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REVIEW ARTICLE

An Upadated Checklist of Tri-trophic Associations of Arthropod Predators, Aphids, and Their Host Plants in Different Districts of Rajasthan, India

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ABSTRACT

The study documents 96 tri-trophic associations involving 20 predator species, 11 aphid species, and 35 host plants across 9 districts of Rajasthan. The network ranges from highly specialised to strongly polyphagous interactions. Coccinellidae dominated, with *Coccinella septempunctata* and *Cheilomenes sexmaculata* showing the highest ecological amplitude (21 triplets each). Syrphids exhibited moderate diversity, while hemipterans were limited, and Chrysoperla zastrowi sillemi represented the most important neuropteran predator. Among aphids, *Lipaphis erysimi* and *Brevicoryne brassicae* were the most widely exploited, whereas *Aphis nerii* and *Rhopalosiphum padi* were highly specialised. Cruciferous crops (*Brassica* spp.) formed the main centres of interaction, followed by *Coriandrum sativum* and *Zea mays*. Udaipur emerged as the main hotspot, while other districts showed moderate to low diversity. The limited distribution of records is primarily due to insufficient survey effort, along with ecological and agricultural factors. Overall, the results highlight a complex but underexplored tri-trophic network with strong implications for biological control.

Key Words: Aphid, biodiversity, conservation, hover flies, lacewings, ladybirds, predators, tri-trophic associations.

INTRODUCTION

Aphids (Hemiptera: Aphididae) are among the most important sap-feeding insect pests in agroecosystems, characterised by rapid reproduction, parthenogenetic life cycles, and the ability to form dense colonies on a wide range of host plants. Their feeding on phloem sap not only weakens plant vigour but also facilitates transmission of numerous plant viruses, thereby causing significant economic losses in agricultural and horticultural crops (Dixon, 1985; Blackman & Eastop, 2006; Singh & Singh, 2022). Globally, aphids are highly diverse and ecologically plastic, with their population dynamics strongly influenced by environmental factors such as temperature, humidity, and host plant quality (Dixon, 1998). In India, aphids infest a wide spectrum of crops, including cereals, oilseeds, vegetables, and pulses, making them key components of agroecosystem food webs (Singh *et al*., 2023a).

Aphids form the central link in complex tri-trophic interactions involving host plants (first trophic level), aphids as herbivores (second trophic level), and their natural enemies such as predators and parasitoids (third trophic level). These interactions are driven by both bottom-up forces (plant quality, nutrition, and stress) and top-down regulation by natural enemies. The aphid–predator–plant system has long been recognised as a model for studying multitrophic interactions, where plant nutritional status and environmental stress can significantly

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influence higher trophic levels (Mooney *et al*., 2012). For instance, drought stress in arid environments can enhance aphid performance while simultaneously reducing the efficiency and attraction of parasitoids/predators, thereby altering ecological balance and potentially leading to pest outbreaks (Rahman *et al.,* 2025). Such findings highlight the importance of studying aphids within a tritrophic framework rather than in isolation.

Regional documentation of tri-trophic relationships is essential, as species interactions vary with climate, vegetation, and land-use patterns. Differences in aphid composition and their natural enemies across agroecological zones reflect environmental gradients and host plant diversity, making region-specific data crucial for identifying dominant aphids, their host plants, and effective biological control agents. Such documentation provides fundamental insights into ecological complexity, biodiversity, and the organisation of natural control systems (Singh, 2025, 2026a, b; Singh & Omkar, 2025; Singh & Singh, 2026; Singh & Srivastav, 2025). These tri-trophic associations form dynamic networks that regulate herbivore populations and sustain ecosystem stability. Their regional assessment enhances understanding of faunal diversity and species interactions, while also supporting applied outcomes. Specifically, knowledge of aphidophagous predator assemblages, such as coccinellids, syrphids, chrysopids, and predatory hemipterans, facilitates the development of Integrated Pest Management strategies that reduce pesticide dependence and promote sustainable agriculture. Additionally, these predators serve as useful bioindicators for evaluating ecosystem health (Andersen, 1999; Iperti & Paoletti, 1999).

The dry desert regions of Rajasthan, particularly the Thar Desert and adjoining semi-arid zones, present unique ecological conditions for aphid population dynamics and their associated natural enemies. These regions are characterised by extreme temperatures, low rainfall, high evapotranspiration, and sparse vegetation, all of which influence insect survival, reproduction, and interactions. Studies from north-western Rajasthan have demonstrated that aphid populations in crops such as wheat, brassicas and coriander show strong seasonal fluctuations and are closely associated with their natural enemies, including coccinellids, syrphids, and parasitoids (Choudhary *et al*., 2025). In such harsh environments, abiotic stress factors often modify plant physiology, which in turn affects aphid biology and the efficiency of higher trophic levels, making tritrophic interactions particularly dynamic and context dependent.

From an ecological perspective, the aphid–host plant–predator system in desert environments is of considerable importance because it reflects how species interactions are modified under environmental stress. Limited moisture availability and high temperatures can alter plant physiology, affecting aphid growth and reproduction, which in turn influences predator performance and survival. These interactions provide valuable insights into community organisation, trophic dynamics, and adaptive strategies of insects in arid ecosystems (Schowalter, 2016). Moreover, the resilience and persistence of predator populations in such environments highlight their ecological significance in maintaining balance within agroecosystems. From an applied standpoint, understanding the relationships among aphids, their predators, and host plants in Rajasthan's dry regions is essential for developing sustainable pest management strategies. Conservation and augmentation of natural enemies offer an environmentally sound alternative to chemical control, particularly in fragile desert ecosystems where pesticide use can have long-lasting adverse effects. Therefore, detailed knowledge of species composition, seasonal dynamics, and interaction patterns is critical for enhancing biological control programmes and improving crop productivity in arid and semi-arid regions.

