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Research Article

An updated tri-trophic associations of arthropod predators of aphids (Hemiptera: Aphididae) in the agro-ecological landscapes in different districts of Kerala, India

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ABSTRACT: A total of 73 predator species were recorded preying on 17 aphid species infesting 77 host plants, forming 355 predator-aphid-plant associations across 13 districts. These predators belong to Araneae and four insect orders, Coleoptera, Diptera, Lepidoptera, and Neuroptera. *Aphis craccivora*, *Aphis gossypii*, *Aphis aurantii*, and *Pentalonia nigronervosa* were the most frequently attacked aphids, mainly on leguminous, malvaceous, solanaceous, and musaceous hosts. Thiruvananthapuram district recorded the highest diversity (263 triplets), followed by Thrissur, Wayanad, Kasaragod, and Kozhikode districts. Coccinellids dominated with 44 species forming 286 triplets (over 80% of all interactions), emphasising their pivotal role in aphid suppression. Polyphagous species such as *Cheilomenes sexmaculata*, *Nephus ancyroides*, *Coccinella septempunctata*, and *Coccinella transversalis* exhibited broad trophic linkages across crops. Spiders constituted the second major guild, represented by 16 species in eight families and forming 39 triplets. The pyralid *Dipha aphidivora* was the only lepidopteran aphid predator, feeding on *Ceratovacuna lanigera* on sugarcane in Kannur, while five neuropterans contributed 29 triplets, *Chrysoperla zastrowi sillemi* being the key aphidophagous lacewing. This inventory provides a baseline of diversity of aphidophagous predators and their possible role in region-specific Integrated Pest Management strategies.

KEYWORDS: Aphidophagous predators, biodiversity conservation, tri-trophic associations, Kerela

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INTRODUCTION

Aphids (Hemiptera: Aphididae) are among the most destructive sap-feeding insects in both natural and managed ecosystems, causing extensive yield losses through direct feeding and the transmission of a wide range of plant viruses (Singh & Singh, 2021). Their rapid parthenogenetic reproduction, short generation time, and ability to exploit diverse host plants enable populations to reach damaging levels within a short period (Singh & Singh, 2022). Because of these biological traits, aphids have become key targets for natural control mechanisms mediated by predatory and parasitic arthropods (Singh & Singh, 2016). Among these, aphidophagous arthropods, those that feed primarily or opportunistically on aphids, represent one of the most important components of terrestrial biological control systems.

Aphidophagous arthropods encompass a wide taxonomic spectrum including beetles (Coccinellidae) (Hodek & Honěk, 2009; Singh, 2025), hover flies (Syrphidae) (Joshi *et al*., 2023; Singh, 2026), lacewings (Chrysopidae, Hemerobiidae) (Bakthavatsalam & Varshney, 2023; Singh *et al*., 2024a), predatory midges (Cecidomyiidae) (Bhat *et al*., 1986; Bhagat, 2014), predatory bugs (Hemiptera) (Ballal *et al*., 2023; Singh & Srivastav, 2024), and several groups of spiders (Singh *et al*., 2024b) and predatory mites (Debnath, 1991; Singh & Srivastav, 2025). These predators regulate aphid populations through direct predation, parasitism, and disturbance effects that alter aphid behaviour and dispersal (Dixon, 1998; Nelson & Rosenheim, 2006). Their activities impose strong top-down control on aphid colonies, curtailing population explosions before they exceed economic thresholds.

Intra- and inter-guild predation can influence aphid biological control by reducing predator abundance through predation on competing natural enemies or conspecifics, particularly during prey scarcity. Although excessive interference may weaken aphid suppression, moderate levels may enhance predator persistence and contribute to stable pest regulation in diverse agroecosystems (Müller & Brodeur, 2002; Lucas, 2005).

Aphidophagous arthropods are integral components of agro-ecosystem resilience and biodiversity maintenance. Their trophic interactions extend beyond simple predator-prey relationships, forming complex tri-trophic networks linking predators, aphid herbivores, and host plants. These networks enhance ecosystem stability by distributing control across multiple predator guilds, thereby minimising the risk of aphid outbreaks following environmental perturbations or chemical disturbance (Singh & Singh, 2026). Furthermore, documenting the regional diversity of aphidophagous predators, including ladybird beetles, hover flies, lacewings, and predatory bugs, provides valuable insights for identifying potential bioindicators that can be used to evaluate ecosystem health (Iperti & Paoletti, 1999).

A survey of the literature indicates that Rao (1969) was among the earliest to document tri-trophic associations involving three hover fly species in Kerala, followed by records of two aphidophagous coccinellids by Mathew *et al.* (1971) and Johnson (1972). Subsequently, studies by Radhakrishnan & Muraleedharan (1986, 1991), Radhakrishnan *et al.* (1988), Rani (1995), Nandakumar & Sheela (1996), and Padmalatha & Singh (1998) expanded the faunal inventory of ladybirds and hover flies associated with diverse aphid taxa in Kerala. Further contributions by Jose (2003), Sheena (2003), Manu (2005), Vijayasree (2006), Thamilvel (2009), Jagdish *et al.* (2011), and Verghese (2013) added new records of aphidophagous arthropods, particularly from Thiruvananthapuram. More recent studies by Vidya & Bhaskar (2017), Srikanth *et al.* (2021), Gokul (2023), Gokul *et al.* (2024), Manoj *et al.* (2024), and Yasasvi *et al.* (2025) have further elucidated the diversity, prey associations, and host plant relationships of aphidophagous arthropods across Kerala.

A review of the literature revealed that the available information on the tri-trophic relationships involving these aphidophagous predators in Kerala is scattered, and some areas have not yet been surveyed. For taxonomists, researchers, academics, conservation managers, and policymakers, this checklist serves as an essential tool for confirming that these natural foes can be employed in the natural or biological management strategies for these aphids (Sharma *et al*., 2025).

MATERIALS AND METHODS

Site description

Kerala, located between latitudes 8°18'-12°48'N and longitudes 74°52'-77°22'E, lies between the Lakshadweep Sea to the west and the Western Ghats to the east, encompassing a coastline of approximately 590 km. Geographically, the state comprises three distinct climatic zones: (i) The eastern highlands, (ii) the central midlands characterised by undulating hills and cool mountain terrain, and (iii) The western lowlands or coastal plains. The state experiences a humid tropical rainforest climate, receiving an average annual rainfall exceeding 2,900 mm, primarily from the southwest and northeast monsoons. Administratively, Kerala is divided into 14 districts, grouped into three major regions based on geography, culture, and history: Malabar (north Kerala) (Kasaragod, Kannur, Kozhikode, Malappuram, Wayanad), Kochi region (central Kerala) (Palakkad, Thrissur, Ernakulam) and Travancore (south Kerala) (Alappuzha, Idukki, Kottayam, Pathanamthitta, Kollam, Thiruvananthapuram).

The present checklist is based on the published literature on the tri-trophic associations of predators, their aphid preys and host plants from Kerala, e.g. books, book chapters, journals, proceedings of conferences, Records and Fauna Series of the Zoological Survey of India, Kolkata, few authentic theses, websites (only research grade contents) up to November 30, 2025. Previous literature, and even some recent sources, often exhibited taxonomic inconsistencies in the identification of predators, aphids, and host plants. These inaccuracies largely stemmed from the rapid advancements in taxonomic research and the limited incorporation of updated classifications. To maintain consistency and accuracy, the present compilation follows standardised nomenclature systems: aphid names are adopted from the Aphid Species File (https://aphid.speciesfile.org), host plant taxonomy from World Flora Online (https://www.worldfloraonline.org), and arthropod names from the Global Biodiversity Information Facility (GBIF) (https://www.gbif.org).

RESULTS AND DISCUSSION

The analysis of tri-trophic interactions among aphidophagous predators, their aphid prey, and associated host plants in Kerala reveals 73 predator species collectively

Table 1. Records of numbers of predator species belonging to different taxa reported preying numbers of aphid species infesting host plant species and triplets in Kerala

Class/Order/ Family of the aphidophagous predators	Number of				
	Predator species	**Aphid species**	**Plant species**	**Triplets**	**Districts**
Arachnida/Araneae					
Araneidae	4	3	3	5	2
Clubionidae	1	1	1	1	1
Lycosidae	1	1	2	2	1
Oxyopidae	3	5	5	7	4
Salticidae	3	2	2	3	4
Tetragnathidae	2	3	3	3	2
Theridiidae	1	1	1	1	3
Thomisidae	1	1	1	1	1
Coleoptera: Coccinellidae	44	15	74	286	13
Diptera: Syrphidae	7	8	5	16	6
Lepidoptera: Pyralidae	1	1	1	1	1
Neuroptera: Chrysopidae	2	2	7	12	1
Neuroptera: Hemerobiidae	3	5	16	17	6
Total	**73**	**17**	**77**	**355**	**14**

preying on 17 aphid species infesting 77 host plants, resulting in 355 distinct predator-aphid-plant associations across all districts of the state. The documented predators belong to one order of Arachnida: Araneae (8 families: Araneidae, Clubionidae, Lycosidae, Oxyopidae, Salticidae, Tetragnathidae, Theridiidae, and Thomisidae), and four orders of Insecta: Coleoptera (Coccinellidae), Diptera (Syrphidae), Lepidoptera (Pyralidae), and Neuroptera (Chrysopidae, Hemerobiidae) (Table 1).

Among the recorded tri-trophic associations (triplets), the majority of aphidophagous species were observed preying on *Aphis craccivora* primarily on leguminous crops (34 triplets), followed by *Aphis gossypii* infesting malvaceous, cucurbitaceous, and solanaceous vegetables (29 triplets), and *Aphis aurantii* on tea plantations and *Pentalonia nigronervosa* on banana crops (each with 20 triplets).

Kerala exhibits diverse agro-ecological landscapes shaped by variations in climate, topography, and cropping systems, influencing tri-trophic interactions across districts. Southern districts, including Thiruvananthapuram, Kollam, Alappuzha, and Kottayam, are dominated by humid lowland and homestead agroecosystems with coconut, paddy, banana, and rubber. Central districts such as Ernakulam, Thrissur, and Palakkad support diversified agriculture, with Palakkad representing a relatively drier zone due to the Palakkad Gap. Northern districts, including Kannur, Kasaragod, and Kozhikode, are characterized by plantation and perennial crop systems such as coconut, arecanut, cashew, and pepper. In contrast, the highland districts of Idukki and Wayanad comprise montane agroecosystems with tea, coffee, cardamom, and pepper under agroforestry systems. This agro-ecological heterogeneity likely contributes to district-wise variation in aphid-host plant-predator associations in Kerala.

