different number of host plant species and tri-trophic associations (triplets) in Maharashtra.

Families	Species of predators		Number of			
			Species of aphid	Species of host plant	Triplets	Districts
Araneidae	*1.*	*Araneus* sp.	1	1	1	1
	2.	*Cyrtophora cicatrosa*	1	1	1	1
	3.	*Eriovixia* spp.	6	8	8	1
	4.	*Neoscona theisi*	1	1	1	1
	5.	*Neoscona* spp.	7	9	9	1
Clubionidae	*6.*	*Clubiona* sp.	1	2	2	1
Lycosidae	*7.*	*Pardosa pseudoannulata*	1	6	6	1
	8.	*Wadicosa fidelis*	1	6	6	1
Oxyopidae	*9.*	*Oxyopes hindostanicus*	2	2	4	2
Salticidae	*10.*	*Hasarius adansoni*	1	6	6	1
	11.	*Hyllus semicupreus*	1	1	1	1
	12.	*Plexippus paykulli*	1	6	6	1
Tetragnathidae	*13.*	*Leucauge decorata*	2	2	2	1
	14.	*Tetragnatha* sp.	1	1	1	1
Thomisidae	*15.*	*Thomisus projectus*	1	6	6	1
	16.	*Thomisus spectabilis*	1	1	1	1
	17.	*Thomisus* sp.	2	2	2	1
		Total	**7**	**15**	**65**	**3**

a. Family: Araneidae

1. *Araneus* sp.

- ***Aphis citricidus* (Kirkaldy, 1907)**
  - *Citrus* sp. - Akola (Kale *et al.*, 2020)

2. *Cyrtophora cicatrosa* (Stoliczka, 1869)

- ***Aphis citricidus* (Kirkaldy, 1907)**
  - *Citrus* sp. - Akola (Kale *et al.*, 2020)

3. *Eriovixia* spp.

- ***Aphis citricidus* (Kirkaldy, 1907)**
  - *Citrus* sp. - Akola (Kale *et al.*, 2020)
- ***Aphis gossypii* Glover, 1877**
  - *Abelmoschus esculentus* (L.) Moench - Akola (Kale *et al.*, 2020)
  - *Gossypium hirsutum* L. - Akola (Kale *et al.*, 2020)
  - *Helianthus annuus* L. - Akola (Kale *et al.*, 2020)
- ***Hysteroneura setariae* (Thomas, 1878)**
  - *Triticum aestivum* L. - Akola (Kale *et al.*, 2020)
- ***Lipaphis erysimi* (Kaltenbach, 1843)**
  - *Brassica rapa* L. - Akola (Kale *et al.*, 2020)
- ***Rhopalosiphum maidis* (Fitch, 1856)**
  - *Sorghum bicolor* (L.) Moench - Akola (Kale *et al.*, 2020)
- ***Uroleucon compositae* (Theobald, 1915)**
  - *Carthamus tinctorius* L. - Akola (Kale *et al.*, 2020)

4. *Neoscona theisi* (Walckenaer, 1841)

- ***Aphis gossypii* Glover, 1877**
  - *Gossypium hirsutum* L. - Nagpur (Nagrare *et al.*, 2015)

5. *Neoscona* spp.

- ***Aphis citricidus* (Kirkaldy, 1907)**
  - *Citrus* sp. - Akola (Kale *et al.*, 2020)
- ***Aphis craccivora* Koch, 1854**
  - *Lablab purpureus* (L.) Sweet - Akola (Kale *et al.*, 2020)
- ***Aphis gossypii* Glover, 1877**
  - *Abelmoschus esculentus* (L.) Moench - Akola (Kale *et al.*, 2020)
  - *Gossypium hirsutum* L. - Akola (Kale *et al.*, 2020)
  - *Helianthus annuus* L. - Akola (Kale *et al.*, 2020)
- ***Hysteroneura setariae* (Thomas, 1878)**
  - *Triticum aestivum* L. - Akola (Kale *et al.*, 2020)
- ***Lipaphis erysimi* (Kaltenbach, 1843)**
  - *Brassica rapa* L. - Akola (Kale *et al.*, 2020)
- ***Rhopalosiphum maidis* (Fitch, 1856)**
  - *Sorghum bicolor* (L.) Moench - Akola (Kale *et al.*, 2020)
- ***Uroleucon compositae* (Theobald, 1915)**
  - *Carthamus tinctorius* L. - Akola (Kale *et al.*, 2020)

b. Family: Clubionidae

1. *Clubiona* sp.

- ***Aphis gossypii* Glover, 1877**
  - *Gossypium hirsutum* L. - Akola (Kale *et al.*, 2020)
  - *Helianthus annuus* L. - Akola (Kale *et al.*, 2020)

c. Family: Lycosidae

1. *Pardosa pseudoannulata* (Bösenberg & Strand, 1906)

- ***Lipaphis erysimi* (Kaltenbach, 1843)**
  - *Brassica juncea* (L.) Czern. - Pune (Shaikh *et al.*, 2020)

- *Brassica oleracea* L. var. *botrytis* - Pune (Shaikh *et al.*, 2020)
- *Brassica oleracea* L. var. *capitata* - Pune (Shaikh *et al.*, 2020)
- *Brassica oleracea* L. var. *gongylodes* - Pune (Shaikh *et al.*, 2020)
- *Brassica oleracea* L. var. *italica* - Pune (Shaikh *et al.*, 2020)
- *Raphanus sativus* L. - Pune (Shaikh *et al.*, 2020)

2. *Wadicosa fidelis* (O. Pickard- Cambridge, 1872)

- ***Lipaphis erysimi* (Kaltenbach, 1843)**
  - *Brassica juncea* (L.) Czern. - Pune (Shaikh *et al.*, 2020)
  - *Brassica oleracea* L. var. *botrytis* - Pune (Shaikh *et al.*, 2020)
  - *Brassica oleracea* L. var. *capitata* - Pune (Shaikh *et al.*, 2020)
  - *Brassica oleracea* L. var. *gongylodes* - Pune (Shaikh *et al.*, 2020)
  - *Brassica oleracea* L. var. *italica* - Pune (Shaikh *et al.*, 2020)
  - *Raphanus sativus* L. - Pune (Shaikh *et al.*, 2020)

d. Family: Oxyopidae

1. *Oxyopes hindostanicus* Pocock, 1901

- ***Aphis gossypii* Glover, 1877**
  - *Gossypium hirsutum* L. - Akola (Kale *et al.*, 2020); Nagpur (Nagrare *et al.*, 2015)
- ***Rhopalosiphum maidis* (Fitch, 1856)**
  - *Sorghum bicolor* (L.) Moench - Akola (Kale *et al.*, 2020)

e. Family: Salticidae

1. *Hasarius adansoni* (Audouin, 1826)

- ***Lipaphis erysimi* (Kaltenbach, 1843)**
  - *Brassica juncea* (L.) Czern. - Pune (Shaikh *et al.*, 2020)
  - *Brassica oleracea* L. var. *botrytis* - Pune (Shaikh *et al.*, 2020)
  - *Brassica oleracea* L. var. *capitata* - Pune (Shaikh *et al.*, 2020)
  - *Brassica oleracea* L. var. *gongylodes* - Pune (Shaikh *et al.*, 2020)
  - *Brassica oleracea* L. var. *italica* - Pune (Shaikh *et al.*, 2020)
  - *Raphanus sativus* L. - Pune (Shaikh *et al.*, 2020)

2. *Hyllus semicupreus* (Simon, 1885)

- ***Rhopalosiphum maidis* (Fitch, 1856)**
  - *Sorghum bicolor* (L.) Moench - Akola (Kale *et al.*, 2020)

3. *Plexippus paykulli* (Audouin, 1826)

- ***Lipaphis erysimi* (Kaltenbach, 1843)**
  - *Brassica juncea* (L.) Czern. - Pune (Shaikh *et al.*, 2020)
  - *Brassica oleracea* L. var. *botrytis* - Pune (Shaikh *et al.*, 2020)
  - *Brassica oleracea* L. var. *capitata* - Pune (Shaikh *et al.*, 2020)
  - *Brassica oleracea* L. var. *gongylodes* - Pune (Shaikh *et al.*, 2020)
  - *Brassica oleracea* L. var. *italica* - Pune (Shaikh *et al.*, 2020)
  - *Raphanus sativus* L. - Pune (Shaikh *et al.*, 2020)

f. Family: Tetragnathidae

1. *Leucauge decorata* (Blackwall, 1864)

- ***Aphis craccivora* Koch, 1854**
  - *Lablab purpureus* (L.) Sweet - Akola (Kale *et al.*, 2020)
- ***Uroleucon compositae* (Theobald, 1915)**
  - *Carthamus tinctorius* L. - Akola (Kale *et al.*, 2020)

2. *Tetragnatha* sp.

