Entomology

A catalogue of tri-trophic associations of aphidophagous arthropods in Gujarat, India

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Abstract

The checklist documents 140 predator-aphid-host plant tritrophic associations in Gujarat, involving 43 aphidophagous arthropod species linked to 15 aphid species on 33 host plants across 14 districts. Spiders (Araneae) were represented by 20 species from 10 families, while Coccinellidae (Coleoptera) was the most diverse and dominant insect group, with 13 species accounting for 91 associations. *Cheilomenes sexmaculata* showed the broadest ecological range (14 aphid species on 29 host plants), followed by *Coccinella septempunctata* and *Coccinella transversalis* (seven aphid species each), whereas most other coccinellids exhibited narrow host ranges. Dipteran predators were scarce, represented by *Leucopis auraria* (Chamaemyiidae) and two syrphids (*Eupeodes confrater* and *Ischiodon scutellaris*), together forming nine associations with six aphid species on eight host plants. Chrysopidae (Neuroptera) comprised four species associated with nine aphid species on 14 host plants, yielding 16 associations, with *Chrysoperla zastrowi sillemi* being the most prevalent. Predators were most frequently associated with *Aphis craccivora* and *Aphis gossypii*, while *Gossypium hirsutum* supported the highest predator diversity. Overall, the dataset underscores the predominant role of coccinellids and spiders in aphid suppression within Gujarat's agroecosystems. However, the limited representation of dipteran and neuropteran predators, coupled with uneven district-level coverage, reveals substantial gaps in current knowledge and emphasises the need for more comprehensive, systematic surveys across the state.

Keywords: Aphid, Biological control, Checklist, Hover flies, Lacewings, Ladybirds, Predator, Spiders, Tri-trophic associations

Introduction

Aphids (Hemiptera: Aphididae) are small, soft-bodied phloem-feeding insects that infest a wide array of cultivated and wild plants worldwide [1]. They rank among the most economically significant agricultural pests, causing direct damage through nutrient depletion, reduced plant vigour, stunted growth, and leaf, stem, and fruit deformation. Indirectly, aphids act as vectors of plant viruses, excrete honeydew that fosters sooty mould growth, and attract secondary pests, thereby amplifying crop losses [2]. Globally, aphid infestations can lead to substantial yield reductions in cereals, legumes, vegetables, cotton, and fruit crops, translating into considerable economic impact. Their population dynamics are influenced by both biotic and abiotic factors, with aphidophagous predators playing a key role in natural population regulation [3]. These predators suppress aphid outbreaks not only by consuming individuals across all life stages but also by altering aphid behaviour and distribution.

Arthropod predators of aphids comprise a taxonomically diverse guild across multiple insect orders and arachnids, including Coleoptera (Coccinellidae) [4], Neuroptera (Chrysopidae, Hemerobiidae) [5], Diptera (Syrphidae) [6], predatory Hemiptera [7], and spiders (Araneae) [8]. Among these, ladybird beetles (Coccinellidae) are particularly important, with both larvae and adults preying on a broad spectrum of aphid species. Hover flies (Syrphidae) are ecologically significant for their dual role, with larvae as voracious aphid predators and adults as effective pollinators. Similarly, lacewings, including green (Chrysopidae) and brown (Hemerobiidae) species, are recognized for their larval predation on aphids, while predatory bugs also contribute substantially to aphid suppression.

Understanding the complexity of interactions among predators, aphids, and host plants requires a tritrophic perspective. Tri-trophic associations, the linked relationships between predator species, aphid prey, and their host plants, are essential for elucidating the structure and function of agroecosystem food webs, identifying key natural enemies, and determining which predator species are most effective against particular aphid pests in specific crop systems [9]. Such comprehensive datasets provide baseline information for ecological research, biodiversity assessments, and region-specific integrated pest management planning [10]. For example, regional compilations of aphidophagous predators, their aphid prey, and host plants have been used to map spatial patterns of biocontrol potential and to inform sustainable pest management frameworks in various Indian states.

Predators aid in the regulation of aphid pests, allow the reduction or elimination of pesticides, and therefore play an important role in agricultural ecosystems [11]. However, the role of biodiversity among predators in determining the efficacy of pest suppression is controversial [12]. In particular, the relative

roles of species richness and species composition in determining pest control, and how these cascade across trophic levels to influence crop growth, remain unclear [13]. Natural enemy composition rather than richness determines pest suppression [14]. Although the ecological roles of aphidophagous predators are well documented globally [15], regional studies on predator diversity, prey-predator associations, and seasonal dynamics are limited for many Indian states [16]. Localised documentation is critical for identifying key predator taxa, understanding community structure, and integrating these natural enemies into region-specific integrated pest management programs. Furthermore, knowledge of host-prey associations supports mass-rearing and augmentative biocontrol of economically important predators [17]. By linking biodiversity conservation with sustainable pest management, comprehensive tri-trophic documentation strengthens the ecological basis for biological control [18].

The present study compiles a detailed checklist of tri-trophic associations among aphidophagous arthropods, their aphid prey, and host plants in Gujarat, India. This compilation provides baseline data on species diversity, distribution, and host specificity, serving as a valuable resource for ecological research, biodiversity assessment, and the development of informed and sustainable pest management strategies.