The preparation of tritrophic associations (host plant–aphid–predator) in Rajasthan is essential for understanding how pest populations are naturally regulated in arid agroecosystems. Aphids act as a key link between plants and their natural enemies, and studying these interactions helps reveal how plant quality and predator activity together influence aphid outbreaks. Such documentation is important for identifying major aphid pests, their host plants, and effective predators, along with their seasonal relationships. This information is crucial for developing biological control and integrated pest management strategies, particularly in desert regions where reducing pesticide use is important for ecological stability. Overall, tritrophic studies provide a holistic understanding of ecosystem functioning, supporting sustainable agriculture and conservation of beneficial insect diversity in Rajasthan.

MATERIALS & METHODS

Site of study

Rajasthan, located between 23.3–30.12° N and 69.30–78.17° E, is the largest state of India, covering 342,239 km². It is bordered by Punjab, Haryana, Uttar Pradesh, Madhya Pradesh, Gujarat, and Pakistan, and comprises 33 administrative districts. (Figure 1) The state's landscape is defined by the Thar Desert and the Aravalli Range, which divides it into arid western and relatively fertile eastern regions. Nearly 60% of Rajasthan lies in the Thar Desert, characterised by low rainfall (<400 mm), extreme temperatures, and sparse vegetation, with major districts including Jodhpur, Jaisalmer, Barmer, Bikaner, and Nagaur. In contrast, eastern and southeastern regions such as Mewar and the Kota–Bundi plateau are more fertile and better watered, with the Vagad region being the wettest and most forested. Agriculture is adapted to these climatic conditions. Irrigated and semi-arid areas produce wheat, mustard, cabbage, barley, gram,

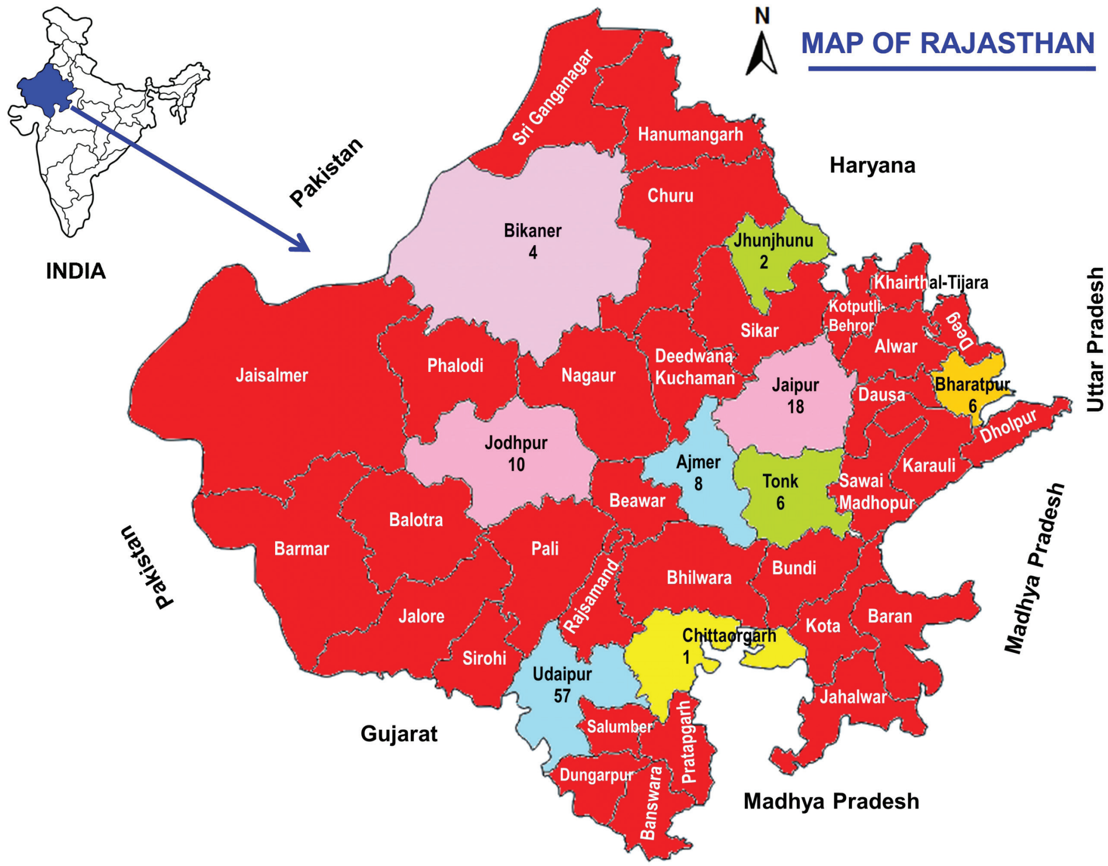

Figure 1: Number of tri-trophic associations of aphidophagous predators in different districts of Rajasthan. No record is available in red shaded districts.

and cotton, while arid zones grow drought-tolerant crops such as pearl millet (bajra), guar, moth bean, and sesame. Spices like cumin and coriander are also important. River systems such as the Banas and Chambal drain the eastern parts, while the Luni serves in the west. Despite its aridity, Rajasthan supports diverse ecosystems and protected areas, including Keoladeo National Park, Ranthambore National Park, Desert National Park, and Sariska Tiger Reserve.