- ***Rhopalosiphum maidis* (Fitch, 1856)**
  - *Sorghum bicolor* (L.) Moench - Akola (Kale *et al.*, 2020)

g. Family: Thomisidae

1. *Thomisus projectus* Tikader, 1960

- ***Lipaphis erysimi* (Kaltenbach, 1843)**
  - *Brassica juncea* (L.) Czern. - Pune (Shaikh *et al.*, 2020)
  - *Brassica oleracea* L. var. *botrytis* - Pune (Shaikh *et al.*, 2020)
  - *Brassica oleracea* L. var. *capitata* - Pune (Shaikh *et al.*, 2020)
  - *Brassica oleracea* L. var. *gongylodes* - Pune (Shaikh *et al.*, 2020)
  - *Brassica oleracea* L. var. *italica* - Pune (Shaikh *et al.*, 2020)
  - *Raphanus sativus* L. - Pune (Shaikh *et al.*, 2020)

2. *Thomisus spectabilis* Doleschall, 1859

- ***Aphis gossypii* Glover, 1877**
  - *Gossypium hirsutum* L. - Nagpur (Nagrare *et al.*, 2015)

3. *Thomisus* sp.

- ***Aphis gossypii* Glover, 1877**
  - *Abelmoschus esculentus* (L.) Moench - Akola (Kale *et al.*, 2020)

- ***Lipaphis erysimi* (Kaltenbach, 1843)**
  - *Brassica rapa* L. - Akola (Kale *et al.*, 2020)

II. Class: Insecta

A. Order: Coleoptera: Family: Coccinellidae

Agarwala & Ghosh (1988) first documented 36 species of aphidophagous Coccinellidae in India, providing early prey records and general distributional insights. Subsequently, Singh (2025a) substantially expanded this knowledge by reporting 148 ladybird beetle species associated with 181 aphid species on 350 host plants, together forming 3,102 tri-trophic associations nationwide. In Maharashtra, Coccinellidae are represented by 23 species linked to 15 aphid species infesting 47 host plants, resulting in 207 recorded tri-trophic associations mostly in Kolhapur district (77 triplets), followed by Aurangabad (56 triplets), Pune (51 triplets) and Akola (14 triplets) (Table 4). These data highlight the dominant role of coccinellids in aphid suppression and their significance in both natural and applied biological control. Ladybird beetles are among the most efficient and well-studied predatory insects; both larvae and adults actively prey on a wide range of soft-bodied pests, including aphids, whiteflies, scale insects, mealybugs, and mites. Owing to their high predatory efficiency, broad prey spectrum, and ecological adaptability, coccinellids contribute substantially to pest regulation in cereals, pulses, cotton, vegetables, fruit crops, and oilseeds, support reduced pesticide dependence, and have been widely employed in classical and augmentative biological control programmes against aphid pests (Singh, 2025a).

Within the family Coccinellidae, *Cheilomenes sexmaculata* was the most polyphagous species, recorded feeding on 15 aphid species infesting 44 host plants, followed by *Coccinella transversalis* (12 aphid species on 23 host plants) and *Coccinella septempunctata* (8 aphid species on 33 host plants) (Table 4). These taxa exhibit extensive aphid–host plant linkages across Maharashtra, reflecting their broad prey spectra, high ecological plasticity, and functional versatility. In contrast, the remaining coccinellid species were associated with fewer than ten aphid species, indicating comparatively narrower trophic ranges.

In Maharashtra, aphidophagous coccinellids were most frequently associated with *Aphis craccivora*, which accounted for 48 documented tri-trophic associations, predominantly on fabaceous crops such as cowpea, faba bean, groundnut, hyacinth bean, and pigeon pea. This was

Table 4: Number of species of ladybirds (Coccinellidae: Coleoptera) predators preying on different number of aphid species infesting different number of host plant species and triplets in Maharashtra.

	Family/Species of predators	Number of			
		Species of aphid	Species of host plant	Triplets	Districts
1.	*Brumoides suturalis*	5	12	12	3
2.	*Cheilomenes sexmaculata*	15	44	61	13
3.	*Chilocorus nigrata*	2	2	2	1
4.	*Chilocorus renipustulatus*	1	1	1	1
5.	*Coccinella septempunctata*	8+21	33	45	6
6.	*Coccinella transversalis*	12	23	25	4
7.	*Cryptolaemus montrousieri*	1	1	1	1
8.	*Harmonia octomaculata*	2	2	2	2
9.	*Harmonia* sp.	1	1	1	1
10.	*Hippodamia variegata*	2	4	4	1
11.	*Illeis cincta*	2	2	2	1
12.	*Illeis* sp.	1	2	2	1
13.	*Micraspis discolor*	3	2	3	1
14.	*Micromus igorotus*	2	2	2	2
15.	*Nephus ancyroides*	4	5	6	1
16.	*Propylea dissecta*	3	4	5	2
17.	*Pseudaspidimerus flaviceps*	1	2	2	1
18.	*Pseudaspidimerus trinotata*	2	4	4	2
19.	*Scymnus coccivora*	1	10	10	1
20.	*Scymnus latemaculatus*	1	2	3	2
21.	*Scymnus loewii*	1	10	10	1
22.	*Scymnus nubilus*	1	10	10	1
23.	*Scymnus* sp.	3	3	3	2
24.	*Synonycha grandis*	1	1	1	1
	Total	**17**	**47**	**216**	**14**

followed by *Myzus persicae*, forming 45 tri-trophic associations on brassica vegetables, oilseed crops, and solanaceous crops, including brinjal, tomato, and potato. Other commonly recorded aphid species included *Aphis gossypii*, involved in 24 associations on crops such as okra and cotton, and *Rhopalosiphum maidis*, with 21 associations primarily on maize and sorghum. The remaining aphid species each contributed relatively few tri-trophic associations, occurring across a diverse array of cultivated and wild host plants. Overall, ladybird beetles constitute a key stabilising component of agroecosystems, functioning as efficient biological control agents that underpin integrated pest management and promote sustainable agricultural practices.

A detailed account of the tri-trophic associations of ladybird beetles in Maharashtra is presented below.