Material and Methods

The present checklist of tritrophic associations involving aphidophagous arthropods in Gujarat was compiled from recently published books, peer-reviewed journals, validated theses, and credible online databases available up to 31 January 2026. Much of the earlier literature, including some recent contributions, contains taxonomic inconsistencies in predator, aphid, and host-plant nomenclature, reflecting rapid advances in systematics and the limited adoption of updated classifications. As research on predator-prey interactions continues to expand, new records and taxonomic revisions are generated regularly. To ensure taxonomic accuracy and uniformity, aphid nomenclature was standardised using the Aphid Species File (https://Aphid.SpeciesFile.org), host-plant names followed World Flora Online (https://www.worldfloraonline.org), and arthropod taxonomy was aligned with the Global Biodiversity Information Facility (https://www.gbif.org).

Results & Discussion

The analysis of tritrophic associations in Gujarat records 43 species of aphidophagous predators from multiple insect and arachnid orders, associated with 15 aphid species infesting 33 host plants. These interactions encompass 140 distinct predator-aphid-host plant linkages distributed across various districts of the state. The predator assemblage comprises a single arachnid order, Araneae, represented by ten spider families (Araneidae, Cheiracanthiidae, Clubionidae, Corinnidae, Lycosidae, Oxyopidae, Salticidae, Theridiidae, Thomisidae, and Uloboridae), and four insect orders: Coleoptera (Coccinellidae), Diptera (Chamaemyiidae and Syrphidae), and Neuroptera (Chrysopidae) (Table 1).

Arachnid predators in Gujarat were represented by 20 species across 10 families. Among insects, Coccinellidae (Coleoptera) emerged as the most diverse and dominant group, with 13 species linked to 15 aphid species on 29 host plants, accounting for the highest number of associations (91 triplets). Dipteran predators showed relatively low diversity, represented by only three species, whereas Chrysopidae (Neuroptera) comprised four species. Collectively, these findings emphasise the key role of coccinellids and spiders in aphid suppression and highlight the ecological importance of aphidophagous predators in natural pest regulation across Gujarat's agroecosystems.

Although the documented tri-trophic associations in Gujarat encompass multiple ecological guilds, they display a comparatively lower level of taxonomic diversity than those reported from several northern Indian states and union territories, such as Uttar Pradesh (1,098 triplets involving 70 predator species [18], Uttarakhand (760 triplets and 135 predator species [19], Jammu & Kashmir (716 triplets and 71 predator species [20], West Bengal (612 triplets and 125 predator species [21], and Himachal Pradesh (358 triplets and 74 predator species [22]. Indeed, in Gujarat, studies on aphidophagy remain very limited, with tri-trophic interactions documented in only 14 of the 33 districts, revealing substantial gaps in regional knowledge. The greatest number of predator-aphid-plant associations was recorded from Anand (83 triplets), followed by Banaskantha (27 triplets), Kheda (16 triplets), and Junagarh (15 triplets). In contrast, fewer than 15 associations were documented from the remaining districts, while 19 districts currently lack any records of aphidophagy, particularly, southeast and the southwest regions (Figure 1). This apparent disparity is not necessarily indicative of genuinely lower predator diversity in Gujarat, but rather reflects limitations in existing research. Faunistic surveys within the state have been sporadic and geographically uneven, and have largely concentrated on major agricultural crops, leaving large areas, natural habitats, and non-crop host plants poorly explored. Consequently, the current dataset likely underrepresents the true diversity and complexity of aphid-predator-host plant associations in Gujarat.

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 Gujarat

Class/Order/Family of the aphidophagous predators	Number of				
	Predator species	Aphid species	Plant species	Triplets	Districts
Class: Arachnida					
Araneae: 10 families	20	3	5	22	10
Class: Insecta					
Coleoptera: Coccinellidae	13	15	29	91	9
Diptera: Chamaemyiidae	1	1	1	1	1
Diptera: Syrphidae	2	6	8	10	3
Total Diptera	3	6	8	11	3
Neuroptera: Chrysopidae	4	9	14	16	7
Total predators	43	15	33	140	14

In Gujarat, the majority of aphidophagous predators were associated with *Aphis craccivora* (25 predator species, 45 triplets) recorded on cowpea, faba bean, groundnut, hyacinth bean, and pigeon pea. This was followed by *Aphis gossypii*, with 16 predator species forming 33 predator-aphid-plant triplets on crops such as brinjal, coriander, cumin, okra, and cotton. The remaining aphid species supported between 1 and 5 predator species across a range of cultivated and wild host plants (Table 2).

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

Aphid species	Number of			
	Predator species	Host plant species	Triplets	Districts
1. *Acyrthosiphon pisum*	2	1	2	1
2. *Aphis craccivora*	25	9	45	13
3. *Aphis gossypii*	16	8	33	5
4. *Aphis nerii*	3	2	4	2
5. *Brevicoryne brassicae*	4	1	4	2
6. *Hyadaphis coriandri*	5	4	10	3
7. *Lipaphis erysimi*	5	3	10	4
8. *Lipaphis pseudobrassicae*	1	1	1	1
9. *Myzus persicae*	5	3	7	2
10. *Rhopalosiphum maidis*	2	3	4	2
11. *Schoutedenia emblica*	5	1	5	1
12. *Sitobion alopecuri*	1	2	2	1
13. *Sitobion miscanthi*	1	1	1	1
14. *Therioaphis trifolii*	1	1	1	1
15. *Uroleucon compositae*	4	3	4	1
Total	43	15	140	14

Among the host plants, *Gossypium hirsutum* harboured the greatest diversity of predators, with 27 species, mainly associated with *Aphis gossypii*. This was followed by *Brassica oleracea* var. *capitata*, which supported nine predator species, largely preying on *Brevicoryne brassicae* and *Lipaphis erysimi*. *Arachis hypogaea*, *Brassica juncea*, and *Vigna unguiculata* each hosted seven predator species. The remaining host plants supported between one and six predator species across various aphid taxa.