Among the districts, Thiruvananthapuram recorded the highest number of triplets (263), accounting for nearly three-fourths of the total associations. The district also supported the greatest diversity of predator guilds, including spiders, ladybirds, hover flies, and lacewings. This high diversity may be attributed to its heterogeneous agro-ecological landscape comprising humid tropical conditions, diverse horticultural and plantation crops, home gardens, and mixed farming systems that provide continuous prey availability and refugia for natural enemies. Similarly, Thrissur (70 triplets) and Wayanad (69 triplets) exhibited comparatively high tri-trophic diversity. Wayanad, located in the Western Ghats highlands, is characterised by a mosaic of coffee, spice, and mixed-cropping systems under semi-natural vegetation, which likely favours a wider assemblage of aphid predators. Thrissur, with its diversified agricultural landscapes and plantation ecosystems, also supported multiple predator groups. Moderately high numbers of triplets were recorded from Kasaragod (54), Kozhikode (51), Idukki (48), and Kannur (47). The elevated diversity in these districts may reflect the predominance of plantation crops, spice agroecosystems, and perennial vegetation that sustain aphid populations and their predators throughout the year. In Idukki and Kannur, the occurrence of multiple predator guilds, including hover flies, lacewings, and pyralid moths, indicates relatively complex trophic interactions within agroecosystems.

In contrast, districts such as Alappuzha, Ernakulam, and Malappuram each recorded only 23 triplets, while Kottayam and Palakkad showed moderate associations (32 and 39 triplets, respectively). Kollam exhibited the lowest diversity (6 triplets), and no records were available from Pathanamthitta, possibly reflecting inadequate sampling and reporting rather than true absence of tri-trophic systems. The relatively lower number of associations in some

Table 2. Number of tri-trophic associations (triplets) of aphidophagous arthropods of different taxa in different districts of Kerala

Name of districts	Number of triplets					
	Spiders	**Ladybirds**	**Hover flies**	**Pyralid moth**	**Lacewings**	**Total**
Alappuzha	-	23	-	-	-	23
Ernakulam	-	23	-	-	-	23
Idukki	-	39	8	-	1	48
Kannur	-	44	-	1	2	47
Kasaragod	-	54	-	-	-	54
Kollam	-	4	2	-	-	6
Kottayam	-	32	-	-	-	32
Kozhikode	-	51	-	-	-	51
Malappuram	-	23	-	-	-	23
Palakkad	-	32	6	-	1	39
Pathanamthitta	-	-	-	-	-	-
Thiruvananthapuram	9	223	5	-	26	263
Thrissur	10	58	2	-	-	70
Wayanad	4	58	6	-	1	69
Unspecified district	8	4	5	-	-	17
Total	**23**	**286**	**16**	**1**	**29**	**355**

districts may also be linked to agricultural intensification, reduced habitat heterogeneity, or limited documentation of aphidophagous fauna.

Overall, the observed district-wise variation emphasises the importance of Kerala's diverse agro-ecological landscapes in shaping aphid-host plant-predator interactions. Highland plantation ecosystems and diversified mixed-cropping regions generally supported richer tri-trophic networks than intensively managed or poorly documented agroecosystems. These findings underscore the need for region-specific ecological surveys and conservation of natural enemy diversity to strengthen sustainable aphid management in Kerala's agroecosystems. This comprehensive synthesis provides a baseline reference to predator diversity, prey specificity, and host-plant linkages of diverse aphid prey species, and is likely to serve as a foundation for ecological research and the formulation of location-specific Integrated Pest Management strategies in Kerala.

I Class: Arachnida

Order: Araneae

The order Araneae comprises spiders, which serve as key ecological regulators by preying primarily on insects and thereby contributing substantially to the natural control

Table 3. Records of number of spider species belonging to different families preying on number of aphid species infesting host plant species and triplets in Kerala.

Families	Species of predators	Number of			
		Species of aphid	Species of host plant	Triplets	Districts
Araneidae	*Araneus bilunifer*	1	1	1	1
	Argiope pulchella	1	1	1	1
	Neoscona mukerjei	2	2	2	1
	Porcataraneus bengalensis	1	1	1	1
Clubionidae	*Clubiona drassodes*	1	1	1	1
Lycosidae	*Pardosa pseudoannulata*	1	2	2	1
Oxyopidae	*Oxyopes birmanicus*	2	2	2	3
	Oxyopes javanus	3	3	3	2
	Oxyopes shweta	2	2	2	2
Salticidae	*Plexippus paykulli*	1	1	1	3
	Ptocasius sp.	1	1	1	3
	Thiania bhamoensis	1	1	1	1
Tetragnathidae	*Tetragnatha mandibulata*	2	2	2	1
	Tetragnatha sp.	1	1	1	1
Theridiidae	*Theridion* sp.	1	1	1	3
Thomisidae	*Thomisus* sp.	1	1	1	1
Total		**5**	**6**	**23**	**4**

of pest populations (Singh *et al*., 2023). Despite their crucial role in maintaining ecosystem stability, spiders have historically received comparatively limited attention as potential agents of biological control relative to insect predators. Recently, Singh *et al*. (2024b) documented 79 species of aphid-associated spiders in India, linked with 53 aphid species occurring on 59 host plant species, underscoring the previously underappreciated diversity and trophic importance of spiders in aphidophagous predator assemblages.

Table 3 summarises the records of aphid-feeding spiders belonging to eight families listing 16 spider species (some identified only to the generic level) recorded preying upon five aphid species and forming 23 distinct predator-aphid-plant associations only in four districts. Among these, the family Araneidae was the most prominent, represented by four species exhibiting predation on one to two aphid species.

The detailed tri-trophic associations of these spiders are presented in Table 4.

Table 4. Documented tri-trophic relationships among spider (order: Araneae) species of different families, aphid prey species, and their associated host plants across various districts of Kerala

Orders/Families/ Species of predators	**Aphid species**	**Plant species**	**Districts**	**References**
1. Family: Araneidae				
Araneus bilunifer Pocock, 1900	*Pentalonia nigronervosa* Coquerel, 1859	*Musa acuminata* Colla	Kerala	Verghese, 2013
Argiope pulchella Thorell, 1881	*Pentalonia nigronervosa* Coquerel, 1859	*Musa acuminata* Colla	Kerala	Verghese, 2013
Neoscona mukerjei Tikader, 1980	*Aphis craccivora* Koch, 1854	*Vigna unguiculata (*L.) Walp.	Thrissur	Manu, 2005
	Aphis gossypii Glover, 1977	*Abelmoschus esculentus* Moench	Thrissur	Manu, 2005
Porcataraneus bengalensis (Tikader, 1975)	*Pentalonia nigronervosa* Coquerel, 1859	*Musa acuminata* Colla	Kerala	Verghese, 2013
2. Family: Clubionidae				
Clubiona drassodes O. Pickard-Cambridge, 1874	*Pentalonia nigronervosa* Coquerel, 1859	*Musa acuminata* Colla	Kerala	Verghese, 2013
3. Family: Lycosidae				
Pardosa pseudoannulata (Bösenberg & Strand, 1906)	*Aphis craccivora* Koch, 1854	*Gliricidia maculata* (Kunth) Steud.	Thiruvananthapuram	Reji Rani, 1995
	Aphis craccivora Koch, 1854	*Vigna unguiculata* (L.) Walp.	Thiruvananthapuram	Reji Rani, 1995
4. Family: Oxyopidae				
Oxyopes birmanicus Thorell, 1887	*Macrosiphum euphorbiae* (Thomas, 1878)	*Gerbera jamesonii* Bolus ex Hooker F.	Thiruvananthapuram, Thrissur, Wayanad	Yasasvi et al., 2025
	Pentalonia nigronervosa Coquerel, 1859	*Musa acuminata* Colla	Kerala	Verghese, 2013

Table 4. Continued

Orders/Families/ Species of predators	Aphid species	Plant species	Districts	References
Oxyopes javanus Thorell, 1887	*Aphis craccivora* Koch, 1854	*Vigna unguiculata (*L.) Walp.	Thrissur	Manu, 2005
	Aphis gossypii Glover, 1977	*Abelmoschus esculentus* Moench	Thrissur	Manu, 2005
	Pentalonia nigronervosa Coquerel, 1859	*Musa acuminata* Colla	Kerala	Verghese, 2013
Oxyopes shweta Tikader, 1970	*Aphis spiraecola* Patch, 1914	*Coccinia grandis* (L.) Voigt	Thiruvananthapuram	Vijayasree, 2006
	Pentalonia nigronervosa Coquerel, 1859	*Musa acuminata* Colla	Kerala	Verghese, 2013
5. Family: Salticidae				
Plexippus paykulli (Audouin, 1826)	*Macrosiphum euphorbiae* (Thomas, 1878)	*Gerbera jamesonii* Bolus ex Hooker F.	Thiruvananthapuram, Thrissur, Wayanad	Yasasvi et al., 2025
Ptocasius sp.	*Macrosiphum euphorbiae* (Thomas, 1878)	*Gerbera jamesonii* Bolus ex Hooker F.	Thiruvananthapuram, Thrissur, Wayanad	Yasasvi et al., 2025
Thiania bhamoensis Thorell, 1887	*Pentalonia nigronervosa* Coquerel, 1859	*Musa acuminata* Colla	Kerala	Verghese, 2013
6. Family: Tetragnathidae				
Tetragnatha mandibulata Walckenaer, 1841	*Aphis craccivora* Koch, 1854	*Vigna unguiculata (*L.) Walp.	Thrissur	Manu, 2005
	Aphis gossypii Glover, 1977	*Abelmoschus esculentus* Moench	Thrissur	Manu, 2005
Tetragnatha sp.	*Aphis spiraecola* Patch, 1914	*Coccinia grandis* (L.) Voigt	Thiruvananthapuram	Vijayasree, 2006
7. Family: Theriidae				
Theridion sp.	*Macrosiphum euphorbiae* (Thomas, 1878)	*Gerbera jamesonii* Bolus ex Hooker F.	Thiruvananthapuram, Thrissur, Wayanad	Yasasvi et al., 2025
8. Family: Thomisidae				
Thomisus sp.	*Aphis spiraecola* Patch, 1914	*Coccinia grandis* (L.) Voigt	Thiruvananthapuram	Vijayasree, 2006

II. Class: Insecta

Order: Coleoptera: Family: Coccinellidae

Across India, 148 species of aphidophagous coccinellids have been documented, associated with 181 aphid species occurring on 350 host plants, forming 3,102 tri-trophic associations across 31 states and union territories (Singh, 2025). This extensive diversity underscores their ecological importance and central role in natural aphid regulation within the country's varied agro-ecosystems.

