Article

The updated tri-trophic associations of the aphidophagous arthropods in West Bengal, India

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Abstract

A comprehensive analysis of tri-trophic interactions among aphidophagous predators, their aphid prey, and associated host plants in West Bengal revealed a rich and diverse predator community distributed across multiple ecological guilds. A total of 125 predator species belonging to Arachnida (Araneae) and Insecta (Coleoptera, Diptera, Hemiptera, Neuroptera) were recorded, forming 612 distinct predator–aphid–plant associations involving 57 aphid species on 98 host plants. The most dominant groups were Coccinellidae (60 species) and Syrphidae (22 species), which together accounted for the majority of tri-trophic linkages. Other significant predator families included Araneidae, Chrysopidae, Hemerobiidae, Anthocoridae, and Chamaemyiidae, representing key natural enemies contributing to aphid suppression in both agricultural and natural ecosystems. Coccinellids such as *Coccinella septempunctata*, *Cheilomenes sexmaculata*, and *Micraspis discolor* emerged as the most polyphagous predators, preying on multiple aphid species across diverse crops, including *Solanum melongena*, *Brassica juncea*, *Triticum aestivum*, and *Camellia sinensis*. Syrphid flies like *Betasyrphus isaaci*, *Episyrphus balteatus*, *Sphaerophoria scripta*, and *Ischiodon scutellaris* also displayed wide prey ranges, highlighting their potential as biocontrol agents. Other guilds, including spiders, lacewings, and minute pirate bugs, exhibited complementary predatory roles, with spiders showing activity across both cultivated and natural habitats. The findings highlight the ecological complexity and functional diversity of aphidophagous assemblages in West Bengal. This dataset provides a critical baseline for biodiversity monitoring, ecological modeling, and the development of region-specific Integrated Pest Management strategies aimed at enhancing sustainable and environmentally sound pest regulation in the state.

Keywords tri-trophic interactions; aphidophagous arthropods; host plants, aphids; Coccinellidae; Chrysopida; Syrphidae; biodiversity conservation.

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1 Introduction

Tri-trophic interactions represent fundamental ecological relationships among plants (first trophic level), herbivorous insects such as aphids (second trophic level), and their natural enemies including predators and parasitoids (third trophic level). These interactions form the basis of most terrestrial food webs and are critical to understanding community dynamics, biological control, and ecosystem functioning (Singh, 2003; Singh and Singh, 2016). In aphid-based systems, plants serve as both habitat and nutritional resource for aphids, while aphids, in turn, provide food resources for a diverse assemblage of aphidophagous arthropods, such as spiders (Arachnida: Araneae) (Singh et al., 2024a), coccinellid beetles (Coleoptera: Coccinellidae) (Singh, 2025a), syrphid flies (Diptera: Syrphidae) (Singh, 2026a), lacewings (Neuroptera: Chrysopidae, Hemerobiidae) (Singh et al., 2024b), and predatory bugs (Hemiptera: Nabidae, Anthocoridae, Miridae) (Singh and Srivastav, 2024). Among aphid natural enemies, aphidophagous predators play a crucial ecological role as biocontrol agents in agricultural and natural ecosystems. Ladybird beetles, hover flies, lacewings and bugs are especially significant for their high voracity, prey specificity, and adaptability to different habitats (Omkar, 2023). These predators contribute to natural pest suppression, thereby reducing the dependence on chemical pesticides, conserving biodiversity, and promoting ecologically sustainable pest management. The interplay between plant characteristics, aphid behaviour, and predator efficiency determines the overall stability and resilience of these tri-trophic systems (Dixon, 2000; Hodek and Honěk, 2009; Hodek et al., 2012).

Regional documentation of tri-trophic relationships is particularly significant because biotic interactions vary geographically with climate, vegetation type, and land-use patterns. The composition of aphid species and their associated predators and parasitoids often differs across agroecological zones, reflecting the influence of environmental gradients and host plant diversity. By compiling region-specific data, researchers can identify dominant aphid species, their preferred host plants, and key natural enemies, which together form the basis for effective biological control strategies tailored to local conditions. The documentation of tri-trophic associations among plants, aphids, and aphidophagous arthropods in a particular region is fundamental to understanding that region's ecological complexity and biodiversity (Singh, 2025b, 2026b, c; Singh and Omkar, 2025; Singh and Singh, 2026; Singh and Srivastav, 2025). These associations constitute intricate ecological networks that regulate herbivore populations and maintain ecosystem stability. Recording such interactions at the regional level provides crucial insights into local faunal diversity, species relationships, and the organization of natural control systems that support both natural and agricultural environments. From an applied standpoint, a detailed account of these associations deepens our knowledge of natural enemy assemblages responsible for aphid suppression in different cropping systems. This information is invaluable for developing Integrated Pest Management strategies that minimize pesticide use and promote environmentally sustainable agriculture. Additionally, understanding the regional diversity of aphidophagous predators, such as ladybird beetles, hoverflies, lacewings, and predatory bugs, can aid in identifying bioindicators useful for assessing ecosystem health and (Andersen, 1999; Iperti and Paoletti, 1999).

Cataloguing the tritrophic associations of aphidophagous arthropods with their aphid prey and host plants is essential for both ecological understanding and applied pest management (Emden and Harrington, 2007; Singh and Singh, 2016). Such inventories not only document the biodiversity of predators and parasitoids but also provide baseline information on the structure of local agroecosystems and natural habitats. By mapping predator-prey-plant linkages, catalogues elucidate ecological networks, highlight keystone species, and guide the selection of effective natural enemies for augmentative and conservation biological control. They further serve as valuable reference tools for monitoring invasive pests, tracking range shifts of natural enemies, and assessing changes in host-parasite interactions under global change (Singh and Srivastav, 2025). In addition, catalogues support agroecological practices by informing habitat management strategies that enhance natural

enemy services, while enabling comparative research across regions to reveal biogeographical trends and climatic influences. Collectively, these resources form a scientific foundation for strengthening sustainable aphid management through an integrated understanding of biodiversity and ecosystem function (Singh, 2025b).

Aphids (Hemiptera: Aphididae) are small, soft-bodied phloem feeders and among the most important plant pests. In India, about 794 species are known, with nearly 250 causing serious damage to agricultural and horticultural crops (Singh and Singh, 2016, 2019; Singh et al., 2023a). Their success is attributed to a broad host range, flexible reproduction, diverse development, and pronounced polymorphism (Singh and Singh, 2022). By extracting plant sap, aphids weaken host vigour, distort new growth, and transmit over 200 plant viruses, leading to substantial yield losses (Singh and Singh, 2021).

The article provides a comprehensive checklist of tri-trophic associations involving aphidophagous arthropods, their aphid prey, and host plants in West Bengal. This compilation offers vital baseline data on species diversity, distribution, and host specificity, forming a foundation for ecological studies and pest management initiatives. Overall, this work represents a valuable resource for researchers, policymakers, and practitioners dedicated to sustainable pest management.

2 Materials and Methods

West Bengal (21°2524″ –27°13′15″ N; 85°48′20″–89°53′04″ E) covers an area of 88,752 km² and lies in eastern India, bordered by Bangladesh, Nepal, Bhutan, and the Indian states of Sikkim, Assam, Bihar, Jharkhand, and Odisha (Figure 1). Administratively divided into 23 districts, the state encompasses diverse landscapes including the Darjeeling Himalayas, the Terai and Ganges plains, the Rarh plateau, and the Sundarbans mangrove delta along the Bay of Bengal. Major rivers include the Ganges (Bhagirathi–Hooghly) and its tributaries, along with the Teesta, Torsa, Jaldhaka, Mahananda, Damodar, Ajay, and Kangsabati. The climate ranges from humid subtropical in the north to tropical savanna in the south, with heavy monsoonal rainfall (up to 250 cm in Darjeeling, Jalpaiguri, and Cooch Behar). Forests cover about 16,805 km², including the Sundarbans, one of the world's largest mangrove ecosystems and a designated Biosphere Reserve. The state hosts five national parks, Sundarbans, Buxa, Gorumara, Neora Valley, and Singalila, and 15 wildlife sanctuaries. North Bengal is noted for its 450 tea gardens, while the rest of the state produces rice, jute, sugarcane, oilseeds, pulses, tobacco, and vegetables, reflecting its rich agricultural and ecological diversity.

This list of tri-trophic associations involving aphidophagous arthropods in West Bengal has been compiled using information from recently published books, scientific journals, verified theses, and reliable online databases up to 30 December, 2025. Earlier literature, including some contemporary sources, often contained taxonomic inaccuracies in the names of predators, aphids, and host plants, mainly due to the rapid evolution of taxonomic knowledge and the frequent neglect of updated references. As research on predator–prey dynamics continues to expand, new species records, nomenclatural revisions, and status updates are regularly produced. To ensure accuracy, the present compilation has standardized aphid names according to the Aphid Species File (https://aphid.speciesfile.org), and host plant nomenclature following World Flora Online (https://www.worldfloraonline.org) and for the arthropods, the Global Biodiversity Information Facility (GBIF) (https://www.gbif.org).

Fig. 1 Geographic location of the state of West Bengal within India, highlighted in blue shading.

3 Results and Discussion

A review of the literature indicates that Rao (1969) was likely the first to mention tri-trophic associations involving three species of hover flies in West Bengal. Subsequently, Kapur and Munshi (1970) added a record of one aphidophagous ladybird species from West Bengal. In the following years, Nath and Sen (1976), Roy and Basu (1977), Raychaudhuri et al. (1978, 1979), Agarwala et al. (1979, 1980, 1981, 1982), Ghosh et al. (1981), Ghosh and Raychaudhuri (1982), Poddar (1982), Ghosh (1983) and others documented various species of ladybirds and hover flies feeding on different aphid species in different localities of West Bengal on a range of agricultural and horticultural crops. Subsequent contributions came from several workers (Poorani, 2002; Bhattacharyya and Mandal, 2004; Satpathi and Mandal, 2006; Das et al., 2010; Roy et al., 2010; Chakrabarti et al., 2012) who reported additional aphidophagous arthropods from the region. More recent survey programmes (Gurung et al., 2019; Kumar and Pal, 2019; Debnath, 2020; Maji et al., 2023; Pal et al., 2023a, b; Saha et al., 2023) have focused on the diversity of aphidophagous arthropods, their prey, and host plants in several districts of West Bengal.

The analysis of tri-trophic associations among aphidophagous predators, their aphid prey, and host plants in West Bengal reveals a rich diversity of predator taxa distributed across multiple ecological guilds. A total of 125 predator species were documented, preying upon 57 aphid species associated with 98 host plants, forming 612 distinct predator–aphid–plant triplets across different region of the state. All the predators belong to one order of class Arachnida, the order Araneae (9 families: Araneidae, Linyphiidae, Lycosidae, Oxyopidae, Philodromidae, Salticidae, Theridiidae, Thomisidae, Uloboridae); 5 orders of class Insecta: Coleoptera (Chrysomelidae, Coccinellidae, Staphilinidae), Diptera (Calliphoridae, Chamaemyiidae, Syrphidae); Hemiptera (Anthocoridae, Geocoridae); Lepidoptera (Pyralidae) and Neuroptera (Chrysopidae, Hemerobiidae) (Table 1). Most the aphidophagous species in West Bengal are predatory on *Aphis craccivora* on leguminous crops, *Aphis gossypii* on malvaceous, cucurbitaceous and solanaceous vegetables, *Myzus persicae* on brinjal,

Lipaphis erysimi on brassica crops, *Sitobion miscanthi* on wheat, *Aphis aurantii* on citrus and tea, *Macrosiphum rosae* and *Sitobion rosaeiformis* on roses and several species of aphids on chillies, cucurbits, maize etc.

Overall, the composition and diversity of aphidophagous predators indicate a complex and functionally rich trophic network within West Bengal's agroecosystems. The predominance of Coccinellidae and Syrphidae demonstrates their ecological importance in natural aphid regulation, while the occurrence of multiple other predator groups underscores the multi-guild structure of the aphidophagous community. This comprehensive record serves as a valuable reference for understanding regional predator diversity, prey specialization, and host-plant associations, providing a crucial foundation for ecological studies, biodiversity assessment, and the development of region-specific Integrated Pest Management programs in the state.

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 West Bengal.

Class/Order/Family of the aphidophagous predators	Number of			
	Predator species	Aphid species	Plant species	Triplets
Class: Arachnida				
Araneae: 9 families	**22**	**8**	**14**	**31**
Class: Insecta				
Coleoptera: Chrysomelidae	4	3	4	6
Coleoptera: Coccinellidae	60	49	89	405
Coleoptera: Staphilinidae	2	2	1	4
Total Coleoptera	**66**	**49**	**89**	**415**
Diptera: Calliphoridae	1	1	2	2
Diptera: Chamaemyiidae	2	2	2	2
Diptera: Syrphidae	22	17	38	121
Total Diptera	**24**	**17**	**38**	**125**
Hemiptera: Anthocoridae	3	2	3	5
Hemiptera: Geocoridae	1	1	1	1
Total Hemiptera	**4**	**3**	**4**	**6**
Lepidoptera: Pyralidae	1	1	1	1
Neuroptera: Chrysopidae	8	10	14	24
Neuroptera: Hemerobiidae	2	4	8	10
Total Neuroptera	**10**	**12**	**17**	**34**
Total predators	**125**	**57**	**98**	**612**

3.1 Class: Arachnida, Order: Araneae

The order Araneae includes spiders, which play a vital ecological role as natural predators, primarily feeding on insects and helping to regulate their populations (Singh et al., 2023b). However, despite their significant contribution to ecosystem balance, spiders have received far less attention as biological control agents compared to insect predators. In a recent study, Singh et al. (2024b) recorded 79 species of aphid-feeding spiders in India, associated with 53 aphid species occurring on 59 host plant species.

Table 2 presents data on araneid (spider) predators belonging to nine families recorded preying on aphids infesting different host plants across West Bengal. A total of 22 spider species (several species identified as generic level) were documented, collectively preying on 14 aphid species with 31 tri-trophic associations

(triplets). Among the families, Araneidae was the most dominant, represented by six species showing predation on multiple aphid species. Other families such as Linyphiidae, Lycosidae, Oxyopidae, Philodromidae, Salticidae, Theridiidae, Thomisidae, and Uloboridae were represented by 1-3 species.

Table 2 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 triplets in West Bengal.

Families	Species of predators	Number of		
		Species of aphid	Species of host plant	Triplets
Araneidae	1. *Araneus* sp.	2	1	2
	2. *Cyclosa insulana*	1	1	1
	3. *Cyclosa* sp.	1	1	1
	4. *Leucauge celebesiana*	2	2	2
	5. *Neoscona nautica*	2	1	2
	6. *Neoscona* sp.	1	1	1
Linyphiidae	7. *Linyphia* sp.	1	1	1
Lycosidae	8. *Pardosa pseudoannulata*	1	1	1
	9. *Pardosa* sp.	1	1	1
	10. Unidentified	1	1	1
Oxyopidae	11. *Oxyopes javanus*	1	2	2
	12. *Oxyopes* sp.	1	1	1
Philodromidae	13. *Tibellus oblongus*	1	1	1
Salticidae	14. *Marpissa* sp.	1	1	1
	15. *Phintella vittata*	1	2	2
	16. *Rhene flavigera*	1	1	1
Theridiidae	17. *Chrysso angula*	1	1	1
	18. *Theridion* sp.	3	3	3
Thomisidae	19. *Camaricus formosus*	1	2	2
	20. *Thomisus pugilis*	2	2	2
	21. *Thomisus* sp.	1	1	1
Uloboridae	22. *Uloborus* sp.	1	1	1
	Total	**8**	**14**	**31**

Table 2 also shows that spiders prey upon a limited but economically important group of aphid species infesting various host plants. A total of 8 aphid species were recorded, *Aphis craccivora*, *Aphis gossypii*, *Cinara tujafilina*, *Lipaphis erysimi*, *Macrosiphum rosae*, *Myzus persicae*, *Sitobion rosaeiformis*, and *Taoia indica*, occurring on 14 host plant species across diverse plant families. Among these, *Lipaphis erysimi* and *Aphis gossypii* were the most frequently preyed upon, mainly from Brassicaceae and Solanaceae crops, respectively. *Macrosiphum rosae* and *Sitobion rosaeiformis* were both confined to *Rosa* spp., while *Cinara tujafilina* was associated with *Cupressus* sp. and *Thuja* sp. (Cupressaceae). The diversity of host plants, ranging from cultivated crops like *Brassica juncea*, *Vicia faba*, and *Solanum melongena* to ornamental and forest species like *Alnus nepalensis*, indicates that spiders exploit aphid prey from both agricultural and natural ecosystems.

Overall, these records highlight the broad prey spectrum and ecological versatility of spiders as aphid predators in West Bengal, highlighting their potential role in the natural regulation of aphid populations across multiple habitats. The detailed tri-trophic associations of these spiders are given below.

3.1.1 Family: Araneidae

3.1.1.1 *Araneus* sp.

• *Macrosiphum rosae* (Linnaeus, 1758)

- *Rosa* sp. (Debnath, 2020)

• *Sitobion rosaeiformis* (Das, 1918)

- *Rosa* sp. (Debnath, 2020)

3.1.1.2 *Cyclosa insulana* (Costa, 1834)

• *Aphis craccivora* Koch, 1854

- *Vicia faba* L. (Raychaudhuri et al., 1979; Debnath, 2020)

3.1.1.3 *Cyclosa* sp.