In Gujarat, studies on aphidophagy remain very limited, with tri-trophic interactions documented in only 14 of the 33 districts, revealing substantial gaps in regional knowledge. The greatest number of predator-aphid-plant associations was recorded from Anand (83 triplets), followed by Banaskantha (27 triplets), Kheda (16 triplets), and Junagarh (15 triplets). In contrast, fewer than 15 associations were documented from the remaining districts, while 19 districts currently lack any records of aphidophagy, particularly, the southeast and southwest regions (Figure 1).

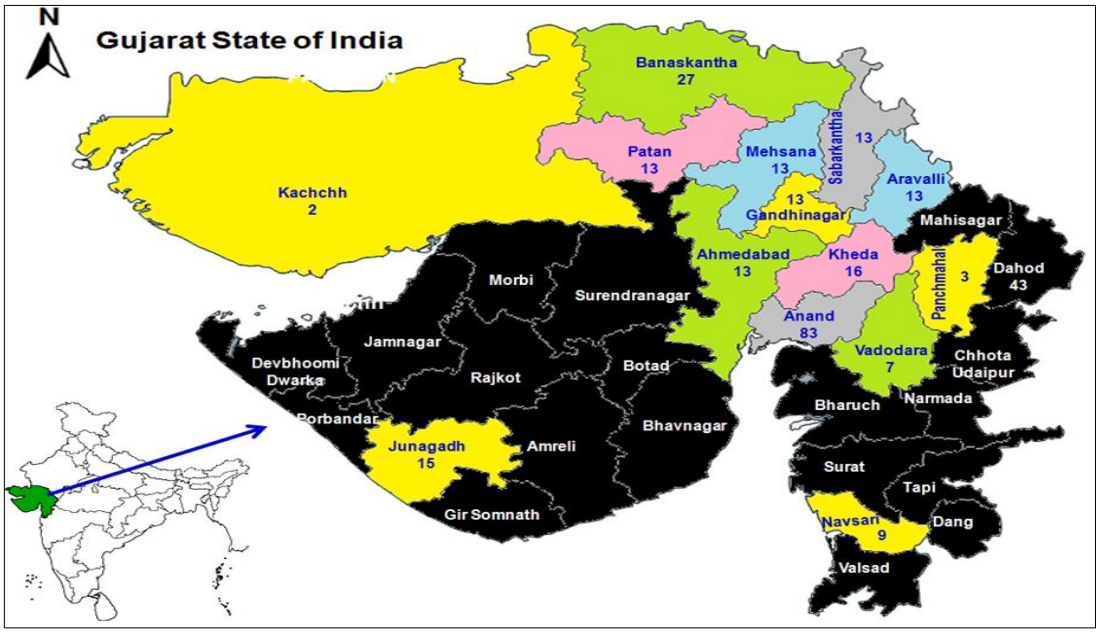

Fig 1: Number of tri-trophic associations (triplets) of aphidophagous arthropod predators in different districts of Gujarat. No record is available in black shaded districts

Overall, the diversity and assemblage of aphidophagous predators in Gujarat indicate a complex and functionally integrated trophic network within the state's agroecosystems. The predominance of spiders and coccinellids underscores their central role in natural aphid regulation, while the occurrence of other predator groups reflects a multi-guild community structure. This consolidated dataset provides a robust baseline on regional predator diversity, prey associations, and host-plant linkages, thereby supporting ecological studies, biodiversity assessments, and the formulation of region-specific integrated pest management strategies.

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

I. Class: Arachnida: Order Araneae

The order Araneae comprises spiders, which act as important natural enemies by preying mainly on insects and thereby contributing to population regulation and ecosystem stability [23]. Although their role as biological control agents has received relatively little attention compared with insect predators, recent work documented 79 species of aphidophagous spiders in India, associated with 53 aphid species on 59 host plants, highlighting their significant yet underappreciated contribution to aphid suppression [8].

Table 3 summarises records of araneid (spider) predators from 10 families attacking aphids on a few host plants in Gujarat. A total of 20 spider species were reported, forming 22 predator-aphid-host plant associations involving just three aphid species in 10 districts of Gujarat. Each spider family was represented by 1-4 species. Predation was recorded on aphids infesting 5 host plants and was largely centred on *Aphis craccivora* on cotton. Overall, the available records indicate a narrow prey range and limited documented associations of spiders as aphid predators in Karnataka. Nevertheless, these findings highlight their potential role in aphid regulation and emphasise the need for broader, systematic surveys across diverse regions and cropping systems in the state.