The family Coccinellidae comprises 44 species collectively preying on 15 aphid species associated with 74 host plants, resulting in 286 distinct predator-aphid-plant associations recorded across 13 districts of the state (Table 5). The highest number of associations has been documented from Thiruvananthapuram (222 triplets), followed by Thrissur and Wayanad (each 58 triplets), Kasaragod (54 triplets), and Kozhikode (51 triplets), while fewer than 50 triplets were noted in the remaining 8 districts (Table 2). Among these, *Cheilomenes sexmaculata* (10 aphid species

Table 5. Records of numbers of coccinellid species preying numbers of aphid species infesting host plant species and triplets in Kerala

Family/Species of predators	Number of			
	Species of aphid	Species of host plant	Triplets	Districts
Adalia bipunctata	1	1	1	2
Anegleis cardoni	1	3	3	5
Brumoides suturalis	2	10	11	7
Cheilomenes sexmaculata	10	45	51	10
Coccinella septempunctata	6	14	14	7
Coccinella transversalis	5	39	46	7
Coelophora bissellata	1	1	1	3
Coelophora saucia	2	2	2	5
Cryptogonus lepidus	1	1	1	3
Cryptogonus orbiculus	3	4	4	5
Harmonia octomaculata	4	9	9	2
Jauravia dorsalis	1	1	1	1
Jauravia opaca	1	1	1	3
Jauravia pallidula	1	1	1	1
Jauravia pubescens	1	1	1	3
Jauravia simplex	1	1	1	3
Jauravia soror	3	3	3	3
Jauravia sp.	1	3	3	4
Micraspis discolor	3	6	6	1

Table 5. Continued

Family/Species of predators	Number of			
	Species of aphid	Species of host plant	Triplets	Districts
Micraspis yasumatsui	1	2	2	1
Micromus igorotus	1	1	1	1
Nephus ancyroides	7	36	40	12
Nephus spp.	2	5	5	1
Phrynocaria perrotteti	1	1	1	1
Propylea dissecta	1	2	2	6
Propylea japonica	1	6	6	1
Pseudaspidimerus flaviceps	2	5	5	1
Pseudaspidimerus trinotata	4	18	18	8
Sasajiscymnus luteus	1	1	1	2
Scymnus castaneus	2	3	3	5
Scymnus coccivora	1	2	2	1
Scymnus latemaculatus	1	1	1	4
Scymnus nr. posticalis	2	3	3	4
Scymnus nubilus	3	4	4	12
Scymnus o-nigrum	2	3	3	1
Scymnus pyrocheilus	5	11	12	12
Scymnus pyrocheilus	1	1	1	2
Scymnus quadrillum	1	1	1	12
Scymnus spp.	4	6	6	12
Sticholotis obscurella	2	4	4	1
Sticholotis sp.	1	1	1	1
Synona rougeti	1	2	2	1
Synonychimorpha chittagongi	1	1	1	4
Telsimia sp.	1	1	1	1
Total	**15**	**74**	**286**	**13**

on 45 host plants), *Nephus ancyroides* (7 aphid species on 36 host plants), *Coccinella septempunctata* (6 aphid species on 14 host plants), and *Coccinella transversalis* (5 aphid species on 39 host plants) are found to be highly polyphagous and widely distributed species, exhibiting broad trophic linkages with multiple aphid-plant. systems.

Aphis craccivora exhibited the highest number of tri-trophic associations (26 triplets), primarily on leguminous crops followed by *Aphis gossypii* (22 triplets), *Aphis aurantii* (13 triplets) and *Pentalonia nigronervosa* (12 triplets). The remaining aphid species were involved in only 1-4 tri-trophic associations each.

Table 6. Documented tri-trophic relationships among coccinellids (Coleoptera: Coccinellidae), aphid prey species, and their associated host plants across various districts of Kerala

Species of ladybird predators	Aphid species	Plant species	Districts	References
Adalia bipunctata (Linnaeus, 1758)	*Pentalonia nigronervosa* Coquerel, 1859	*Musa acuminata* Colla	Kozhikode, Thrissur	Padmalatha & Singh, 1998
Anegleis cardoni (Weise, 1892)	*Aphis craccivora* Koch, 1854	*Chromolaena odorata* (L.) R.M.King & H. Rob.	Kasaragod, Kannur, Kozhikode, Wayanad	Gokul, 2023; Gokul et al., 2024
		Lablab purpureus (L.) Sweet	Thrissur	Jose, 2003
		Vigna unguiculata (L.) Walp.	Kasaragod, Kannur, Kozhikode, Wayanad	Gokul, 2023; Gokul et al., 2024
Brumoides suturalis (Fabricius, 1798)	*Aphis craccivora* Koch, 1854	*Aeschynomene indica* L.	Thiruvananthapuram	Thamilvel, 2009
		Indigofera tinctoria L.	Thiruvananthapuram	Thamilvel, 2009
		Lablab purpureus (L.) Sweet	Thrissur	Jose, 2003
		Psophocarpus tetragonolobus (L.) DC.	Thiruvananthapuram	Thamilvel, 2009
		Vigna unguiculata (L.) Walp.	Thrissur	Sheena, 2003
			Kannur	Thamilvel, 2009
	Aphis gossypii Glover, 1977	*Abelmoschus esculentus* (L.) Moench	Thiruvananthapuram	Thamilvel, 2009
		Capsicum annuum L.	Thiruvananthapuram	Thamilvel, 2009
		Capsicum frutescens L.	Kasaragod	Gokul, 2023; Gokul et al., 2024
		Commelina benghalensis L.	Thiruvananthapuram	Thamilvel, 2009
		Portulaca oleraceae L.	Thiruvananthapuram	Thamilvel, 2009
		Solanum melongena L.	Kasaragod, Kannur, Kozhikode, Wayanad	Gokul, 2023; Gokul et al., 2024
Cheilomenes sexmaculata (Fabricius, 1781)	*Aphis aurantii* Boyer de Fonsc., 1841	*Camellia sinensis* (L.) Kuntze	Idukki, Palakkad, Wayanad	Radhakrishnan & Muraaledharan, 1991; Radhakrishnan et al., 1988

Table 6. Continued

Species of ladybird predators	Aphid species	Plant species	Districts	References
Cheilomenes sexmaculata (Fabricius, 1781)	*Aphis craccivora* Koch, 1854	*Aeschynomene indica* L.	Thiruvananthapuram	Thamilvel, 2009
		Amaranthus tricolor L.	Thiruvananthapuram	Thamilvel, 2009
		Canavalia gladiata (Jack) DC.	Thiruvananthapuram	Thamilvel, 2009
		Crotolaria pallida Aiton	Thiruvananthapuram	Thamilvel, 2009
		Cyamopsis tetragonoloba (L.) Taub.	Thiruvananthapuram	Thamilvel, 2009
		Gliricidia maculata (Kunth) Steud.	Thiruvananthapuram	Reji Rani, 1995
		Indigofera tinctoria L.	Thiruvananthapuram	Thamilvel, 2009
		Lablab purpureus (L.) Sweet	Thiruvananthapuram	Thamilvel, 2009
			Thrissur	Jose, 2003
		Pisum sativum L.	Kerala	Mathew et al., 1971
		Psophocarpus tetragonolobus (L.) DC.	Thiruvananthapuram	Thamilvel, 2009
		Tephrosia purpurea (L.) Pers.	Thiruvananthapuram	Thamilvel, 2009
		*Vigna unguiculata (*L.) Walp.	Kannur	Thamilvel, 2009
			Kasaragod, Kannur, Kozhikode, Wayanad	Gokul, 2023; Gokul et al., 2024
			Kottayam, Thiruvananthapuram, Wayanad	Reji Rani, 1995; Nandakumar & Sheela,1996; Manoj et al., 2024
			Thrissur	Sheena, 2003; Jagdish et al., 2011
Cheilomenes sexmaculata (Fabricius, 1781)	*Aphis gossypii* Glover, 1977	*Abelmoschus esculentus* (L.) Moench	Thiruvananthapuram	Thamilvel, 2009
		Acalypha indica L.	Thiruvananthapuram	Thamilvel, 2009
		Ageratum conyzoides L.	Thiruvananthapuram	Thamilvel, 2009
		Amaranthus tricolor L.	Thiruvananthapuram	Thamilvel, 2009
		Barleria prionitis L.	Thiruvananthapuram	Thamilvel, 2009
		Boerhavia repens L.	Thiruvananthapuram	Thamilvel, 2009
		Capsicum annuum L.	Thiruvananthapuram	Thamilvel, 2009
		Capsicum frutescens L.	Thiruvananthapuram	Thamilvel, 2009
		Cardiospermum halicacabum L.	Thiruvananthapuram	Thamilvel, 2009