This checklist of tri-trophic associations involving aphidiine parasitoids in Rajasthan has been systematically compiled from a wide range of authoritative sources, including recently published books, peer-reviewed journal articles, validated theses, and credible online databases available up to 30 April 2026. Earlier literature, as well as some more recent contributions, often exhibited taxonomic inconsistencies in the nomenclature of parasitoids, aphids, and their host plants. Such discrepancies largely reflect the rapid progress in taxonomic research and the historical reliance on outdated or incomplete reference frameworks. Given the continuous expansion of knowledge on trophic interactions, including frequent additions of new species records, revisions in classification, and updates in taxonomic status, it was essential to ensure a high level of accuracy and uniformity in the present synthesis. Accordingly, aphid nomenclature has been standardised using the Aphid Species File (https://aphid.speciesfile.org), host plant names have been verified following the World Flora Online (https://www.worldfloraonline.org), and the taxonomy of parasitoids has been validated through the Global Biodiversity Information Facility (https://www.gbif.org). This integrative approach ensures that the checklist reflects current taxonomic consensus and provides a reliable foundation for ecological and applied studies.

RESULTS & DISCUSSION

The history of surveys on aphidophagous predators forming tri-trophic associations in Rajasthan shows a progressive expansion from isolated early records to comprehensive, crop-based ecological studies. Early contributions by Pal (1974) and Joshi & Mathur (1965) documented initial associations of hemipteran and coccinellid predators on aphids infesting crops such as tomato and lucerne in Jodhpur and Bharatpur. This was followed by the work of Sharma (1973), who reported multiple predator–aphid–plant associations from Udaipur, particularly involving *Cheilomenes sexmaculata* on legumes, cereals, and crucifers, marking the beginning of systematic studies. Subsequent records during the 1980s and early 2000s, notably by Gupta & Yadav (1989) and Lekha & Jat (2002), expanded the scope to spice and vegetable crops, including cumin and coriander. From the late 2000s onward, studies by Dhaka & Pareek (2007) and Swami and Bajpai (2009) emphasised cotton, mustard, and cereal ecosystems, documenting diverse predator assemblages. A major increase in records occurred during the 2010s, with studies such as Lal *et al.* (2014) and Jat *et al.* (2017), which highlighted extensive associations of coccinellids, syrphids, and chrysopids on cruciferous crops in Udaipur and Jaipur. Recent studies, including those by Ola *et al.* (2024) documented predator associations on *Plantago ovata* in Jodhpur, while Sarsaiya & Singh (2025) reported *Coccinella septempunctata* and *Chrysoperla zastrowi sillemi* on *Aphis gossypii* infesting *Abelmoschus esculentus* in Ajmer. Additional recent works have also recorded new district-level occurrences and expanded host ranges, particularly in crops such as *Vigna unguiculata*, *Brassica rapa*, and *Zea mays*.

The data displayed in Table 1 reveal a diverse network of tri-trophic associations among aphids, their predators, and host plants across different districts of Rajasthan. A total of 20 predator species, belonging to four orders, Coleoptera, Diptera, Hemiptera, and Neuroptera, were recorded. These predators collectively exploited 11 aphid species, infesting 35 host plant species, forming 96 tri-trophic associations (triplets) distributed across only 9 out of 41 districts of Rajasthan. The interaction network exhibited marked variation in trophic breadth, ranging from highly specialised associations (single aphid–single host plant–single triplet) to strongly polyphagous relationships involving up to nine aphid species, seventeen host plants, and twenty-one triplets.

Among predators, Coleoptera, particularly the family Coccinellidae (ladybirds), constituted the most dominant group in terms of both diversity and number of interactions. *Coccinella septempunctata* recorded the highest ecological amplitude, being associated with 9 aphid species on 17 host plants, forming 21 triplets across 9 out of 41 districts. Similarly, *Cheilomenes sexmaculata* exhibited extensive polyphagy, with 8 aphid species, 16 host plants, and 21 triplets across 6 districts. Other coccinellids, such as *Hippodamia variegata* and *Brumoides suturalis,* showed moderate levels of association, whereas *Micraspis discolor*, *Coccinella transversalis*, and *Scymnus* sp. were relatively restricted.

Table 1: Number of species of predators preying on different number of aphid species infesting different number of host plant species and triplets in Rajasthan.

Order/Family	Species of the predators	Number of			
		Aphid species	**Plant species**	**Triplets**	**Districts**
Order: Coleoptera					
Carabidae	*1.* *Chlaenius aspericollis*	1	1	1	1
Coccinellidae	*2.* *Brumoides suturalis*	4	5	5	4
	3. *Cheilomenes sexmaculata*	8	16	21	6
	4. *Coccinella septempunctata*	9	17	21	9
	5. *Coccinella transversalis*	2	2	3	2
	6. *Hippodamia variegata*	5	6	9	5
	7. *Micraspis discolor*	3	1	3	1
	8. *Scymnus* sp.	1	1	1	1
Staphylinidae	*9.* *Paederus fuscipes*	1	1	1	1
Order: Diptera					
Syrphidae	*10.* *Betasyrphus serarius*	1	1	1	1
	11. *Episyrphus balteatus*	2	1	2	1
	12. *Episyrphus* sp.	1	1	1	1
	13. *Ischiodon scutellaris*	4	3	4	2
	14. *Ischiodon* sp.	5	3	5	1
	15. *Syrphus* sp.	3	1	3	1
	16. *Xanthogramma* sp.	1	1	1	1
Order: Hemiptera					
Geocoridae	*17.* *Geocoris jucundus*	2	2	2	1
	18. *Geocoris* sp.	1	1	1	1
Order: Neuroptera					
Chrysopidae	*19.* *Chrysoperla zastrowi sillemi*	6	9	9	4
	20. *Chrysoperla* sp.	2	2	2	2
Total		**11**	**35**	**96**	**9**