• *Sitobion rosaeiformis* (Das, 1918)

- *Rosa* sp. (Raychaudhuri et al., 1978)

3.1.1.4 *Leucauge celebesiana* (Walckenaer, 1841)

• *Aphis craccivora* Koch, 1854

- *Vicia faba* L. (Raychaudhuri et al., 1979; Debnath, 2020)

• *Aphis gossypii* Glover, 1977

- *Galinsoga parviflora* Cav. (Raychaudhuri et al., 1979; Debnath, 2020)

3.1.1.5 *Neoscona nautica* (L. Koch, 1875)

• *Macrosiphum rosae* (Linnaeus, 1758)

- *Rosa* sp. (Raychaudhuri et al., 1979; Debnath, 2020)

• *Sitobion rosaeiformis* (Das, 1918)

- *Rosa* sp. (Debnath, 2020)

3.1.1.6 *Neoscona* sp.

• *Myzus persicae* (Sulzer, 1776)

- *Solanum tuberosum* L. (Nayak et al., 2019)

3.1.2 Family: Linyphiidae

3.1.2.1 *Linyphia* sp.

• *Taoia indica* (Ghosh and Raychaudhuri, 1972)

- *Alnus nepalensis* D. Don (Raychaudhuri et al., 1979; Debnath, 2020)

3.1.3 Family: Lycosidae

3.1.3.1 *Pardosa pseudoannulata* (Bösenberg and Strand, 1906)

• *Aphis gossypii* Glover, 1977

- *Solanum melongena* L. (Satpathi, 1999)

3.1.3.2 *Pardosa* sp.

• *Aphis gossypii* Glover, 1977

- *Solanum melongena* L. (Satpathi, 1999)

3.1.3.3 Unidentified species

• *Myzus persicae* (Sulzer, 1776)

- *Brassica oleracea* L. var. *capitata* (Anusha et al., 2022)

3.1.4 Family: Oxyopidae

3.1.4.1 *Oxyopes javanus* Thorell, 1887

• *Lipaphis erysimi* (Kaltenbach, 1843)
- *Brassica juncea* (L.) Czern. (Ghosh, 1983)
- *Brassica* sp. (Agarwala et al., 1981)

3.1.4.2 *Oxyopes* sp.

• *Myzus persicae* (Sulzer, 1776)
- *Solanum tuberosum* L. (Nayak et al., 2019)

3.1.5 Family: Philodromidae

3.1.5.1 *Tibellus oblongus* (Walckenaer, 1802

• *Myzus persicae* (Sulzer, 1776)
- *Solanum tuberosum* L. (Nayak et al., 2019)

3.1.6 Family: Salticidae

3.1.6.1 *Marpissa* sp.

• *Cinara tujafilina* (del Guercio, 1909)
- *Cupressus* sp. (Raychaudhuri et al., 1979; Debnath, 2020)

3.1.6.2 *Phintella vittata* (C. L. Koch, 1846)

• *Lipaphis erysimi* (Kaltenbach, 1843)
- *Brassica juncea* (L.) Czern. (Ghosh, 1983)
- *Brassica* sp. (Agarwala et al., 1981)

3.1.6.3 *Rhene flavigera* (C. L. Koch, 1846)

• *Macrosiphum rosae* (Linnaeus, 1758)
- *Rosa* sp. (Raychaudhuri et al., 1978; Debnath, 2020)

3.1.7 Family: Theridiidae

3.1.7.1 *Chrysso angula* (Tikader, 1970)

• *Cinara tujafilina* (del Guercio, 1909)
- *Thuja* sp. (Raychaudhuri et al., 1998)

3.1.7.2 *Theridion* sp.

• *Aphis craccivora* Koch, 1854
- Unidentified plant (Raychaudhuri et al., 1979)
• *Cinara tujafilina* (del Guercio, 1909)
- *Cupressus* sp. (Raychaudhuri et al., 1978)
• *Lipaphis erysimi* (Kaltenbach, 1843)
- *Brassica juncea* (L.) Czern. (Ghosh, 1983)

3.1.8 Family: Thomisidae

3.1.8.1 *Camaricus formosus* Thorell, 1887

• *Lipaphis erysimi* (Kaltenbach, 1843)
- *Brassica juncea* (L.) Czern. (Ghosh, 1983)
- *Brassica rapa* L. (Agarwala et al., 1981)

3.1.8.2 *Thomisus pugilis* Stoliczka, 1869

• *Aphis craccivora* Koch, 1854
- *Lablab purpureus* (L.) Sweet ssp. *purpureus* (Agarwala et al., 1981)
• *Lipaphis erysimi* (Kaltenbach, 1843)
- *Brassica juncea* (L.) Czern. (Ghosh, 1983)

3.1.8.3 *Thomisus* sp.

• *Macrosiphum rosae* (Linnaeus, 1758)

- *Rosa* sp. (Raychaudhuri et al., 1979; Debnath, 2020)

3.1.9 Family: Uloboridae

3.1.9.1 *Uloborus* sp.

• *Aphis gossypii* Glover, 1977

- *Tagetes erecta* L. (Raychaudhuri et al., 1979; Debnath, 2020)

• *Cinara tujafilina* (del Guercio, 1909)

- *Cupressus* sp. (Raychaudhuri et al., 1979)

3.2 Class: Insecta, Order: Coleoptera

Among the recorded taxa, the order Coleoptera emerged as the most dominant group, comprising 66 species associated with 49 aphid species on 89 host plants, forming 415 tri-trophic linkages (Table 3). Within Coleoptera, the family Coccinellidae was overwhelmingly predominant, accounting for 60 species, nearly half of all predator species, reflecting their major role in aphid suppression and their well-established importance in natural and applied biological control (Kumar and Omkar, 2023). Other coleopteran families, such as Chrysomelidae and Staphylinidae, were represented by comparatively fewer species and associations.

3.2.1 Family: Chrysomelidae (leaf beetles)

Although traditionally known as phytophagous, a few members of Chrysomelidae exhibit opportunistic predatory behaviour on aphids, indicating their minor yet ecologically relevant role in aphid regulation within the region's agroecosystems. The family Chrysomelidae in West Bengal is represented by four predatory species, *Altica* sp., *Aspidolopha* sp., *Monolepta signata*, and *Sphenoraia bicolor*, that together prey upon three aphid species, mostly *Lipaphis erysimi* and *Macrosiphum rosae* feeding on brassica crops and roses, respectively and are associated with four host plant species in total, forming a sum of six tri-trophic associations. The detailed tri-trophic associations of these spiders are given below.

3.2.1.1 *Altica* sp.

• *Sitobion miscanthi* (Takahashi, 1921)

- *Hordeum vulgare* L. (Ghosh and Raychaudhuri, 1982)

3.2.1.2 *Aspidolopha* sp.

• *Lipaphis erysimi* (Kaltenbach, 1843)

- *Brassica nigra* L (Ghosh et al., 1981)

3.2.1.3 *Monolepta signata* (Olivier, 1808)

• *Lipaphis erysimi* (Kaltenbach, 1843)

- *Brassica juncea* (L.) Czern. (Ghosh, 1983)

- *Brassica nigra* L. (Ghosh et al., 1981)

• *Macrosiphum rosae* (Linnaeus, 1758)

- *Rosa* sp. (Ghosh and Raychaudhuri, 1982; Debnath, 2020)

3.2.1.4 *Sphenoraia bicolor* (Hope, 1831)

• *Macrosiphum rosae* (Linnaeus, 1758)

- *Rosa* sp. (Raychaudhuri et al., 1979; Debnath, 2020)

3.2.2 Family: Coccinellidae (the ladybirds)

Ladybird beetles are among the most effective and well-known predatory insects, serving as vital natural enemies of numerous agricultural pests. Both their larvae and adults feed extensively on soft-bodied insects such as aphids, whiteflies, scales, mealybugs, and mites. By regulating these pest populations, coccinellids play a crucial role in safeguarding crops including cereals, vegetables, fruits, and oilseeds (Singh, 2025c, d, e; Singh and Ahmad, 2025a; Singh and Pandey, 2025; Tiwari and Singh, 2025a, b; Tiwari et al., 2024). Their strong predatory efficiency and broad ecological tolerance make them valuable agents in biological control,

helping to reduce chemical pesticide use and promote sustainable farming practices. Several species have been successfully utilized in both classical and applied biological control programmes targeting aphids (Kumar and Omkar, 2025). In India, a total of 148 species of aphidophagous coccinellids have been documented, associated with 181 aphid species occurring on 350 host plant species, accounting for 3,102 recorded tri-trophic associations across 31 states and union territories (Singh, 2025a).

The family Coccinellidae represents the most dominant and diverse group of aphidophagous predators in West Bengal, comprising 60 species that together prey upon 49 aphid species associated with 89 host plant species, forming a total of 405 tri-trophic associations (Table 3). Among these, *Coccinella septempunctata* (24 aphid species on 35 host plants, *Cheilomenes sexmaculata* (18 aphid species on 34 host plants), *Micraspis discolor* (17 aphid species on 28 host plants) and *Coccinella transversalis* (13 aphid species on 32 host plants), and emerged as the most polyphagous species, interacting with numerous aphid–plant combinations across the state. The wide prey spectrum, high adaptability, and ecological versatility of coccinellids highlight their pivotal role in the natural suppression of aphid populations. These beetles form a crucial component of agroecosystem stability and serve as efficient biological control agents, supporting integrated pest management and contributing significantly to sustainable agricultural practices in West Bengal.

Table 3 Number of species of coleopteran predators preying on different number of aphid species infesting different number of host plant species and triplets in West Bengal.

Family/Species of predators	Number of		
	Species of aphid	Species of host plant	Triplets
Chrysomelidae			
1. *Altica* sp.	1	1	1
2. *Aspidolopha* sp.	1	1	1
3. *Monolepta signata*	2	3	3
4. *Sphenoraia bicolor*	1	1	1
Total Chrysomelidae	3	4	6
Coccinellidae			
5. *Adalia bipunctata*	1	1	1
6. *Afidentula manderstjernae*	1	1	1
7. *Alloneda dodecaspilota*	1	1	1
8. *Coccinella repanda*	1	1	1
9. *Coelophora inaequalis*	1	1	1
10. *Coelophora saucia*	1	1	1
11. Henosepilachna septima	1	1	1
12. Henosepilachna sp.	1	1	1
13. *Micraspis allardi*	1	1	1
14. *Nephus regularis*	1	1	1
15. *Oenopia conglobata*	1	1	1
16. *Ola* sp.	1	1	1
17. *Platynaspis variegata*	1	1	1
18. *Platynaspis* sp.	1	1	2
19. *Scymnus nymphaeus*	1	1	1
20. *Sticholotis binotata*	1	1	1

Family/Species of predators	Number of		
	Species of aphid	Species of host plant	Triplets
21. *Synonychimorpha chittagongi*	1	1	1
22. *Ballia* sp.	2	2	2
23. *Coelophora* sp.	2	2	2
24. *Cryptogonus bimaculatus*	2	1	2
25. Jauravia pallidula	2	1	2
26. *Scymnus fuscatus*	2	1	2
27. *Scymnus nubilus*	2	2	2
28. *Scymnus pyrocheilus*	2	9	9
29. *Scymnus quadrillum*	2	1	2
30. *Synonycha grandis*	2	2	2
31. *Chilocorus politus*	3	1	3
32. *Chilocorus rubidus*	3	2	3
33. *Cryptolaemus montrouzieri*	3	1	3
34. Harmonia spp.	3	3	3
35. *Megalocaria dilatata*	3	2	3
36. *Micraspis crocea*	3	1	3
37. *Oenopia quadripunctata*	3	1	3
38. *Scymnus xerampelinus*	3	3	3
39. *Anegleis cardoni*	4	4	6
40. *Chilocorus circumdatus*	4	2	4
41. *Coelophora biplagiata*	4	3	5
42. *Harmonia sedecimnotata*	4	3	4
43. Illeis indica	4	4	6
44. Jauravia quadrinotata	4	2	4
45. *Scymnus* spp.	4	4	6
46. *Stethorus gilvifrons*	4	2	4
47. *Adalia tetraspilota*	5	4	5
48. *Micraspis yasumatsui*	5	4	7
49. *Phrynocaria unicolor*	5	3	5
50. *Propylea japonica*	5	4	6
51. *Propylea quatuordecimpunctata*	5	5	5
52. *Pseudaspidimerus trinotata*	5	14	16
53. *Harmonia dimidiata*	7	3	7
54. *Oenopia sauzeti*	7	7	9
55. *Oenopia sexareata*	7	7	11
56. *Propylea dissecta*	7	7	10
57. *Oenopia kirbyi*	8	8	11
58. *Propylea luteopustulata*	8	8	12
59. *Brumoides suturalis*	9	7	12
60. *Cryptogonus quadriguttatus*	9	5	10
61. *Coccinella transversalis*	13	32	41
62. *Micraspis discolor*	17	28	38

Family/Species of predators	Number of		
	Species of aphid	Species of host plant	Triplets
63. *Cheilomenes sexmaculata*	18	34	43
64. *Coccinella septempunctata*	24	35	51
Total Coccinellidae	**49**	**89**	**405**
Staphilinidae			
65. *Paederus fuscipes*	2	1	2
66. *Paederus* sp.	2	1	2
Total Staphilinidae	**2**	**2**	**4**
Total Coleoptera	**49**	**89**	**415**

Myzus persicae, infesting 11 food plant species, particularly solanaceous and brassica vegetable crops, s upports the highest number of predators (33 species). This is followed by *Aphis gossypii*, which infests 19 food plants including brinjal, chillies, cucurbits, okra etc., and is preyed upon by 30 predator species. *Aphis craccivora*, *Aphis aurantii*, *Rhopalosiphum maidis* and *Sitobion miscanthi* are attacked by 27, 21, 18 and 11 predator species, respectively, whereas other aphid species attract fewer than 10 predators.

Among the host plants, solanaceous crops, particularly *Solanum melongena*, exhibited the highest number of tri-trophic associations, supporting a remarkable diversity of coccinellid predators. This crop harbored three major aphid species, *Aphis craccivora*, *Aphis gossypii*, and *Myzus persicae*, which attracted 23, 26, and 29 predator species, respectively. Another prominent host, wheat (*Triticum aestivum*), though infested by only three aphid species, *Rhopalosiphum maidis*, *Sitobion avenae*, and *Sitobion miscanthi*, supported a rich assemblage of 25 ladybird species. Collectively, these aphids damage a wide range of crops, including pulses, vegetables, oilseeds, cereals, and fruit trees (Singh and Singh, 2023; Singh, 2024a, b; Singh, 2025e, f). Likewise, *Brassica juncea*, *Camellia sinensis*, *Capsicum frutescens*, and several leguminous crops also sustained high predator diversity, with numerous coccinellid species preying upon multiple aphid taxa across these host plants.

Following is the detailed account of tri-trophic associations of aphidophagous ladybirds in West Bengal.

3.2.2.1 *Adalia bipunctata* (Linnaeus, 1758)

• *Brachycaudus helichrysi* (Kaltenbach, 1843)

- Unknown plant (Chakrabarti et al., 2012)

3.2.2.2 *Adalia tetraspilota* (Hope, 1831)

• *Aphis craccivora* Koch, 1854

- *Solanum melongena* L. (Satpathi and Mandal, 2006)

• *Aphis gossypii* Glover, 1977

- *Solanum melongena* L. (Satpathi and Mandal, 2006)

• *Aphis pomi* Vallot, 1802

- Unknown plant (Chakrabarti et al., 2012)

• *Brachycaudus helichrysi* (Kaltenbach, 1843)

- *Artemisia vulgaris* L. (Chakrabarti et al., 2012)

• *Myzus persicae* (Sulzer, 1776)

- *Solanum melongena* L. (Satpathi and Mandal, 2006)

- *Solanum nigrum* L. (Chakrabarti et al., 2012)

3.2.2.3 *Afidentula manderstjernae* (Mulsant, 1853)

• *Aphis aurantii* Boyer de Fonsc., 1841
- *Camellia sinensis* (L.) Kuntze (Roy et al., 2010)

3.2.2.4 *Alloneda dodecaspilota* (Hope, 1831)

• *Taoia indica* (Ghosh and Raychaudhuri, 1972)
- *Alnus* sp. (Ghosh and Raychaudhuri, 1982; Debnath, 2020)

3.2.2.5 *Anegleis cardoni* (Weise, 1892)

• *Aphis craccivora* Koch, 1854
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
• *Aphis gossypii* Glover, 1977
- *Capsicum annuum* (Chili) (Maji et al., 2023)
- *Capsicum frutescens* L. (Gurung et al., 2019)
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
• *Brevicoryne brassicae* (Linnaeus, 1758)
- *Brassica* sp. (Chakrabarti et al., 2012)
• *Myzus persicae* (Sulzer, 1776)
- *Solanum melongena* L. (Satpathi and Mandal, 2006)

3.2.2.6 *Ballia* sp.