Table 6. Continued

Species of ladybird predators	Aphid species	Plant species	Districts	References
Cheilomenes sexmaculata (Fabricius, 1781)	*Aphis gossypii* Glover, 1977	*Catharanthus pusillus* (Murray) G.Don	Thiruvananthapuram	Thamilvel, 2009
		Catharanthus roseus (L.) G.Don	Thiruvananthapuram	Thamilvel, 2009
		Centella asiatica (L.) Urb.	Thiruvananthapuram	Thamilvel, 2009
		Coccinia grandis (L.) Voigt	Thiruvananthapuram	Thamilvel, 2009
		Commelina benghalensis L.	Thiruvananthapuram	Thamilvel, 2009
		Cucumis sativus L.	Thiruvananthapuram	Thamilvel, 2009
		Cyanthillium cinereum (L.) H.Rob.	Thiruvananthapuram	Thamilvel, 2009
		Gloriosa superba L.	Thiruvananthapuram	Thamilvel, 2009
		Momordica charantia L.	Thrissur	Jose, 2003; Thamilvel, 2009
		*Sieruela rutidosperma var. burmanni (*Wight & Arn.) Roalson & J.C.Hall	Thiruvananthapuram	Thamilvel, 2009
		Solanum lycopersicum L.	Thrissur	Jose, 2003; Thamilvel, 2009
		Solanum melongena L.	Kasaragod, Kannur, Kozhikode, Wayanad	Gokul, 2023; Gokul et al., 2024
			Kottayam , Thiruvananthapuram	Thamilvel, 2009; Manoj et al., 2024
		Stachytarpheta jamaicensis (L.) Vahl	Thiruvananthapuram	Thamilvel, 2009
		Trichosanthes cucumerina L.	Thiruvananthapuram	Thamilvel, 2009
	Aphis nerii Boyer de Fonsc., 1841	*Calotropis gigantea* (L.) W.T. Aiton	Thiruvananthapuram	Thamilvel, 2009
		Capsicum annuum L.	Thiruvananthapuram	Thamilvel, 2009
	Aphis spiraecola Patch, 1914	*Coccinia grandis* (L.) Voigt	Thiruvananthapuram	Vijayasree, 2006
	Brevicoryne brassicae (Linnaeus, 1758)	*Brassica oleracea* L. var. *botrytis*	Idukki, Kollam, Thiruvananthapuram,Thrissur	Ravi et al., 2014
	Hysteroneura setariae (Thomas, 1878)	*Amaranthus tricolor* L.	Thiruvananthapuram	Thamilvel, 2009
		Chloris barbata Sw.	Thiruvananthapuram	Thamilvel, 2009
		Dactyloctenium aegyptium (L.) Willd.	Thiruvananthapuram	Thamilvel, 2009
		Digitaria ciliaris (Retz.) Koeler	Thiruvananthapuram	Thamilvel, 2009

Table 6. Continued

Species of ladybird predators	Aphid species	Plant species	Districts	References
Cheilomenes sexmaculata (Fabricius, 1781)	*Lipaphis erysimi* (Kaltenbach, 1843)	*Arivela viscosa* (L.) Raf.	Thiruvananthapuram	Thamilvel, 2009
		Brassica oleracea L. var. *capitata*	Idukki, Kollam, Thiruvananthapuram,Thrissur	Ravi et al., 2014
		Raphanus sativus L.	Thiruvananthapuram	Thamilvel, 2009
	Myzus persicae (Sulzer, 1776)	*Brassica oleracea* L. var. *capitata*	Wayanad	Gokul, 2023; Gokul et al., 2024
		Solanum lycopersicum L.	Thiruvananthapuram	Thamilvel, 2009
		Solanum melongena L.	Kottayam, Thiruvananthapuram, Wayanad	Manoj et al., 2024
		Solanum nigrum L.	Thiruvananthapuram	Thamilvel, 2009
	Pentalonia nigronervosa Coquerel, 1859	*Musa acuminata* Colla	Kozhikode, Thrissur	Padmalatha & Singh, 1998
Coccinella septempunctata Linnaeus, 1758	*Aphis aurantii* Boyer de Fonsc., 1841	*Camellia sinensis* (L.) Kuntze	Idukki, Palakkad, Wayanad	Radhakrishnan & Muraaledharan, 1991
	Aphis craccivora Koch, 1854	*Psophocarpus tetragonolobus* (L.) DC.	Thiruvananthapuram	Thamilvel, 2009
		Vigna unguiculata (L.) Walp.	Thiruvananthapuram	Reji Rani, 1995
	Aphis gossypii Glover, 1977	*Abelmoschus esculentus* (L.) Moench	Thiruvananthapuram	Thamilvel, 2009
		Ageratum conyzoides L.	Thiruvananthapuram	Thamilvel, 2009
		Amaranthus tricolor L.	Thiruvananthapuram	Thamilvel, 2009
		Capsicum annuum L.	Thiruvananthapuram	Thamilvel, 2009
		Chromolaena odorata (L.) R.M.King & H.Rob.	Thiruvananthapuram	Thamilvel, 2009
		Clerodendrum infortunatum L.	Thiruvananthapuram	Thamilvel, 2009
		Coccinia grandis (L.) Voigt	Thiruvananthapuram	Thamilvel, 2009
		Convolvulus arvensis L.	Thrissur, Thiruvananthapuram	Manoj et al., 2024
		Cucumis sativus L.	Thiruvananthapuram	Thamilvel, 2009
	Brevicoryne brassicae (Linnaeus, 1758)	*Brassica oleracea* L. var. *botrytis*	Idukki, Kollam, Thiruvananthapuram,Thrissur	Ravi et al., 2014
	Lipaphis erysimi (Kaltenbach, 1843)	*Brassica oleracea* L. var. *capitata*	Idukki, Kollam, Thiruvananthapuram,Thrissur	Ravi et al., 2014
	Pentalonia nigronervosa Coquerel, 1859	*Musa acuminata* Colla	Kozhikode, Thrissur	Padmalatha & Singh, 1998

Table 6. Continued

Species of ladybird predators	Aphid species	Plant species	Districts	References
Coccinella transversalis Fabricus, 1781	*Aphis craccivora* Koch, 1854	*Aeschynomene indica* L.	Thiruvananthapuram	Thamilvel, 2009
		Amaranthus tricolor L.	Thiruvananthapuram	Thamilvel, 2009
		Canavalia gladiata (Jack) DC.	Thiruvananthapuram	Thamilvel, 2009
		Convolvulus arvensis L.	Kasaragod, Kottayam Thiruvananthapuram	Manoj et al., 2024
		Crotolaria pallida Aiton	Thiruvananthapuram	Thamilvel, 2009
		Cucumis sativus L.	Kasaragod, Kottayam Thiruvananthapuram	Manoj et al., 2024
		Cyamopsis tetragonoloba (L.) Taub.	Thiruvananthapuram	Thamilvel, 2009
		Indigofera tinctoria L.	Thiruvananthapuram	Thamilvel, 2009
		Lablab purpureus (L.) Sweet	Thrissur	Jose, 2003
			Thiruvananthapuram	Thamilvel, 2009
		Manihot esculenta Crantz	Kasaragod, Kottayam Thiruvananthapuram	Manoj et al., 2024
		Psophocarpus tetragonolobus (L.) DC.	Thiruvananthapuram	Thamilvel, 2009
		Senna auriculata (L.) Roxb.	Thiruvananthapuram	Thamilvel, 2009
		Solanum melongena L.	Kasaragod, Kottayam Thiruvananthapuram	Manoj et al., 2024
		Tephrosia purpurea (L.) Pers.	Thiruvananthapuram	Thamilvel, 2009
		Tephrosia tinctoria (L.) Pers.	Thiruvananthapuram	Thamilvel, 2009
		Trianthema portulacastrum L.	Thiruvananthapuram	Thamilvel, 2009
		*Vigna unguiculata (*L.) Walp.	Kasaragod, Kannur, Kozhikode, Wayanad	Gokul, 2023; Gokul et al., 2024
			Kottayam Thiruvananthapuram	Manoj et al., 2024
			Thrissur	Sheena, 2003
	Aphis gossypii Glover, 1977	*Abelmoschus esculentus* (L.) Moench	Kasaragod, Kozhikode	Gokul, 2023; Gokul et al., 2024
		Amaranthus tricolor L.	Thiruvananthapuram	Thamilvel, 2009
		Capsicum annuum L.	Thiruvananthapuram	Thamilvel, 2009
		Capsicum frutescens L.	Kasaragod	Gokul, 2023; Gokul et al., 2024

Table 6. Continued

Species of ladybird predators	Aphid species	Plant species	Districts	References
Coccinella transversalis Fabricus, 1781	*Aphis gossypii* Glover, 1977	*Catharanthus pusillus* (Murray) G.Don	Thiruvananthapuram	Thamilvel, 2009
		Catharanthus roseus (L.) G.Don	Thiruvananthapuram	Thamilvel, 2009
		Centella asiatica (L.) Urb.	Thiruvananthapuram	Thamilvel, 2009
		Coccinia grandis (L.) Voigt	Thiruvananthapuram	Thamilvel, 2009
		Commelina benghalensis L.	Thiruvananthapuram	Thamilvel, 2009
		Cucumis sativus L.	Thiruvananthapuram	Thamilvel, 2009
		Momordica charantia L.	Kasaragod, Kannur, Kozhikode, Wayanad	Gokul, 2023; Gokul et al., 2024
			Thrissur	Jose, 2003
		Moringa oleifera Lam	Thiruvananthapuram	Thamilvel, 2009
		Psophocarpus tetragonolobus (L.) DC.	Thiruvananthapuram	Thamilvel, 2009
		Sieruela rutidosperma var. burmanni (Wight & Arn.) Roalson & J.C.Hall	Thiruvananthapuram	Thamilvel, 2009
		Solanum lycopersicum L.	Thiruvananthapuram	Thamilvel, 2009
		Solanum melongena L.	Kasaragod, Kannur, Kozhikode, Wayanad	Gokul, 2023; Gokul et al., 2024
		Trichosanthes cucumerina L.	Thiruvananthapuram	Thamilvel, 2009
		Tridax procumbens L.	Thiruvananthapuram	Thamilvel, 2009
	Aphis spiraecola Patch, 1914	*Allmania nodiflora* (L.) R.Br. ex Wight	Thiruvananthapuram	Thamilvel, 2009
		Coccinia grandis (L.) Voigt	Thiruvananthapuram	Thamilvel, 2009
		Cucumis sativus L.	Thiruvananthapuram	Thamilvel, 2009
	Hysteroneura setariae (Thomas, 1878)	*Amaranthus tricolor* L.	Thiruvananthapuram	Thamilvel, 2009
		Chloris barbata Sw	Thiruvananthapuram	Thamilvel, 2009
		Dactyloctenium aegyptium (L.) Willd.	Thiruvananthapuram	Thamilvel, 2009
		Digitaria ciliaris (Retz.) Koeler	Thiruvananthapuram	Thamilvel, 2009
Coccinella transversalis Fabricus, 1781	*Hysteroneura setariae* (Thomas, 1878)	*Echinochloa colonum* (L.) Link	Thiruvananthapuram	Thamilvel, 2009
		Eleusine indica (L.) Gaertn.	Thiruvananthapuram	Thamilvel, 2009
	Lipaphis erysimi (Kaltenbach, 1843)	*Arivela viscosa* (L.) Raf.	Thiruvananthapuram	Thamilvel, 2009
		Raphanus sativus L.	Thiruvananthapuram	Thamilvel, 2009