1. ***Brumoides suturalis* (Fabricius, 1798)**
   - ***Aphis craccivora* Koch, 1854**
     - *Abelmoschus esculentus* (L.) Moench - Kolhapur (Bhandare & Chaugale, 2022)
     - *Cajanus cajan* (L.) Millsp. - Kolhapur (Bhandare & Chaugale, 2022)
     - *Lablab purpureus* (L.) Sweet - Kolhapur (Bhandare & Chaugale, 2022)
     - *Moringa oleifera* Lam. - Kolhapur (Bhandare & Chaugale, 2022)
     - *Vicia faba* L. - Kolhapur (Bhandare & Chaugale, 2022)
     - *Vigna mungo* (L.) Hepper - Kolhapur (Bhandare & Chaugale, 2022)
     - *Vigna radiata* (L.) R.Wilczek - Aurangabad (Muley & Chavan, 2024)
     - *Vigna unguiculata* (L.) Walp. - Kolhapur (Bhandare & Chaugale, 2022)
   - ***Aphis gossypii* Glover, 1877**
     - *Gossypium hirsutum* L. - Parbhani (Gangaprasad, 2021)
   - ***Aphis nerii* Boyer de Fonsc., 1841**
     - *Calotropis procera* (Aiton) Dryand. - Jalgaon (Sawarkar, 2021)
   - ***Myzus persicae* (Sulzer, 1776)**
     - *Glycine max* (L.) Merr. - Aurangabad (Muley & Chavan, 2024)
   - ***Uroleucon compositae* (Theobald, 1915)**
     - Unknown plant - Kolhapur (Sathe & Bhosale, 2001)
2. ***Cheilomenes sexmaculata* (Fabricius, 1781**
   - ***Aphis citricidus* (Kirkaldy, 1907)**
     - *Citrus* sp. - Akola (Kale *et al.*, 2020)
   - ***Aphis craccivora* Koch, 1854**
     - *Abelmoschus esculentus* (L.) Moench - Kolhapur (Bhandare & Chaugale, 2022)
     - *Arachis hypogaea* - Aurangabad (Muley & Chavan, 2024)
     - *Cajanus cajan* (L.) Millsp. - Kolhapur (Bhandare & Chaugale, 2022); Aurangabad (Muley & Chavan, 2024)
     - *Cicer arietinum* L. - Aurangabad (Muley & Chavan, 2024)
     - *Glycine max* (L.) Merr. - Aurangabad (Muley & Chavan, 2024)
     - *Lablab purpureus* (L.) Sweet - Kolhapur (Bhandare & Chaugale, 2022); Akola (Kale *et al.*, 2020)
     - *Moringa oleifera* Lam. - Kolhapur (Bhandare & Chaugale, 2022)
     - *Vicia faba* L. - Kolhapur (Bhandare & Chaugale, 2022)
     - *Vigna mungo* (L.) Hepper - Kolhapur (Bhandare & Chaugale, 2022)
     - *Vigna radiata* (L.) R.Wilczek - Aurangabad (Muley & Chavan, 2024)
     - *Vigna unguiculata* (L.) Walp. - Kolhapur (Bhandare & Chaugale, 2022); Parbhani (Gangaprasad, 2021)
   - ***Aphis gossypii* Glover, 1877**
     - *Abelmoschus esculentus* (L.) Moench - Akola (Kale *et al.*, 2020); Aurangabad (Muley & Chavan, 2024); Pune (Pandurang, 2018)
     - *Capsicum frutescens* L. - Aurangabad (Muley & Chavan, 2024)
     - *Glycine max* (L.) Merr. - Aurangabad (Muley & Chavan, 2024)
     - *Gossypium hirsutum* L. - Nagpur (Vennila *et al.*, 2007; Kale *et al.*, 2020); Parbhani (Gangaprasad, 2021)
     - *Gossypium* sp. - Aurangabad (Muley & Chavan, 2024)
     - *Helianthus annuus* L. - Akola (Kale *et al.*, 2020)
   - ***Aphis nerii* Boyer de Fonsc., 1841**
     - *Calotropis procera* (Aiton) Dryand. -Kolhapur (Bhandare & Chaugale, 2023a)
     - *Nerium oleander* L. - Kolhapur (Bhandare & Chaugale, 2023a)
   - ***Aphis punicae* Passerini, 1863**
     - *Punica granatum* L. –Prabhani (Gangaprasad, 2021)
   - ***Aphis spiraecola* Patch, 1914**
     - *Citrus jambhiri Lush.* - Nagpur (Rao & Shivanhar, 2012)

- *Citrus reticulata* Blanco - Nagpur (Rao & Shivanhar, 2012)

• ***Brevicoryne brassicae* (Linnaeus, 1758)**
- *Brassica oleracea* L. *var. capitata* - Prabhani (Gangaprasad, 2021)

• ***Ceratovacuna lanigera* Zehntner, 1897**
- *Saccharum officinarum* L. - Ahmednagar, Aurangabad, Jalna, Kolhapur, Latur, Osmanabad, Pune, Sangli, Satara, Solapur (Verghese, 2013)

• ***Hysteroneura setariae* (Thomas, 1878)**
- *Triticum aestivum* L. - Akola (Kale *et al.*, 2020)

• ***Lipaphis erysimi* (Kaltenbach, 1843)**
- *Brassica juncea* (L.) Czern. - Prabhani (Gangaprasad, 2021); Pune (Shaikh *et al.*, 2020)
- *Brassica oleracea* L. *var. botrytis* - Pune (Shaikh *et al.*, 2020)
- *Brassica oleracea* L. *var. capitata* - Pune (Shaikh *et al.*, 2020)
- *Brassica oleracea* L. *var. gongylodes* - Pune (Shaikh *et al.*, 2020)
- *Brassica oleracea* L. *var. italica* - Pune (Shaikh *et al.*, 2020)
- *Brassica rapa* L. - Akola (Kale *et al.*, 2020)
- *Raphanus sativus* L. - Pune (Shaikh *et al.*, 2020)

• ***Myzus persicae* (Sulzer, 1776)**
- *Brassica oleracea* L. *var. botrytis* - Aurangabad (Muley & Chavan, 2024)
- *Capsicum frutescens* L. - Aurangabad (Muley & Chavan, 2024)
- *Nicotiana tabacum* L. - Kolhapur (Bhandare, 2022)

• ***Rhopalosiphum maidis* (Fitch, 1856)**
- *Cenchrus americanus* (L.) Morrone - Aurangabad (Muley & Chavan, 2024)
- *Sorghum bicolor* (L.) Moench - Akola (Kale *et al.*, 2020); Aurangabad (Muley & Chavan, 2024); Prabhani (Gangaprasad, 2021)
- *Triticum aestivum* L. - Aurangabad (Muley & Chavan, 2024)
- *Zea mays* L. - Aurangabad (Muley & Chavan, 2024); Prabhani (Udtewar *et al.*, 2022)

• ***Sitobion miscanthi* (Takahashi, 1921)**
- *Triticum aestivum* L. - Prabhani (Gangaprasad, 2021)

• **Unidentified aphid**
- *Abelmoschus esculentus* (L.) Moench - Pune (Bagal & Trehan, 1945)
- *Brassica oleracea* L. *var. capitata* - Pune (Bagal & Trehan, 1945)
- *Brassica oleracea* L. *var. gongylodes* - Pune (Bagal & Trehan, 1945)
- *Brassica rapa* L. - Pune (Bagal & Trehan, 1945)
- *Capsicum annuum* L. - Pune (Bagal & Trehan, 1945)
- *Carthamus tinctorius* L. - Pune (Bagal & Trehan, 1945)
- *Citrus* spp. - Pune (Bagal & Trehan, 1945)
- *Coccinia grandis* (L.) Voigt - Pune (Bagal & Trehan, 1945)
- *Cyamopsis psoralioides* DC. - Pune (Bagal & Trehan, 1945)
- *Gossypium* spp. - Pune (Bagal & Trehan, 1945)
- *Lens culinaris* Medik. - Pune (Bagal & Trehan, 1945)
- *Linum usitatissimum* L. - Pune (Bagal & Trehan, 1945)
- *Medicago sativa* L. - Pune (Bagal & Trehan, 1945)
- *Nicotiana tabacum* L. - Pune (Bagal & Trehan, 1945)
- *Pisum sativum* L. - Pune (Bagal & Trehan, 1945)
- *Raphanus sativus* L. - Pune (Bagal & Trehan, 1945)
- *Solanum melongena* L. - Pune (Bagal & Trehan, 1945)
- *Solanum tuberosum* L. - Pune (Bagal & Trehan, 1945)
- *Sorghum bicolor* (L.) Moench - Pune (Bagal & Trehan, 1945)