The non-coccinellid coleopterans, *Chlaenius aspericollis* and *Paederus fuscipes*, were highly specialised, each forming a single triplet (Table 1). Several species of ladybirds have been utilised in the biological control of aphids worldwide (Kumar & Omkar, 2023, 2025).

Predatory Syrphidae (hover flies) have long been recognised as effective biological control agents against aphids (Rodriguez-Gasol *et al*., 2020). In India, 49 species of aphidophagous hover flies are recorded feeding on 94 species of aphids, utilising 149 food plants (Singh, 2026c). However, in Rajasthan, only 7 species were recorded with *Ischiodon* spp. showing comparatively broader host ranges (up to 5 aphid species), while *Episyrphus*, *Syrphus*, and *Xanthogramma* spp. were largely confined to crucifer-associated aphids.

Though a total of 29 species of Hemiptera are aphidophagous in India, belonging to 6 families (Singh & Srivastav, 2024), in Rajasthan, only a single family, Geocoridae, is represented, with *Geocoris jucundus* forming two triplets and *Geocoris* sp. a single triplet.

The importance of Neuroptera (lacewings) as predators of aphids has been overshadowed by greater attention paid to more abundant aphid predators like hover flies and ladybird beetles (Bakthavatsalam & Varshney, 2023). In India, a total of 32 species of lacewings are recorded aphidophagous, belonging to 4 families, Chrysopidae being the largest one, preying on 68 species of aphids infesting 107 species of plants (Singh *et al*., 2024). In Rajasthan, particularly *Chrysoperla zastrowi sillemi*, displayed substantial ecological breadth, associated with 6 aphid species on 9 host plants, forming 9 triplets across 4 districts. (Table 1)

A considerable variation was observed in predator exploitation and host plant range. *Lipaphis erysimi* and *Brevicoryne brassicae* were the most widely exploited species, each associated with 10 predator species, forming 20 and 13 triplets, respectively. *Myzus persicae* (9 predators, 16 triplets) and *Hyadaphis coriandri* (8 predators, 8 triplets) also showed high connectivity, while *Aphis gossypii* and *Rhopalosiphum maidis* were moderately represented. In contrast, *Aphis nerii* and *Rhopalosiphum padi* exhibited strict specialisation with single triplet records. (Table 2)

Host plant-wise, cruciferous crops formed the principal centres of interaction. *Brassica oleracea* var. *botrytis* supported the highest number of associations (19 triplets), followed by var. *capitata* (14 triplets) and *Brassica juncea* (7 triplets). Among non-cruciferous plants, *Coriandrum sativum* and *Zea may also support* relatively high interaction diversity (7 triplets each), whereas most other plants were associated with fewer and more specialised interactions. (Table 3)

Spatially, the distribution of these interactions was highly uneven, with Udaipur district emerging as the principal hotspot, supporting the maximum number of predators, aphids, host plants, and triplets. This was followed by Jaipur, Jodhpur, Bharatpur, Ajmer, and Tonk, which exhibited moderate diversity linked to specific cropping systems such as crucifers, legumes, and spices. In contrast, Bikaner, Jhunjhunu, and Chittorgarh showed relatively fewer and more specialised associations. (Figure 1)

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 Rajasthan.

Aphid species	Number of			
	Predator species	Host plant species	Trip-lets	Dis-tricts
1. Acyrthosiphon pisum	1	2	2	2
2. Aphis craccivora	5	5	11	2
3. Aphis gossypii	7	5	15	4
4. Aphis nerii	1	1	1	1
5. Bevicoryne brassicae	10	2	13	1
6. Hyadaphis coriandri	8	2	8	4
7. Lipaphis erysimi	10	4	20	4
8. Myzus persicae	9	3	16	3
9. Rhopalosiphum maidis	7	3	7	2
10. Rhopalosiphun padi	1	1	1	1
11. Therioaphis trifolii	2	1	2	2
Total	20	35	96	9

Overall, the tri-trophic assemblage documented from Rajasthan reflects a comparatively lower level of taxonomic richness, even though it encompasses representatives of multiple functional guilds of aphidophagous predators. When viewed in a broader biogeographic context, this diversity appears substantially reduced relative to that reported from several northern states and union territories. For instance, Uttar Pradesh supports an extensive network comprising 1,098 tri-trophic associations involving 70 predator species (Singh, 2025a, b), while Uttarakhand exhibits even greater predator diversity with 135 species forming 760 associations (Singh & Srivastav, 2025). Similarly, Jammu & Kashmir (716 associations, 71 predator species; Singh *et al*., 2025), West Bengal (612 associations, 125 predator species; Singh & Shukla, 2026a), and Himachal Pradesh (354 associations, 87 predator species; Singh & Shukla, 2026b) all demonstrate comparatively richer and more complex tri-trophic networks. Thus, despite the presence of multiple predator guilds, the

Table 3: Number of species of plants infested by different numbers of aphid species consumed by different numbers of predator species along with tri-trophic associations (triplets) in different number of districts in Rajasthan.