• *Myzus persicae* (Sulzer, 1776)
- *Gynura bicolor* DC. (Debnath, 2020)
• *Rhopalosiphum maidis* (Fitch, 1856)
- *Zea mays* L. (Agarwala et al., 1981)

3.2.2.7 *Brumoides suturalis* (Fabricius, 1798)

• *Aphis craccivora* Koch, 1854
- *Lablab purpureus* (L.) Sweet ssp. *purpureus* (Gurung et al., 2019)
- *Lens culinaris* Medik. (Poddar, 1982)
• *Aphis gossypii* Glover, 1977
- *Abelmoschus esculentus* (L.) Moench (Gurung et al., 2019; Maji et al., 2023)
- *Solanum melongena* L. (Gurung et al., 2019)
• *Brachycaudus helichrysi* (Kaltenbach, 1843)
- *Brassica rapa* L. (Nath and Sen, 1976)
• *Brevicoryne brassicae* (Linnaeus, 1758)
- *Brassica rapa* L. (Nath and Sen, 1976)
• *Lipaphis erysimi* (Kaltenbach, 1843)
- *Brassica juncea* (L.) Czern. (Ghosh, 1983)
• *Myzus persicae* (Sulzer, 1776)
- *Abelmoschus esculentus* (L.) Moench (Gurung et al., 2019)
- *Solanum melongena* L. (Gurung et al., 2019)
• *Rhopalosiphum maidis* (Fitch, 1856)
- *Triticum aestivum* L. (Gurung et al., 2019)
• *Sitobion avenae* (Fabricius, 1775)
- *Triticum aestivum* L. (Maji et al., 2023)
• *Sitobion miscanthi* (Takahashi, 1921)
- *Triticum aestivum* L. (Gurung et al., 2019)

3.2.2.8 *Cheilomenes sexmaculata* (Fabricius, 1781)

• *Acyrthosiphon pisum* (Harris, 1776)
- *Pisum sativum* L. (Maji et al., 2023)
- *Trigonella foenum- graecum* L. (Bindhani et al., 2020)
• *Aphis aurantii* Boyer de Fonsc., 1841
- *Phlogacanthus thyrsiformis* (Roxb. ex Hardw.) Mabb. (Maji et al., 2023)
• *Aphis craccivora* Koch, 1854
- *Lablab purpureus* (L.) Sweet (Ghosh et al., 1981; Gurung et al., 2019)
- *Lathyrus aphaca* L. (Poddar, 1982)
- *Mussaenda acuminata* Blume (Maji et al., 2023)
- *Pisum sativum* L. (Pal et al., 2023a)
- *Senna sophera* (L.) Roxb. (Poddar, 1982)
- *Senna tora* (L.) Roxb. (Poddar, 1982)
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
- *Trigonella foenum-graecum* L. (Poddar, 1982)
- *Vicia faba* L. (Poddar, 1982)
- *Vigna mungo* (L.) Hepper (Poddar, 1982)
- *Vigna unguiculata* (L.) Walp. (Poddar, 1982)
• *Aphis gossypii* Glover, 1977
- *Abelmoschus esculentus* (L.) Moench (Gurung et al., 2019)
- *Capsicum annuum* L. (Maji et al., 2023)
- *Capsicum frutescens* L. (Gurung et al., 2019)
- *Colocasia esculenta* (L.) Schott (Bhattacharyya and Mandal, 2004)
- *Gossypium arboreum* L. (Agarwala and Saha, 1986)
- *Gossypium hirsutum* L. (Maji et al., 2023)
- *Lagenaria siceraria* (Molino) Standl. (Saha et al., 2016)
- *Malus domestica* (Suckow) Borkh. (Chakrabarti et al., 2012)
- *Ocimum tenuiflorum* L. (Maji et al., 2023)
- *Solanum melongena* L. (Satpathi, 1999; Satpathi and Mandal, 2006; Gurung et al., 2019)
• *Aphis nerii* Boyer de Fonsc., 1841
- *Calotropis procera* (Aiton) Dryand. (Chaudhuri et al., 1983)
• *Aphis odinae* (van der Goot, 1917)
- *Mangifera indica* L. (Maji et al., 2023)
• *Ceratovacuna lanigera* Zehntner, 1897
- *Saccharum officinarum* L. (Kumar and Pal, 2022; Maji et al., 2023)
• *Cervaphis rappardi indica* Basu, 1961
- *Cajanus cajan* (L.) Millsp. (Maji et al., 2023)
• *Greenidea psidii* van der Goot, 1917
- *Psidium guajava* L. (Ghosh and Raychaudhuri, 1982; Chakrabarti et al., 2012)
• *Hyadaphis coriandri* (Das, 1918)
- *Coriandrum sativum* L. (Maji et al., 2023)
• *Lipaphis erysimi* (Kaltenbach, 1843)
- *Brassica juncea* (L.) Czern. (Ghosh, 1983)
- *Brassica napus* L. (Pal & Debnath, 2020)
- *Brassica nigra* (L.) W.D.J.Koch (Ghosh et al., 1981)

• *Macrosiphoniella sanborni* (Gillette, 1908)
- *Chrysanthemum indicum* L. (Maji et al., 2023)
• *Myzus persicae* (Sulzer, 1776)
- *Abelmoschus esculentus* (L.) Moench (Gurung et al., 2019)
- *Linum usitatissimum* L. (Gurung et al., 2019)
- *Solanum melongena* L. (Satpathi and Mandal, 2006; Gurung et al., 2019)
- *Solanum tuberosum* L. (Nayak et al., 2019)
• *Rhopalosiphum maidis* (Fitch, 1856)
- *Triticum aestivum* L. (Gurung et al., 2019)
- *Zea mays* L. (Gurung et al., 2019; Maji et al., 2023)
• *Schizoneuraphis himalayensis* (Ghosh and Raychaudhuri, 1973)
- *Machilus gamblei* King ex Hook.f. (Ponnusamy et al., 2019)
• *Sitobion avenae* (Fabricius, 1775)
- *Triticum aestivum* L. (Maji et al., 2023)
• *Sitobion miscanthi* (Takahashi, 1921)
- *Triticum aestivum* L. (Gurung et al., 2019)
• *Sitobion* sp.
- *Zea mays* L. (Maji et al., 2023)

3.2.2.9 *Chilocorus circumdatus* (Gyllenhal, 1808)

• *Aphis aurantii* Boyer de Fonsc., 1841
- *Camellia sinensis* (L.) Kuntze (Roy et al., 2010)
• *Aphis craccivora* Koch, 1854
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
• *Aphis gossypii* Glover, 1977
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
• *Myzus persicae* (Sulzer, 1776)
- *Solanum melongena* L. (Satpathi and Mandal, 2006)

3.2.2.10 *Chilocorus politus* Mulsant 1850

• *Aphis craccivora* Koch, 1854
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
• *Aphis gossypii* Glover, 1977
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
• *Myzus persicae* (Sulzer, 1776)
- *Solanum melongena* L. (Satpathi and Mandal, 2006)

3.2.2.11 *Chilocorus rubidus* Hope, 1831

• *Macrosiphum rosae* (Linnaeus, 1758)
- *Rosa* sp. (Raychaudhuri et al., 1979; Agarwala, 1983)
• *Nippolachnus piri* Matsumura, 1917
- *Pyrus communis* L. (Ghosh and Raychaudhuri, 1982)
• *Sitobion rosaeiformis* (Das, 1918)
- *Rosa* sp. (Raychaudhuri et al., 1979; Agarwala, 1983)

3.2.2.12 *Coccinella repanda* Thunberg, 1781

• *Aphis aurantii* Boyer de Fonsc., 1841
- *Camellia sinensis* (L.) Kuntze (Roy et al., 2010)

3.2.2.13 *Coccinella septempunctata* Linnaeus, 1758

• *Acyrthosiphon pisum* (Harris, 1776)
- *Pisum sativum* L. (Debnath, 2020; Saha et al., 2023)
- *Trigonella foenum-graecum* L. (Bindhani et al., 2020)
• *Aphis aurantii* Boyer de Fonsc., 1841
- *Camellia sinensis* (L.) Kuntze (Das et al., 2010)
- *Citrus limon* (L.) Osbeck (Gurung et al., 2019)
- *Citrus* sp. (Chakrabarti et al., 2012)
- *Schima wallichii* (DC.) Korth. (Raychaudhuri et al., 1998; Debnath, 2020)
• *Aphis citricidus* (Kirkaldy, 1907)
- *Citrus limon* (L.) Osbeck (Gurung et al., 2019; Maji et al., 2023)
- *Citrus* sp. (Raychaudhuri et al., 1998)
• *Aphis craccivora* Koch, 1854
- *Lablab purpureus* (L.) Sweet ssp. *purpureus* (Ghosh et al., 1981; Debnath, 2020)
- *Pisum sativum* L. (Pal et al., 2023a)
- *Senna tora* (L.) Roxb. (Poddar, 1982)
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
- *Vicia faba* L. (Debnath, 2020)
- *Vigna mungo* (L.) Hepper (Poddar, 1982)
- *Vigna radiata* (L.) R. Wiczek (Maji et al., 2023)
• *Aphis fabae* Scopoli, 1763
- *Solanum nigrum* L. (Maji et al., 2023)
• *Aphis gossypii* Glover, 1977
- *Ageratum conyzoides* L. (Ghosh and Raychaudhuri, 1982; Debnath, 2020)
- *Bidens pilosa* L. (Debnath, 2020)
- *Capsicum annuum* L. (Maji et al., 2023)
- *Capsicum frutescens* L. (Gurung et al., 2019; Debnath, 2020)
- *Solanum melongena* L. (Satpathi and Mandal, 2006; Gurung et al., 2019)
• *Aphis spiraecola* Patch, 1914
- *Capsicum frutescens* L. (Debnath, 2020)
- *Magnolia champaka* (L.) Baill. ex Pierre (Raychaudhuri et al., 1998)
• *Brachycaudus helichrysi* (Kaltenbach, 1843)
- *Artemesia* sp. (Debnath, 2020)
- *Prunus persica* (L.) Stokes (Debnath, 2020)
• *Brevicoryne brassicae* (Linnaeus, 1758)
- *Brassica oleracea* L. var. *capitata* (Maji et al., 2023)
• *Cinara tujafilina* (del Guercio, 1909)
- *Cupressus* sp. (Raychaudhuri et al., 1998)
• *Ericolophium holsti* (Takahashi, 1935)
- *Rhododendron* sp. (Agarwala et al., 1981)
• *Greenidea psidii* van der Goot, 1917
- *Psidium guajava* L. (Ghosh and Raychaudhuri, 1982; Chakrabarti et al., 2012)
• *Lipaphis erysimi* (Kaltenbach, 1843)
- *Brassica juncea* (L.) Czern. (Ghosh, 1983)

- *Brassica napus* L. (Pal & Debnath, 2020)
- *Brassica nigra* (L.) W.D.J.Koch (Ghosh et al., 1981)
- *Brassica oleracea* L. var. *capitata* (Gurung et al., 2019)
- *Brassica rapa* L. (Gurung et al., 2019; Maji et al., 2023)

• *Macrosiphum rosae* (Linnaeus, 1758)

- *Rosa canina* L. (Debnath, 2020)
- *Rosa indica* L. (Gurung et al., 2019)
- *Rosa* sp. (Raychaudhuri et al., 1979; Debnath, 2020)

• *Myzus persicae* (Sulzer, 1776)

- *Brassica rapa* L. (Gurung et al., 2019)
- *Capsicum frutescens* L. (Gurung et al., 2019)
- *Solanum melongena* L. (Satpathi and Mandal, 2006; Gurung et al., 2019)
- *Solanum nigrum* L. (Chakrabarti et al., 2012; Debnath, 2020)
- *Solanum tuberosum* L. (Nayak et al., 2019; Maji et al., 2023)

• *Pentalonia nigronervosa* Coquerel, 1859

- *Musa* sp. (Agarwala et al., 1981; Chakrabarti et al., 2012)

• *Prociphilus micheliae* Hille Ris Lambers, 1933

- *Magnolia champaka* (L.) Baill. ex Pierre (Raychaudhuri et al., 1998)

• *Rhopalosiphum maidis* (Fitch, 1856)

- *Triticum aestivum* L. (Gurung et al., 2019)

• *Schizoneuraphis himalayensis* (Ghosh and Raychaudhuri, 1973)

- *Machilus gamblei* King ex Hook.f. (Ponnusamy et al., 2019)

• *Sitobion avenae* (Fabricius, 1775)

- *Triticum aestivum* L. (Maji et al., 2023)

• *Sitobion miscanthi* (Takahashi, 1921)

- *Triticum aestivum* L. (Gurung et al., 2019)

• *Sitobion rosaeiformis* (Das, 1918)

- *Rosa canina* L. (Agarwala, 1983)
- *Rosa* sp. (Debnath, 2020)

• *Taoia indica* (Ghosh and Raychaudhuri, 1972)

- *Alnus nepalensis* D. Don (Ghosh and Raychaudhuri, 1982; Debnath, 2020)

• *Tuberculatus paiki* Hille Ris Lambers, 1974

- *Quercus serrata* Murray (Chakrabarti et al., 2012)

3.2.2.14 *Coccinella transversalis* Fabricus, 1781

• *Acyrthosiphon pisum* (Harris, 1776)

- *Pisum sativum* L. (Saha et al., 2023)
- *Trigonella foenum-graecum* L. (Bindhani et al., 2020)

• *Aphis aurantii* Boyer de Fonsc., 1841

- *Camellia sinensis* (L.) Kuntze (Das et al., 2010)
- *Phlogacanthus thyrsiformis* (Roxb. ex Hardw.) Mabb. (Maji et al., 2023)

• *Aphis craccivora* Koch, 1854

- *Lablab purpureus* (L.) Sweet (Ghosh et al., 1981; Gurung et al., 2019)
- *Lens culinaris* Medik. (Poddar, 1982)
- *Pisum sativum* L. (Poddar, 1982; Pal et al., 2023a)

- *Senna tora* (L.) Roxb. (Poddar, 1982)
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
- *Vicia faba* L. (Poddar, 1982)
- *Vigna mungo* (L.) Hepper (Poddar, 1982)
- *Vigna unguiculata* (L.) Walp. (Poddar, 1982)

• *Aphis fabae* Scopoli, 1763

- *Solanum nigrum* L. (Maji et al., 2023)

• *Aphis gossypii* Glover, 1977

- *Abelmoschus esculentus* (L.) Moench (Gurung et al., 2019; Maji et al., 2023)
- *Capsicum annuum* L. (Maji et al., 2023)
- *Capsicum frutescens* L. (Gurung et al., 2019)
- *Colocasia esculenta* (L.) Schott (Bhattacharyya and Mandal, 2004)
- *Glebionis carinata* (Schousb.) Tzvelev (Maji et al., 2023)
- *Gossypium hirsutum* L. (Agarwala and Saha, 1986)
- *Lagenaria siceraria* (Molino) Standl. (Saha et al., 2016)
- *Momordica charantia* L. (Maji et al., 2023)
- *Solanum melongena* L. (Satpathi and Mandal, 2006; Gurung et al., 2019)

• *Aphis odinae* (van der Goot, 1917)

- *Neolamarckia cadamba* (Roxb.) Bosser (Maji et al., 2023)

• *Brevicoryne brassicae* (Linnaeus, 1758)

- *Brassica oleracea* L. var. *capitata* (Maji et al., 2023)

• *Hyadaphis coriandri* (Das, 1918)

- *Coriandrum sativum* L. (Maji et al., 2023)

• *Lipaphis erysimi* (Kaltenbach, 1843)

- *Brassica juncea* (L.) Czern. (Ghosh, 1983; Maji et al., 2020)
- *Brassica napus* L. (Pal & Debnath, 2020)
- *Brassica nigra* (L.) W.D.J.Koch (Ghosh et al., 1981)
- *Brassica oleracea* L. var. *capitata* (Gurung et al., 2019)
- *Brassica rapa* L. (Gurung et al., 2019; Maji et al., 2023)

• *Myzus persicae* (Sulzer, 1776)

- *Abelmoschus esculentus* (L.) Moench (Gurung et al., 2019)
- *Brassica napus* L. (Karthik et al., 2023)
- *Brassica rapa* L. (Gurung et al., 2019)
- *Capsicum frutescens* L. (Gurung et al., 2019)
- *Helianthus annuus* L. (Maji et al., 2023)
- *Linum usitatissimum* L. (Gurung et al., 2019)
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
- *Solanum tuberosum* L. (Nayak et al., 2019)

• *Rhopalosiphum maidis* (Fitch, 1856)

- *Triticum aestivum* L. (Gurung et al., 2019)
- *Zea mays* L. (Maji et al., 2023)

• *Sitobion miscanthi* (Takahashi, 1921)

- *Triticum aestivum* L. (Gurung et al., 2019)

• *Sitobion* sp.

- *Zea mays* L. (Maji et al., 2023)

3.2.2.15 *Coelophora biplagiata* (Swartz, 1808)

• *Aphis craccivora* Koch, 1854

- *Solanum melongena* L. (Satpathi and Mandal, 2006)
- *Vicia faba* L. (Debnath, 2020)

• *Aphis gossypii* Glover, 1977

- *Solanum melongena* L. (Satpathi and Mandal, 2006)

• *Myzus persicae* (Sulzer, 1776)

- *Solanum melongena* L. (Satpathi and Mandal, 2006)

• *Rhopalosiphum maidis* (Fitch, 1856)

- *Zea mays* L. (Chakrabarti et al., 2012; Debnath, 2020)

3.2.2.16 *Coelophora inaequalis* (Fabricius, 1775)

• *Macrosiphum* sp.