• ***Uroleucon compositae* (Theobald, 1915)**
- *Carthamus tinctorius* L. - Akola (Kale *et al.*, 2020); Prabhani (Gangaprasad, 2021; Udtewar *et al.*, 2022)

3. *Chilocorus nigrata* (Fabricius, 1798)

• ***Aphis craccivora* Koch, 1854**
- *Vigna radiata* (L.) R.Wilczek - Aurangabad (Muley & Chavan, 2024)

• ***Aphis gossypii* Glover, 1877**
- *Glycine max* (L.) Merr. - Aurangabad (Muley & Chavan, 2024)

4. *Chilocorus renipustulatus* (Scriba, 1791)

• ***Aphis nerii* Boyer de Fonsc., 1841**
- *Calotropis procera* (Aiton) Dryand. - Jalgaon (Sawarkar, 2021)

5. *Coccinella septempunctata* Linnaeus, 1758

• ***Aphis craccivora* Koch, 1854**
- *Arachis hypogaea* L. - Aurangabad (Muley & Chavan, 2024)

- *Cajanus cajan* (L.) Millsp. - Aurangabad (Muley & Chavan, 2024)
- *Cicer arietinum* L. - Aurangabad (Muley & Chavan, 2024)
- *Glycine max* (L.) Merr. - Aurangabad (Muley & Chavan, 2024)
- *Vigna radiata* (L.) R.Wilczek - Aurangabad (Muley & Chavan, 2024)

• ***Aphis gossypii* Glover, 1877**
- *Abelmoschus esculentus* (L.) Moench - Aurangabad (Muley & Chavan, 2024); Parbhani (Ghuge *et al.*, 2020); Pune (Pandurang, 2018)
- *Capsicum frutescens* L. - Aurangabad (Muley & Chavan, 2024)
- *Glycine max* (L.) Merr. - Aurangabad (Muley & Chavan, 2024)
- *Gossypium hirsutum* L. - Nagpur (Vennila *et al.*, 2007); Prabhani (Gangaprasad, 2021)
- *Gossypium* sp. - Aurangabad (Muley & Chavan, 2024)

• ***Aphis nerii* Boyer de Fonsc., 1841**
- *Nerium oleander* L. - Kolhapur (Bhandare & Chaugale, 2023a)

• ***Brevicoryne brassicae* (Linnaeus, 1758)**
- *Brassica oleracea* L. *var. capitata* - Latur (Panchal *et al.*, 2013)

• ***Lipaphis erysimi* (Kaltenbach, 1843)**
- *Brassica juncea* (L.) Czern. - Pune (Shaikh *et al.*, 2020)
- *Brassica oleracea* L. *var. botrytis* - Pune (Shaikh *et al.*, 2020)
- *Brassica oleracea* L. *var. capitata* - Pune (Shaikh *et al.*, 2020)
- *Brassica oleracea* L. *var. gongylodes* - Pune (Shaikh *et al.*, 2020)
- *Brassica oleracea* L. *var. italica* - Pune (Shaikh *et al.*, 2020)
- *Brassica rapa* L. - Latur (Panchal *et al.*, 2013)
- *Raphanus sativus* L. - Pune (Shaikh *et al.*, 2020)

• ***Myzus persicae* (Sulzer, 1776)**
- *Brassica oleracea* L. *var. botrytis* - Aurangabad (Muley & Chavan, 2024)
- *Capsicum frutescens* L. - Aurangabad (Muley & Chavan, 2024)

• ***Rhopalosiphum maidis* (Fitch, 1856)**
- *Cenchrus americanus* (L.) Morrone - Aurangabad (Muley & Chavan, 2024)
- *Triticum aestivum* L. - Aurangabad (Muley & Chavan, 2024)
- *Zea mays* L. - Aurangabad (Muley & Chavan, 2024)

• **Unidentified aphid**
- *Abelmoschus esculentus* (L.) Moench - Pune (Bagal & Trehan, 1945)
- *Brassica oleracea* L. *var. capitata* - Pune (Bagal & Trehan, 1945)
- *Brassica oleracea* L. *var. gongylodes* - Pune (Bagal & Trehan, 1945)
- *Brassica rapa* L. - Pune (Bagal & Trehan, 1945)
- *Capsicum annuum* L. - Pune (Bagal & Trehan, 1945)
- *Carthamus tinctorius* L. - Pune (Bagal & Trehan, 1945)
- *Citrus* spp. - Pune (Bagal & Trehan, 1945)
- *Coccinia grandis* (L.) Voigt - Pune (Bagal & Trehan, 1945)
- *Cyamopsis psoralioides* DC. - Pune (Bagal & Trehan, 1945)
- *Gossypium* spp. - Pune (Bagal & Trehan, 1945)
- *Lens culinaris* Medik. - Pune (Bagal & Trehan, 1945)
- *Linum usitatissimum* L. - Pune (Bagal & Trehan, 1945)
- *Medicago sativa* L. - Pune (Bagal & Trehan, 1945)
- *Nicotiana tabacum* L. - Pune (Bagal & Trehan, 1945)
- *Pisum sativum* L. - Pune (Bagal & Trehan, 1945)
- *Raphanus sativus* L. - Pune (Bagal & Trehan, 1945)
- *Solanum melongena* L. - Pune (Bagal & Trehan, 1945)
- *Solanum tuberosum* L. - Pune (Bagal & Trehan, 1945)
- *Sorghum bicolor* (L.) Moench - Pune (Bagal & Trehan, 1945)

• ***Uroleucon carthami* (Hille Ris Lambers, 1948)**
- *Carthamus tinctorius* L. - Latur (Panchal *et al.*, 2013)

6. ***Coccinella transversalis* Fabricus, 1781**

• ***Acyrthosiphon pisum* (Harris, 1776)**
- *Glycine max* (L.) Merr. - Aurangabad (Muley & Chavan, 2024)

• ***Aphis citricidus* (Kirkaldy, 1907)**
- *Citrus* sp. - Akola (Kale *et al.*, 2020)

• ***Aphis craccivora* Koch, 1854**

- *Abelmoschus esculentus* (L.) Moench - Kolhapur (Bhandare & Chaugale, 2022)
- *Arachis hypogaea* L. - Aurangabad (Muley & Chavan, 2024)
- *Cajanus cajan* (L.) Millsp. - Aurangabad (Muley & Chavan, 2024); Kolhapur (Bhandare & Chaugale, 2022)
- *Cicer arietinum* L. - Aurangabad (Muley & Chavan, 2024)
- *Lablab purpureus* (L.) Sweet - Kolhapur (Bhandare & Chaugale, 2022); Akola (Kale *et al.*, 2020)
- *Moringa oleifera* Lam. - Kolhapur (Bhandare & Chaugale, 2022)
- *Vicia faba* L. - Kolhapur (Bhandare & Chaugale, 2022)
- *Vigna mungo* (L.) Hepper - Kolhapur (Bhandare & Chaugale, 2022)
- *Vigna radiata* (L.) R.Wilczek - Aurangabad (Muley & Chavan, 2024)
- *Vigna unguiculata* (L.) Walp. - Kolhapur (Bhandare & Chaugale, 2022); Prabhani (Gangaprasad, 2021)

• ***Aphis gossypii* Glover, 1877**
- *Gossypium hirsutum* L. - Akola (Kale *et al.*, 2020); Prabhani (Gangaprasad, 2021)
- *Vigna unguiculata* (L.) Walp. - Prabhani (Udtewar *et al.*, 2022)