Plant species	Number of: Aphid species	Predator species	Triplets	Districts
1. *Abelmoschus esculentus*	1	2	2	1
2. *Arachis hypogaea*	1	2	2	1
3. *Brassica juncea*	1	7	7	3
4. *Brassica oleracea* var. *botrytis*	3	7	19	1
5. *Brassica oleracea* var. *capitata*	3	7	14	2
6. *Brassica rapa*	1	3	3	4
7. *Calotropis procera*	1	1	1	1
8. *Cenchrus americanus*	1	1	1	1
9. *Coriandrum sativum*	1	7	7	4
10. *Cuminum cyminum*	1	4	4	2
11. *Foeniculum vulgare*	1	1	1	1
12. *Gossypium hirsutum*	1	6	6	2
13. *Hordeum vulgare*	1	2	2	2
14. *Lablab purpureus*	1	1	1	2
15. *Medicago sativa*	1	2	2	2
16. *Plantago ovata*	1	3	3	1
17. *Solanum lycopersicum*	1	1	1	1
18. *Solanum melongena*	1	2	2	1
19. *Trigonella foenum-graecum*	1	2	2	2
20. *Triticum aestivum*	1	1	1	1
21. *Vigna mungo*	1	4	4	1
22. *Vigna radiata*	1	1	1	1
23. *Vigna unguiculata*	1	3	3	2
24. *Zea mays*	1	7	7	1
Total	11	20	96	9

overall structure of the tri-trophic system in Rajasthan remains relatively less diverse and less intricate than those documented from northern regions.

A major and most decisive factor is the lack of survey effort. As evident from Figure 1, there is no record of aphidophagous predators in 32 districts. This indicates that the apparent restriction of tri-trophic associations to only 9 districts is largely an artefact of incomplete sampling. Many districts likely harbour rich aphid–plant–predator networks that remain undocumented due to the absence of systematic faunistic surveys.

Among the surveyed districts, variation in habitat diversity plays a key role. Districts such as Udaipur (57 associations) and Jaipur (18) are ecologically more heterogeneous, with diverse vegetation and cropping systems that support a wider range of aphids and their natural enemies. In contrast, districts like Chittorgarh and Jhunjhunu, with very low counts, may have relatively limited host plant diversity or fewer recorded aphid infestations, thereby constraining the formation of tri-trophic linkages.

Climatic harshness, particularly in arid and semi-arid environments, has been shown to significantly reduce trophic complexity, as extreme temperatures, low precipitation, and sparse vegetation constrain aphid population growth and the associated abundance of natural enemies. Studies indicate that aphid dynamics are strongly influenced by water availability and vegetation cover, with reduced resources in arid habitats leading to lower population densities and altered community structure (Andrade *et al.,* 2017). Recent experimental evidence further demonstrates that water stress and drought conditions directly impair aphid performance, reducing survival, reproduction, and population buildup, thereby limiting the resource base available to predators (Kansman *et al*., 2022). Additionally, drought-induced changes in plant physiology can disrupt multi-trophic interactions, weakening both bottom-up (plant–aphid) and top-down (predator/parasitoid) regulatory mechanisms in agroecosystems (Rahman *et al.,* 2025). Moreover, landscape-level studies from arid ecosystems reveal that sparse vegetation and low host density in such environments significantly reduce the abundance and effectiveness of natural enemies, thereby weakening biological control and overall trophic connectivity (Liu *et al*., 2026). Collectively, these findings support the conclusion that climatic harshness in arid and semi-arid regions constrains aphid populations and their associated predator diversity, resulting in simplified and less detectable tri-trophic associations.

Another important factor influencing tri-trophic structure is the feeding range (diet breadth) of predators. Predator assemblages dominated by species with narrow prey and host plant ranges typically generate fewer distinct tri-trophic linkages, as ecological specialisation restricts resource use to a limited set of hosts and habitats. In contrast, generalist predators, by exploiting a wider spectrum of prey, contribute disproportionately to multiple associations and enhance connectivity within food webs (Straub *et al*., 2008; Krey *et al*., 2021). Agricultural practices strongly influence tri-trophic interactions, particularly through intensification, monoculture, and pesticide use. Recent studies show that modern intensive agriculture, characterised by agrochemical inputs and monocropping, negatively affects biodiversity and disrupts ecological interactions within agroecosystems (Michalko *et al*., 2024; Pratissoli, 2025). Additionally, reduced habitat heterogeneity in monocultures limits resources for natural enemies, further weakening trophic complexity (Landis *et al*., 2000). Finally, temporal limitations in sampling may lead to an underestimation of interaction diversity. Aphid populations and their predators exhibit strong seasonal dynamics, and surveys conducted over limited time periods may fail to capture peak abundance and the full extent of tri-trophic associations (Winder *et al*., 2005).