Table 3: Number of species of araneid arachnid (spiders) predators belonging to different families preying on different number of aphid species infesting different number of host plant species and triplets in Gujarat

Families	Species of predators	Number of			
		Species of aphid	Species of host plant	Triplets	Districts
Araneidae	1. *Argiope* sp.	1	1	1	1
	2. *Neoscona theisi*	1	3	3	1
	3. *Neoscona* sp.	1	1	1	1
Cheiracanthiidae	4. *Cheiracanthium melanostomum*	1	1	1	8
Clubionidae	5. *Clubiona filicata*	1	1	1	8
Corinnidae	6. *Castianeira* sp.	1	1	1	1
Lycosidae	7. *Lycosa poonaensis*	1	1	1	8
	8. *Lycosa tista*	1	1	1	8
	9. *Pardosa birmanica*	1	1	1	8
	10. *Pardosa sumatrana*	1	1	1	8
Oxyopidae	11. *Oxyopes chittrae*	1	1	1	8
	12. *Oxyopes shweta*	1	1	1	8
	13. *Oxyopes* sp.	1	1	1	1
	14. *Peucetia* sp.	1	1	1	1
Salticidae	15. *Plexippus paykulli*	1	1	1	8
	16. *Telamonia dimidiata*	1	1	1	8
Theridiidae	17. *Theridion manjithar*	1	1	1	8
Thomisidae	18. *Thomisus pugilis*	1	1	1	8
	19. *Xysticus croceus*	1	1	1	8
Uloboridae	20. *Uloborus khasiensis*	1	1	1	1
Total		3	5	22	10

A detail account of tri-trophic associations of aphidophagous spiders are listed familywise below:

A. Class: Arachnida, Order: Araneae

a. Family: Araneidae

i) *Argiope* sp.

• *Schoutedenia emblica* (Patel & Kulkarni, 1952)

- *Phyllanthus emblica* L. - Anand [24]

ii) *Neoscona theisi* (Walckenaer, 1841)

• *Aphis gossypii* Glover, 1977

- *Gossipium barbadense* L. - Nagpur [25]

- *Gossypium herbaceum* L. - Nagpur [25]

- *Gossypium hirsutum* - Nagpur [25]

iii.) *Neoscona* sp.

• *Schoutedenia emblica* (Patel & Kulkarni, 1952)

- *Phyllanthus emblica* L. - Anand [24]

b. Family: Cheiracanthiidae

i) *Cheiracanthium melanostomum* (Thorell, 1895)

• *Aphis craccivora* Koch, 1854

- *Gossypium hirsutum* L. - Ahmedabad, Aravalli, Banaskantha, Gandhinagar, Kheda, Mehsana, Patan, Sabarkantha [26]

c. Family: Clubionidae

i) *Clubiona filicata* O. Pickard -Cambridge, 1874

• *Aphis craccivora* Koch, 1854

- *Gossypium hirsutum* L. - Ahmedabad, Aravalli, Banaskantha, Gandhinagar, Kheda, Mehsana, Patan, Sabarkantha [26]

d. Family: Corinnidae

i) *Castianeira* sp.

• *Aphis gossypii* Glover, 1977

- *Gossypium hirsutum* L. - Anand [27]

e. Family: Lycosidae

i) *Lycosa poonaensis* Tikader & Malhotra, 1980

• *Aphis craccivora* Koch, 1854

- *Gossypium hirsutum* L. - Ahmedabad, Aravalli, Banaskantha, Gandhinagar, Kheda, Mehsana, Patan, Sabarkantha [26]

ii) *Lycosa tista* Tikader, 1970

• *Aphis craccivora* Koch, 1854

- *Gossypium hirsutum* L. - Ahmedabad, Aravalli, Banaskantha, Gandhinagar, Kheda, Mehsana, Patan, Sabarkantha [26]

iii) *Pardosa birmanica* Simon, 1884

• *Aphis craccivora* Koch, 1854

- *Gossypium hirsutum* L. - Ahmedabad, Aravalli, Banaskantha, Gandhinagar, Kheda, Mehsana, Patan, Sabarkantha [26]

iv) *Pardosa sumatrana* (Thorell, 1890)

• *Aphis craccivora* Koch, 1854

- *Gossypium hirsutum* L. - Ahmedabad, Aravalli, Banaskantha, Gandhinagar, Kheda, Mehsana, Patan, Sabarkantha [26]

f. Family: Oxyopidae

i) *Oxyopes chittrae* Tikader, 1965

• *Aphis craccivora* Koch, 1854

- *Gossypium hirsutum* L. - Ahmedabad, Aravalli, Banaskantha, Gandhinagar, Kheda, Mehsana, Patan, Sabarkantha [26]

ii) *Oxyopes shweta* Tikader, 1970

• *Aphis craccivora* Koch, 1854

- *Gossypium hirsutum* L. - Ahmedabad, Aravalli, Banaskantha, Gandhinagar, Kheda, Mehsana, Patan, Sabarkantha [26]

iii) *Oxyopes* sp.

• *Schoutedenia emblica* (Patel & Kulkarni, 1952)

- *Phyllanthus emblica L.* - Anand [24]

iv) *Peucetia* sp.