- *Artemisia vulgaris* L. (Agarwala, 1983; Debnath, 2020)

3.2.2.17 *Coelophora saucia* (Mulsant, 1850

• *Rhopalosiphum maidis* (Fitch, 1856)

- *Zea mays* L. (Chakrabarti et al., 2012)

3.2.2.18 *Coelophora* sp.

• *Aphis gossypii* Glover, 1977

- *Galinsoga parviflora* Cav. (Debnath, 2020)

• *Macrosiphum rosae* (Linnaeus, 1758)

- *Rosa* sp. (Agarwala, 1983; Debnath, 2020)

3.2.2.19 *Cryptogonus bimaculatus* Kapur, 1948

• *Aphis aurantii* Boyer de Fonsc., 1841

- *Citrus limon* (L.) Osbeck (Gurung et al., 2019)

• *Aphis citricidus* (Kirkaldy, 1907)

- *Citrus limon* (L.) Osbeck (Gurung et al., 2019; Maji et al., 2023)

3.2.2.20 *Cryptogonus quadriguttatus* (Weise, 1895)

• *Aphis aurantii* Boyer de Fonsc., 1841

- *Citrus limon* (L.) Osbeck (Gurung et al., 2019)
- *Camellia sinensis* (L.) Kuntze (Roy et al., 2010)

• *Aphis citricidus* (Kirkaldy, 1907)

- *Citrus limon* (L.) Osbeck (Gurung et al., 2019)

• *Aphis craccivora* Koch, 1854

- *Solanum melongena* L. (Satpathi and Mandal, 2006)

• *Aphis gossypii* Glover, 1977

- *Solanum melongena* L. (Satpathi and Mandal, 2006)

• *Macrosiphum rosae* (Linnaeus, 1758)

- *Rosa* sp. (Raychaudhuri et al., 1979; Agarwala, 1983)

• *Melanaphis sacchari* (Zehntner, 1897)

- *Zea mays* L. (Raychaudhuri et al., 1978; Chakrabarti et al., 2012)

• *Myzus persicae* (Sulzer, 1776)

- *Solanum melongena* L. (Satpathi and Mandal, 2006)

• *Rhopalosiphum maidis* (Fitch, 1856)

- *Zea mays* L. (Agarwala et al., 1981; Chakrabarti et al., 2012)
• *Sitobion rosaeiformis* (Das, 1918)
- *Rosa* sp. (Raychaudhuri et al., 1979; Agarwala, 1983)

3.2.2.21 *Cryptolaemus montrouzieri* Mulsant, 1853

• *Aphis craccivora* Koch, 1854
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
• *Aphis gossypii* Glover, 1977
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
• *Myzus persicae* (Sulzer, 1776)
- *Solanum melongena* L. (Satpathi and Mandal, 2006)

3.2.2.22 *Harmonia dimidiata* (Fabricius, 1781)

• *Aiceona* sp
- *Machilus gamblei* King ex Hook.f. (Maji et al., 2023)
• *Aphis craccivora* Koch, 1854
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
• *Aphis gossypii* Glover, 1977
- *Solanum melongena* L. (Satpathi and Mandal, 2006; Gurung et al., 2019)
• *Myzus persicae* (Sulzer, 1776)
- *Solanum melongena* L. (Satpathi and Mandal, 2006; Gurung et al., 2019)
• *Rhopalosiphum maidis* (Fitch, 1856)
- *Triticum aestivum* L. (Gurung et al., 2019)
• *Schizoneuraphis himalayensis* (Ghosh and Raychaudhuri, 1973)
- *Machilus gamblei* King ex Hook.f. (Gurung et al., 2019; Ponnusamy et al., 2019)
• *Sitobion miscanthi* (Takahashi, 1921)
- *Triticum aestivum* L. (Gurung et al., 2019)

3.2.2.23 *Harmonia sedecimnotata* (Fabricius, 1801)

• *Aphis aurantii* Boyer de Fonsc., 1841
- *Camellia sinensis* (L.) Kuntze (Roy et al., 2010)
• *Aphis gossypii* Glover, 1977
- *Colocasia esculenta* (L.) Schott (Bhattacharyya and Mandal, 2004)
• *Rhopalosiphum maidis* (Fitch, 1856)
- *Triticum aestivum* L. (Gurung et al., 2019)
• *Sitobion miscanthi* (Takahashi, 1921)
- *Triticum aestivum* L. (Gurung et al., 2019)

3.2.2.24 *Harmonia* sp.

• *Myzus persicae* (Sulzer, 1776)
- *Gynura bicolor* DC. (Chakrabarti et al., 2012)
• *Rhopalosiphum maidis* (Fitch, 1856)
- *Zea mays* L. (Chakrabarti et al., 2012)
• *Tuberolachnus salignus* (Gmelin, 1790)
- *Salix* sp. (Chakrabarti et al., 2012)

3.2.2.25 *Henosepilachna septima* (Dieke, 1947)

• *Aphis aurantii* Boyer de Fonsc., 1841
- *Camellia sinensis* (L.) Kuntze (Roy et al., 2010)

3.2.2.26 *Henosepilachna* sp.

• *Sitobion miscanthi* (Takahashi, 1921)

- *Hordeum vulgare* L. (Ghosh and Raychaudhuri, 1982)

3.2.2.27 *Illeis indica* Timberlake, 1943

• *Aphis craccivora* Koch, 1854

- *Lablab purpureus (*L.) Sweet (Gurung et al., 2019)

• *Aphis gossypii* Glover, 1977

- *Capsicum frutescens* L. (Gurung et al., 2019)

- *Solanum melongena* L. (Gurung et al., 2019)

• *Myzus persicae* (Sulzer, 1776)

- *Capsicum frutescens* L. (Gurung et al., 2019)

- *Solanum melongena* L. (Gurung et al., 2019)

• *Sitobion avenae* (Fabricius, 1775)

- *Triticum aestivum* L. (Maji et al., 2023)

3.2.2.28 *Jauravia pallidula* Motschulsky, 1858

• *Aphis aurantii* Boyer de Fonsc., 1841

- *Citrus limon* (L.) Osbeck (Gurung et al., 2019)

• *Aphis citricidus* (Kirkaldy, 1907)

- *Citrus limon* (L.) Osbeck (Gurung et al., 2019)

3.2.2.29 *Jauravia quadrinotata* Kapur, 1946

• *Aphis aurantii* Boyer de Fonsc., 1841

- *Camellia sinensis* (L.) Kuntze (Roy et al., 2010)

• *Aphis craccivora* Koch, 1854

- *Solanum melongena* L. (Satpathi and Mandal, 2006)

• *Aphis gossypii* Glover, 1977

- *Solanum melongena* L. (Satpathi and Mandal, 2006)

• *Myzus persicae* (Sulzer, 1776)

- *Solanum melongena* L. (Satpathi and Mandal, 2006)

3.2.2.30 *Megalocaria dilatata* (Fabricius, 1775)

• *Aiceona* sp

- *Machilus gamblei* King ex Hook.f. (Pal et al., 2023b)

• *Ceratovacuna lanigera* Zehntner, 1897

- *Saccharum officinarum* L. (Kumar and Pal, 2019)

• *Schizoneuraphis himalayensis* (Ghosh and Raychaudhuri, 1973)

- *Machilus gamblei* King ex Hook.f. (Gurung et al., 2019; Ponnusamy et al., 2019)

3.2.2.31 *Micraspis allardi* (Mulsant, 1866)

• *Myzus persicae* (Sulzer, 1776)

- *Solanum nigrum* L. (Chakrabarti et al., 2012)

3.2.2.32 *Micraspis crocea* (Mulsant)

• *Aphis craccivora* Koch, 1854

- *Solanum melongena* L. (Satpathi and Mandal, 2006)

• *Aphis gossypii* Glover, 1977

- *Solanum melongena* L. (Satpathi and Mandal, 2006)

• *Myzus persicae* (Sulzer, 1776)

- *Solanum melongena* L. (Satpathi and Mandal, 2006)

3.2.2.33 *Micraspis discolor* (Fabricius, 1798)

• *Acyrthosiphon pisum* (Harris, 1776)
- *Pisum sativum* L. (Maji et al., 2023; Saha et al., 2023)
- *Trigonella foenum-graecum* L. (Bindhani et al., 2020)
• *Aphis aurantii* Boyer de Fonsc., 1841
- *Camellia sinensis* (L.) Kuntze (Das et al., 2010)
- *Citrus limon* (L.) Osbeck (Gurung et al., 2019)
• *Aphis citricidus* (Kirkaldy, 1907)
- *Citrus limon* (L.) Osbeck (Gurung et al., 2019; Maji et al., 2023)
• *Aphis craccivora* Koch, 1854
- *Lablab purpureus (*L.) Sweet (Poddar, 1982; Gurung et al., 2019)
- *Lens culinaris* Medik. (Poddar, 1982)
- *Mussaenda acuminata* Blume (Maji et al., 2023)
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
- *Vigna radiata* (L.) R. Wiczek (Maji et al., 2023)
• *Aphis gossypii* Glover, 1977
- *Abelmoschus esculentus* (L.) Moench (Gurung et al., 2019; Maji et al., 2023)
- *Capsicum frutescens* L. (Gurung et al., 2019)
- *Gossypium hirsutum* L. (Maji et al., 2023)
- *Lagenaria siceraria* (Molino) Standl. (Saha et al., 2016)
- *Momordica charantia* L. (Maji et al., 2023)
- *Solanum melongena* L. (Satpathi and Mandal, 2006; Gurung et al., 2019)
• *Aphis odinae* (van der Goot, 1917)
- *Mangifera indica* L. (Maji et al., 2023)
• *Aphis punicae* Passerini, 1863
- *Punica granatum* L. (Maji et al., 2023)
• *Brevicoryne brassicae* (Linnaeus, 1758)
- *Brassica oleracea* L. var. *capitata* (Maji et al., 2023)
• *Ceratovacuna lanigera* Zehntner, 1897
- *Saccharum officinarum* L. (Kumar and Pal, 2022)
• *Cervaphis rappardi indica* Basu, 1961
- *Cajanus cajan* (L.) Millsp. (Maji et al., 2023)
• *Hayhurstia atriplicis* (Linnaeus, 1761)
- *Chenopodium album* L. (Maji et al., 2023)
• *Hyadaphis coriandri* (Das, 1918)
- *Coriandrum sativum* L. (Maji et al., 2023)
• *Lipaphis erysimi* (Kaltenbach, 1843)
- *Brassica juncea* (L.) Czern. (Ghosh, 1983)
- *Brassica napus* L. (Pal & Debnath, 2020)
- *Brassica nigra* (L.) W.D.J.Koch (Ghosh et al., 1981)
- *Brassica oleracea* L. var. *capitata* (Gurung et al., 2019)
- *Brassica rapa* L. (Gurung et al., 2019; Maji et al., 2023)
• *Myzus persicae* (Sulzer, 1776)

- *Abelmoschus esculentus* (L.) Moench (Gurung et al., 2019)
- *Brassica rapa* L. (Gurung et al., 2019)
- *Capsicum frutescens* L. (Gurung et al., 2019)
- *Helianthus annuus* L. (Maji et al., 2023)
- *Linum usitatissimum* L. (Gurung et al., 2019)
- *Solanum melongena* L. (Satpathi and Mandal, 2006; Gurung et al., 2019)
- *Solanum tuberosum* L.(Nayak et al., 2019; Maji et al., 2023)

• *Rhopalosiphum maidis* (Fitch, 1856)
- *Triticum aestivum* L. (Gurung et al., 2019)
- *Zea mays* L. (Gurung et al., 2019; Maji et al., 2023)

• *Sitobion avenae* (Fabricius, 1775)
- *Triticum aestivum* L. (Maji et al., 2023)

• *Sitobion miscanthi* (Takahashi, 1921)
- *Triticum aestivum* L. (Gurung et al., 2019)

• *Sitobion* sp.
- *Zea mays* L. (Maji et al., 2023)

3.2.2.34 *Micraspis yasumatsui* Sasaji, 1968

• *Aphis gossypii* Glover, 1977
- *Capsicum frutescens* L. (Gurung et al., 2019)
- *Solanum melongena* L. (Gurung et al., 2019)

• *Ceratovacuna lanigera* Zehntner, 1897
- *Saccharum officinarum* L. (Kumar and Pal, 2022; Maji et al., 2023)

• *Myzus persicae* (Sulzer, 1776)
- *Capsicum frutescens* L. (Gurung et al., 2019)
- *Solanum melongena* L. (Gurung et al., 2019)

• *Rhopalosiphum maidis* (Fitch, 1856)
- *Triticum aestivum* L. (Gurung et al., 2019)

• *Sitobion miscanthi* (Takahashi, 1921)
- *Triticum aestivum* L. (Gurung et al., 2019)

3.2.2.35 *Nephus regularis* (Sicard, 1929)

• *Rhopalosiphum maidis* (Fitch, 1856)
- *Zea mays* L. (Chakrabarti et al., 2012)

3.2.2.36 *Oenopia conglobata* (Linnaeus, 1758)

• *Macrosiphum rosae* (Linnaeus, 1758)
- *Rosa* sp. (Agarwala, 1983)

3.2.2.37 *Oenopia kirbyi* Mulsant, 1850

• *Aphis aurantii* Boyer de Fonsc., 1841
- *Camellia sinensis* (L.) Kuntze (Roy et al., 2010)

• *Aphis craccivora* Koch, 1854
- *Solanum melongena* L. (Satpathi and Mandal, 2006)

• *Aphis fabae* Scopoli, 1763
- *Solanum nigrum* L. (Poorani, 2002)

• *Aphis gossypii* Glover, 1977
- *Cucumis sativus* L. (Poorani, 2002)

- *Solanum melongena* L. (Satpathi and Mandal, 2006)
• *Aphis solanella* Theobald, 1854
- *Argemone mexicana* L. (Debnath, 2020)
- Unknown plant (Chakrabarti et al., 2012)
• *Macrosiphum rosae* (Linnaeus, 1758)
- *Rosa indica* L. (Gurung et al., 2019)
- *Rosa* sp. (Ghosh and Raychaudhuri, 1982; Debnath, 2020)
• *Myzus persicae* (Sulzer, 1776)
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
• *Sitobion rosaeiformis* (Das, 1918)
- *Rosa* sp. (Raychaudhuri et al., 1979; Agarwala, 1983)

3.2.2.38 *Oenopia quadripunctata* Kapur, 1963

• *Aphis craccivora* Koch, 1854
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
• *Aphis gossypii* Glover, 1977
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
• *Myzus persicae* (Sulzer, 1776)
- *Solanum melongena* L. (Satpathi and Mandal, 2006)

3.2.2.39 *Oenopia sauzeti* Mulsant, 1866

• *Aphis spiraecola* Patch, 1914
- *Eupatorium* sp. (Poorani, 2002)
- Unidentified plant (Agarwala et al., 1981)
• *Brachycaudus* sp.
- *Crotalaria saltiana* Andrews (Poorani, 2002)
- *Eupatorium* sp. (Poorani, 2002)
• *Macrosiphoniella pseudoartemisiae* Shinji, 1933
- *Glebionis coronaria* (L.) Cass. ex Spach (Raychaudhuri et al., 1978; Chakrabarti et al., 2012)
• *Macrosiphoniella sanborni* (Gillette, 1908)
- *Chrysanthemum* sp. (Ghosh and Raychaudhuri, 1982; Chakrabarti et al., 2012)
• *Macrosiphoniella* sp.
- *Chrysanthemum* sp. (Poorani, 2002)
• *Macrosiphum rosae* (Linnaeus, 1758)
- *Rosa indica* L. (Gurung et al., 2019)
• Unidentified aphid
- *Sonchus arvensis* L. (Poorani, 2002)

3.2.2.40 *Oenopia sexareata* (Mulsant, 1853)

• *Aphis aurantii* Boyer de Fonsc., 1841
- *Camellia sinensis* (L.) Kuntze (Das et al., 2010 ; Roy et al., 2010)
• *Brachycaudus helichrysi* (Kaltenbach, 1843)
- *Clerodendron* sp. (Chakrabarti et al., 2012)
• *Macrosiphum rosae* (Linnaeus, 1758)
- *Rosa canina* L. (Raychaudhuri et al., 1978; Debnath, 2020)
- *Rosa indica* L. (Gurung et al., 2019)
- *Rosa* sp. (Agarwala, 1983; Debnath, 2020)

• *Mollitrichosiphum montanum* (van der Goot, 1917)
- *Alnus nepalensis* D. Don (Debnath, 2020)
• *Rhopalosiphum maidis* (Fitch, 1856)
- *Zea mays* L. (Agarwala et al., 1981; Debnath, 2020)
• *Sitobion rosaeiformis* (Das, 1918)
- *Alnus nepalensis* D. Don (Debnath, 2020)
- *Rosa canina* L. (Raychaudhuri et al., 1978; Debnath, 2020)
- *Rosa* sp. (Debnath, 2020)
• *Taoia indica* (Ghosh and Raychaudhuri, 1972)
- *Alnus nepalensis* D. Don (Raychaudhuri et al., 1978; Ghosh and Raychaudhuri, 1982)

3.2.2.41 *Ola* sp.