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

A. Order: Coleoptera

a. Family: Carabidae

1. *Chlaenius aspericollis* Bates, 1873

- ***Aphis craccivora* Koch, 1854**
  - *Vigna mungo* (L.) Hepper - Udaipur (Jat & Rana, 2018)

b. Family: Coccinellidae

1. *Brumoides suturalis* (Fabricius, 1798)

- ***Aphis gossypii* Glover, 1877**
  - *Gossypium hirsutum* L. - Tonk (Dhaka & Pareek, 2007; Dhaka, 2013)
  - *Plantago ovata* Forssk. - Jodhpur (Ola *et al.,* 2024)
- ***Hyadaphis coriandri* (Das, 1918)**
  - *Coriandrum sativum* L. - Ajmer (Kant *et al*., 2019)
- ***Myzus persicae* (Sulzer, 1776)**
  - *Cuminum cyminum* L. - Jodhpur (Gupta & Yadav, 1989a)
- ***Rhopalosiphum maidis* (Fitch, 1856)**
  - *Zea mays* L. - Udaipur (Swami & Bajpai, 2009; Swaminathan *et al*., 2015)

2. *Cheilomenes sexmaculata* (Fabricius, 1781)

- ***Aphis craccivora* Koch, 1854**
  - *Lablab purpureus* (L.) Sweet - Jaipur (Choudhary *et al*., 2020); Udaipur (Sharma, 1973)
  - *Vigna mungo* (L.) Hepper - Udaipur (Jat & Rana, 2018)
  - *Vigna radiata* (L.) R. Wilczek - Udaipur (Jat *et al*., 2018)
  - *Vigna unguiculata* (L.) Walp. - Udaipur (Chhangani *et al*., 2022)
- ***Aphis gossypii* Glover, 1877**
  - *Gossypium hirsutum* L. - Tonk (Dhaka & Pareek, 2007; Dhaka, 2013)
  - *Plantago ovata* Forssk. - Jodhpur (Ola *et al.*, 2024)
  - *Solanum melongena* L. - Udaipur (Sharma, 1973)
- ***Brevicoryne brassicae* (Linnaeus, 1758)**
  - *Brassica oleracea* L. var. *botrytis* - Udaipur (Sharma, 1973; Jat *et al.*, 2017; Saranya *et al.*, 2022)
  - *Brassica oleracea* L. var. *capitata* - Udaipur (Lal *et al.*, 2014)
- ***Hyadaphis coriandri* (Das, 1918)**
  - *Coriandrum sativum* L. - Jaipur (Swami *et al*., 2018; Dalal *et al*., 2024); Udaipur (Meena *et al.*, 2009)
- ***Lipaphis erysimi* (Kaltenbach, 1843)**
  - *Brassica juncea* (L.) Czern - Jaipur (Mishra & Kanwat, 2018)
  - *Brassica juncea* (L.) Czern. - Bharatpur (Singh *et al*., 2009)
  - *Brassica oleracea* L. var. *botrytis* - Udaipur (Saranya *et al.*, 2022)
  - *Brassica oleracea* L. var. *capitata* - Udaipur (Jat *et al.*, 2021)
  - *Brassica rapa* L. - Bharatpur (Singh *et al.*, 2009); Jhunjhunu (Chaudhari *et al*., 2022a); Udaipur (Sharma, 1973)
- ***Myzus persicae* (Sulzer, 1776)**
  - *Brassica oleracea* L. var. *botrytis* - Udaipur (Saranya *et al*., 2022)
  - *Brassica oleracea* L. var. *capitata* - Udaipur (Lal *et al*., 2014)
  - *Cuminum cyminum* L. - Jodhpur (Gupta & Yadav, 1989a)
- ***Rhopalosiphum maidis* (Fitch, 1856)**
  - *Cenchrus americanus* (L.) Morrone - Udaipur (Sharma, 1973)
  - *Zea mays* L. - Udaipur (Swami & Bajpai, 2009; Swaminathan *et al*., 2015)
- ***Therioaphis trifolii* (Monell, 1882)**
  - *Medicago sativa* L. - Bharatpur (Joshi & Mathur, 1965)