• *Schoutedenia emblica* (Patel & Kulkarni, 1952)

- *Phyllanthus emblica* L. - Anand [24]

g. Family: Salticidae

i) *Plexippus paykulli* (Audouin, 1826)

• *Aphis craccivora* Koch, 1854

- *Gossypium hirsutum* L. - Ahmedabad, Aravalli, Banaskantha, Gandhinagar, Kheda, Mehsana, Patan, Sabarkantha [26]

ii) *Telamonia dimidiata* (Simon, 1899)

• *Aphis craccivora* Koch, 1854

- *Gossypium hirsutum* L. - Ahmedabad, Aravalli, Banaskantha, Gandhinagar, Kheda, Mehsana, Patan, Sabarkantha [26]

h. Family: Theridiidae

i) *Theridion manjithar* Tikader, 1970

• *Aphis craccivora* Koch, 1854

- *Gossypium hirsutum* L. - Ahmedabad, Aravalli, Banaskantha, Gandhinagar, Kheda, Mehsana, Patan, Sabarkantha [26]

i. Family: Thomisidae

i) *Thomisus pugilis* Stoliczka, 1869

• *Aphis craccivora* Koch, 1854

- *Gossypium hirsutum* L. - Ahmedabad, Aravalli, Banaskantha, Gandhinagar, Kheda, Mehsana, Patan, Sabarkantha [26]

ii) *Xysticus croceus* Fox, 1937

• *Aphis craccivora* Koch, 1854

- *Gossypium hirsutum* L. - Ahmedabad, Aravalli, Banaskantha, Gandhinagar, Kheda, Mehsana, Patan, Sabarkantha [26]

j. Family: Uloboridae

i) *Uloborus khasiensis* Tikader, 1969

• *Aphis gossypii* Glover, 1977

- *Gossypium hirsutum* L. - Anand [27]

B. Class: Insecta

I. Order: Coleoptera, Family: Coccinellidae

Agarwala & Ghosh [28] first reported 36 aphidophagous coccinellid species in India, along with their prey records and general distribution. Building on this foundation, Singh [4] enlisted 148 ladybird beetle species associated with 181 aphid species on 350 host plants, resulting in 3,102 tritrophic associations in India.

In Gujarat, the family Coccinellidae is represented by only 13 species associated with 15 aphid species on 29 host plants, forming 91 documented tritrophic linkages (Table 4). These records highlight the prominent role of coccinellids in aphid suppression and their importance in biological control, owing to their high predatory efficiency, broad prey range and adaptability across major crop systems. Within Coccinellidae, *Cheilomenes sexmaculata* was the most polyphagous species, recorded on 14 aphid species infesting 29 host plants, followed by *Coccinella septempunctata* and *Coccinella transversalis*, each associated with seven aphid species on 29 and 16 host plants, respectively (Table 4). These taxa show extensive aphid-host plant linkages across the state, indicating broad prey spectra, high ecological plasticity and functional versatility, whereas other coccinellid species were restricted to associations with only one to three aphid species.

Table 4: Number of species of coleopteran predators preying on different number of aphid species infesting different number of host plant species and triplets in Gujarat

Family/Species of predators	Number of			
	Species of aphid	Species of host plant	Triplets	Districts
1. *Anegleis cardoni*	1	2	2	1
2. *Brumoides suturalis*	1	1	1	1
3. *Cheilomenes sexmaculata*	14	29	35	6
4. *Coccinella septempunctata*	7	16	22	7
5. *Coccinella transversalis*	7	12	13	4
6. *Harmonia axyridis*	1	1	1	1
7. *Harmonia octomaculata*	3	5	5	3
8. *Hippodamia variegata*	3	4	4	2
9. *Nephus ancyroides*	1	1	1	1
10. *Pharoscymnus flexibilis*	1	1	1	1
11. *Propylea dissecta*	2	4	4	1
12. *Propylea sp.*	1	1	1	1
13. *Scymnus coccivora*	1	1	1	1
Total	15	29	91	9

In Gujarat, aphidophagous coccinellids were most frequently associated with *Aphis craccivora* and *Aphis gossypii*, accounting for 26 and 24 tritrophic associations, respectively. *Aphis craccivora* occurred mainly on leguminous crops such as cowpea, faba bean, groundnut, hyacinth bean and pigeon pea, whereas *Aphis gossypii* was commonly recorded on coriander, cotton and okra. Other commonly encountered aphids included *Hyadaphis coriandri* (8 associations, largely on fennel) and *Lipaphis erysimi* (8 associations on brassica crops). The remaining aphid species each formed fewer than ten tritrophic associations and were distributed across a wide range of cultivated and wild host plants.

The detailed account of tri-trophic associations of ladybird beetles is given below:

1. *Anegleis cardoni* (Weise, 1892

• *Aphis craccivora* Koch, 1854
- *Vigna unguiculata* (L.) Walp. - Vadodara [29]
- *Phaseolus vulgaris* L. - Vadodara [29]

2. *Brumoides suturalis* (Fabricius, 1798)

• *Aphis gossypii* Glover, 1977
- *Gossypium hirsutum* L. - Anand [30]

3. *Cheilomenes sexmaculata* (Fabricius, 1781)

• *Aphis craccivora* Koch, 1854
- *Arachis hypogaea* L. - Anand [31], Junagarh [32]
- *Cajanus cajan* (L.) Millsp. - Panchmahal [33]
- *Lablab purpureus* (L.) Sweet - Banaskantha [34], Navsari [35]
- *Vigna mungo* (L.) Hepper - Anand [30]
- *Vigna unguiculata* (L.) Walp. - Anand [36], Navsari [37]