• *Aphis aurantii* Boyer de Fonsc., 1841
- *Camellia sinensis* (L.) Kuntze (Das et al., 2010)

3.2.2.42 *Phrynocaria unicolor* (Fabricius, 1792)

• *Aphis aurantii* Boyer de Fonsc., 1841
- *Camellia sinensis* (L.) Kuntze (Roy et al., 2010)
• *Aphis craccivora* Koch, 1854
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
• *Aphis gossypii* Glover, 1977
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
• *Myzus persicae* (Sulzer, 1776)
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
• *Tuberculatus indicus* Ghosh, 1972
- *Quercus serrata* Murray (Chakrabarti et al., 2012)

3.2.2.43 *Platynaspis variegata* Crotch, 1874 [

• *Greenidea psidii* van der Goot, 1917
- *Psidium guajava* L. (Chakrabarti et al., 2012)

3.2.2.44 *Platynaspis* sp.

• *Greenidea psidii* van der Goot, 1917
- *Psidium guajava* L. (Chakrabarti et al., 2012)
- *Syzygium cumini* (L.) Skeels (Chakrabarti et al., 2012)

3.2.2.45 *Propylea dissecta* (Mulsant, 1850)

• *Aphis craccivora* Koch, 1854
- *Lablab purpureus (*L.) Sweet (Gurung et al., 2019)
• *Aphis gossypii* Glover, 1977
- *Capsicum frutescens* L. (Gurung et al., 2019)
- *Solanum melongena* L. (Gurung et al., 2019)
• *Ceratovacuna lanigera* Zehntner, 1897
- *Saccharum officinarum* L. (Kumar and Pal, 2022; Maji et al., 2023)
• *Macrosiphoniella sanborni* (Gillette, 1908)
- *Chrysanthemum indicum* L. (Maji et al., 2023)
• *Myzus persicae* (Sulzer, 1776)
- *Capsicum frutescens* L. (Gurung et al., 2019)
- *Solanum melongena* L. (Gurung et al., 2019)

• *Myzus persicae* (Sulzer, 1776)
- *Solanum nigrum* L. (Chakrabarti et al., 2012)
- *Solanum tuberosum* L. (Nayak et al., 2019)
• *Rhopalosiphum maidis* (Fitch, 1856)
- *Triticum aestivum* L. (Gurung et al., 2019)
• *Rhopalosiphum padi* (Linnaeus, 1758)
- *Zea mays* L. (Chakrabarti et al., 2012)
• *Sitobion miscanthi* (Takahashi, 1921)
- *Triticum aestivum* L. (Gurung et al., 2019)

3.2.2.46 *Propylea japonica* (Thunberg, 1781)

• *Aphis gossypii* Glover, 1977
- *Solanum melongena* L. (Gurung et al., 2019)
• *Myzus persicae* (Sulzer, 1776)
- *Solanum melongena* L. (Gurung et al., 2019)
• *Rhopalosiphum maidis* (Fitch, 1856)
- *Triticum aestivum* L. (Gurung et al., 2019)
• *Sitobion miscanthi* (Takahashi, 1921)
- *Triticum aestivum* L. (Gurung et al., 2019)

3.2.2.47 *Propylea luteopustulata* (Mulsant, 1850)

• *Aphis aurantii* Boyer de Fonsc., 1841
- *Camellia sinensis* (L.) Kuntze (Roy et al., 2010)
• *Aphis craccivora* Koch, 1854
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
• *Aphis gossypii* Glover, 1977
- *Colocasia esculenta* (L.) Schott (Bhattacharyya and Mandal, 2004)
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
• *Lipaphis erysimi* (Kaltenbach, 1843)
- *Brassica juncea* (L.) Czern. (Ghosh, 1983)
- *Brassica nigra* (L.) W.D.J.Koch (Ghosh et al., 1981)
- *Rosa* sp. (Agarwala et al., 1980)
• *Macrosiphum rosae* (Linnaeus, 1758)
- *Rosa* sp. (Raychaudhuri et al., 1979; Agarwala, 1983)
• *Myzus persicae* (Sulzer, 1776)
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
• *Rhopalosiphum maidis* (Fitch, 1856)
- *Zea mays* L. (Agarwala et al., 1981; Chakrabarti et al., 2012)
• *Sitobion rosaeiformis* (Das, 1918)
- *Rosa canina* L. (Raychaudhuri et al., 1978; Ghosh and Raychaudhuri, 1982)
- *Rosa* sp. (Raychaudhuri et al., 1979; Debnath, 2020)

3.2.2.48 *Propylea quatuordecimpunctata* (Linnaeus, 1758)

• *Acyrthosiphon pisum* (Harris, 1776)
- *Pisum sativum* L. (Chakrabarti et al., 2012)
• *Aphis nerii* Boyer de Fonsc., 1841
- *Solanum* sp. (Chakrabarti et al., 2012)

• *Lipaphis erysimi* (Kaltenbach, 1843)
- *Zea mays* L. (Chakrabarti et al., 2012)
• *Melanaphis sacchari* (Zehntner, 1897)
- *Gynura bicolor* DC. (Chakrabarti et al., 2012)
• *Myzus persicae* (Sulzer, 1776)
- *Musa* sp. (Chakrabarti et al., 2012)

3.2.2.49 *Pseudaspidimerus trinotata* (Thunberg, 1781)

• *Aphis aurantii* Boyer de Fonsc., 1841
- *Camellia sinensis* (L.) Kuntze (Sarkar and Mukhopadhyay, 2006; Das et al., 2010)
• *Aphis craccivora* Koch, 1854
- *Lablab purpureus (*L.) Sweet (Poddar and Ghosh, 1984)
- *Senna alata* (L.) Roxb.) (Poddar and Ghosh, 1984)
- *Senna sophera* (L.) Roxb. (Poddar and Ghosh, 1984)
- *Senna tora* (L.) Roxb. (Poddar and Ghosh, 1984)
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
- *Vicia faba* L. (Poddar and Ghosh, 1984)
- *Vigna mungo* (L.) Hepper (Poddar and Ghosh, 1984)
- *Vigna unguiculata* (L.) Walp. (Poddar, 1982; Poddar and Ghosh, 1984)
• *Aphis gossypii* Glover, 1977
- *Gossypium* sp. (Poddar and Ghosh, 1984)
- *Lablab purpureus* (L.) Sweet ssp. *purpureus* (Poddar and Ghosh, 1984)
- *Psidium guajava* L. (Poddar and Ghosh, 1984)
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
• *Lipaphis erysimi* (Kaltenbach, 1843)
- *Brassica juncea* (L.) Czern. (Ghosh, 1983)
- *Brassica nigra* (L.) W.D.J.Koch (Poddar and Ghosh, 1984)
• *Myzus persicae* (Sulzer, 1776)
- *Solanum melongena* L. (Satpathi and Mandal, 2006)

3.2.2.50 *Scymnus fuscatus* Boheman, 1859

• *Aphis craccivora* Koch, 1854
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
• *Myzus persicae* (Sulzer, 1776)
- *Solanum melongena* L. (Satpathi and Mandal, 2006)

3.2.2.51 *Scymnus nubilus* Mulsant, 1850

• *Pentalonia nigronervosa* Coquerel, 1859
- *Musa* sp. (Chakrabarti et al., 2012)
• *Uroleucon compositae* (Theobald, 1915)
- *Carthamus* sp. (Chakrabarti et al., 2012)

3.2.2.52 *Scymnus nymphaeus* (Kapur and Munshi, 1970)

• *Rhopalosiphum nymphaeae* (Linnaeus, 1761)
- *Pistia stratiotes* L. (Kapur and Munshi, 1970)

3.2.2.53 *Scymnus pyrocheilus* Mulsant, 1853

• *Aphis craccivora* Koch, 1854
- *Lablab purpureus (*L.) Sweet (Ghosh et al., 1981)

- *Senna sophera* (L.) Roxb. (Poddar, 1982)
- *Senna tora* (L.) Roxb. (Poddar, 1982)
- *Trigonella foenum-graecum* L. (Poddar, 1982)
- *Vicia faba* L. (Poddar, 1982)
- *Vigna mungo* (L.) Hepper (Poddar, 1982)
- *Vigna unguiculata* (L.) Walp. (Poddar, 1982)

• *Lipaphis erysimi* (Kaltenbach, 1843)
- *Brassica juncea* (L.) Czern. (Ghosh, 1983)
- *Brassica nigra* (L.) W.D.J.Koch (Ghosh et al., 1981)

3.2.2.54 *Scymnus quadrillum* Motschulsky, 1858

• *Aphis craccivora* Koch, 1854
- *Solanum melongena* L. (Satpathi and Mandal, 2006)

• *Myzus persicae* (Sulzer, 1776)
- *Solanum melongena* L. (Satpathi and Mandal, 2006)

3.2.2.55 *Scymnus xerampelinus* Canepari, 2003

• *Aphis fabae* Scopoli, 1763
- *Vicia faba* L. (Chakrabarti et al., 2012)

• *Aphis gossypii* Glover, 1977
- *Capsicum frutescens* L. (Chakrabarti et al., 2012)

• *Brevicoryne brassicae* (Linnaeus, 1758)
- *Brassica* sp. (Chakrabarti et al., 2012)

3.2.2.56 *Scymnus* sp.

• *Aphis aurantii* Boyer de Fonsc., 1841
- *Camellia sinensis* (L.) Kuntze (Das et al., 2010)

• *Aphis craccivora* Koch, 1854
- *Solanum melongena* L. (Satpathi and Mandal, 2006)

• *Aphis gossypii* Glover, 1977
- *Lagenaria siceraria* (Molino) Standl. (Saha et al., 2016)
- *Solanum melongena* L. (Satpathi, 1999; Satpathi and Mandal, 2006)
- Unknown plant (Rao, 1969)

• *Myzus persicae* (Sulzer, 1776)
- *Solanum melongena* L. (Satpathi and Mandal, 2006)

3.2.2.57 *Stethorus gilvifrons* (Mulsant, 1850)

• *Aphis aurantii* Boyer de Fonsc., 1841
- *Camellia sinensis* (L.) Kuntze (Roy et al., 2010)

• *Aphis craccivora* Koch, 1854
- *Solanum melongena* L. (Satpathi and Mandal, 2006)

• *Aphis gossypii* Glover, 1977
- *Solanum melongena* L. (Satpathi and Mandal, 2006)

• *Myzus persicae* (Sulzer, 1776)
- *Solanum melongena* L. (Satpathi and Mandal, 2006)

3.2.2.58 *Sticholotis binotata* (Gorham, 1894)

• *Brachycaudus helichrysi* (Kaltenbach, 1843)
- *Ageratum conyzoides* L. (Chakrabarti et al., 2012)

3.2.2.59 *Synonycha grandis* (Thunberg, 1781)

• *Aphis gossypii* Glover, 1977

- *Lablab purpureus* (L.) Sweet ssp. *purpureus* (Chakrabarti et al., 2012)

• *Pseudoregma alexanderi* (Takahashi, 1924)

- *Bambusa* sp. (Ghosh and Raychaudhuri, 1982; Debnath, 2020)

3.2.2.60 *Synonychimorpha chittagongi* (Vazirani, 2003)

• *Aphis odinae* (van der Goot, 1917)

- *Neolamarckia cadamba* (Roxb.) Bosser (Maji et al., 2023)

3.2.3 Family: Staphilinidae

The family Staphylinidae, commonly referred to as rove beetles, constitutes one of the largest and most ecologically versatile groups within the order Coleoptera. These beetles serve vital ecological functions as predators, scavengers, and decomposers in terrestrial ecosystems. Most species, in both their larval and adult stages, are predaceous, feeding on a wide range of soft-bodied invertebrates, including aphids, springtails, mites, fly larvae, and small caterpillars (Irmler et al., 2018). Members of the genus *Paederus* are particularly noted for their intense predatory activity in agricultural habitats. In West Bengal, the following tri-trophic associations have been documented:

3.2.3.1 *Paederus fuscipes* Curtis, 1826

• *Aphis craccivora* Koch, 1854

- *Solanum melongena* L. (Satpathi and Mandal, 2006)

• *Aphis gossypii* Glover, 1977

- *Solanum melongena* L. (Satpathi, 1999; Satpathi and Mandal, 2006)

3.2.3.2 *Paederus* sp.

• *Aphis craccivora* Koch, 1854

- *Solanum melongena* L. (Satpathi and Mandal, 2006)

• *Aphis gossypii* Glover, 1977

- *Solanum melongena* L. (Satpathi, 1999; Satpathi and Mandal, 2006)

3.3 Order: Diptera

The data presented in Table 4 indicate that dipteran predators constitute a significant component of the aphidophagous guild in West Bengal, represented by 22 species distributed across three families, Calliphoridae, Chamaemyiidae, and Syrphidae. Among these, the family Syrphidae (hover flies) exhibited the highest diversity and ecological significance, encompassing 19 species preying on 17 aphid species infesting 38 species of host plants, forming 125 tri-trophic associations in West Bengal.

Table 4 Number of species of aphidophagous Diptera belonging to different families preying on different number of aphid species infesting different number of host plant species and triplets in West Bengal.

Families	Species of predators	Number of		
		Species of aphid	Species of host plant	Triplets
Calliphoridae	1. *Calliphora pattoni*	1	2	2
Chamaemyiidae	2. *Leucopis simlai*	1	1	2
	3. *Leucopis* sp.	1	1	1
Syrphidae	4. *Allograpta javana*	2	1	2
	5. *Baccha* sp.	1	1	1

Families	Species of predators	Number of		
		Species of aphid	Species of host plant	Triplets
	6. *Betasyrphus isaaci*	9	14	16
	7. *Dideopsis aegrota*	4	5	7
	8. *Episyrphus balteatus*	5	10	14
	9. *Eristalis tenax*	3	1	3
	10. *Eupeodes confrater*	4	11	12
	11. *Eupeodes corollae*	1	1	1
	12. *Ischiodon scutellaris*	6	15	18
	13. *Melanostoma orientale*	3	1	3
	14. *Microdon bellus*	3	1	3
	15. *Paragus politus*	4	2	4
	16. *Paragus serratus*	2	9	9
	17. *Paragus tibialis*	4	4	4
	18. *Paragus yerburiensis*	5	5	7
	19. *Sphaerophoria indiana*	3	1	3
	20. *Sphaerophoria scripta*	7	8	10
	21. *Sphaerophoria* spp.	3	1	3
	22. *Syrphus* sp.	1	1	1
	Total	**17**	**38**	**125**

3.3.1 Family: Calliphoridae

The family Calliphoridae (blow flies) represents a diverse group of dipterans with wide ecological and functional significance across terrestrial ecosystems. Most species are saprophagous or necrophagous, with larvae developing in carrion, dung, and decomposing organic matter, thereby contributing to nutrient recycling and decomposition processes. However, several species exhibit predatory or parasitic behaviour, feeding on soft-bodied invertebrates such as aphids and caterpillars. Only one species, *Calliphora pattoni* Aubertin, 1931 was observed feeding on *Pseudoregma alexanderi* on *Bambusa* sp. in West Bengal (Raychaudhuri et al., 1978; Debnath, 2020).

3.3.2 Family: Chamaemyiidae

The family Chamaemyiidae (silver flies) consists of small dipterans whose larvae are mainly aphidophagous and coccidophagous, serving as important biological control agents of soft-bodied Hemiptera. Larvae are active predators while adults feed on nectar, honeydew, and plant exudates like hover flies. Following is the detailed account of aphidophagous silver flies in West Bengal.

3.3.2.1 *Leucopis simlai* Das, Poddar and Raychaudhuri, 1981

• *Aphis craccivora* Koch, 1854

- *Lens culinaris* Medik. (Poddar, 1982)
- *Vigna unguiculata* (L.) Walp. (Poddar, 1982)

3.3.2.2 *Leucopis sp.*

• *Lipaphis erysimi* (Kaltenbach, 1843)

- *Brassica juncea* (L.) Czern. (Ghosh, 1983)

3.3.3 Family: Syrphidae

The family Syrphidae, commonly known as hover flies perform important ecological roles as both pollinators

and natural enemies, with larvae predominantly preying on aphids. These dual ecosystem services play a crucial role in enhancing crop productivity while simultaneously reducing reliance on chemical pesticides (Li et al., 2023). Although biological control and pollination can interact in shaping crop yields, they are usually studied independently because different arthropod groups typically provide each service. In India, 49 species from 17 genera are confirmed aphid predators, preying on 94 aphid species across 149 food plants and forming 1,025 tri-trophic associations across 27 states and union territories (Singh, 2026a).