3. ***Coccinella septempunctata* Linnaeus, 1758**
   - ***Acyrthosiphon pisum* (Harris, 1776)**
     - *Trigonella foenum-graecum* L. - Bikaner (Naga *et al*., 2015); Jodhpur (Meena *et al*., 2002)
   - ***Aphis craccivora* Koch, 1854**
     - *Arachis hypogaea* L. - Jaipur (Gocher & Ahmad, 2019; Priyanka *et al*., 2022)
     - *Vigna mungo* (L.) Hepper - Udaipur (Jat & Rana, 2018)
     - *Vigna unguiculata* (L.) Walp. - Jaipur (Choudhary *et al*., 2021; Yadav *et al*., 2025); Udaipur (Chhangani *et al*., 2022)
   - ***Aphis gossypii* Glover, 1877**
     - *Abelmoschus esculentus* (L.) Moench - Ajmer (Sarsaiya & Singh, 2025)
     - *Gossypium hirsutum* L. - Tonk (Dhaka & Pareek, 2007; Dhaka, 2013)
     - *Plantago ovata* Forssk. - Jodhpur (Ola *et al.,* 2024)
     - *Solanum melongena* L. - Udaipur (Kumar *et al*, 2018)
   - ***Brevicoryne brassicae* (Linnaeus, 1758)**
     - *Brassica oleracea* L. var. *botrytis* - Udaipur (Saranya *et al*., 2022)
     - *Brassica oleracea* L. var. *capitata* - Udaipur (Lal *et al*., 2014; Jat *et al*., 2017)
   - ***Hyadaphis coriandri* (Das, 1918)**
     - *Coriandrum sativum* L. - Ajmer (Kant *et al*., 2019); Bikaner (Kumar, 2023); Jaipur (Lekha & Jat, 2002; Pareek *et al*., 2014; Dalal *et al*., 2024); Udaipur (Meena et al., 2009)
     - *Foeniculum vulgare* Mill. - Jaipur (Kumari *et al*., 2023)
   - ***Lipaphis erysimi* (Kaltenbach, 1843)**
     - *Brassica juncea* (L.) Czern - Jaipur (Mishra & Kanwat, 2017; Chand et al., 2022; Dotasara *et al*., 2022; Yadav *et al*., 2023; Arvind *et al*., 2024); Bharatpur (Singh *et al*., 2009; Singh *et al.,* 2011)
     - *Brassica oleracea* L. var. *botrytis* - Udaipur (Saranya *et al.*, 2022)
     - *Brassica oleracea* L. var. *capitata* - Jaipur (Bana *et al.*, 2012; Choudhary *et al.*, 2023); Udaipur (Jat *et al.,* 2021)
     - *Brassica rapa* L. - Bharatpur (Singh *et al.*, 2009; Singh & Meghwal, 2010); Jaipur (Gour & Pareek, 2003); Jhunjhunu (Chaudhari *et al*., 2022a)
   - ***Myzus persicae* (Sulzer, 1776)**
     - *Brassica oleracea* L. var. *botrytis* - Udaipur (Saranya *et al*., 2022)
     - *Brassica oleracea* L. var. *capitata* - Udaipur (Lal *et al*., 2014)
     - *Cuminum cyminum* L. - Bikaner (Yadav *et al.*, 2018); Jodhpur (Gupta & Yadav, 1989b)
   - ***Rhopalosiphum maidis* (Fitch, 1856)**
     - *Hordeum vulgare* L. - Jaipur (Choudhary *et al*., 2022b)
     - *Zea mays* L. - Udaipur (Swami & Bajpai, 2009; Swaminathan *et al*., 2015; Singh *et al*., 2023b)
   - ***Rhopalosiphun padi***
     - *Triticum aestivum* - Chittorgarh (Bhati & Upadhyay, 2022)
4. ***Coccinella transversalis* Fabricus, 1781**
   - ***Brevicoryne brassicae* (Linnaeus, 1758)**
     - *Brassica oleracea* L. var. *botrytis* - Udaipur (Saranya *et al*., 2022)
   - ***Lipaphis erysimi* (Kaltenbach, 1843)**
     - *Brassica juncea* (L.) Czern - Jaipur (Mishra & Kanwat, 2017; Mishra & Kanwat, 2018)
     - *Brassica oleracea* L. var. *botrytis* - Udaipur (Saranya *et al.*, 2022)
5. ***Hippodamia variegata* (Goeze, 1777)**
   - ***Aphis gossypii* Glover, 1877**
     - *Gossypium hirsutum* L. - Tonk (Dhaka & Pareek, 2007; Dhaka, 2013)
   - ***Brevicoryne brassicae* (Linnaeus, 1758)**
     - *Brassica oleracea* L. var. *botrytis* - Udaipur (Saranya *et al.*, 2022)
     - *Brassica oleracea* L. var. *capitata* - Udaipur (Lal *et al*., 2014)
   - ***Hyadaphis coriandri* (Das, 1918)**
     - *Coriandrum sativum* L. - Ajmer (Kant *et al.*, 2019); Jaipur (Pareek *et al.*, 2013)
   - ***Lipaphis erysimi* (Kaltenbach, 1843)**
     - *Brassica juncea* (L.) Czern - Jaipur (Mishra & Kanwat, 2017)
     - *Brassica oleracea* L. var. *botrytis* - Udaipur (Saranya *et al*., 2022)
   - ***Myzus persicae* (Sulzer, 1776)**
     - *Brassica oleracea* L. var. *botrytis* - Udaipur (Saranya *et al*., 2022)
     - *Brassica oleracea* L. var. *capitata* - Udaipur (Lal *et al*., 2014)

- *Cuminum cyminum* L. - Jodhpur (Gupta & Yadav, 1989a)

6. ***Micraspis discolor* (Fabricius, 1798)**
   - ***Brevicoryne brassicae* (Linnaeus, 1758)**
     - *Brassica oleracea* L. var. *botrytis* - Udaipur (Saranya *et al*., 2022)
   - ***Lipaphis erysimi* (Kaltenbach, 1843)**
     - *Brassica oleracea* L. var. *botrytis* - Udaipur (Saranya *et al*., 2022)
   - ***Myzus persicae* (Sulzer, 1776)**
     - *Brassica oleracea* L. var. *botrytis* - Udaipur (Saranya *et al*., 2022)
7. ***Scymnus* sp.**
   - ***Hyadaphis coriandri* (Das, 1918)**
     - *Coriandrum sativum* L. - Ajmer (Kant *et al*., 2019)

c. Family: Staphylinidae

1. ***Paederus fuscipes* Curtis, 1826**
   - ***Rhopalosiphum maidis* (Fitch, 1856)**
     - *Zea mays* L. - Udaipur (Swaminathan *et al*., 2015)