Table 6. Continued

Species of ladybird predators	Aphid species	Plant species	Districts	References
Coelophora bissellata Mulsant, 1850	*Aphis aurantii* Boyer de Fonsc., 1841	*Camellia sinensis* (L.) Kuntze	Idukki, Palakkad, Wayanad	Radhakrishnan & Muraaledharan, 1991
Coelophora saucia (Mulsant, 1850)	*Aphis aurantii* Boyer de Fonsc., 1841	*Camellia sinensis* (L.) Kuntze	Idukki, Wayanad	Radhakrishnan et al., 1988
	Aphis craccivora Koch, 1854	*Vigna unguiculata (*L.) Walp.	Kasaragod, Kannur, Kozhikode, Wayanad	Gokul, 2023; Gokul et al., 2024
Cryptogonus lepidus (Weise, 1885	*Aphis aurantii* Boyer de Fonsc., 1841	*Camellia sinensis* (L.) Kuntze	Idukki, Palakkad, Wayanad	Radhakrishnan & Muraleedharan, 1995
Cryptogonus orbiculus (Gyllenhal, 1808)	*Aphis aurantii* Boyer de Fonsc., 1841	*Camellia sinensis* (L.) Kuntze	Idukki, Wayanad	Radhakrishnan et al., 1988
	Aphis craccivora Koch, 1854	*Lablab purpureus (*L.) Sweet	Thrissur	Jose, 2003
	Aphis gossypii Glover, 1977	*Abelmoschus esculentus* (L.) Moench	Thiruvananthapuram	Thamilvel, 2009
		Capsicum annuum L.	Thiruvananthapuram	Thamilvel, 2009
Harmonia octomaculata (Fabricius, 1781)	*Aphis craccivora* Koch, 1854	*Lablab purpureus (*L.) Sweet	Thrissur	Jose, 2003
		Psophocarpus tetragonolobus (L.) DC.	Thiruvananthapuram	Thamilvel, 2009
		Vigna unguiculata (L.) Walp.	Thiruvananthapuram	Thamilvel, 2009
	Aphis gossypii Glover, 1977	*Abelmoschus esculentus* (L.) Moench	Thiruvananthapuram	Thamilvel, 2009
		Amaranthus tricolor L.	Thiruvananthapuram	Thamilvel, 2009
		Capsicum annuum L.	Thiruvananthapuram	Thamilvel, 2009
	Aphis nerii Boyer de Fonsc., 1841	*Calotropis gigantea* (L.) W.T. Aiton	Thiruvananthapuram	Thamilvel, 2009
		Capsicum annuum L.	Thiruvananthapuram	Thamilvel, 2009
	Aphis spiraecola Patch, 1914	*Chromolaena odorata* (L.) R.M.King & H.Rob.	Thiruvananthapuram	Thamilvel, 2009
		Moringa oleifera Lam	Thiruvananthapuram	Thamilvel, 2009
Jauravia dorsalis (Weise, 1908)	*Aphis gossypii* Glover, 1977	*Coccinia* sp.	Thrissur	Jose, 2003
Jauravia opaca (Weise, 1900	*Aphis aurantii* Boyer de Fonsc., 1841	*Camellia sinensis* (L.) Kuntze	Idukki, Palakkad, Wayanad	Radhakrishnan & Muraleedharan, 1986
Jauravia pallidula Motschulsky, 1858	*Aphis gossypii* Glover, 1977	*Coccinia* sp.	Thrissur	Jose, 2003

Table 6. Continued

Species of ladybird predators	Aphid species	Plant species	Districts	References
Jauravia pubescens	*Aphis aurantii* Boyer de Fonsc., 1841	*Camellia sinensis* (L.) Kuntze	Idukki, Palakkad, Wayanad	Radhakrishnan et al., 1988; Radhakrishnan & Muraaledharan, 1991
Jauravia simplex (Walker, 1859	*Aphis aurantii* Boyer de Fonsc., 1841	*Camellia sinensis* (L.) Kuntze	Idukki, Palakkad, Wayanad	Radhakrishnan & Muraleedharan, 1986
Jauravia soror (Weise, 1892	*Aphis aurantii* Boyer de Fonsc., 1841	*Camellia sinensis* (L.) Kuntze	Idukki, Palakkad, Wayanad	Radhakrishnan & Muraleedharan, 1986
	Aphis craccivora Koch, 1854	*Lablab purpureus (*L.) Sweet	Thrissur	Jose, 2003
		Vigna unguiculata (L.) Walp.	Thrissur	Sheena, 2003
	Pentalonia nigronervosa Coquerel, 1859	*Musa acuminata* Colla	Kerala	Verghese, 2013
Jauravia sp.	*Aphis craccivora* Koch, 1854	*Luffa acutangula* (L.) Roxb.	Kasaragod	Gokul, 2023; Gokul et al., 2024
		Psidium guajava L.	Kasaragod, Kannur, Kozhikode, Wayanad	Gokul, 2023; Gokul et al., 2024
		*Vigna unguiculata (*L.) Walp.	Kasaragod, Kannur, Kozhikode, Wayanad	Gokul, 2023; Gokul et al., 2024
Micraspis discolor (Fabricius, 1798)	*Aphis craccivora* Koch, 1854	*Psophocarpus tetragonolobus* (L.) DC.	Thiruvananthapuram	Thamilvel, 2009
		Vigna unguiculata (L.) Walp.	Thiruvananthapuram	Thamilvel, 2009
	Aphis gossypii Glover, 1977	*Abelmoschus esculentus* (L.) Moench	Thiruvananthapuram	Thamilvel, 2009
		Amaranthus tricolor L.	Thiruvananthapuram	Thamilvel, 2009
		Capsicum annuum L.	Thiruvananthapuram	Thamilvel, 2009
	Hysteroneura setariae (Thomas, 1878)	*Dactyloctenium aegyptium* (L.) Willd.	Thiruvananthapuram	Thamilvel, 2009
Micraspis yasumatsui Sasaji, 1968 (m.i.)	*Aphis craccivora* Koch, 1854	*Gliricidia maculata* (Kunth) Steud.	Thiruvananthapuram	Reji Rani, 1995
		Vigna unguiculata (L.) Walp.	Thiruvananthapuram	Reji Rani, 1995
Micromus igorotus Banks, 1920	*Ceratovacuna lanigera* Zehntner, 1897	*Saccharum robustum* E.W.Brandes & Jeswiet ex Grassl	Kannur	Srikanth et al., 2021

Table 6. Continued

Species of ladybird predators	Aphid species	Plant species	Districts	References
Nephus ancyroides Pang & Pu, 1988	*Aphis craccivora* Koch, 1854	*Amaranthus tricolor* L.	Thiruvananthapuram	Thamilvel, 2009
		Canavalia gladiata (Jack) DC.	Thiruvananthapuram	Thamilvel, 2009
		Cyamopsis tetragonoloba (L.) Taub.	Thiruvananthapuram	Thamilvel, 2009
		Gliricidia maculata (Kunth) Steud.	Alappuzha, Ernakulam, Idukki, Kannur, Kasaragod, Kottayam, Kozhikode, Malappuram, Palakkad, Thiruvananthapuram, Thrissur, Wayanad	Vidya & Bhaskar, 2017
		Lablab purpureus (L.) Sweet	Thrissur	Jose, 2003; Thamilvel, 2009
		Moringa oleifera Lam.	Thiruvananthapuram	Thamilvel, 2009
		Phaseolus vulgaris L.	Thiruvananthapuram	Thamilvel, 2009
	Aphis fabae Scopoli, 1763	*Psophocarpus tetragonolobus* (L.) DC.	Thiruvananthapuram	Thamilvel, 2009
	Aphis gossypii Glover, 1977	*Tephrosia purpurea* (L.) Pers.	Thiruvananthapuram	Thamilvel, 2009
		Trianthema portulacastrum L.	Thiruvananthapuram	Thamilvel, 2009
		Vigna unguiculata (L.) Walp.	Alappuzha, Ernakulam, Idukki, Kannur, Kasaragod, Kottayam, Kozhikode, Malappuram, Palakkad, Thiruvananthapuram, Thrissur, Wayanad	Vidya & Bhaskar, 2017
		Psophocarpus tetragonolobus (L.) DC.	Thiruvananthapuram	Thamilvel, 2009
		Abelmoschus esculentus (L.) Moench	Thiruvananthapuram	Thamilvel, 2009
		Ageratum conyzoides L.	Thiruvananthapuram	Thamilvel, 2009
		Capsicum annuum L.	Thiruvananthapuram	Thamilvel, 2009
		Capsicum frutescens L.	Alappuzha, Ernakulam, Idukki, Kannur, Kasaragod, Kottayam, Kozhikode, Malappuram, Palakkad, Thiruvananthapuram, Thrissur, Wayanad	Vidya & Bhaskar, 2017
		Coccinia grandis (L.) Voigt	Thiruvananthapuram	Thamilvel, 2009