The data displayed in table 5 indicate that the family Syrphidae in West Bengal comprises 18 species of aphidophagous hover flies belonging to various genera, collectively preying on 17 aphid species across 38 host plants. These interactions result in 122 documented tri-trophic associations, highlighting the significant role of syrphid flies as natural enemies of aphids. Species such as *Betasyrphus isaaci*, *Episyrphus balteatus*, *Sphaerophoria scripta* and *Ischiodon scutellaris* exhibit particularly high predator–prey interactions, indicating their potential importance in the biological control of aphid populations in agroecosystems (Singh, 2025g; Singh and Ahmad, 2025b; Singh and Samuel, 2025). Record of *Eristalis tenax* (Linnaeus) as predator of *Aphis craccivora, Aphis gossypii* and *Myzus persicae* (on *Solanum melongena*) in Darjeeling district of West Bengal is doubtful as like other species of *Eristalis*, its larvae are aquatic saprophagous filter-feeders in polluted or organic-rich water bodies and they do not feed aphids or any other insects (Singh, 2026a). Hence, these records are excluded from this checklist. Overall, syrphid hover flies contribute substantially to the regulation of aphid pests and the maintenance of ecological balance in the studied habitats.

Among the most polyphagous species, *Betasyrphus isaaci* exhibited the widest range, preying on 9 aphid species across 14 host plants in West Bengal. This was followed by *Sphaerophoria scripta* (7 aphid species on 8 host plants), *Ischiodon scutellaris* (6 aphid species on 15 host plants), *Episyrphus balteatus* (5 aphid species on 10 host plants), and Other species showed narrower prey ranges, feeding on 1-4 aphid species associated with varying numbers of host plants (Table 4).

Aphis craccivora supports high diversity of predators (14 species) followed by *Aphis gossypii* (13 species), *Myzus persicae* (11 species) and *Lipaphis erysimi* (8 species) infesting leguminous (beans, pulses), solanaceous (brinjal, potato) and brassica (mustard) crops. Among the crops, brinjal (*Solanum melongena*) attracts a maximum of 10 predator species followed by mustard crops (*Brassica juncea*, *brassica nigra* and *Brassica rapa*) (6 predator species).

Following is the detailed account of tri-trophic associations of aphidophagous hover flies in West Bengal.

3.3.3.1 *Allograpta javana* (Wiedemann, 1824)

• *Macrosiphum rosae* (LinnAeus, 1758)

- *Rosa* sp. (Agarwala et al., 1982; Debnath, 2020)

• *Sitobion rosaeiformis* (DAs, 1918)

- *Rosa* sp. (Agarwala et al., 1982; Debnath, 2020)

3.3.3.2 *Baccha* sp.

• *Lipaphis erysimi* (KAltenbAch, 1843)

- *Brassica nigra* (L.) W.D.J.Koch (Ghosh et al., 1981)

3.3.3.3 *Betasyrphus serarius* (Wiedemann, 1830)

• *Aphis craccivora* Koch, 1854

- *Artemesia vulgaris* L. (Debnath, 2020)

- *Impatiens balsamina* L. (Chakrabarti et al., 2012; Debnath, 2020)

- *Lablab purpureus* (L.) Sweet (Debnath, 2020)

- *Sinapis arvensis* L. (Debnath, 2020)

• *Aphis gossypii* Glover, 1977

- *Capsicum frutescens* (Debnath, 2020)
- Unknown plant (Rao, 1969)
• *Aphis spiraecola* PAtch, 1914
- *Bidens pilosa* L. (Agarwala et al., 1982)
- Unknown plant (Rao, 1969)
• *Aphis* sp.
- Unknown plant (Rao, 1969)
• *Aulacorthum albimagnoliae* Lee, 2006
- *Sicyos edulis* Jacq. (Debnath, 2020)
• *Lipaphis erysimi* (KAltenbAch, 1843)
- *Brassica oleracea* L. (Agarwala et al., 1982)
- *Brassica* sp. (Rao, 1969)
• *Macrosiphum rosae* (LinnAeus, 1758)
- *Rosa canina* L. (Raychaudhuri et al., 1978; Agarwala, 1983)
- *Rosa* sp. (Raychaudhuri et al., 1978; Agarwala et al., 1982)
• *Pseudomegoura magnoliae* (Essig and Kuwana, 1918)
- *Sicyos edulis* Jacq. (Debnath, 2020)
• *Sitobion rosaeiformis* (Das, 1918)
- *Rosa* sp. (Debnath, 2020)

3.3.3.4 *Dideopsis aegrota* (Fabricius, 1805)

• *Aphis craccivora* Koch, 1854
- *Lablab purpureus* (L.) Sweet (Ghosh et al., 1981)
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
- *Vicia faba* L. (Agarwala et al., 1984)
• *Aphis gossypii* Glover, 1977
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
• *Aphis spiraecola* PAtch, 1914
- *Artemisia vulgaris* L. (Rao, 1969)
- *Bidens pilosa* L. (Agarwala et al., 1984a)
• *Myzus persicae* (Sulzer, 1776)
- *Solanum melongena* L. (Satpathi and Mandal, 2006)

3.3.3.5 *Episyrphus balteatus* (De Geer, 1776)

• *Aphis craccivora* Koch, 1854
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
• *Aphis gossypii* Glover, 1977
- *Cucumis sativus* L. (Agarwala et al., 1982)
- *Fagopyrum* sp. (Agarwala et al., 1982)
- *Solanum betaceum* Cav. (Agarwala et al., 1982)
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
• *Lipaphis erysimi* (KAltenbAch, 1843)
- *Brassica juncea* (L.) Czern. (Ghosh, 1983)
- *Brassica nigra* (L.) W.D.J.Koch (Ghosh et al., 1981)
- *Brassica* sp. (Roy and Basu, 1977)
• *Melanaphis sacchari* (Zehntner, 1897)

- *Brassica napus* L. (Karthik et al., 2023)
- *Zea mays* L. (Agarwala et al., 1982; Debnath, 2020)
• *Myzus persicae* (Sulzer, 1776)
- *Cucumis sativus* L. (Agarwala et al., 1982)
- *Solanum betaceum* Cav. (Agarwala et al., 1982)
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
- *Solanum tuberosum* L. (Agarwala et al., 1982; Nayak et al., 2019)

3.3.3.6 *Eupeodes confrater* (Wiedemann, 1830)

• *Aphis craccivora* Koch, 1854
- *Lablab purpureus* (L.) Sweet (Ghosh et al., 1981)
- *Pisum sativum* L. (Poddar, 1982)
- *Senna tora* (L.) Roxb. (Poddar, 1982)
- *Vicia faba* L. (Poddar, 1982)
- *Vigna mungo* (L.) Hepper (Poddar, 1982)
- *Vigna unguiculata* (L.) Walp. (Poddar, 1982)
• *Aphis gossypii* Glover, 1977
- *Bidens pilosa* L. (Agarwala et al., 1982)
- *Lagenaria siceraria* (Molino) Standl. (Saha et al., 2016)
• *Aphis spiraecola* PAtch, 1914
- *Bidens pilosa* L. (Agarwala et al., 1982)
• *Lipaphis erysimi* (KAltenbAch, 1843)
- *Brassica juncea* (L.) Czern. (Ghosh, 1983)
- *Brassica nigra* (L.) W.D.J.Koch (Ghosh et al., 1981)
- *Brassica* sp. (Roy and Basu, 1977)

3.3.3.7 *Eupeodes corollae* (Fabricius, 1794)

• *Brachycaudus helichrysi* (KAltenbAch, 1843)
- *Prunus persica* (L.) Batsch (Ghosh et al., 1985; Chakraborty and Chakrabarty, 2002)

3.3.3.8 *Ischiodon scutellaris* (Fabricius, 1805)

• *Acyrthosiphon pisum* (HArris, 1776)
- *Pisum sativum* L. (Agarwala et al., 1979)
• *Aphis craccivora* Koch, 1854
- *Lablab purpureus* (L.) Sweet (Ghosh et al., 1981)
- *Lens culinaris* Medik. (Poddar, 1982)
- *Pisum sativum* L. (Poddar, 1982)
- *Senna sophera* (L.) Roxb. (Poddar, 1982)
- *Senna tora* (L.) Roxb. (Poddar, 1982)
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
- *Vicia faba* L. (Ghosh et al., 1981)
- *Vigna mungo* (L.) Hepper (Poddar, 1982)
- *Vigna unguiculata* (L.) Walp. (Poddar, 1982)
- Unknown plant (Agarwala et al., 1982)
• *Aphis gossypii* Glover, 1977
- *Lagenaria siceraria* (Molino) Standl. (Saha et al., 2016)
- *Solanum melongena* L. (Agarwala et al., 1982; Satpathi and Mandal, 2006)

• *Brevicoryne brassicae* (LinnAeus, 1758)
- *Brassica oleracea* L. var. *botrytis* (Agarwala et al., 1982)
• *Lipaphis erysimi* (KAltenbAch, 1843)
- *Brassica juncea* (L.) Czern. (Ghosh, 1983)
- *Brassica nigra* (L.) W.D.J.Koch (Ghosh et al., 1981)
- *Brassica* sp. (Roy and Basu, 1977)
• *Myzus persicae* (Sulzer, 1776)
- *Solanum melongena* L. (Agarwala et al., 1982; Satpathi and Mandal, 2006)

3.3.3.9 *Melanostoma orientale* (Wiedemann, 1824)

• *Aphis craccivora* Koch, 1854
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
• *Aphis gossypii* Glover, 1977
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
• *Myzus persicae* (Sulzer, 1776)
- *Solanum melongena* L. (Satpathi and Mandal, 2006)

3.3.3.10 *Microdon bellus* Brunetti, 1923

• *Aphis craccivora* Koch, 1854
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
• *Aphis gossypii* Glover, 1977
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
• *Myzus persicae* (Sulzer, 1776)
- *Solanum melongena* L. (Satpathi and Mandal, 2006)

3.3.3.11 *Paragus politus* Wiedemann, 1830

• *Aphis craccivora* Koch, 1854
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
• *Aphis gossypii* Glover, 1977
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
• *Aphis spiraecola* PAtch, 1914
- *Bidens pilosa* L. (Raychaudhuri et al., 1978)
• *Myzus persicae* (Sulzer, 1776)
- *Solanum melongena* L. (Satpathi and Mandal, 2006)

3.3.3.12 *Paragus serratus* (Fabricius, 1805)

• *Aphis craccivora* Koch, 1854
- *Lablab purpureus* (L.) Sweet (Ghosh et al., 1981)
- *Lens culinaris* Medik. (Poddar, 1982)
- *Pisum sativum* L. (Poddar, 1982)
- *Senna tora* (L.) Roxb. (Poddar, 1982)
- *Vicia faba* L. (Ghosh et al., 1981)
- *Vigna mungo* (L.) Hepper (Poddar, 1982)
- *Vigna unguiculata* (L.) Walp. (Poddar, 1982)
• *Lipaphis erysimi* (KAltenbAch, 1843)
- *Brassica juncea* (L.) Czern. (Ghosh, 1983)
- *Brassica nigra* (L.) W.D.J.Koch (Ghosh et al., 1981)

3.3.3.13 *Paragus tibialis* (Fallén, 1817)

• *Aphis spiraecola* PAtch, 1914
- *Bidens pilosa* L. (Agarwala et al., 1982)
• *Melanaphis sacchari* (Zehntner, 1897)
- Not mentioned (Rao, 1969)
• *Myzus persicae* (Sulzer, 1776)
- Not mentioned (Rao, 1969)
• *Rhopalosiphum maidis* (Fitch, 1856)
- Not mentioned (Rao, 1969)

3.3.3.14 *Paragus yerburiensis* Stuckenberg, 1954

• *Aphis craccivora* Koch, 1854
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
- *Vigna unguiculata* (L.) Walp. (Agarwala et al., 1984)
• *Aphis gossypii* Glover, 1977
- *Gossypium* sp. (Agarwala et al., 1984)
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
• *Aphis spiraecola* Patch, 1914
- *Bidens pilosa* L. (Agarwala et al., 1982)
• *Myzus persicae* (Sulzer, 1776)
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
• *Myzus persicae nicotianae* Blackman, 1987
- *Nicotiana tabacum* L. (Agarwala et al., 1984)

3.3.3.15 *Sphaerophoria indiana* Bigot, 1884

• *Aphis craccivora* Koch, 1854
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
• *Aphis gossypii* Glover, 1977
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
• *Myzus persicae* (Sulzer, 1776)
- *Solanum melongena* L. (Satpathi and Mandal, 2006)

3.3.3.16 *Sphaerophoria scripta* (Linnaeus, 1758)

• *Aphis craccivora* Koch, 1854
- *Lablab purpureus* (L.) Sweet (Agarwala et al., 1982; Agarwala et al., 1984)
• *Aphis gossypii* Glover, 1977
- *Capsicum annuum* L. (Agarwala et al., 1982)
- *Capsicum frutescens* L. (Agarwala et al., 1984)
• *Brachycaudus helichrysi* (KAltenbAch, 1843)
- *Ageratum conyzoides* L. (Agarwala et al., 1982; Agarwala et al., 1984)
• *Lipaphis erysimi* (KAltenbAch, 1843)
- *Brassica juncea* (L.) Czern. (Ghosh, 1983)
- *Brassica nigra* (L.) W.D.J.Koch (Ghosh et al., 1981; Debnath, 2020)
- *Brassica nigra* (L.) W.D.J.Koch (Agarwala et al., 1984; Chakrabarti et al., 2012)
• *Macrosiphum rosae* (LinnAeus, 1758)
- *Rosa* sp. (Raychaudhuri et al., 1979; Agarwala et al., 1984)
• *Mollitrichosiphum nandii* BAsu, 1964
- *Alnus nepalensis* D. Don (Agarwala et al., 1982; Agarwala et al., 1984)

• *Sitobion rosaeiformis* (DAs, 1918)
- *Rosa* sp. (Raychaudhuri et al., 1979; Agarwala et al., 1982)

3.3.3.17 *Sphaerophoria* spp.

• *Aphis craccivora* Koch, 1854
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
• *Aphis gossypii* Glover, 1977
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
• *Myzus persicae* (Sulzer, 1776)
- *Solanum melongena* L. (Satpathi and Mandal, 2006)

3.3.3.18 *Syrphus* sp.

• *Aphis gossypii* Glover, 1977
- *Solanum melongena* L. (Satpathi, 1999)

3.4 Order: Hemiptera

Hemipteran predators, commonly called as bugs, mainly from families such as Anthocoridae, Geocoridae, Miridae, Pentatomidae, Reduviidae, and Nabidae, are important aphidophagous arthropods contributing to natural aphid control. Both nymphs and adults actively prey on aphids using piercing-sucking mouthparts, reducing infestations in cereals, vegetables, legumes, and orchards (Singh and Srivastav, 2024). Their generalist feeding habits, mobility, and ability to act early in infestations make them valuable components of integrated pest management, complementing other predators like coccinellids, lacewings and syrphids. Recently, Singh and Srivastav (2024) enlisted a total of 29 species of Hemiptera are aphidophagous in India belonging to 6 families, Anthocoridae, Miridae, Reduviidae, Geocoridae, Nabidae and Pentatomidae preying on 45 species of aphids associated with 37 species of plants in 13 states/union territories of India. However, in West Bengal only members of two families, Anthocoridae and Geocoridae were recorded as aphidophagous as mentioned below.

3.4.1 Family: Anthocoridae

The family Anthocoridae (minute pirate bugs) comprises small predatory bugs widely distributed across the world, known for preying on soft-bodied arthropods such as aphids, thrips, mites, and caterpillars (Muraleedharan and Ananthakrishnan, 1978). Both nymphs and adults are effective predators and play an important role in biological pest control, with several species commercially utilized in Europe. In India, studies have focused on species diversity, prey range, and biocontrol potential, with ICAR-NBAIR, Bangalore developing mass-rearing and field application techniques (Ballal and Yamada, 2016; Ballal et al., 2023). In India, a total of 17 aphidophagous anthocorid species have been documented preying on 30 aphid species infesting 27 host plants (Singh and Srivastav, 2024). In West Bengal, 3 species were recorded forming 6 tri-trophic associations with 3 aphid species on 4 host plants as mentioned below.

3.4.1.1 *Bilia castanea* (Carvalho, 1951)

• *Lipaphis erysimi* (Kaltenbach, 1843)
- *Brassica juncea* (L.) Czern.(Ghosh, 1983)
- *Brassica nigra* L.(Ghosh et al., 1981; Saxena, 1981)

3.4.1.2 *Bilia* sp.

• *Greenidea psidii* van der Goot, 1917
- *Psidium guajava* L(Raychaudhuri et al., 1978; Debnath, 2020)

3.4.1.3 *Orius albidipennis* (Reuter, 1884)

• *Lipaphis erysimi* (Kaltenbach, 1843)
- *Brassica juncea* (L.) Czern.(Ghosh, 1983)

- *Brassica nigra* L.(Ghosh et al., 1981)

3.4.2 Family: Geocoridae

Geocoridae is a small family of Hemiptera, commonly called as big-eyed bugs. The members of its subfamily Geocorinae are generalist predators (Kóbor, 2020) while others are herbivorous, few of them are granivorous. Few species of the type genus *Geocoris* Fallen, 1814 have received attention as biocontrol agents in pest management researches (Kumar and Ananthakrishnan, 1985; Sweet, 2000). In India, two species were observed preying on 4 aphid species feeding on 8 host plants of agricultural importance (Singh and Srivastav, 2024). In West Bengal, only one species, *Geocoris ochropterus* (Fieber, 1844) was recorded feeding on *Aphis aurantii* on *Camellia sinensis* (tea) host plants (Mukhopadhyay and Sannigrahi, 1993; Das et al., 2010).