• ***Aphis nerii* Boyer de Fonsc., 1841**
- *Calotropis procera* (Aiton) Dryand. - Kolhapur (Bhandare & Chaugale, 2023a)

• ***Aphis punicae* Passerini, 1863**
- *Punica granatum* L. –Prabhani (Gangaprasad, 2021)

• ***Brevicoryne brassicae* (Linnaeus, 1758)**
- *Brassica oleracea* L. *var. capitata* - Prabhani (Gangaprasad, 2021)

• ***Lipaphis erysimi* (Kaltenbach, 1843)**
- *Brassica juncea* (L.) Czern. – Prabhani (Gangaprasad, 2021)

• ***Myzus persicae* (Sulzer, 1776)**
- *Nicotiana tabacum* L. - Kolhapur (Bhandare, 2022)

• ***Rhopalosiphum maidis* (Fitch, 1856)**
- *Cenchrus americanus* (L.) Morrone - Aurangabad (Muley & Chavan, 2024)
- *Sorghum bicolor* (L.) Moench - Akola (Kale *et al.*, 2020); Aurangabad (Muley & Chavan, 2024); Prabhani (Gangaprasad, 2021)
- *Triticum aestivum* L. - Aurangabad (Muley & Chavan, 2024)
- *Zea mays* L. - Aurangabad (Muley & Chavan, 2024)

• ***Sitobion miscanthi* (Takahashi, 1921)**
- *Triticum aestivum* L. - Prabhani (Gangaprasad, 2021)

• ***Uroleucon compositae* (Theobald, 1915)**
- *Carthamus tinctorius* L. - Prabhani (Gangaprasad, 2021; Pranav *et al.*, 2021)

7. *Cryptolaemus montrousieri* Mulsant, 1853

• ***Aphis gossypii* Glover, 1877**
- *Gossypium hirsutum* L. - Prabhani (Surwase *et al.*, 2020)

8. *Harmonia octomaculata* (Fabricius, 1781)

• ***Aphis craccivora* Koch, 1854**
- *Vigna radiata* (L.) R.Wilczek - Aurangabad (Muley & Chavan, 2024)

• ***Ceratovacuna lanigera* Zehntner, 1897**
- *Saccharum officinarum* L. - Kolhapur (Rabindra *et al.*, 2002)

8. *Harmonia* sp.

• ***Aphis gossypii* Glover, 1877**
- *Gossypium hirsutum* L. - Prabhani (Gangaprasad, 2021)

9. *Hippodamia variegata* (Goeze, 1777)

• ***Aphis craccivora* Koch, 1854**
- *Arachis hypogaea* L. - Aurangabad (Muley & Chavan, 2024)
- *Cajanus cajan* (L.) Millsp. - Aurangabad (Muley & Chavan, 2024)
- *Vigna radiata* (L.) R.Wilczek - Aurangabad (Muley & Chavan, 2024)

• ***Myzus persicae* (Sulzer, 1776)**
- *Brassica oleracea* L. *var. botrytis* - Aurangabad (Muley & Chavan, 2024)

10. *Illeis cincta* (Fabricius, 1798)

• ***Aphis craccivora* Koch, 1854**
- *Cajanus cajan* (L.) Millsp. - Aurangabad (Muley & Chavan, 2024)

• ***Myzus persicae* (Sulzer, 1776)**
- *Capsicum frutescens* L. - Aurangabad (Muley & Chavan, 2024)

11. *Illeis* sp.

• ***Aphis gossypii* Glover, 1877**
- *Abelmoschus esculentus* (L.) Moench - Akola (Kale *et al.*, 2020)

- *Gossypium hirsutum* L. - Akola (Kale *et al.*, 2020)

12. *Micraspis discolor* (Fabricius, 1798)

- ***Aphis craccivora* Koch, 1854**
  - *Glycine max* (L.) Merr. - Aurangabad (Muley & Chavan, 2024)
- ***Aphis gossypii* Glover, 1877**
  - *Glycine max* (L.) Merr. - Aurangabad (Muley & Chavan, 2024)
- ***Rhopalosiphum maidis* (Fitch, 1856)**
  - *Cenchrus americanus* (L.) Morrone - Aurangabad (Muley & Chavan, 2024)

13. *Micromus igorotus* Banks, 1920

- ***Ceratovacuna lanigera* Zehntner, 1897**
  - *Saccharum officinarum* L. - Ahmednagar (Kare, 2007)
- ***Myzus persicae* (Sulzer, 1776)**
  - *Nicotiana tabacum* L. - Kolhapur (Bhandare & Chaugale, 2023b)

14. *Nephus ancyroides* Pang & Pu, 1988

- ***Aphis craccivora* Koch, 1854**
  - *Lablab purpureus* (L.) Sweet - Kolhapur (Bhandare & Chaugale, 2022)
  - *Solanum lycopersicum* L. - Kolhapur (Bhandare & Chaugale, 2022)
  - *Solanum melongena* L. - Kolhapur (Bhandare & Chaugale, 2022)
- ***Aphis nerii* Boyer de Fonsc., 1841**
  - *Calotropis gigantea* (L.) W.T. Aiton - Kolhapur (Bhandare & Chaugale, 2022)
- ***Myzus persicae* (Sulzer, 1776)**
  - *Solanum lycopersicum* L. - Kolhapur (Bhandare, 2022)
  - *Solanum tuberosum* L. - Kolhapur (Bhandare, 2022)

15. *Propylea dissecta* (Mulsant, 1850)

- Acyrthosiphon pisum (Harris, 1776)
  - *Vigna radiata* (L.) R.Wilczek - Aurangabad (Muley & Chavan, 2024)
- ***Aphis craccivora* Koch, 1854**
  - *Vigna radiata* (L.) R.Wilczek - Aurangabad (Muley & Chavan, 2024)
- ***Myzus persicae* (Sulzer, 1776)**
  - *Brassica oleracea* L. *var. capitata* - Kolhapur (Bhandare, 2022)
  - *Raphanus sativus* L. - Kolhapur (Bhandare, 2022)
  - *Solanum melogena* L. - Kolhapur (Bhandare, 2022)

16. *Pseudaspidimerus flaviceps* (Walker, 1859)

- ***Aphis nerii* Boyer de Fonsc., 1841**
  - *Calotropis procera* (Aiton) Dryand. - Kolhapur (Bhandare & Chaugale, 2023a)
  - *Nerium oleander* L. - Kolhapur (Bhandare & Chaugale, 2023a)

17. *Pseudaspidimerus trinotata* (Thunberg, 1781)

- ***Aphis nerii* Boyer de Fonsc., 1841**
  - *Calotropis procera* (Aiton) Dryand. - Kolhapur (Bhandare & Chaugale, 2023a)
  - *Nerium oleander* L. - Kolhapur (Bhandare & Chaugale, 2023a)
- ***Rhopalosiphum maidis* (Fitch, 1856)**
  - *Cenchrus americanus* (L.) Morrone - Aurangabad (Muley & Chavan, 2024)
  - *Sorghum bicolor* (L.) Moench - Aurangabad (Muley & Chavan, 2024)

18. *Scymnus coccivora* Ayyar, 1925

- ***Myzus persicae* (Sulzer, 1776)**
  - *Brassica juncea* (L.) Czern. - Kolhapur (Bhandare, 2022)
  - *Brassica oleracea* L. *var. botrytis* - Kolhapur (Bhandare, 2022)
  - *Brassica oleracea* L. *var. capitata* - Kolhapur (Bhandare, 2022)
  - *Brassica rapa* L. - Kolhapur (Bhandare, 2022)
  - *Nicotiana tabacum* L. - Kolhapur (Bhandare, 2022)
  - *Pisum sativum* L. - Kolhapur (Bhandare, 2022)
  - *Raphanus sativus* L. - Kolhapur (Bhandare, 2022)
  - *Solanum melogena* L. - Kolhapur (Bhandare, 2022)
  - *Solanum nigrum* L. - Kolhapur (Bhandare, 2022)
  - *Solanum tuberosum* L. - Kolhapur (Bhandare, 2022)