• *Aphis gossypii* Glover, 1977
- *Abelmoschus esculentus* (L.) Moench - Anand [30]
- *Anethum graveolens* L. - Anand [38]
- *Coriandrum sativum* L. - Anand [38]
- *Cuminum cyminum* L. - Junagarh [39]
- *Gossipium barbadense* L. Nagpur [25]
- *Gossypium herbaceum* L. - Anand [40], Nagpur [25]
- *Gossypium hirsutum* - Anand [36], Banaskantha [34], Nagpur [25]
- *Trachyspermum ammi* Sprague - Anand [38]

• *Aphis nerii* Boyer de Fonsc., 1841
- *Calotropis procera* (Aiton) Dryand. - Banaskantha [34]
- *Leptadenia reticulata* (Retz.) Wight and Arn. - Anand [30]

• *Brevicoryne brassicae* (Linnaeus, 1758)
- *Brassica oleracea* L. var. *capitata* - Anand [30], Banaskantha [34]

• *Hyadaphis coriandri* (Das, 1918)
- *Foeniculum vulgare* Mill. - Banaskantha [34], Junagarh [41, 42]
- *Trachyspermum ammi* Sprague - Anand [38]

• *Lipaphis erysimi* (Kaltenbach, 1843)
- *Brassica juncia* L. - Banaskantha [34], Anand [43]
- *Brassica oleracea* L. var. *capitata* - Anand [30]
- *Brassica rapa* L. - Anand [30]

• *Lipaphis pseudobrassicae*
- *Brassica juncea* - Anand [36]

• *Myzus persicae* (Sulzer, 1776)
- *Brassica oleracea* L. var. *capitata* - Anand [30]
- *Brassica rapa* L. - Anand [30]

• *Rhopalosiphum maidis* (Fitch, 1856)
- *Cenchrus americanus* (L.) Morrone - Anand [30]
- *Cenchrus purpureus* (Schumach.) Morrone Schumach. - Anand [30]
- *Sorghum bicolor* (L.) Moench - Anand [30]
- *Zea mays* L. - Anand [30], Banaskantha [44]

• *Schoutedenia emblica* (Patel & Kulkarni, 1952)
- *Phyllanthus emblica* L. - Anand [24]

• *Sitobion alopecuri* (Takahashi, 1921)
- *Hordeum vulgare* L. - Anand [30]
- *Triticum aestivum* L. - Anand [30]

• *Sitobion miscanthi* (Takahashi, 1921)
- *Triticum aestivum* L. - Anand [45]

• *Therioaphis trifolii* (Monell, 1882)
- *Medicago sativa* L. - Banaskantha [34]

• *Uroleucon compositae* (Theobald, 1915)
- *Guizotia abyssinica* (L. f.) Cass. - Navsari [46]
- *Gaillardia pulchella* Foug. - Anand [36]

4. *Coccinella septempunctata* Linnaeus, 1758
• *Aphis craccivora* Koch, 1854
- *Arachis hypogaea* L. - Junagarh [32], Kheda [47]
- *Cajanus cajan* (L.) Millsp. - Panchmahal [33]
- *Phaseolus vulgaris* L. - Vadodara [29]
- *Vigna unguiculata* (L.) Walp. - Vadodara [29]
• *Aphis gossypii* Glover, 1977
- *Abelmoschus esculentus* (L.) Moench - Kachchh [48]
- *Anethum graveolens* L. - Anand [38]
- *Coriandrum sativum* L. - Anand [38]
- *Cuminum cyminum* L. - Junagarh [39]
- *Gossypium herbaceum* L. - Anand [40]
- *Plantago ovata* Forssk. - Banaskantha [49]
- *Trachyspermum ammi* Sprague - Anand [38]
• *Brevicoryne brassicae* (Linnaeus, 1758)
- *Brassica oleracea* L. var. *capitata* - Anand [30]
• *Hyadaphis coriandri* (Das, 1918)
- *Anethum graveolens* L. - Anand [38]
- *Coriandrum sativum* L. - Anand [38], Junagarh [50]
- *Foeniculum vulgare* Mill. - Junagarh [41]
- *Trachyspermum ammi* Sprague - Anand [38]
• *Lipaphis erysimi* (Kaltenbach, 1843)
- *Brassica juncea* L. - Banaskantha [51, 52]
- *Brassica oleracea* L. var. *capitata* - Anand [30]
- *Brassica rapa* L. - Junagarh [50]
• *Myzus persicae* (Sulzer, 1776)
- *Brassica oleracea* L. var. *capitata* - Anand [30]
- *Brassica rapa* L. - Anand [30]
• *Schoutedenia emblica* (Patel & Kulkarni, 1952)
- *Phyllanthus emblica* L. - Anand [24]

5. *Coccinella transversalis* Fabricus, 1781
• *Aphis craccivora* Koch, 1854
- *Arachis hypogaea* L. - Junagarh [32]
- *Cajanus cajan* (L.) Millsp. - Panchmahal [33]
- *Lablab purpureus* (L.) Sweet - Anand [30]
- *Vicia faba* L. - Anand [53]
- *Vigna mungo* (L.) Hepper - Anand [30]
- *Vigna unguiculata* (L.) Walp. - Anand [30], Navsari [54]
• *Aphis gossypii* Glover, 1977
- *Cuminum cyminum* L. - Junagarh [39]
- *Gossypium hirsutum* L. - Anand [30, 53]
• *Aphis nerii* Boyer de Fonsc., 1841
- *Calotropis procera* (Aiton) Dryand. - Anand [53]
• *Hyadaphis coriandri* (Das, 1918)
- *Foeniculum vulgare* Mill. - Junagarh [41]
• *Lipaphis erysimi* (Kaltenbach, 1843)
- *Brassica juncea* L. - Anand [53], Navsari [54]
• *Myzus persicae* (Sulzer, 1776)
- Unknown plant - Navsari [54]
• *Uroleucon compositae* (Theobald, 1915)
- *Galardia* sp. - Anand [30]