3.5 Order: Lepidoptera

Aphidophagous Pyralidae is uncommon within the family, as most pyralids are herbivorous or detritivorous. However, a few species have evolved predatory habits, primarily feeding on aphids. The best-known example is *Dipha aphidivora* Meyrick (Galleriinae), whose larvae prey upon the sugarcane woolly aphid, *Ceratovacuna lanigera* Zehntner, 1897 recorded from sugarcane in different states of India (Srikanth et al., 2015) including West Bengal (Basu and Banerjee, 1958; Kumar and Pal, 2022).

3.6 Order: Neuroptera

The order Neuroptera, including lacewings, mantidflies, and antlions, is globally distributed and largely carnivorous, with many species preying on soft-bodied insects like aphids. In India, aphidophagy is recorded in four families, Chrysopidae, Coniopterygidae, Dilaridae, and Hemerobiidae (Singh et al., 2024b). Among these, green lacewings (Chrysopidae) and brown lacewings (Hemerobiidae) are important natural enemies in agroecosystems, significantly contributing to pest suppression (Devetak and Klokočovnik, 2016). While Chrysopid larvae and hemerobiid larvae and adults are voracious aphid predators, their ecological importance has received less attention compared to syrphids and coccinellids (Bakthavatsalam and Varshney, 2023).

In India, 32 species of lacewings are recorded as aphidophagous, Chrysopidae being the largest one comprising 24 species under 11 genera followed by Hemerobiidae (6 species in 2 genera) preying on 68 species of aphids belonging to 37 genera associated with 107 species of plants (Singh et al., 2024b). Table 5 displays that a total of 10 species of lacewings preying on 12 species of aphids infesting 17 species of host plants with 35 tri-trophic associations are recorded in West Bengal. Familywise detailed accounts are given below.

Table 5 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 West Bengal.

Families		Species of predators	Number of		
			Species of aphid	Species of host plant	Triplets
Chrysopidae	1.	*Chrysopa pallens*	1	2	2
	2.	*Chrysopa virgestes*	3	1	3
	3.	*Chrysopa* sp.	3	3	4
	4.	*Chrysoperla zastrowi sillemi*	7	7	9
	5.	*Cunctochrysa albolineata*	2	2	2
	6.	*Cunctochrysa jubingensis*	1	1	1
	7.	*Mallada desjardinsi*	3	1	3
	8.	*Tumeochrysa indica*	1	1	1
		Sub total	**10**	**14**	**25**

Hemerobiidae	1.	*Hemerobius indicus*	1	1	1
	2.	*Micromus timidus*	4	7	9
		Sub total	**4**	**8**	**10**
		Total	**12**	**17**	**35**

3.6.1 Family: Chrysopidae

The family Chrysopidae (green lacewings) represents one of the most important groups of aphid predators in agricultural ecosystems. Their larvae, commonly known as aphid-lions, are voracious feeders that regulate aphid populations across a wide range of crops, while also preying on other soft-bodied insects under fluctuating prey conditions. Adults primarily consume nectar, pollen, and honeydew, thereby contributing indirectly to pollination and overall ecological balance. Chrysopids play a crucial role in natural and augmentative biological control programs, with species such as *Chrysoperla carnea* and *Chrysoperla zastrowi sillemi* being successfully incorporated into integrated pest management systems due to their adaptability and efficiency (Nair et al., 2020). These eco-friendly predators help reduce reliance on chemical pesticides and promote biodiversity conservation. Despite their ecological significance, the role of chrysopids often receives less attention compared to other aphidophagous predators like coccinellids and syrphids, and their field efficacy can be affected by environmental stress, intraguild predation, and pesticide exposure (Bakthavatsalam and Varshney, 2023).

In India, Chrysopidae comprises 24 aphidophagous species belonging to 10 genera. All these species prey upon 55 species of aphids infesting 84 species of food plants distributed in 22 states/union territories in India (Singh et al., 2024b). In West Bengal, 8 species of aphidophagous green lacewings were recorded feeding on 10 species of aphids infesting 14 species of host plants with 25 tri-trophic associations. Only one species of this family, *Chrysoperla zastrowi sillemi* is polyphagous feeding on 7 species of aphids infesting 7 species of food plants (Table 5). These lacewings prey mostly on *Aphis craccivora*, *Aphis gossypii* and *Myzus persicae* infesting brinjal crops; *Brevicoryne brassicae* and *Lipaphis erysimi* on brassica oil crops and vegetables. The detail account of tri-trophic associations of Chrysopidae in West Bengal is given below.

3.6.1.1 *Chrysopa pallens* (Rambur, 1838)

• *Brevicoryne brassicae* (Linnaeus, 1758)
- *Brassica oleracea* L. var. *botrytis* (Dey and De, 2018)
- *Brassica rapa* L. (Dey and De, 2018)

3.6.1.2 *Chrysopa virgestes* Banks, 1911

• *Aphis craccivora* Koch, 1854
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
• *Aphis gossypii* Glover, 1977
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
• *Myzus persicae* (Sulzer, 1776)
- *Solanum melongena* L. (Satpathi and Mandal, 2006)

3.6.1.3 *Chrysopa* spp.

• *Aphis craccivora* Koch, 1854
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
- *Vigna unguiculata* (L.) Walp. (Poddar, 1982)
• *Aphis gossypii* Glover, 1977
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
• *Lipaphis erysimi* (Kaltenbach, 1843)

- *Brassica nigra* L. (Ghosh et al., 1981)

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

• *Capitophorus formosartemisiae* (Takahashi, 1921)

- *Cajanus cajan* (L.) Millsp. (Dey and De, 2018)

• *Lipaphis erysimi* (Kaltenbach, 1843)

- *Brassica juncea* (L.) Czern. (Ghosh, 1983)

• *Macrosiphoniella formosartemisiae* Takahashi, 1921

- *Arachis hypogaea* L. (Dey and De, 2018)

• *Myzus persicae* (Sulzer, 1776)

- *Solanum tuberosum* L. (Nayak et al., 2019)

• *Rhopalosiphum maidis* (Fitch, 1856)

- *Triticum aestivum* L. (Dey and De, 2018)

• *Rhopalosiphum padi* (Linnaeus, 1758)

- *Triticum aestivum* L. (Dey, 2015; Dey and De, 2018)

• *Sitobion miscanthi* (Takahashi, 1921)

- *Lens culinaris* Medik. (Dey and De, 2018)

- *Vigna mungo* (L.) Hepper (Dey and De, 2018)

3.6.1.4 *Cunctochrysa albolineata* (Killington, 1935)

• *Brevicoryne brassicae* (Linnaeus, 1758)

- *Brassica rapa* L. (Dey and De, 2018)

• *Rhopalosiphum maidis* (Fitch, 1856)

- *Triticum aestivum* L. (Dey and De, 2018)

3.6.1.5 *Cunctochrysa jubingensis* (Hölzel, 1973)

• *Brevicoryne brassicae* (Linnaeus, 1758)

- *Brassica* sp. (Dey, 2014a)

3.6.1.6 *Mallada desjardinsi* (Navás, 1911)

• *Aphis craccivora* Koch, 1854

- *Solanum melongena* L. (Satpathi and Mandal, 2006)

• *Aphis gossypii* Glover, 1977

- *Solanum melongena* L. (Satpathi and Mandal, 2006)

• *Myzus persicae* (Sulzer, 1776)

- *Solanum melongena* L. (Satpathi and Mandal, 2006)

3.6.1.7 *Tumeochrysa indica* Needham, 1909

• *Lipaphis erysimi* (Kaltenbach, 1843)

- *Brassica oleracea* L. var. *capitata* (Dey and De, 2018)

3.6.2 Family: Hemerobiidae

The Hemerobiidae (brown lacewings) are valuable natural enemies in agroecosystems, with both larvae and adults preying on aphids and other soft-bodied pests. They are particularly effective in temperate and cooler environments, remaining active when other predators are less so, thus contributing to early-season aphid control. In addition to aphids, they also attack whiteflies, scale insects, and mites, functioning as generalist predators (Bakthavatsalam and Varshney, 2023). Although their ecological role is often underestimated compared to coccinellids and syrphids due to their smaller size and lower visibility, hemerobiids play an essential role in enhancing ecosystem stability and are important components of integrated pest management strategies (Devetak and Klokočovnik, 2016).

In India, six species belonging to the genera *Hemerobius* and *Micromus* have been recorded as predators of 29 aphid species infesting 48 host plants across 14 states and union territories (Singh et al., 2024b). Species of the genus *Micromus* are widely recognised for their effectiveness against aphids and other soft-bodied pests in various regions of the world (Bakthavatsalam and Varshney, 2023). In West Bengal, only two species have been reported, *Hemerobius indicus*, preying on a single aphid species, and *Micromus timidus*, which feeds on two aphid species found on five host plants. Detailed accounts of these species are presented below.

3.6.2.1 *Hemerobius indicus* Kimmins, 1938

• *Lipaphis erysimi* (Kaltenbach, 1843)

- *Brassica rapa* L. (Dey et al., 2016)

3.6.2.2 *Micromus timidus* Hagen, 1853

• *Aphis craccivora* Koch, 1854

- *Lablab purpureus* (L.) Sweet (Ghosh et al., 1981; Poddar, 1982)
- *Senna tora* (L.) Roxb. (Poddar, 1982)
- *Solanum melongena* L. (Satpathi and Mandal, 2006)
- *Vicia faba* L. (Poddar, 1982)

• *Aphis gossypii* Glover, 1977

- *Lagenaria siceraria* (Molino) Standl. (Saha et al., 2016)
- *Solanum melongena* L. (Satpathi, 1999; Satpathi and Mandal, 2006)

• *Lipaphis erysimi* (Kaltenbach, 1843)

- *Brassica juncea* (L.) Czern. (Ghosh, 1983)
- *Brassica nigra* L. (Ghosh et al., 1981)

• *Myzus persicae* (Sulzer, 1776)

- *Solanum melongena* L. (Satpathi and Mandal, 2006)

4 Conclusion

The study provides a comprehensive overview of aphid–predator–plant interactions in West Bengal, documenting 125 predator species forming 612 tri-trophic associations across varied habitats. Dominant groups such as Coccinellidae and Syrphidae play major roles in controlling aphid populations on key crops, while spiders, lacewings, minute pirate bugs, and silver flies also contribute significantly. Less common families, including Chrysomelidae, Staphylinidae, and Calliphoridae, display opportunistic or specialised aphid predation. The wide range of host plants, from cultivated to wild species, highlights the ecological breadth of these predators. Overall, the findings underscore the functional diversity and ecological importance of aphidophagous predators in sustaining pest control and guiding region-specific Integrated Pest Management strategies in West Bengal.

References

Agarwala BK, Ghosh D, Das SK, Poddar SC, Raychaudhuri DN. 1981. Parasites and predators of aphids (Homoptera: Aphididae) from India. V. New records of two aphidiid parasites, nine arachnids and one dipteran predator from India. Entomon, 6(3): 233-238

Agarwala BK, Raychaudhuri D, Raychaudhuri DN. 1980. Parasites and predators of aphids in Sikkim and Manipur (Northeast India). III. Entomon, 5(1): 39-42

Agarwala BK. 1983. Parasites and predators of rose infesting aphids (Homoptera: Aphididae) in India. Entomon, 8: 35-39

Agarwala BK, Dutta S, Raychaudhuri DN. 1982. An account of syrphid (Diptera: Syrphididae) predators of aphids (Homoptera: Aphididae) available in Darjeeling district of West Bengal and Sikkim. Pranikee, 3: 15-21

Agarwala BK, Dutta, S, Raychaudhari DN. 1979. An account of syrphid (Diptera, Syrphidae) predators of aphids available in the Darjeeling district of West Bengal and Sikkim. 15-16, Symposium on Recent Trends in Aphidological Studies, Bhubneshwar, India

Agarwala BK, Saha JL. 1986. Larval voracity development and relative abondance of predators of *Aphis gossypii* Glover on cotton in India. In: Ecology of Aphidophaga (Hodek I, ed). 339-344, Academia Prague and Dr. W. Junk, Dordrecht, Netherlands

Agarwala BK, Laska P, Raychaudhuri DN. 1984. Prey records of aphidophagous syrphid flies from India (Diptera: Syrphidae). Acta Entomologica Bohemslovaka, 81: 15-21

Anusha M, Roy K, Maiti AK. 2022. Feeding efficiency of predatory spiders on *Myzus persicae* (Sulzer). Indian Journal of Entomology, 84(1): 129-131. doi: 10.55446/IJE.2021.334

Bakthavatsalam N, Varshney R. 2023. Chrysopids (Neuroptera: Chrysopidae). In: Insect Predators in Pest Management (Omkar, ed). 161-174, CRC Press, Taylor and Francis Group, LLC,USA

Ballal CR, Gupta T, Varshney R. 2023. The flower bugs (Anthocoridae). In. Insect Predators in Pest Management (Omkar, ed). 183-216, CRC Press, Taylor and Francis Group, LLC, USA. doi: 10.1201/9781003370864-3

Ballal CR, Yamada K. 2016. Anthocorid Predators. In: Ecofriendly Pest Management for Food Security (Omkar, ed). 183-216. Academic Press, USA. doi: 10.1016/B978-0-12-803265-7.00006-3

Basu AN, Banerjee SN. 1958. Aphids of economic plants of West Bengal. Indian Agriculture, 2: 89-112

Bhattacharyya A, Mandal SK. 2004. Population dynamics and relative density of coccinellid predators of *Aphis gossypii* Glove. infesting taro. Indian Journal of Entomology, 66: 153-154

Bindhani G, Das A, Chakraborti, S. 2020. Study on the pest-complex of fenugreek in West Bengal. Journal of Entomology and Zoology Studies, 9(1): 349-352

Chakrabarti S, Sarkar S, Debnath M. 2012. Diversity, bioecology and biosystematics of aphidophagous predators of eastern Himalaya and northeast India. In: Biodiversitat und Naturausstattung im Himalaya, IV (eds. Hartmann, M, Weipert, J.), Naturkundemuseum Erfurt, pp. 129-147

Chakraborty S, Chakrabarty S. 2002. Tritrophic relationship: Aphidophaga, aphid and its host plant: A study on *Brachycaudus helichrysi.* Journal of Aphidology, 16: 39-44

Chaudhuri D, David BA, Singh DR. 1983. Studies on the host preference of *Chilomenes sexmaculata* (Fabr.) (Coleoptera: Coccinellidae) on the different aphid hosts. Comparative Physiology and Ecology, 8: 289-290

Das S, Roy S, Mukhopadhyay A. 2010. Diversity of arthropod natural enemies in the tea plantations of north Bengal with emphasis on their association with tea pests. Current Science, 99: 1457-1463

Debnath M. 2020. Aphidophagous predator diversity in Kalimpong district, India. International Journal of Experimental Research and Review, 22: 30-36. doi: 10.52756/ijerr.2020.v22.004

Devetak D, Klokočovnik V. 2016. The feeding biology of adult lacewings (Neuroptera): a review. Trends in Entomology, 12: 29-42

Dey SR, De M. 2018. Report on winter crop plant-aphid-aphidophagous Chrysopidae (Neuroptera: Insecta) association from Murshidabad district, West Bengal, India. International Journal of Experimental Research and Review, 16: 7-13. doi: 10.52756/ijerr.2018.v16.002

Dey SR, Sikdar SR, Ghose TK, De M. 2016. Study of the efficiency of Neuropteran predator, *Hemerobius indicus* Kimmins as potential biocontrol agent of notorious aphid, *Lipaphis erysimi* (Kaltenbuch) on

Brassica campestris Linn. (cv. B-9). International Journal of Experimental Research and Review, 7: 21-31

Dixon AFG. 2000. Insect Predator-Prey Dynamics: Ladybird Beetles and Biological Control. Cambridge University Press, Cambridge, UK

Emden HFV, Harrington R. 2007. Aphids as Crop Pests. CABI. doi: 10.1079/9780851998190.0000

Ghosh AK, Raychaudhuri DN. 1982. Ecology of natural enemy complex of Aphidoidea (Homoptera) in some areas of eastern India. Proceedings of the symposium on Ecology of Animal Population, Zoological Survey of India, 3: 55-69

Ghosh D. 1983. Studies on mustard aphid *Lipaphis erysimi* (Kltb.) (Homoptera: Insecta) and its natural enemy complex in some parts of West Bengal. Ph. D. thesis, Calcutta University, Kolkata, West Bengal, India. http://hdl.handle.net/10603/163460

Ghosh D, Debnath N, Chakrabarti S. 1985. Predators and parasites of aphids (Homoptera: Aphididae) from northwest Himalaya: Ten species of syrphids (Diptera: Syrphidae) from Garhwal range. Entomon, 10: 301-303

Ghosh D, Poddar SC, Raychaudhuri DN. 1981. Natural enemy complex of *Aphis craccivora* Koch and *Lipaphis erysimi* (Kalt.) in and around Calcutta. Science and Culture, 47: 58-60

Gurung B, Ponnusamy N, Pal, S. 2019. Species diversity of predaceous coccinellids in different crop ecosystems under the hilly and terai region of West Bengal (India). Ecology Environment and Conservation, 25(2): 636-642

Hodek I, Van Emden HF, Honek I. 2012. Ecology and behavior of ladybird beetles (Coccinellidae). Blackwell Publishing Ltd, USA. doi:10.1002/9781118223208