19. *Scymnus latemaculatus* Motschulsky, 1858

- ***Aphis nerii* Boyer de Fonsc., 1841**
  - *Nerium oleander* L. - Kolhapur (Bhandare & Chaugale, 2023a)
  - *Calotropis procera* (Aiton) Dryand. - Kolhapur (Bhandare & Chaugale, 2023a); Jalgaon (Sawarkar, 2021)

20. *Scymnus loewii* Mulsant, 1850

- ***Myzus persicae* (Sulzer, 1776)**

- *Brassica juncea* (L.) Czern. - Kolhapur (Bhandare, 2022)
- *Brassica oleracea* L. *var. botrytis* - Kolhapur (Bhandare, 2022)
- *Brassica oleracea* L. *var. capitata* - Kolhapur (Bhandare, 2022)
- *Brassica rapa* L. - Kolhapur (Bhandare, 2022)
- *Nicotiana tabacum* L. - Kolhapur (Bhandare, 2022)
- *Pisum sativum* L. - Kolhapur (Bhandare, 2022)
- *Raphanus sativus* L. - Kolhapur (Bhandare, 2022)
- *Solanum melogena* L. - Kolhapur (Bhandare, 2022)
- *Solanum nigrum* L. - Kolhapur (Bhandare, 2022)
- *Solanum tuberosum* L. - Kolhapur (Bhandare, 2022)

21. *Scymnus nubilus* (Mulsant, 1850)

- ***Myzus persicae* (Sulzer, 1776)**
  - *Brassica juncea* (L.) Czern. - Kolhapur (Bhandare, 2022)
  - *Brassica oleracea* L. *var. botrytis* - Kolhapur (Bhandare, 2022)
  - *Brassica oleracea* L. *var. capitata* - Kolhapur (Bhandare, 2022)
  - *Brassica rapa* L. - Kolhapur (Bhandare, 2022)
  - *Nicotiana tabacum* L. - Kolhapur (Bhandare, 2022)
  - *Pisum sativum* L. - Kolhapur (Bhandare, 2022)
  - *Raphanus sativus* L. - Kolhapur (Bhandare, 2022)
  - *Solanum melogena* L. - Kolhapur (Bhandare, 2022)
  - *Solanum nigrum* L. - Kolhapur (Bhandare, 2022)
  - *Solanum tuberosum* L. - Kolhapur (Bhandare, 2022)

22. *Scymnus* spp.

- ***Aphis craccivora* Koch, 1854**
  - *Vigna unguiculata* (L.) Walp. - Prabhani (Gangaprasad, 2021)
- ***Aphis gossypii* Glover, 1877**
  - *Gossypium hirsutum* L. - Nagpur (Vennila *et al.*, 2007); Prabhani (Gangaprasad, 2021)
- Aphis punicae Passerini, 1863
  - *Punica granatum* L. - Prabhani (Gangaprasad, 2021; Udtewar *et al.*, 2022)

23. *Synonycha grandis* (Thunberg, 1781)

- ***Ceratovacuna lanigera* Zehntner, 1897**
  - *Saccharum officinarum* L. - Kolhapur (Rabindra *et al.*, 2002)

B. Order: Diptera, Family: Syrphidae (hover flies)

Aphidophagous Syrphidae occupies a pivotal ecological niche by integrating two complementary functions within agroecosystems: larval predation and adult-mediated pollination. The larval stages are highly efficient predators of aphids and contribute substantially to natural pest suppression, thereby limiting aphid-induced crop damage. In contrast, adults primarily subsist on nectar and pollen, enhancing pollination services and supporting plant reproductive success (Singh, 2026). Through this dual functional role, hover flies reinforce integrated pest management programmes by reducing reliance on chemical pesticides, while their diversity and abundance serve as reliable bioindicators of habitat quality and overall ecosystem health. Collectively, syrphids enhance biodiversity, ecosystem stability, and sustainable agricultural productivity.

Recently, Singh (2026a) reported 49 aphidophagous hover fly species representing 17 genera, associated with 94 aphid species infesting 149 host plants, collectively forming 1,025 predator–aphid–plant linkages across 27 states and union territories of India. Table 5 summarises the documented records of aphidophagous hover flies (Diptera: Syrphidae) in Maharashtra and highlights their comparatively limited but ecologically significant role in aphid regulation. In total, five syrphid species were recorded, collectively associated with nine aphid species, infesting 17 host plant species, resulting in 40 documented predator–aphid–host plant triplets across 12 districts of the state.

Among the recorded taxa, *Ischiodon scutellaris* emerged as the most ecologically versatile species, exhibiting the widest prey and host range, with associations involving ten aphid species on 19 host plants and accounting for 21 tri-trophic interactions. *Episyrphus balteatus* also showed moderate ecological breadth, preying on two aphid species across 10 host plants and forming 10 triplets. In contrast, *Betasyrphus serarius* was associated with a single aphid species but exhibited a relatively broad host-plant range, resulting in 10 triplets. The remaining species displayed highly restricted associations, each recorded with only one aphid species and one host plant. The aphid fauna most frequently preyed upon by hover flies in Maharashtra are *Myzus persicae,* mostly on brassica begetables, and *Ceratovacuna lanigera* on sugarcane. Most of the tri-trophic associations were recorded in Kolhapur district (33 triplets), followed by Akola (8 triplets). Overall, the data indicate that aphidophagous syrphids in Maharashtra are represented by a small assemblage dominated by one or two functionally important species, with most others exhibiting narrow prey and host specificity.

Table 5: Number of species of aphidophagous hover flies (Syrphidae Diptera) belonging to different families preying on different number of aphid species infesting different number of host plant species and triplets in Maharashtra.

Species of predators	Number of			
	Species of aphid	Species of host plant	Triplets	Districts
1. *Betasyrphus serarius*	1	10	10	1
2. *Dideopsis aegrota*	1	1	1	1
3. *Episyrphus balteatus*	2	10	10	1
4. *Eupeodes confrater*	1	1	1	10
5. *Ischiodon scutellaris*	10	19	21	3
Total	**10**	**19**	**43**	**12**

The limited number of recorded associations suggests that syrphid–aphid interactions in the state remain under-documented, emphasising the need for more comprehensive surveys to better elucidate their diversity, distribution, and contribution to natural aphid control in Maharashtra's agroecosystems.

The following is the detailed account of the tri-trophic associations of aphidophagous hover flies in Maharashtra.