6. *Harmonia axyridis* (Pallas, 1773)
• *Aphis craccivora* Koch, 1854
- *Phaseolus vulgaris* L. - Vadodara [29]

7. *Harmonia octomaculata* (Fabricius, 1781)
• *Acyrthosiphon pisum* (Harris, 1776)
- *Medicago sativa* L. - Navsari [55]
• *Aphis craccivora* Koch, 1854
- *Phaseolus vulgaris* L. - Vadodara [29]
- *Vigna mungo* (L.) Hepper - Anand [30]
- *Vigna unguiculata* (L.) Walp. - Anand [30], Vadodara [29]
• *Aphis gossypii* Glover, 1977
- *Gossypium hirsutum* L. - Anand [30]

8. *Hippodamia variegata* (Goeze, 1777)
• *Aphis craccivora* Koch, 1854
- *Arachis hypogaea* L. - Anand [56], Junagarh [32]
• *Aphis gossypii* Glover, 1977
- *Cuminum cyminum* L. - Junagarh [39]
- *Gossypium hirsutum* L. - Anand [30]
• *Hyadaphis coriandri* (Das, 1918)
- *Foeniculum vulgare* Mill. - Junagarh [41]

9. *Nephus ancyroides* Pang & Pu, 1988
• *Aphis craccivora* Koch, 1854
- *Arachis hypogaea* L. - Junagarh [32]

10. *Pharoscymnus flexibilis* (Mulsant, 1853)
• *Aphis gossypii* Glover, 1977
- *Gossypium hirsutum* L. - Anand [30]

11. *Propylea dissecta* (Mulsant, 1850)
• *Aphis craccivora* Koch, 1854
- *Lablab purpureus* (L.) Sweet - Anand [30]
- *Vigna mungo* (L.) Hepper - Anand [30]
- *Vigna unguiculata* (L.) Walp. - Anand [30]
• *Aphis gossypii* Glover, 1977
- *Gossypium hirsutum* L. - Anand [30]

12. *Propylea* sp.
• *Acyrthosiphon pisum* (Harris, 1776)
- *Medicago sativa* L. - Navsari [57]

13. *Scymnus coccivora* Ayyar, 1925
• *Aphis gossypii* Glover, 1977
- *Gossypium hirsutum* L. - Anand [30]

II. Order: Diptera
Members of two families of Diptera, Chamaemyiidae and Syrphidae, have been recorded as aphidophagous in Gujarat. A total of only 3 species of aphidophagous flies were recorded preying on 6 species of aphids infesting 8 species of plants, mostly agricultural crops, with 11 tri-trophic associations in Gujarat (Table 5). A detailed account of the aphidophagy of its families is given below.

Table 5: 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 Gujarat

Families/ Species of predators	Number of			
	Species of aphid	Species of host plant	Triplets	Districts
Chamaemyiidae				
Leucopis auraria	1	1	1	1
Syrphidae				
Eupeodes confrater	1	1	1	1
Ischiodon scutellaris	6	8	9	3
Total	6	8	11	3

a. Family: Chamaemyiidae

The family Chamaemyiidae (silver flies) includes small dipteran insects whose larvae are primarily aphidophagous and coccidophagous, making them important natural enemies of soft-bodied hemipteran pests. In contrast, the adults feed mainly on nectar, honeydew, and plant exudates, exhibiting feeding behaviour comparable to that of hoverflies [58]. In Gujarat, only one species, *Leucopis auraria* Tanasijtshuk, 1961 was recorded on *Aphis gossypii* infesting *Gossypium hirsutum* in Anand district [59].

b. Family: Syrphidae

Aphidophagous Syrphidae (hover flies) contribute to agroecosystems through dual ecological functions: larval predation and adult pollination. Larvae are efficient aphid predators that aid natural pest suppression, while adults feed on nectar and pollen, enhancing pollination services and supporting integrated pest management [6]. Their diversity and abundance also reflect habitat quality and ecosystem health. Recently, Singh [6] documented 49 aphidophagous syrphid species in 17 genera, associated with 94 aphid species on 149 host plants, forming 1,025 tritrophic linkages across 27 Indian states and union territories. In contrast, Gujarat currently accounts for only 2 syrphid species, *Eupeodes confrater* and *Ischiodon scutellaris*, documented as predators of 6 aphid species infesting 8 host plants, resulting in 9 tri-trophic associations (Table 5).