B. Order: Diptera, Family: Syrphidae

1. ***Betasyrphus serarius* (Wiedemann, 1830)**
   - ***Aphis gossypii* Glover, 1877**
     - *Gossypium hirsutum* L. - Tonk (Dhaka & Pareek, 2007; Dhaka, 2013)
2. ***Episyrphus balteatus* (De Geer, 1779)**
   - ***Brevicoryne brassicae* (Linnaeus, 1758)**
     - *Brassica oleracea* L. var. *capitata* - Udaipur (Lal *et al*., 2014)
   - ***Myzus persicae* (Sulzer, 1776)**
     - *Brassica oleracea* L. var. *capitata* - Udaipur (Lal *et al*., 2014)
3. ***Episyrphus* sp.**
   - ***Hyadaphis coriandri* (Das, 1918)**
     - *Coriandrum sativum* L. - Ajmer (Kant *et al*., 2019)
4. ***Ischiodon scutellaris* (Fabricius, 1805)**
   - ***Aphis craccivora* Koch, 1854**
     - *Arachis hypogaea* L. - Jaipur (Priyanka *et al*., 2022)
   - ***Brevicoryne brassicae* (Linnaeus, 1758)**
     - *Brassica oleracea* L. var. *capitata* - Udaipur (Lal *et al*., 2014)
   - ***Lipaphis erysimi* (Kaltenbach, 1843)**
     - *Brassica juncea* (L.) Czern - Jaipur (Mishra & Kanwat, 2017; Chand *et al*., 2022; Arvind *et al*., 2025)
   - ***Myzus persicae* (Sulzer, 1776)**
     - *Brassica oleracea* L. var. *capitata* - Udaipur (Lal *et al*., 2014)
5. ***Ischiodon* sp.**
   - ***Aphis craccivora* Koch, 1854**
     - *Vigna mungo* (L.) Hepper - Udaipur (Jat & Rana, 2018)
   - ***Brevicoryne brassicae* (Linnaeus, 1758)**
     - *Brassica oleracea* L. var. *botrytis* - Udaipur (Saranya *et al*., 2022)
   - ***Lipaphis erysimi* (Kaltenbach, 1843)**
     - *Brassica oleracea* L. var. *botrytis* - Udaipur (Saranya *et al*., 2022)
   - ***Myzus persicae* (Sulzer, 1776)**
     - *Brassica oleracea* L. var. *botrytis* - Udaipur (Saranya *et al*., 2022)
   - ***Rhopalosiphum maidis* (Fitch, 1856)**
     - *Zea mays* L. - Udaipur (Swaminathan *et al*., 2015)
6. ***Syrphus* spp.**
   - ***Brevicoryne brassicae* (Linnaeus, 1758)**
     - *Brassica oleracea* L. var. *botrytis* - Udaipur (Saranya *et al*., 2022)
   - ***Lipaphis erysimi* (Kaltenbach, 1843)**
     - *Brassica oleracea* L. var. *botrytis* - Udaipur (Saranya *et al*., 2022)
   - ***Myzus persicae* (Sulzer, 1776)**
     - *Brassica oleracea* L. var. *botrytis* - Udaipur (Saranya *et al*., 2022)
7. ***Xanthogramma* sp.**
   - ***Lipaphis erysimi* (Kaltenbach, 1843)**
     - *Brassica oleracea* L. var. *capitata* - Jaipur (Choudhary *et al.*, 2023)

C. Order: Hemiptera, Family: Geocoridae

1. ***Geocoris jucundus* (Fieber, 1861)**
   - ***Aphis gossypii* Glover, 1877**
     - *Solanum lycopersicum* L. - Jodhpur (Pal, 1974)
   - ***Therioaphis trifolii* (Monell, 1882)**
     - *Medicago sativa* L. - Jodhpur (Pal, 1974)
2. ***Geocoris* sp.**
   - ***Rhopalosiphum maidis* (Fitch, 1856)**
     - *Zea mays* L. - Udaipur (Swaminathan *et al.*, 2015)

D. Order: Neuroptera, Family: Chrysopidae

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

- ***Aphis craccivora* Koch, 1854**
  - *Vigna unguiculata* (L.) Walp. - Udaipur (Naruka & Ameta, 2015)
- ***Aphis gossypii* Glover, 1877**
  - *Abelmoschus esculentus* (L.) Moench - Ajmer (Sarsaiya & Singh, 2025)
  - *Gossypium hirsutum* L. - Tonk (Dhaka & Pareek, 2007; Dhaka, 2013); Udaipur (Naruka & Ameta, 2015)
- ***Aphis nerii* Boyer de Fonsc., 1841**
  - *Calotropis procera* (Aiton) Dryand. - Udaipur (Naruka & Ameta, 2015)
- ***Hyadaphis coriandri* (Das, 1918)**
  - *Coriandrum sativum* L. - Ajmer (Kant *et al*., 2019)
- ***Lipaphis erysimi* (Kaltenbach, 1843)**
  - *Brassica juncea* (L.) Czern. - Bharatpur (Singh *et al*., 2009); Udaipur (Naruka & Ameta, 2015)
  - *Brassica rapa* L. - Bharatpur (Singh *et al*., 2009)
- ***Rhopalosiphum maidis* (Fitch, 1856)**
  - *Hordeum vulgare* L. - Udaipur (Naruka & Ameta, 2015)
  - *Zea mays* L. - Udaipur (Singh *et al*., 2023b)

2. ***Chrysoperla* sp.**
- ***Acyrthosiphon pisum* (Harris, 1776)**
  - *Trigonella foenum-graecum* L. - Bikaner (Naga *et al*., 2015)
- ***Brevicoryne brassicae* (Linnaeus, 1758)**
  - *Brassica oleracea* L. var. *capitata* - Udaipur (Jat *et al*., 2017)

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