1. *Betasyrphus serarius* (Wiedemann, 1830)

- ***Myzus persicae* (Sulzer, 1776)**
  - *Brassica juncea* (L.) Czern. - Kolhapur (Bhandare, 2022)
  - *Brassica oleracea* L. *var. botrytis* - Kolhapur (Bhandare, 2022)
  - *Brassica oleracea* L. *var. capitata* - Kolhapur (Bhandare, 2022)
  - *Brassica rapa* L. - Kolhapur (Bhandare, 2022)
  - *Nicotiana tabacum* L. - Kolhapur (Bhandare, 2022)
  - *Pisum sativum* L. - Kolhapur (Bhandare, 2022)
  - *Raphanus sativus* L. - Kolhapur (Bhandare, 2022)
  - *Solanum melogena* L. - Kolhapur (Bhandare, 2022)
  - *Solanum nigrum* L. - Kolhapur (Bhandare, 2022)
  - *Solanum tuberosum* L. - Kolhapur (Bhandare, 2022)

2. *Dideopsis aegrota* (Fabricius, 1805)

- ***Ceratovacuna lanigera* Zehntner, 1897**
  - *Saccharum officinarum* L. - Kolhapur (Rabindra *et al.*, 2002)

3. *Episyrphus balteatus* (De Geer, 1776)

- ***Ceratovacuna lanigera* Zehntner, 1897**
  - *Saccharum officinarum* L. - Kolhapur (Rabindra *et al.*, 2002)
- ***Myzus persicae* (Sulzer, 1776)**
  - *Brassica juncea* (L.) Czern. - Kolhapur (Bhandare, 2022)
  - *Brassica oleracea* L. *var. botrytis* - Kolhapur (Bhandare, 2022)
  - *Brassica rapa* L. - Kolhapur (Bhandare, 2022)
  - *Nicotiana tabacum* L. - Kolhapur (Bhandare, 2022)
  - *Pisum sativum* L. - Kolhapur (Bhandare, 2022)
  - *Raphanus sativus* L. - Kolhapur (Bhandare, 2022)
  - *Solanum melogena* L. - Kolhapur (Bhandare, 2022)
  - *Solanum nigrum* L. - Kolhapur (Bhandare, 2022)
  - *Solanum tuberosum* L. - Kolhapur (Bhandare, 2022)

4. *Eupeodes confrater* (Wiedemann, 1830)

- ***Ceratovacuna lanigera* Zehntner, 1897**
  - *Saccharum officinarum* L. - Ahmednagar, Aurangabad, Jalna, Kolhapur, Latur, Osmanabad, Pune, Sangli, Satara, Solapur (Kare, 2007; Verghese, 2013)

5. *Ischiodon scutellaris* (Fabricius, 1805)

- Aphis citricidus (Kirkaldy, 1907)
  - *Citrus* sp. - Akola (Kale *et al.*, 2020)
- ***Aphis craccivora* Koch, 1854**
  - *Lablab purpureus* (L.) Sweet - Akola (Kale *et al.*, 2020)
  - *Vigna unguiculata* (L.) Walp. - Prabhani (Gangaprasad, 2021)
- ***Aphis gossypii* Glover, 1877**
  - *Abelmoschus esculentus* (L.) Moench - Akola (Kale *et al.*, 2020)
  - *Gossypium hirsutum* L. - Akola (Kale *et al.*, 2020); Prabhani (Gangaprasad, 2021)
- Aphis punicae Passerini, 1863
  - *Punica granatum* L. - Prabhani (Gangaprasad, 2021)
- ***Brevicoryne brassicae* (Linnaeus, 1758)**
  - *Brassica oleracea* L. *var. capitata* - Prabhani (Gangaprasad, 2021; Udtewar *et al.*, 2022)
- ***Ceratovacuna lanigera* Zehntner, 1897**
  - *Saccharum officinarum* L. - Kolhapur (Rabindra *et al.*, 2002)
- ***Lipaphis erysimi* (Kaltenbach, 1843)**
  - *Brassica rapa* L. - Akola (Kale *et al.*, 2020)
- ***Myzus persicae* (Sulzer, 1776)**
  - *Brassica juncea* (L.) Czern. - Kolhapur (Bhandare, 2022)

- *Brassica oleracea* L. *var. botrytis* - Kolhapur (Bhandare, 2022)
- *Brassica oleracea* L. *var. capitata* - Kolhapur (Bhandare, 2022)
- *Brassica rapa* L. - Kolhapur (Bhandare, 2022)
- *Nicotiana tabacum* L. - Kolhapur (Bhandare, 2022)
- *Pisum sativum* L. - Kolhapur (Bhandare, 2022)
- *Raphanus sativus* L. - Kolhapur (Bhandare, 2022)
- *Solanum melogena* L. - Kolhapur (Bhandare, 2022)
- *Solanum nigrum* L. - Kolhapur (Bhandare, 2022)
- *Solanum tuberosum* L. - Kolhapur (Bhandare, 2022)

• ***Rhopalosiphum maidis* (Fitch, 1856)**
- *Sorghum bicolor* (L.) Moench - Akola (Kale *et al.*, 2020); Prabhani (Gangaprasad, 2021)

• ***Uroleucon compositae* (Theobald, 1915)**
- *Carthamus tinctorius* L. - Akola (Kale *et al.*, 2020); Prabhani (Gangaprasad, 2021)

C. Order: Hemiptera, Family: Geocoridae

The family Geocoridae, commonly referred to as big-eyed bugs, is relatively small and comprises mainly generalist predatory species, although a few members are herbivorous (Kóbor, 2020). In India, aphidophagy within this family is sparsely documented, with only two species reported to prey on four aphid species infesting eight agriculturally important host plants (Singh & Srivastav, 2024). Records from Maharashtra are particularly very limited, where a single species *Geocoris ochropterus* and an unidentified species of *Geocoris* has been documented as aphid predators, feeding on three species of aphids infesting brassica and cotton crops only in Pune and Prabhani districts as detailed below.

1. *Geocoris ochropterus* (Fieber, 1844)

• ***Lipaphis erysimi* (Kaltenbach, 1843)**
- *Brassica oleracea* L. *var. capitata* - Pune (Shaikh *et al.*, 2020)
- *Brassica oleracea* L. *var. gongylodes* - Pune (Shaikh *et al.*, 2020)
- *Brassica oleracea* L. *var. botrytis* - Pune (Shaikh *et al.*, 2020)
- *Brassica oleracea* L. *var. italica* - Pune (Shaikh *et al.*, 2020)
- *Brassica juncea* (L.) Czern. - Pune (Shaikh *et al.*, 2020)
- *Raphanus sativus* L. - Pune (Shaikh *et al.*, 2020)

1. *Geocoris* sp.

• ***Aphis gossypii* Glover, 1877**
- *Gossypium hirsutum* L. - Prabhani (Gangaprasad, 2021)

• ***Brevicoryne brassicae* (Linnaeus, 1758)**
- *Brassica oleracea* L. *var. capitata* - Prabhani (Gangaprasad, 2021)

D. Order: Lepidoptera, Family: Pyralidae

Aphid predation within the family of Pyralidae is exceptionally uncommon, as the majority of its members are predominantly herbivorous or detritivorous. However, predatory behaviour has evolved independently in a limited number of lineages, in which aphids constitute the primary prey. A well-documented example is *Dipha aphidivora*, whose larvae actively prey on the sugarcane woolly aphid, *Ceratovacuna lanigera*, across several regions of India (Srikanth *et al.*, 2015). The tri-trophic associations involving this species recorded in 10 districts of Maharashtra as presented below.

1. *Dipha aphidivora* Meyrick, 1934

• ***Ceratovacuna lanigera* Zehntner, 1897**
- *Saccharum officinarum* L. - Ahmednagar, Aurangabad, Jalna, Kolhapur, Latur, Osmanabad, Pune, Sangli, Satara, Solapur (Verghese, 2013)

E. Order: Neuroptera

The order Neuroptera, encompassing lacewings, mantidflies, and antlions, is cosmopolitan and predominantly carnivorous, with many species specialising in the predation of soft-bodied insects, particularly aphids. In India, aphidophagy has been documented in four neuropteran families, Chrysopidae, Coniopterygidae, Dilaridae, and Hemerobiidae, with green lacewings (Chrysopidae) and brown lacewings (Hemerobiidae) recognised as especially important biological control agents in agroecosystems (Devetak & Klokočovnik, 2016; Singh *et al.*, 2024a). Overall, 32 aphidophagous lacewing species are known from India, collectively attacking 68 aphid species on 107 host plants, while Maharashtra records 5 species forming 38 tri-trophic associations involving 12 aphid species on 20 host plants (Table 6).

i. Family: Chrysopidae

Chrysopidae (green lacewings) include some of the most efficient aphid predators in agroecosystems. Their larvae are voracious feeders on aphids and other soft-bodied pests, while adults subsist on nectar, pollen, and honeydew. Several species, notably *Chrysoperla zastrowi sillemi*, is widely utilised in integrated pest management (Nair *et al.*, 2020). In India, 24 aphidophagous chrysopid species in 10

Table 6: Number of species of aphidophagous Neuroptera belonging to different families preying on different number of aphid species infesting different number of host plant species and triplets in Maharashtra.