Table 6. Continued

Species of ladybird predators	Aphid species	Plant species	Districts	References
Nephus ancyroides Pang & Pu, 1988	*Aphis gossypii* Glover, 1977	*Colocasia* sp.	Alappuzha, Ernakulam, Idukki, Kannur, Kasaragod, Kottayam, Kozhikode, Malappuram, Palakkad, Thiruvananthapuram, Thrissur, Wayanad	Vidya & Bhaskar, 2017
		Cucumis sativus L.	Thiruvananthapuram	Thamilvel, 2009
		Eupatorium sp.	Alappuzha, Ernakulam, Idukki, Kannur, Kasaragod, Kottayam, Kozhikode, Malappuram, Palakkad, Thiruvananthapuram, Thrissur, Wayanad	Vidya & Bhaskar, 2017
		Gloriosa superba L.	Thiruvananthapuram	Thamilvel, 2009
		Hibiscus sp.	Alappuzha, Ernakulam, Idukki, Kannur, Kasaragod, Kottayam, Kozhikode, Malappuram, Palakkad, Thiruvananthapuram, Thrissur, Wayanad	Vidya & Bhaskar, 2017
		Momordica charantia L.	Thiruvananthapuram	Thamilvel, 2009
		Psidium guajava L.	Alappuzha, Ernakulam, Idukki, Kannur, Kasaragod, Kottayam, Kozhikode, Malappuram, Palakkad, Thiruvananthapuram, Thrissur, Wayanad	Vidya & Bhaskar, 2017
		Ruellia tuberosa L.	Thiruvananthapuram	Thamilvel, 2009
		Solanum lycopersicum L.	Thiruvananthapuram	Thamilvel, 2009
		Solanum melongena L.	Alappuzha, Ernakulam, Idukki, Kannur, Kasaragod, Kottayam, Kozhikode, Malappuram, Palakkad, Thiruvananthapuram, Thrissur, Wayanad	Vidya & Bhaskar, 2017
		Trichosanthes cucumerina L.	Thiruvananthapuram	Thamilvel, 2009

Table 6. Continued

Species of ladybird predators	Aphid species	Plant species	Districts	References
Nephus ancyroides Pang & Pu, 1988	*Aphis gossypii* Glover, 1977	*Tridax procumbens* L.	Thiruvananthapuram	Thamilvel, 2009
		Vemonia cinerea (Linn.) Less	Thiruvananthapuram	Thamilvel, 2009
		*Vigna unguiculata (*L.) Walp.	Alappuzha, Ernakulam, Idukki, Kannur, Kasaragod, Kottayam, Kozhikode, Malappuram, Palakkad, Thiruvananthapuram, Thrissur, Wayanad	Vidya & Bhaskar, 2017
		Withania somnifera (L.) Dunal.	Thiruvananthapuram	Thamilvel, 2009
	Aphis spiraecola Patch, 1914	*Chromolaena odorata* (L.) R.M.King & H.Rob.	Thiruvananthapuram	Thamilvel, 2009
		Clerodendrum infortunatum L.	Thiruvananthapuram	Thamilvel, 2009
	Hysteroneura setariae (Thomas, 1878)	*Eleusine indica* (L.) Gaertn.	Thiruvananthapuram	Thamilvel, 2009
		Megathyrsus maximus (Jacq.) B.K.Simon & S.W.L.Jacobs	Thiruvananthapuram	Thamilvel, 2009
	Myzus persicae (Sulzer, 1776)	*Solanum lycopersicum* L.	Thiruvananthapuram	Thamilvel, 2009
		Solanum nigrum L.	Thiruvananthapuram	Thamilvel, 2009
	Pentalonia nigronervosa Coquerel, 1859	*Musa acuminata* Colla	Alappuzha, Ernakulam, Idukki, Kannur, Kasaragod, Kottayam, Kozhikode, Malappuram, Palakkad, Thiruvananthapuram, Thrissur, Wayanad	Vidya & Bhaskar, 2017
Nephus sp.	*Aphis craccivora* Koch, 1854	*Psophocarpus tetragonolobus* (L.) DC.	Thiruvananthapuram	Thamilvel, 2009
		Vigna unguiculata (L.) Walp.	Thiruvananthapuram	Thamilvel, 2009

Table 6. Continued

Species of ladybird predators	Aphid species	Plant species	Districts	References
Nephus sp.	*Aphis gossypii* Glover, 1977	*Abelmoschus esculentus* (L.) Moench	Thiruvananthapuram	Thamilvel, 2009
		Amaranthus tricolor L.	Thiruvananthapuram	Thamilvel, 2009
		Capsicum annuum L.	Thiruvananthapuram	Thamilvel, 2009
Phrynocaria perrotteti (Mulsant, 1850)	*Aphis gossypii* Glover, 1977	*Capsicum annuum* L.	Thiruvananthapuram	Thamilvel, 2009
Propylea dissecta (Mulsant, 1850)	*Aphis craccivora* Koch, 1854	*Abelmoschus esculentus* (L.) Moench	Kasaragod, Kozhikode	Gokul, 2023; Gokul et al., 2024
			Kottayam, Thiruvananthapuram	Manoj et al., 2024
		*Vigna unguiculata (*L.) Walp.	Kasaragod, Kannur, Kozhikode, Wayanad	Gokul, 2023; Gokul et al., 2024
Propylea japonica (Thunberg, 1781)	*Aphis gossypii* Glover, 1977	*Abelmoschus esculentus* (L.) Moench	Thiruvananthapuram	Thamilvel, 2009
		Amaranthus tricolor L.	Thiruvananthapuram	Thamilvel, 2009
		Capsicum annuum L.	Thiruvananthapuram	Thamilvel, 2009
		Coccinia grandis (L.) Voigt	Thiruvananthapuram	Thamilvel, 2009
		Cucumis sativus L.	Thiruvananthapuram	Thamilvel, 2009
		Solanum melongena L.	Thiruvananthapuram	Thamilvel, 2009
Pseudaspidimerus flaviceps (Walker, 1859)	*Aphis craccivora* Koch, 1854	*Psophocarpus tetragonolobus* (L.) DC.	Thiruvananthapuram	Thamilvel, 2009
		Vigna unguiculata (L.) Walp.	Thiruvananthapuram	Thamilvel, 2009
	Aphis gossypii Glover, 1977	*Abelmoschus esculentus* (L.) Moench	Thiruvananthapuram	Thamilvel, 2009
		Capsicum annuum L.	Thiruvananthapuram	Thamilvel, 2009
		Coccinia grandis (L.) Voigt	Thiruvananthapuram	Thamilvel, 2009

Table 6. Continued

Species of ladybird predators	Aphid species	Plant species	Districts	References
Pseudaspidimerus trinotata (Thunberg, 1781)	*Aphis aurantii* Boyer de Fonsc., 1841	*Camellia sinensis* (L.) Kuntze	Idukki, Palakkad, Wayanad	Radhakrishnan & Muraaledharan, 1991
	Aphis craccivora Koch, 1854	*Amaranthus tricolor* L.	Thiruvananthapuram	Thamilvel, 2009
		Canavalia gladiata (Jack) DC.	Thiruvananthapuram	Thamilvel, 2009
		Chromolaena odorata (L.) R.M.King & H.Rob.	Kasaragod, Kannur, Kozhikode, Wayanad	Gokul, 2023; Gokul et al., 2024
		Cyamopsis tetragonoloba (L.) Taub.	Thiruvananthapuram	Thamilvel, 2009
		Gliricidia sepium (Jacq.) Kunth	Kasaragod	Gokul, 2023; Gokul et al., 2024
		Lablab purpureus (L.) Sweet	Thrissur	Jose, 2003; Thamilvel, 2009
		Moringa oleifera Lam	Thiruvananthapuram	Thamilvel, 2009
		Phaseolus vulgaris L.	Thiruvananthapuram	Thamilvel, 2009
		Psidium guajava L.	Kasaragod, Kannur, Kozhikode, Wayanad	Gokul, 2023; Gokul et al., 2024
		Psophocarpus tetragonolobus (L.) DC.	Thiruvananthapuram	Thamilvel, 2009
		Vigna unguiculata (L.) Walp.	Kasaragod, Kannur, Kozhikode, Wayanad	Gokul, 2023; Gokul et al., 2024
			Thiruvananthapuram	Thamilvel, 2009
	Aphis gossypii Glover, 1977	*Abelmoschus esculentus* (L.) Moench	Thiruvananthapuram	Thamilvel, 2009
		Capsicum annuum L.	Thiruvananthapuram	Thamilvel, 2009
		Coccinia grandis (L.) Voigt	Thiruvananthapuram	Thamilvel, 2009
		Coccinia sp.	Thrissur	Jose, 2003
		Momordica charantia L.	Thrissur	Jose, 2003
	Pentalonia nigronervosa Coquerel, 1859	*Musa acuminata* Colla	Kozhikode, Thrissur	Padmalatha & Singh, 1998
Sasajiscymnus luteus (Sicard, 1929)	*Pentalonia nigronervosa* Coquerel, 1859	*Musa acuminata* Colla	Kozhikode, Thrissur	Padmalatha & Singh, 1998
Scymnus pyrocheilus Mulsant, 1853	*Pentalonia nigronervosa* Coquerel, 1859	*Musa acuminata* Colla	Kozhikode, Thrissur	Padmalatha & Singh, 1998

Table 6. Continued

Species of ladybird predators	Aphid species	Plant species	Districts	References
Scymnus castaneus Sicard, 1929	*Aphis craccivora* Koch, 1854	*Psophocarpus tetragonolobus* (L.) DC.	Thiruvananthapuram	Thamilvel, 2009
		Vigna unguiculata (L.) Walp.	Kasaragod, Kannur, Kozhikode, Wayanad	Gokul, 2023; Gokul et al., 2024
			Thiruvananthapuram	Thamilvel, 2009
	Aphis gossypii Glover, 1977	*Capsicum frutescens* L.	Kasaragod	Gokul, 2023; Gokul et al., 2024
Scymnus coccivora Ayyar, 1925	*Aphis craccivora* Koch, 1854	*Psophocarpus tetragonolobus* (L.) DC.	Thiruvananthapuram	Thamilvel, 2009
		Vigna unguiculata (L.) Walp.	Thiruvananthapuram	Thamilvel, 2009
Scymnus latemaculatus Motschulsky, 1858	*Aphis craccivora* Koch, 1854	*Chromolaena odorata* (L.) R.M.King & H.Rob.	Kasaragod, Kannur, Kozhikode, Wayanad	Gokul, 2023; Gokul et al., 2024
Scymnus nr. *posticalis* Sicard, 1913 ?	*Aphis aurantii* Boyer de Fonsc., 1841	*Camellia sinensis* (L.) Kuntze	Wayanad	Gokul, 2023; Gokul et al., 2024
	Aphis craccivora Koch, 1854	*Capsicum frutescens* L.	Kasaragod	Gokul, 2023; Gokul et al., 2024
		Chromolaena odorata (L.) R.M.King & H.Rob.	Kasaragod, Kannur, Kozhikode, Wayanad	Gokul, 2023; Gokul et al., 2024
Scymnus nubilus Mulsant, 1850	*Aphis craccivora* Koch, 1854	*Gliricidia maculata* (Kunth) Steud.	Alappuzha, Ernakulam, Idukki, Kannur, Kasaragod, Kottayam, Kozhikode, Malappuram, Palakkad, Thiruvananthapuram, Thrissur, Wayanad	Vidya & Bhaskar, 2017
		Lablab purpureus (L.) Sweet	Thrissur	Jose, 2003
	Pentalonia nigronervosa Coquerel, 1859	*Musa acuminata* Colla	Thiruvananthapuram	Johnson, 1972
	Rhopalosiphum maidis (Fitch, 1856)	*Zea mays* L.	Alappuzha, Ernakulam, Idukki, Kannur, Kasaragod, Kottayam, Kozhikode, Malappuram, Palakkad, Thiruvananthapuram, Thrissur, Wayanad	Vidya & Bhaskar, 2017