The following is the detailed account of the tri-trophic associations of aphidophagous hover flies in Gujarat:

1. *Eupeodes confrater* (Wiedemann, 1830)

• *Aphis craccivora* Koch, 1854
- Unknown plant - Anand [60]

2. *Ischiodon scutellaris* (Fabricius, 1805)

• *Aphis craccivora* Koch, 1854
- *Arachis hypogaea* L. - Kheda [47]
- *Vigna unguiculata* (L.) Walp. - Anand [61]
• *Aphis gossypii* Glover, 1977
- *Gossypium hirsutum* L. - Anand [61]
- *Plantago ovata* Forssk. - Banaskantha [49]
• *Brevicoryne brassicae* (Linnaeus, 1758)
- *Brassica oleracea* L. var. *capitata* - Anand [62]
• *Lipaphis erysimi* (Kaltenbach, 1843)
- *Brassica juncea* L. - Anand [61], Banaskantha [51]
- *Brassica oleracea* L. var. *capitata* - Anand [63]
• *Myzus persicae* (Sulzer, 1776)
- *Zea mays* L. - Anand [61]
• *Uroleucon compositae* (Theobald, 1915)
- *Carthamus tinctorius* L. - Anand [63]

c. Order: Neuroptera, Family: Chrysopidae (green lacewings)

The order Neuroptera, comprising lacewings, mantidflies, and antlions, is cosmopolitan and predominantly carnivorous, with many species preying on soft-bodied insects such as aphids. In India, aphidophagy has been reported from four families, Chrysopidae, Coniopterygidae, Dilaridae, and Hemerobiidae [5]. Among these, green and brown lacewings (Chrysopidae and Hemerobiidae) are key biological control agents in agroecosystems, as chrysopid larvae and both larvae and adults of hemerobiids are voracious aphid predators, although their roles remain less studied than those of syrphids and coccinellids [64].

The family Chrysopidae (green lacewings) includes highly effective aphid predators in agroecosystems. Larvae are voracious feeders on aphids and other soft-bodied pests, while adults subsist on nectar, pollen, and honeydew. Species such as *Chrysoperla carnea* and *Chrysoperla zastrowi sillemi* are widely used in integrated pest management [65]. In India, 24 aphidophagous chrysopid species in 10 genera are associated with 55 aphid species on 84 host plants [5], whereas in Gujarat, only four species are recorded, forming 16 tritrophic associations with nine aphid species on 14 host plants (Table 6).

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

Families/ Species of predators	Number of			
	Species of aphid	Species of host plant	Triplets	Districts
1. *Brinckochrysa scelestes*	1	1	1	1
2. *Chrysoperla zastrowi sillemi*	8	11	12	5
3. *Chrysoperla* sp.	2	2	2	2
4.*Mallada desjardinsi*	1	1	1	1
Total	9	14	16	7

The following is the detailed account of the tri-trophic associations of aphidophagous Chrysopidae in Gujarat:

1. *Brinckochrysa scelestes* (Banks, 1911)
• *Aphis gossypii* Glover, 1977
- *Abelmoschus esculentus* (L.) Moench - Kachchh [48]

2. *Chrysoperla zastrowi sillemi* (Esben -Petersen, 1935)
• *Aphis craccivora* Koch, 1854
- *Arachis hypogaea* L. - Kheda [47]
- *Vicia faba* L. - Anand [66]
• *Aphis gossypii* Glover, 1977
- *Gossipium barbadense* L. Nagpur [25]
- *Gossypium herbaceum* L. - Anand [40], Nagpur [25]
- *Gossypium hirsutum* L. - Navsari [67], Nagpur [25]
• *Aphis nerii* Boyer de Fonsc., 1841
- *Calotropis procera* (Aiton) Dryand. - Anand [66]
• *Brevicoryne brassicae* (Linnaeus, 1758)
- *Brassica oleracea* L. var. *capitata* - Anand [66, 68]
• *Hyadaphis coriandri* (Das, 1918)
- *Coriandrum sativum* L. - Anand [68]
• *Lipaphis erysimi* (Kaltenbach, 1843)
- *Brassica juncea* L. - Anand [66, 68]
• *Myzus persicae* (Sulzer, 1776)
- *Zea mays* L. - Navsari [67]
• *Rhopalosiphum maidis* (Fitch, 1856)
- *Zea mays* L. - Anand [68], Banaskantha [44]
• *Uroleucon compositae* (Theobald, 1915)
- *Carthamus tinctorius* L. - Anand [66]

3. *Chrysoperla* sp.
• *Aphis gossypii* Glover, 1977
- *Solanum melongena* L. - Surat [69]
• *Uroleucon compositae* (Theobald, 1915)
- *Guizotia abyssinica* (L. f.) Cass. - Navsari [46]

4. *Mallada desjardinsi* (Navás, 1911)
• *Aphis gossypii* Glover, 1977
- *Gossypium herbaceum* L. - Anand [40]

Conclusion

In conclusion, the present synthesis reveals that Gujarat supports a functionally important but presently under-documented assemblage of aphidophagous arthropods, comprising spiders, coccinellids, dipterans, and neuropterans, collectively forming a complex tri-trophic network with aphids and host plants. Coccinellidae and Araneae clearly dominate aphid suppression across major cropping systems, while dipteran and neuropteran predators remain poorly represented. The comparatively low taxonomic diversity and highly uneven district-wise records primarily reflect limited, crop-centric, and geographically biased surveys rather than true ecological impoverishment. The strong associations of predators with key aphid pests such as *Aphis craccivora* and *Aphis gossypii*, and with major crops like cotton and brassicas, underscore the biological control potential inherent in Gujarat's agroecosystems. Overall, this compilation provides a critical baseline for understanding predator-aphid-host plant relationships in the state and highlights the urgent need for systematic, statewide surveys encompassing non-crop habitats to fully elucidate predator diversity and strengthen region-specific integrated pest management strategies.

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