Hodek I, Honěk A. 1996. Ecology of Coccinellidae. Kluwer Academic Publishers, Doredrecht, The Netherlands

Iperti G, Paoletti MG 1999. Biodiversity of predaceous Coccinellidae in relation to bioindication and economic importance. Special issue: invertebrate biodiversity as bioindicators of sustainable landscapes. Agriculture, Ecosystems and Environment, 74: 323-342

Irmler U, Klimaszewski J, Betz O. 2018. Introduction to the biology of rove beetles. In: Biology of Rove Beetles (Staphylinidae) (Betz O, Irmler U, Klimaszewski J, eds). Springer, Cham, USA. doi: 10.1007/978-3-319-70257-5_1

Kapur AP, Munshi S. 1970. A new species of *Pullus* Mulsant (Coleoptera: Coccinellidae), predaceous on the aphid, *Rhopalosiphum nymphaeae* (Linn.) in Calcutta. Records of Zoological Survey of India, 62(1and2): 1-3. doi: 10.26515/rzsi/v62/i1-2/1964/161626

Karthik R, Deka MK, Ajith S, Prakash NB, Kalita S. 2023. Influence of silicic acid foliar spray on the incidence of sucking insect pests and their natural enemies in rapeseed. Indian Journal of Entomology, 86(3): 830–835. doi: 10.55446/IJE.2023.1395

Kóbor P. 2020. A review on biology and agricultural significance of big-eyed bugs (Heteroptera: Lygaeoidea: Geocoridae). Hungarian Agricultural Research, 2: 4-10

Kumar A, Pal S. 2022. Arthropods biodiversity in sugarcane agro-ecosystem under terai zone of northern West Bengal. Journal of Entomological Research, 46: 878-882. doi: 10.5958/0974-4576.2022.00151.7

Kumar A, Pal SP. 2019. Feeding efficacy of predaceous giant lady beetle, *Anisolemnia dilatata* against sugarcane woolly aphid, *Ceratovacuna lanigera.* Journal of Experimental Zoology, India, 22(2): 1009-1012

Kumar B, Omkar. 2023. Ladybird beetles. In: Insect Predators in Pest Management (Omkar ed). 187-228, CRC Press, Taylor and Francis Group. doi: 10.1201/9781003370864-8

Kumar B, Omkar. 2025. Prey-predator relationships in ladybird beetles and biological control of insect pests. Journal of Applied Biosciences, 51(1): 1-36. doi: 10.61081/joab/51v1i101

Kumar NS, Ananthakrishnan TN. 1985. *Geocoris ochropterus* Fabr. as a predator of some thrips. Proceedings of the National Academy of Sciences, India Section B: Biological Sciences, 51: 185-193

Li H, Wyckhuys KAG, Wu K. 2023. Hoverflies provide pollination and biological pest control in greenhouse grown horticultural crops. Frontiers in Plant Science, 14: 1118388. doi: 10.3389/fpls.2023.1118388

Maji A, Pal S, Chatterjee M, Sahoo SK. 2020. Seasonal incidence of aphid and their natural enemies on mustard from terai region of West Bengal.Journal of Entomological Research, 44(4): 555-558. doi: 10.5958/0974-4576.2020.00093.6

Maji A, Pal S, Gurung B, Banerjee MC, Sahoo SK. 2023. Diversity of aphids and their predatory coccinellids from West Bengal. Indian Journal of Entomology, 85(2): 332–336. doi: 10.55446/IJE.2022.682

Mukhopadhyay A, Sannigrahi S. 1993. Evaluation of predatory potentiality of *Geocoris ochropterus* (Hemiptra: Lygaeidae) on tea aphid *Toxoptera aurantii* (Hemiptera: Aphididae). Tea, 14(1): 44-49

Muraleedharan, N, Ananthakrishnan, T.N, 1978. Bioecology of four species of Anthocoridae (Hemiptera: Insecta) predaceous on thrips, with key to genera of anthocorids from India. Occasional Paper, Records of the Zoological Survey of India, 11: 1-32

Nair IJ, Sharma S, Kaur R. 2020. Efficacy of the green lace wing, *Chrysoperla zastrowi sillemi* (Esben-Peterson) (Neuroptera: Chrysopidae), against sucking pests of tomato: an appraisal under protected conditions. Egyptian Journal of Biological Pest Control, 30: 74. doi: 10.1186/s41938-020-00277-2

Nath DK, Sen B. 1976. Some observations on aphidophagous coccinellid beetles in mustard cultivalion. Science and Culture, 42: 288-290

Nayak AK, Sarkar A, Bala SC. 2019. Studies on population fluctuation and effect of biotic and abiotic stresses on the population of *Myzus persicae* (Sulz.) infesting potato in the gangetic basin of West Bengal. Journal of Entomology and Zoology Studies, 7(1): 14-20

Omkar. 2023. Insect Predators in Pest Management, CRC Press, Taylor and Francis Group, LLC, pp. 320. doi: 10.1201/9781003370864

Pal S, Debnath P. 2020. Seasonal incidence of major insect pests and predators of mustard in lower gangetic plains of West Bengal. Journal of Entomology and Zoology Studies, 8(6): 1424-1430. doi:10.22271/j.ento.2020.v8.i6s.8028

Pal S, Gurung B, Natarajan P, Medda PS. 2023. New prey record of giant ladybird beetle *Anisolemnia dilatata* (Fabricius) (Coccinellidae: Coleoptera) feeding on som plant aphid *Aiceona* sp. Journal of Threatened Taxa, 15(1): 22551–22555. doi: 10.11609/jot.7450.15.1.22551-22555

Pal S, Samanta S, Banerjee A. 2023. Seasonal incidence of pulse aphid (*Aphis craccivora* Koch.) and its natural enemies on field pea (*Pisum sativum* L.) in relation to some abiotic factors in alluvial zone of West Bengal. Legume Research, 46(12): 1680-1685. doi: 10.18805/LR-4464

Poddar SC, Ghosh AK. 1984. Bionomics of an aphidophagous coccinellid predator *Pseudaspidimerus circumflexa* (Motschulsky) (Coccinellidae: Aspidimerini). Records of the Zoological Survey of India, 81(3-4): 67-76. doi: 10.26515/rzsi/v81/i3-4/1984/161219

Poddar SC. 1982. Studies on *Aphis craccivora* Koch and its natural enemies in some parts of India. Ph.D. thesis, Calcutta University, Kolkata, West Bengal, India. http://hdl.handle.net/10603/162498

Ponnusamy N, Karthik S, Sai Reddy MS. 2019. Different coccinellid predators feeding on aphid (*Schizoneuraphis himalayensis* Ghosh and Raychaudhuri) of som plant (*Persea bombycina* Kost) in Terai Region of West Bengal. Agrobios Newsletter, 18(4): 83-84

Poorani J. 2002. A review of the genus *Oenopia* Mulsant (Coleoptera: Coccinellidae) of the Indian

subcontinent, with description of a new species, Oriental Insects, 36(1): 97-116. doi: 10.1080/00305316.2002.10417328

Rao VP. 1969. Survey of natural enemies of aphids in India. Final Report of the Commonwealth Institute of Biological Control, 480: 1-93

Raychaudhuri DN, Dutta S, Agarwala BK, Raha SK, Raychaudhuri D. 1979. Some parasites and predators of aphids in northeastern India and Bhutan. II. Entomon, 4: 163-166

Raychaudhuri DN, Dutta S, Agarwala BK, Raychaudhuri D, Raha SK. 1978. Some parasites and predators of aphids from Northeast India and Bhutan. Entomon, 3: 91-94

Raychaudhuri D, Saha S, Kundu B. 1998. Aphids and their associated insects of Buxa Tiger Reserve, Jalpaiguri, West Bengal. Journal of Aphidology, 12(1and2): 9-20

Roy P, Basu SK. 1977. Bionomics of aphidophagous syrphid flies. Indian Journal of Entomology, 39(2): 165-174.

Roy S, Mukhopadhyay A, Das S,Gurusubramanian G. 2010. Bioefficacy of coccinellid predators on major tea pests. Journal of Biopesticides, 3(1 Spl Issue): 33-36

Saha JL, Chatterjee, T, Chakraborty, K. 2016. Population dynamics of *Aphis gossypii* Glover and its natural enemies on gourd plant. International Journal of Current Agricultural Sciences, 6(10): 117-120

Saha S, Keerthana B, Sarkar S, Karjee M, Dhanapati GK, Sahoo SK, Pal S. 2023. An annotated checklist of Coccinellidae (Coleoptera) from Pundibari region of West Bengal, India. Uttar Pradesh Journal of Zoology, 44(24): 14-27. doi: 10.56557/upjoz/2023/v44i243805

Sarkar M, Mukhopadhyay A. 2006. A comparison of dynamics of tea aphid population from Darjeeling hills and terai plains with a note on its arthropod natural enemies. Journal of Aphidology, 20(1): 39-42

Satpathi CR, Mandal A. 2006. Brinjal aphids and their insect predators in West Bengal. Journal of Aphidology, 20: 37-41

Satpathi CR. 1999. Predators of *Aphis gossypii* Glover (Homoptera: Aphididae) infesting brinjal in dry and laterite zones of West Bengal. Journal of Aphidology, 13: 99-100

Saxena RC. 1981. Natural enemy complex of *Aphis craccivora* Koch. and *Lipaphis erisymi* (Kalt.) in and around Calcutta, West Bengal. Science and Culture, 47: 58-60

Singh R. 2003. Tritrophic interactions with reference to biological control of insect pests: A review. Biological Memoirs, 29(2): 55-70

Singh R. 2024a. Arthropod predators of *Myzus* spp. (Hemiptera: Aphididae) and their distribution in India. Munis Entomology and Zoology, 19 (suppl.): 3131-3168

Singh R. 2024b. Arthropod predators of the bean aphid, *Aphis (Aphis) craccivora* Koch, 1854 (Hemiptera: Aphididae) and their distribution in India. Munis Entomology and Zoology, 19 (suppl.): 3002-3036

Singh R. 2025a. Species diversity and tri-trophic associations of aphidophagous Coccinellidae (Coleoptera: Insecta) in India. Uttar Pradesh Journal of Zoology, 46(18): 225–241. doi: 10.56557/upjoz/2025/v46i185253

Singh R. 2025b. A catalogue of tri-trophic associations of aphidophagous arthropods in Uttar Pradesh, India. Uttar Pradesh Journal of Zoology, 46(19): 158-179. doi: 10.56557/upjoz/2025/v46i195276

Singh R. 2025c. Predators and parasitoids of aphids (Homoptera: Aphididae) infesting cucurbit crops in India. Munis Entomology and Zoology, 20(2): 2638-2662

Singh R. 2025d. Predators and parasitoids of aphids (Homoptera: Aphididae) infesting brinjal (*Solanum melongena* l.) crop in India. Munis Entomology and Zoology, 20(2): 2527-2558

Singh R. 2025e. Predators and parasitoids of *Rhopalosiphum* spp. (Hemiptera: Aphididae) and their distribution in India. Munis Entomology and Zoology, 20(1): 1479-1507

Singh R. 2025f. Checklist of predators and parasitoids of *Sitobion* spp. (Hemiptera: Aphididae) and their distribution in India. Munis Entomology and Zoology, 20 (1): 1356-1381

Singh R. 2025g. An updated checklist of tri-trophic associations of the common hover fly *Ischiodon scutellaris* (Fabricius, 1805) (Syrphidae: Diptera: Insecta) in India. Arthropods, 14(4): 225-245

Singh R. 2026a. Tri-trophic associations of aphidophagous hover flies (Syrphidae: Diptera) in different states and union territories of India. Munis Entomology and Zoology, 21(1): 367-397

Singh R. 2026b. A catalogue of tri-trophic associations of aphidophagous ladybirds (Coccinellidae: Coleoptera) in Uttar Pradesh, India. Munis Entomology and Zoology, 21(1): 432-482

Singh R. 2026c. An updated checklist of tri-trophic associations of aphidophagous ladybirds (Coccinellidae: Coleoptera) in different districts of Uttarakhand, India. Munis Entomology and Zoology, 21(1): 531-561

Singh R, Ahmad ME. 2025a. Predators and parasitoids of aphids (Aphididae: Homoptera) infesting cereal crops in India, Munis Entomology and Zoology, 20(2): 3003-3041

Singh R, Ahmad ME. 2025b. Tritrophic associations of aphidophagous *Betasyrphus* and *Episyrphus* species (Syrphinae: Syrphidae: Diptera) in different states and territories of India, Munis Entomology and Zoology, 20(supplement): 3451-3474

Singh R, Omkar 2025. An updated checklist of tri-trophic associations of aphidophagous Diptera and Neuroptera in different districts of Uttarakhand, India. Journal of Applied Bioscience, 51(2): 35-55

Singh R, Pandey L. 2025. Predators and parasitoids of aphids (Homoptera: Aphididae) infesting okra (*Abelmoschus esculentus* (L.) Moench) crops in India. Munis Entomology and Zoology, 20(2): 2581-2596

Singh R, Samuel, RN. 2025. Tritrophic associations of aphidophagous hover flies *Melanostoma*, *Paragus* and *Sphaerophoria* species (Syrphinae: Syrphidae: Diptera) in different states and territories of India. International Journal on Biological Sciences, 16(1): 31-55

Singh R, Singh BB. 2023. Biosystematics, economic importance, natural enemies and food plants of *Aphis (Toxoptera) aurantii* Boyer de Fonscolombe, 1841 (Insecta: Hemiptera: Aphididae: Aphidinae) in India. Munis Entomology and Zoology, 18(suppl.): 2104-2125

Singh R, Singh G. 2016. Aphids and their biocontrol. In: Ecofriendly Pest Management for Food Security (Omkar , ed). 63-108, Academic Press, USA. doi: 10.1016/B978-0-12-803265-7.00003-8

Singh R, Singh G. 2019. Species diversity of Indian aphids (Hemiptera: Aphididae). International Journal of Biological Innovations, 1(1): 23-29

Singh R, Singh G. 2021. Aphids. In: Polyphagous Pests of Crops (Omkar, ed). 105-182, Springer Nature Singapore. doi: 10.1007/978-981-15-8075-8_3

Singh R, Singh G. 2022. Reproductive Strategies in Aphids. In: Reproductive strategies in insects (eds.) Omkar and Mishra G., Taylor, Francis Group, LLC, pp. 259-282. doi: 10.1201/9781003043195-13

Singh R, Singh N. 2026. Biodiversity of aphidophagous predators in the southeast districts of Uttar Pradesh, India. Munis Entomology and Zoology, 21(1): 181-222

Singh R, Srivastav AK. 2024. Checklist of aphidophagous predatory bugs (Heteroptera: Hemiptera: Insecta) in India. Internationjal Journal of Biological and Environmental Investigations, 4(2): 1-11. doi: 10.33745/ijbei.2024.v04i02.001

Singh R, Srivastav AK. 2025. An updated checklist of tri-trophic associations of aphidophagous arthropods in different districts of Uttarakhand, India. International Journal of Zoological Investigations, 11(2): 810-826. doi: 10.33745/ijzi.2025.v11i02.079

Singh R, Tiwari AK, Tiwari KM. 2024a. Checklist of Aphidophagous Neuroptera (Insecta: Orthoptera) in India. International Journal of Biological Innovations, 6(2): 99-127. doi: 10.46505/IJBI.2024.6204

Singh R, Singh BB, Sharma AK. 2024b. Checklist of aphidophagous spiders (Araneae: Arachnida: Arthropoda) in India. Serket, 20(3): 288-310

Singh R, Verma AK, Singh G. 2023a. Food Plant Catalogue of Indian Aphids (Homoptera: Aphididae). Asian Biological Research Foundation, Nature Light Publications, Pune, India

Singh R, Verma AK, Singh BB, Singh G. 2023b. Spider Fauna of India. Asian Biological Research Foundation, Prayagraj, India, Nature Light Publications, Pune, India

Srikanth J, Singaravelu B, Kurup NK, Mukunthan N, Santhalakshmi G, Nirmala R. 2015. Predators as natural and applied biocontrol agents of sugarcane woolly aphid *Ceratovacuna lanigera* in india: an appraisal. Journal of Sugarcane Research, 5(2): 53-72

Sweet MH. 2000. Economic importance of predation by big-eyed bugs (Geocoridae). In: Schaefer C.W, Panizzi AR (eds.) Heteroptera of economic importance. CRC Press, Boca Raton, USA

Tiwari KM, Singh R. 2025a. Predators and parasitoids of aphids (Aphididae: Homoptera) infesting potato crops in India. Journal of Applied Biosciences, 51(1): 37-46. doi: 10.61081/joab/51v1i102

Tiwari KM, Singh R. 2025b. Predators and parasitoids of aphids (Aphididae: Homoptera) infesting tomato crops in India. International Journal of Biological Innovations. 7(1): 01-12. doi: 10.46505/IJBI.2025.7101

Tiwari KM, Singh R, Tripathi PN. 2024. Biosystematics, economic importance, natural enemies and food plants of *Lipaphis (Lipaphis) erysimi* (Kaltenbach, 1843) (Hemiptera: Aphididae) in India. Munis Entomology and Zoology, 19(2): 615-635