Table 6. Continued

Species of ladybird predators	Aphid species	Plant species	Districts	References
Scymnus o-nigrum Mulsant, 1853	*Aphis craccivora* Koch, 1854	*Psophocarpus tetragonolobus* (L.) DC.	Thiruvananthapuram	Thamilvel, 2009
		Vigna unguiculata (L.) Walp.	Thiruvananthapuram	Thamilvel, 2009
	Aphis fabae Scopoli, 1763	*Psophocarpus tetragonolobus* (L.) DC.	Thiruvananthapuram	Thamilvel, 2009
Scymnus pyrocheilus Mulsant, 1853	*Aphis aurantii* Boyer de Fonsc., 1841	*Camellia sinensis* (L.) Kuntze	Idukki, Wayanad	Radhakrishnan et al., 1988
	Aphis craccivora Koch, 1854	*Gliricidia maculata* (Kunth) Steud.	Alappuzha, Ernakulam, Idukki, Kannur, Kasaragod, Kottayam, Kozhikode, Malappuram, Palakkad, Thiruvananthapuram, Thrissur, Wayanad	Vidya & Bhaskar, 2017
		Vigna unguiculata (L.) Walp.	Alappuzha, Ernakulam, Idukki, Kannur, Kasaragod, Kottayam, Kozhikode, Malappuram, Palakkad, Thiruvananthapuram, Thrissur, Wayanad	Vidya & Bhaskar, 2017
	Aphis gossypii Glover, 1977	*Eupatorium* sp.	Alappuzha, Ernakulam, Idukki, Kannur, Kasaragod, Kottayam, Kozhikode, Malappuram, Palakkad, Thiruvananthapuram, Thrissur, Wayanad	Vidya & Bhaskar, 2017
		Hibiscus sp.	Alappuzha, Ernakulam, Idukki, Kannur, Kasaragod, Kottayam, Kozhikode, Malappuram, Palakkad, Thiruvananthapuram, Thrissur, Wayanad	Vidya & Bhaskar, 2017
		Mikania sp.	Alappuzha, Ernakulam, Idukki, Kannur, Kasaragod, Kottayam, Kozhikode, Malappuram, Palakkad, Thiruvananthapuram, Thrissur, Wayanad	Vidya & Bhaskar, 2017
		Momordica charantia L.	Thrissur	Jose, 2003

Table 6. Continued

Species of ladybird predators	Aphid species	Plant species	Districts	References
Scymnus pyrocheilus Mulsant, 1853	*Aphis gossypii* Glover, 1977	*Psidium guajava* L.	Alappuzha, Ernakulam, Idukki, Kannur, Kasaragod, Kottayam, Kozhikode, Malappuram, Palakkad, Thiruvananthapuram, Thrissur, Wayanad	Vidya & Bhaskar, 2017
		Solanum melongena L.	Alappuzha, Ernakulam, Idukki, Kannur, Kasaragod, Kottayam, Kozhikode, Malappuram, Palakkad, Thiruvananthapuram, Thrissur, Wayanad	Vidya & Bhaskar, 2017
		*Vigna unguiculata (*L.) Walp.	Alappuzha, Ernakulam, Idukki, Kannur, Kasaragod, Kottayam, Kozhikode, Malappuram, Palakkad, Thiruvananthapuram, Thrissur, Wayanad	Vidya & Bhaskar, 2017
	Aphis odinae (van der Goot, 1917)	*Annona squamosa* L.	Alappuzha, Ernakulam, Idukki, Kannur, Kasaragod, Kottayam, Kozhikode, Malappuram, Palakkad, Thiruvananthapuram, Thrissur, Wayanad	Vidya & Bhaskar, 2017
	Pentalonia nigronervosa Coquerel, 1859	*Musa acuminata* Colla	Kerala	Verghese, 2013
Scymnus quadrillum Motschulsky, 1858	*Pentalonia nigronervosa* Coquerel, 1859	*Musa acuminata* Colla	Kozhikode, Thrissur	Padmalatha & Singh, 1998
Scymnus sp.	*Aphis craccivora* Koch, 1854	*Gliricidia maculata* (Kunth) Steud.	Thiruvananthapuram	Reji Rani, 1995
		Vigna unguiculata (L.) Walp.	Thiruvananthapuram	Reji Rani, 1995
	Aphis gossypii Glover, 1977	*Capsicum frutescens* L.	Alappuzha, Ernakulam, Idukki, Kannur, Kasaragod, Kottayam, Kozhikode, Malappuram, Palakkad, Thiruvananthapuram, Thrissur, Wayanad	Vidya & Bhaskar, 2017
	Pentalonia nigronervosa Coquerel, 1859	*Musa × paradisiaca* **L.**	Thrissur	NBAII, 2013
		Musa acuminata Colla	Kerala	Verghese, 2013

Table 6. Continued

Species of ladybird predators	Aphid species	Plant species	Districts	References
Scymnus sp.	*Rhopalosiphum maidis* (Fitch, 1856)	*Zea mays* L.	Alappuzha, Ernakulam, Idukki, Kannur, Kasaragod, Kottayam, Kozhikode, Malappuram, Palakkad, Thiruvananthapuram, Thrissur, Wayanad	Vidya & Bhaskar, 2017
Sticholotis obscurella Weise, 1908	*Aphis craccivora* Koch, 1854	*Psophocarpus tetragonolobus* (L.) DC.	Thiruvananthapuram	Thamilvel, 2009
	Aphis gossypii Glover, 1977	*Abelmoschus esculentus* (L.) Moench	Thiruvananthapuram	Thamilvel, 2009
		Capsicum annuum L.	Thiruvananthapuram	Thamilvel, 2009
		Solanum melongena L.	Thiruvananthapuram	Thamilvel, 2009
Sticholotis sp.	*Aphis gossypii* Glover, 1977	*Capsicum annuum* L.	Thiruvananthapuram	Thamilvel, 2009
Synona rougeti (Mulsant, 1866)	*Aphis gossypii* Glover, 1977	*Capsicum annuum* L.	Thiruvananthapuram	Thamilvel, 2009
		Solanum melongena L.	Thiruvananthapuram	Thamilvel, 2009
Synonychimorpha chittagongi (Vazirani, 1983)	*Greenidea psidii* van der Goot, 1917	*Psidium guajava* L.	Kasaragod, Kannur, Kozhikode, Wayanad	Gokul, 2023; Gokul et al., 2024
Telsimia sp.	*Aphis gossypii* Glover, 1977	*Capsicum annuum* L.	Thiruvananthapuram	Thamilvel, 2009

The following is the detailed account of tri-trophic associations of aphidophagous ladybirds across different districts of in Kerala (Table 6).

Order: Diptera, Family: Syrphidae

The family Syrphidae, commonly known as hover flies, plays a dual ecological role as both pollinators and natural

Table 7. Records of numbers of hover fly species preying number of aphid species infesting host plant species and triplets in Kerala

Species of predators	Number of			
	Species of aphid	Species of host plant	Triplets	Districts
Asiobaccha nubilipennis	1	1	1	3
Betasyrphus serarius	2	2	2	3
Dideopsis aegrota	1	1	1	3
Episyrphus balteatus	1	1	1	3
Ischiodon scutellaris	4	4	5	6
Paragus serratus	2	2	2	2
Paragus tibialis	4	2	4	4
Total	**8**	**5**	**16**	**6**

enemies of insect pests, with their larvae primarily preying upon aphids. This combination of services significantly enhances crop productivity while reducing dependence on chemical pesticides (Li *et al*., 2023). In India, 49 syrphid species representing 17 genera have been documented as confirmed aphid predators, feeding on 94 aphid species associated with 149 host plants, resulting in 1,025 recorded predator-aphid-plant associations across 27 states and union territories (Singh, 2026).