Families	Species of predators	Number of			
		Species of aphid	Species of host plant	Triplets	Districts
Chrysopidae	*1. Chrysoperla zastrowi sillemi*	12	19	26	13
	2. Mallada desjardinsi	6	6	7	2
	3. Mallada sp.	3	3	3	1
	Sub total	**12**	**20**	**35**	**13**
Hemerobiidae	*4. Micromus igorotus*	1	1	1	2
	5. Micromus timidus	1	1	1	10
	Sub total	**1**	**1**	**1**	**11**
	Total	**12**	**20**	**38**	**23**

genera attack 55 aphid species on 84 host plants (Singh *et al.*, 2024a). Maharashtra records three species forming 35 tritrophic associations with 12 aphid species on 20 host plants (Table 6) mostly in Akola, Kolhapur and Pune districts.

1. ***Chrysoperla zastrowi sillemi* (Esben-Petersen, 1935)**
   - ***Acyrthosiphon pisum* (Harris, 1776)**
     - *Medicago sativa* L. - Ahmednagar (Ingawale & Tambe, 2007; Tambe & Kadam, 2015)
   - ***Aphis citricidus* (Kirkaldy, 1907)**
     - *Citrus* sp. - Akola (Kale *et al.*, 2020)
   - ***Aphis craccivora* Koch, 1854**
     - *Medicago sativa* L. - Ahmednagar (Tambe & Kadam, 2015)
     - *Vigna unguiculata* (L.) Walp. - Prabhani (Mounika *et al.*, 2021)
   - ***Aphis gossypii* Glover, 1877**
     - *Abelmoschus esculentus* (L.) Moench - Pune (Pandurang, 2018)
     - *Gossypium hirsutum* L. - Akola (Kale *et al.*, 2020); Nagpur (Vennila *et al.*, 2007; Mounika *et al.*, 2021); Prabhani (Gangaprasad, 2021)
   - ***Brevicoryne brassicae* (Linnaeus, 1758)**
     - *Brassica oleracea* L. *var. capitata* - Prabhani (Mounika *et al.*, 2021)
   - ***Ceratovacuna lanigera* Zehntner, 1897**
     - *Saccharum officinarum* L. - Ahmednagar, Aurangabad, Jalna, Kolhapur, Latur, Osmanabad, Pune, Sangli, Satara, Solapur (Verghese, 2013)
   - ***Lipaphis erysimi* (Kaltenbach, 1843)**
     - *Brassica juncea* (L.) Czern. - Pune (Shaikh *et al.*, 2020); Prabhani (Gangaprasad, 2021)
     - *Brassica oleracea* L. *var. botrytis* - Pune (Shaikh *et al.*, 2020)
     - *Brassica oleracea* L. *var. capitata* - Pune (Shaikh *et al.*, 2020)
     - *Brassica oleracea* L. *var. gongylodes* - Pune (Shaikh *et al.*, 2020)
     - *Brassica oleracea* L. *var. italica* - Pune (Shaikh *et al.*, 2020)
     - *Raphanus sativus* L. - Pune (Shaikh *et al.*, 2020)
   - ***Myzus persicae* (Sulzer, 1776)**
     - *Brassica juncea* (L.) Czern. - Kolhapur (Bhandare, 2022)
     - *Brassica oleracea* L. *var. botrytis* - Kolhapur (Bhandare, 2022)
     - *Brassica oleracea* L. *var. capitata* - Kolhapur (Bhandare, 2022)
     - *Brassica rapa* L. - Kolhapur (Bhandare, 2022)
     - *Nicotiana tabacum* L. - Kolhapur (Bhandare, 2022)
     - *Raphanus sativus* L. - Kolhapur (Bhandare, 2022)
     - *Solanum melogena* L. - Kolhapur (Bhandare, 2022)
     - *Solanum nigrum* L. - Kolhapur (Bhandare, 2022)
     - *Solanum tuberosum* L. - Kolhapur (Bhandare, 2022)
   - ***Rhopalosiphum maidis* (Fitch, 1856)**
     - *Sorghum bicolor* (L.) Moench - Akola (Kale *et al.*, 2020)
   - ***Rhopalosiphum padi* (Linnaeus, 1758)**
     - *Avena sativa* L. - Ahmednagar (Gaikwad *et al.*, 2021)
   - ***Therioaphis trifolii subsp. trifolii* (Monell, 1882)**
     - *Medicago sativa* L. - Ahmednagar (Tambe & Kadam, 2015)
   - ***Uroleucon compositae* (Theobald, 1915)**
     - *Carthamus tinctorius* L. - Akola (Kale *et al.*, 2020); Prabhani (Gangaprasad, 2021; Mounika *et al.*, 2021)
2. ***Mallada desjardinsi* (Navás, 1911)**
   - ***Aphis craccivora* Koch, 1854**
     - *Vigna unguiculata* (L.) Walp. - Nagpur (Nagamallikadevi *et al.*, 2013)
   - ***Aphis gossypii* Glover, 1877**
     - *Gossypium hirsutum* L. – Nagpur (Nehare *et al.*, 2004)
     - Unknown plant - Nagpur (Nagamallikadevi *et al.*, 2013; George *et al.*, 2016)

- ***Brevicoryne brassicae* L.**
  - *Brassica oleracea* L. *var. capitata* - Parbhani (Gade *et al.*, 2010)
- ***Lipaphis erysimi* (Kaltenbach, 1843)**
  - *Brassica juncea* (L.) Czern. - Nagpur (Nehare *et al.*, 2004); Parbhani (Gade *et al.*, 2010)
- ***Rhopalosiphum maidis* (Fitch, 1856)**
  - Unknown plant - Nagpur (Nagamallikadevi *et al.*, 2013);
- ***Uroleucon compositae* (Theobald, 1915)**
  - *Carthamus tinctorius* L. - Nagpur (Nehare *et al.*, 2004); Parbhani (Gade *et al.*, 2010)

3. *Mallada* spp.

- ***Aphis citricidus* (Kirkaldy, 1907)**
  - *Citrus* sp. - Akola (Kale *et al.*, 2020)
- ***Aphis gossypii* Glover, 1877**
  - *Gossypium hirsutum* L. - Akola (Kale *et al.*, 2020)
- ***Rhopalosiphum maidis* (Fitch, 1856)**
  - *Sorghum bicolor* (L.) Moench - Akola (Kale *et al.*, 2020)

ii. Family: Hemerobiidae

Hemerobiidae (brown lacewings) are effective aphid predators, with both larvae and adults actively preying on aphids and other soft-bodied arthropods. Despite their biocontrol potential, they remain relatively understudied (New, 1975; Bakthavatsalam & Varshney, 2023). In India, six species in two genera prey on 29 aphid species across 48 host plants (Singh *et al.*, 2024a). In Maharashtra, two species are known, associated with *Ceratovacuna lanigera* on sugarcane in 10 districts as listed below.

1. *Micromus igorotus* Banks, 1920

- ***Ceratovacuna lanigera* Zehntner, 1897**
  - *Saccharum officinarum* L. - Ahmednagar (Kare, 2007)

2. *Micromus timidus* Hagen, 1853

- ***Ceratovacuna lanigera* Zehntner, 1897**
  - *Saccharum officinarum* L. - Ahmednagar, Aurangabad, Jalna, Kolhapur, Latur, Osmanabad, Pune, Sangli, Satara, Solapur (Anonnymus, 2003)

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