The data presented in Table 7 show that the family Syrphidae in Kerala is represented by seven species reported to prey on eight aphid species associated with five host

Table 8. Documented tri-trophic relationships among hover flies (Diptera: Syrphidae), aphid prey species, and their associated host plants across various districts of Kerala

Species of hover flies predators	Aphid species	Plant species	Districts	References
Asiobaccha nubilipennis (Austen, 1893)	*Aphis aurantii* Boyer de Fonsc., 1841	*Camellia sinensis* (L.) Kuntze	Idukki, Palakkad, Wayanad	Radhakrishnan & Muraaledharan, 1991
Betasyrphus serarius (Wiedemann, 1830)	*Aphis aurantii* Boyer de Fonsc., 1841	*Camellia sinensis* (L.) Kuntze	Idukki, Palakkad, Wayanad	Radhakrishnan & Muraaledharan, 1991
	Aphis spiraecola Patch, 1914	Unknown plant	Kerala	Rao, 1969
Dideopsis aegrota (Fabricius, 1805)	*Aphis aurantii* Boyer de Fonsc., 1841	*Camellia sinensis* (L.) Kuntze	Idukki, Palakkad, Wayanad	Radhakrishnan & Muraaledharan, 1991
Episyrphus balteatus (De Geer, 1776)	*Aphis aurantii* Boyer de Fonsc., 1841	*Camellia sinensis* (L.) Kuntze	Idukki, Palakkad, Wayanad	Radhakrishnan & Muraaledharan, 1991
Ischiodon scutellaris (Fabricius, 1805)	*Aphis aurantii* Boyer de Fonsc., 1841	*Camellia sinensis* (L.) Kuntze	Idukki, Palakkad, Wayanad	Radhakrishnan & Muraaledharan, 1991
	Aphis craccivora Koch, 1854	*Gliricidia maculata* (Kunth) Steud.	Thiruvananthapuram	Reji Rani, 1995
		Vigna unguiculata (L.) Walp.	Thiruvananthapuram	Reji Rani, 1995
	Brevicoryne brassicae (Linnaeus, 1758)	*Brassica oleracea* L. var. *botrytis*	Idukki, Kollam, Thiruvananthapuram,Thrissur	Ravi et al., 2014
	Lipaphis erysimi (Kaltenbach, 1843)	*Brassica oleracea* L. var. *botrytis*	Idukki, Kollam, Thiruvananthapuram,Thrissur	Ravi et al., 2014
Paragus serratus (Fabricius, 1805)	*Aphis gossypii* Glover, 1977	Unknown plant	Kerala	Rao, 1969
	Aphis spiraecola Patch, 1914	*Coccinia grandis* (L.) Voigt	Thiruvananthapuram	Vijayasree, 2006
Paragus tibialis (Fallén, 1817)	*Aphis aurantii* Boyer de Fonsc., 1841	*Camellia sinensis* (L.) Kuntze	Idukki, Palakkad, Wayanad	Radhakrishnan & Muraaledharan, 1991
	Aphis spiraecola Patch, 1914	Unknown plant	Kerala	Rao, 1969
	Melanaphis sacchari (Zehntner, 1897)	Unknown plant	Kerala	Rao, 1969
	Rhopalosiphum maidis (Fitch, 1856)	Unknown plant	Kerala	Rao, 1969

plants, forming 16 distinct predator-aphid-plant associations distributed across six of the state's fourteen districts.

Tri-trophic associations of aphidophagous hover flies across different districts of Kerala are presented in Table 8.

Order: Lepidoptera, Family: Pyralidae

Aphidophagy within the family Pyralidae is relatively rare, as the majority of pyralid moths are herbivorous or detritivorous. The most notable example is *Dipha aphidivora* Meyrick, 1934 (Galleriinae), whose caterpillar actively preys on the sugarcane woolly aphid, *Ceratovacuna lanigera* Zehntner, 1897, a major pest reported from sugarcane across several Indian states (Srikanth *et al*., 2015). This predator was documented to feed on *Ceratovacuna lanigera* in sugarcane fields in Kannur district of Kerala (Srikanth *et al*., 2021).

Order: Neuroptera

The order Neuroptera consists of insects comprising lacewings, mantidflies, and antlions, which are globally distributed and primarily predatory in nature. Among these, the green lacewings (Chrysopidae) and brown lacewings (Hemerobiidae) are particularly significant, serving as key biological control agents that substantially contribute to pest population regulation in cropping systems (Devetak & Klokočovnik, 2016).

In India, 32 species of lacewings have been documented as aphidophagous predators, represented by 24 species under 11 genera of the family Chrysopidae and 6 species under 2 genera of the family Hemerobiidae. Collectively, these lacewings prey upon 68 aphid species belonging to 37 genera, associated with 107 host plant species (Singh *et al*., 2024a). Table 9 presents records of five lacewing species preying upon five aphid species infesting 17 host plant species, resulting in 29 documented predator-aphid-plant associations in Kerala.

Family: Chrysopidae

In Kerala, only two species of aphid-feeding green lacewings have been recorded, associated with two aphid species on seven host plants, forming 12 tri-trophic associations (Table 9). These species primarily prey on *Aphis craccivora* infesting cowpea and gerbera, and *Aphis gossypii* occurring on brinjal, chilli, and okra. The detailed tri-trophic associations of Chrysopidae in Kerala are presented.

Family: Hemerobiidae

In Kerala, only two species, *Micromus igorotus* and *Micromus timidus*, have been recorded, each preying on a single aphid species.

Table 9. Records of numbers of lacewing species belonging to different families preying aphid species infesting host plant species and triplets in Kerala

Families	Species of predators	Number of			
		Species of aphid	Species of host plant	Triplets	Districts
Chrysopidae	*Ankylopteryx octopunctata*	2	5	5	1
	Chrysoperla zastrowi sillemi	2	7	7	1
Sub total		2	7	12	1
Hemerobiidae	*Micromus igorotus*	1	1	1	1
	Micromus timidus	1	1	1	3
	Micromus spp.	4	15	16	5
Sub total		5	16	17	6
Total		**5**	**17**	**29**	**6**

Table 10. Documented tri-trophic relationships among lacewings, aphid prey species, and their associated host plants across various districts of Kerala

Species of lacewings predators	Aphid species	Plant species	Districts	References
Family: Chrysopidae				
Ankylopteryx octopunctata (Fabricius, 1793)	*Aphis craccivora* Koch, 1854	*Psophocarpus tetragonolobus* (L.) DC.	Thiruvananthapuram	Thamilvel, 2009
		Vigna unguiculata (L.) Walp.	Thiruvananthapuram	Thamilvel, 2009
	Aphis gossypii Glover, 1977	*Abelmoschus esculentus* (L.) Moench	Thiruvananthapuram	Thamilvel, 2009
		Capsicum annuum L.	Thiruvananthapuram	Thamilvel, 2009
		Solanum melongena L.	Thiruvananthapuram	Thamilvel, 2009
Chrysoperla zastrowi sillemi (Esben-Petersen, 1935)	*Aphis craccivora* Koch, 1854	*Psophocarpus tetragonolobus* (L.) DC.	Thiruvananthapuram	Thamilvel, 2009
		Vigna unguiculata (L.) Walp.	Thiruvananthapuram	Thamilvel, 2009
	Aphis gossypii Glover, 1977	*Abelmoschus esculentus* (L.) Moench	Thiruvananthapuram	Thamilvel, 2009
		Capsicum annuum L.	Thiruvananthapuram	Thamilvel, 2009
		Catharanthus roseus (L.) G. Don	Thiruvananthapuram	Thamilvel, 2009
		Momordica charantia L.	Thiruvananthapuram	Thamilvel, 2009
		Solanum melongena L.	Thiruvananthapuram	Thamilvel, 2009
Family: Hemerobiidae				
Micromus igorotus Banks, 1920	*Ceratovacuna lanigera* Zehntner, 1897	*Saccharum robustum* E.W.Brandes & Jeswiet ex Grassl	Kannur	Srikanth et al., 2021
Micromus timidus Hagen, 1853	*Aphis aurantii* Boyer de Fonsc., 1841	*Camellia sinensis* (L.) Kuntze	Idukki, Palakkad, Wayanad	Radhakrishnan & Muraaledharan, 1991

Table 10. Continued

Species of lacewings predators	Aphid species	Plant species	Districts	References
Micromus sp.	*Aphis craccivora* Koch, 1854	*Moringa oleifera* Lam.	Thiruvananthapuram	Thamilvel, 2009
		Psophocarpus tetragonolobus (L.) DC.	Thiruvananthapuram	Thamilvel, 2009
		Vigna unguiculata (L.) Walp.	Thiruvananthapuram	Thamilvel, 2009
	Aphis gossypii Glover, 1977	*Abelmoschus esculentus* (L.) Moench	Thiruvananthapuram	Thamilvel, 2009
		Ageratum conyzoides L.	Thiruvananthapuram	Thamilvel, 2009
		Amaranthus tricolor L.	Thiruvananthapuram	Thamilvel, 2009
		Capsicum annuum L.	Thiruvananthapuram	Thamilvel, 2009
		Coccinia grandis (L.) Voigt	Thiruvananthapuram	Thamilvel, 2009
		Momordica charantia L.	Thiruvananthapuram	Thamilvel, 2009
		Solanum melongena L.	Thiruvananthapuram	Thamilvel, 2009
		Trichosanthes cucumerina L.	Thiruvananthapuram	Thamilvel, 2009
	Aphis spiraecola Patch, 1914	*Chromolaena odorata* (L.)	Thiruvananthapuram	Thamilvel, 2009
		Clerodendrum infortunatum L.	Thiruvananthapuram	Thamilvel, 2009
		Coccinia grandis (L.) Voigt	Thiruvananthapuram	Thamilvel, 2009
	Ceratovacuna lanigera Zehntner, 1897	*Saccharum officinarum* L.	Kannur	Srikanth et al., 2021

Tri-trophic associations of aphidophagous lacewings across different districts of Kerala are presented in Table 10.

CONCLUSIONS

The study highlights the structural and functional diversity of aphidophagous predators in Kerala across a range of agroecosystems. With 73 predator species forming 355 tri-trophic associations, the findings reveal a rich network of biological control agents of plant-sap-sucking aphids. The dominance of generalists within Coccinellidae underscores their adaptability and ecological importance in pest suppression. Overall, the results provide a foundational understanding of predator-aphid-plant interactions in the

region and emphasise the significance of conserving native predator communities. Integrating these findings into pest management frameworks can contribute to the long-term sustainability of Kerala's agricultural landscapes.

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AUTHOR CONTRIBUTION

Prof. Rajendra Singh is a distinguished researcher in entomology, aphidology, arachnology, and insect ecology, with significant contributions to the study of aphids, aphidophages, and spider diversity in India. His work on host–parasitoid interactions, tri-trophic associations, biodiversity, and biological control has provided valuable insights for sustainable pest management and biodiversity assessment, while also strengthening zoological and entomological research at Deen Dayal Upadhyay Gorakhpur University, Gorakhpur. Dr. Anuradha Shukla is an Assistant Professor in zoology, with contributions to aphid-associated arthropods, tri-trophic interactions, freshwater ecology, and aquatic toxicology. Her research has enhanced ecological understanding, biodiversity assessment, and zoological education. All authors have read and agreed to the published version of the manuscript.